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TATAURANGA AOTEAROA

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Productivity Statistics: 1978–2009

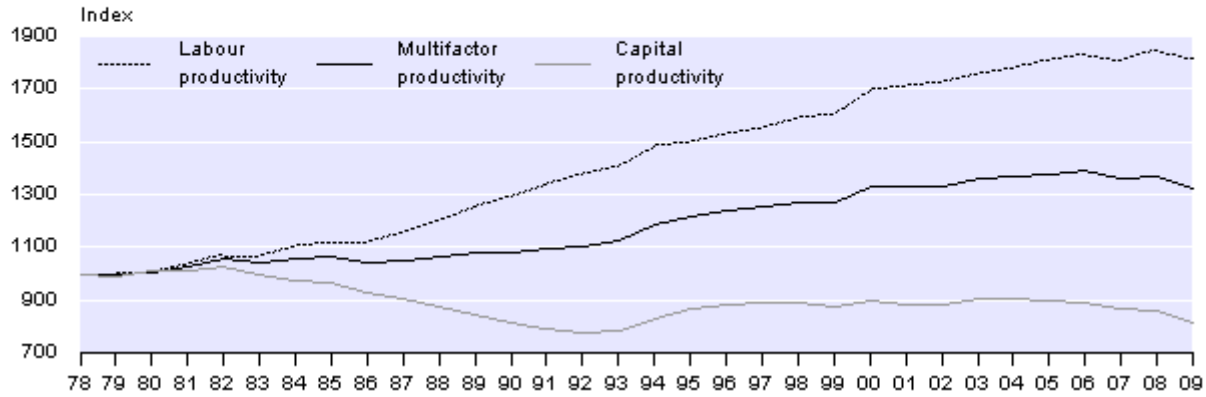
Highlights

- Average annual labour productivity fell 0.3 percent over the 2006–09 period, compared with annual growth of 1.9 percent from 1978–2009.
- Average annual capital productivity fell 3.1 percent over the 2006–09 period, compared with an annual fall of 0.7 percent from 1978–2009.
- Average annual multifactor productivity fell 1.5 percent over the 2006–09 period, compared with annual growth of 0.9 percent from 1978-2009.
- After accounting for differences in the skill composition of workers, labour productivity fell 0.3 percent annually over the 2006–09 period compared with annual growth of 1.0 percent from 1998–2009.

Measured Sector Productivity Indexes

Year ended March, 1978–2009

Base: 1978 (=1000)



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Commentary

Productivity is a measure of how efficiently inputs are being used within the economy to produce outputs. Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input. Growth in productivity means that a nation can produce more output from the same amount of input. Productivity growth is an important contributing factor to a nation's long-term material standard of living.

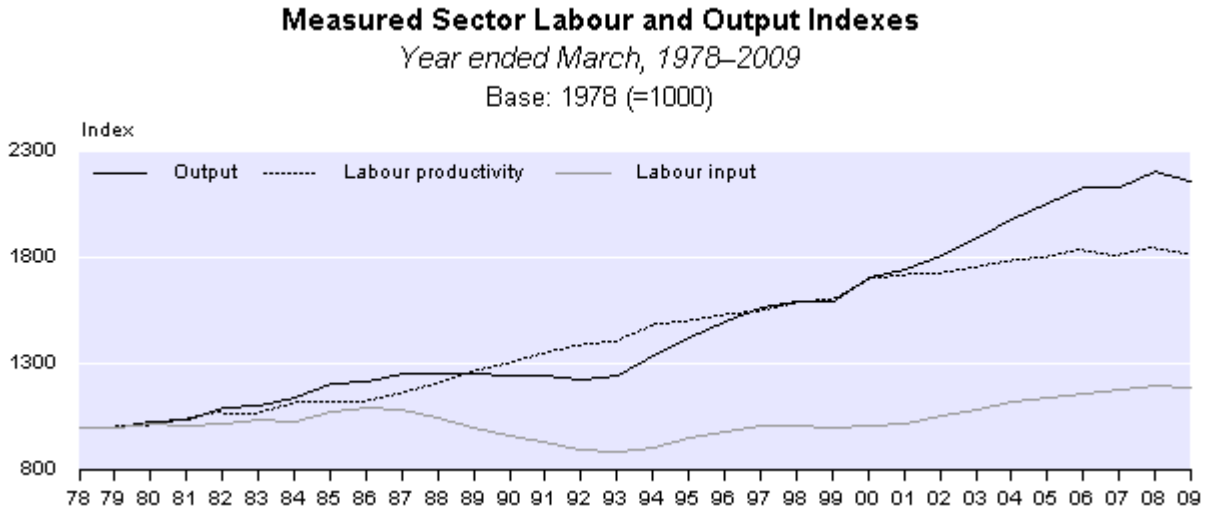
Annual productivity series for the measured sector from 1978–2009 have been released in this publication. In 2007, the latest year for which current price industry value added data are available, the measured sector covered approximately 74 percent of the economy. It excludes the following industries: government administration and defence, health, education, ownership of owner-occupied dwellings, and property services. From 1996 onwards, business services, and personal and other community services are included in the measured sector. See 'Industry coverage – the measured sector' in 'Technical notes' for more detail on the coverage of the measured sector and former measured sector.

The additional tables 1.1–1.8 include data for the former measured sector from 1978–2009. This data maintains comparability with the previously released time series. The former measured sector is the most appropriate sector for comparing with Australian productivity data, which has recently transferred to a new industry classification system. See the 'Comparison with Australia' section for further detail.

Productivity estimates are presented on an annual basis and across business cycles. A business cycle is defined as 'peak to peak'. Estimating growth over business cycles is preferable as it accounts for changes in capacity utilisation rates over the period of a business cycle. New to this release is the identification of 2006 as a peak, which means 2000–06 is a complete cycle. Please note that the latest period (2006–09) is not a complete cycle. Caution is advised when comparing the latest period with other cycles. For more information, see the 'Estimating growth cycles' section in 'Technical notes'.

Unless otherwise stated, all references to average movements are annual geometric mean movements relating to the measured sector.

Labour productivity



Labour productivity is measured as a ratio of output to labour input. In the year ended March 2009, labour productivity decreased by 1.5 percent, due to a fall in both output (down 2.2 percent) and labour input (down 0.7 percent).

The following table presents the average annual growth in labour productivity for the growth cycles identified within the series.

Labour Productivity Average Annual Growth Rates[1][2]
Year ended 31 March

Cycle	Output	Labour input	Labour productivity
	Percent[3]		
1978–82	2.1	0.4	1.7
1982–85	3.4	1.8	1.5
1985–90	0.7	-2.1	2.9
1990–97	3.3	0.7	2.6
1997–2000	3.0	-0.1	3.1
2000–06	3.8	2.4	1.3
2006–09	0.5	0.8	-0.3
1978–2009	**2.5**	**0.6**	**1.9**

[1] The average annual growth rate values do not include the movement for the first year of each cycle, eg the 1978–82 average annual growth rate does not include the movement for 1978.
[2] Business services, and personal and other community services are included in the measured sector from 1996 onwards.
[3] Percentage changes are calculated on unrounded index numbers.

A fall in labour productivity of 1.5 percent for the March 2009 year is below the average annual growth rate for the 2006–09 period of -0.3 percent. The growth rate over this latest period is lower than any of the previous cycles and is the only cycle where labour productivity is negative. However, caution should be exercised in this comparison as the 2006–09 period is not a complete cycle.

Labour input growth averaged 0.8 percent annually over the 2006–09 period. In the year to March 2009, labour input fell 0.7 percent marking the first decrease in this figure in 10 years. The downward movement in labour input growth in the year to March 2009 is consistent with the changes in the labour market during this time.

The weakening of the labour market was highlighted by the unemployment rate increasing to 5.0 percent for March 2009 quarter (up from 3.8 percent for the March 2008 quarter). The unemployment rate is for the whole economy, as an unemployment rate that covers only the measured sector is not available. Indications of a weak labour market are also evident in the New Zealand Institute of Economic Research's Quarterly Survey of Business Opinion (April 2009) which shows that a net 42 percent of respondents thought it was easier to find skilled or technical staff in March 2009 compared with three months prior. The comparable figure for unskilled staff was 63 percent. Both figures are the highest for more than 30 years.

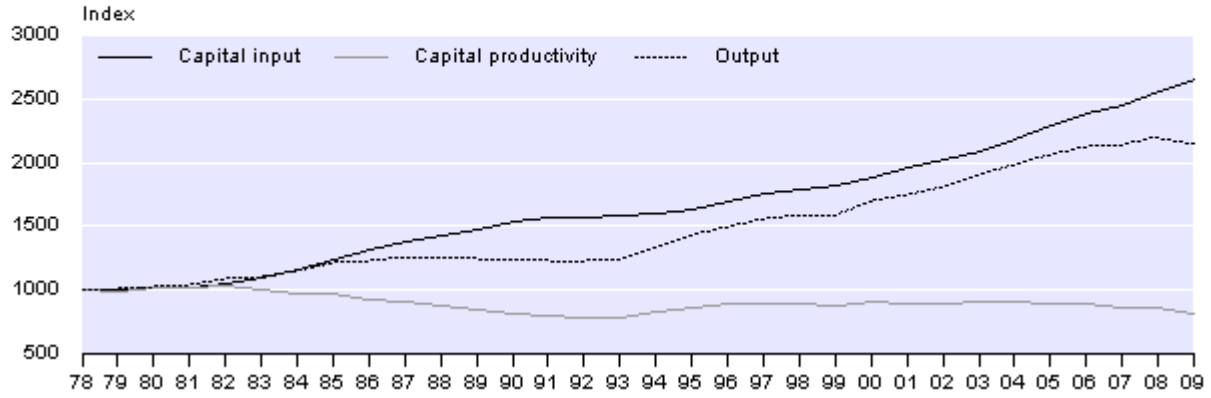
The decline in labour productivity during the 2006–09 cycle has not significantly affected the long-term average growth rate for labour productivity, which remains positive.

Capital productivity

Measured Sector Capital and Output Indexes

Year ended March, 1978–2009

Base: 1978 (=1000)



Capital productivity is measured as a ratio of output to capital input. In the year to March 2009, capital productivity fell 5.3 percent, due to capital inputs increasing by 3.3 percent and output decreasing by 2.2 percent.

The following table presents the growth in capital productivity for the growth cycles identified within the series.

Capital Productivity Average Annual Growth Rates[1][2] *Year ended 31 March*			
Cycle	Output	Capital input	Capital productivity
	Percent[3]		
1978–82	2.1	1.4	0.8
1982–85	3.4	5.5	-2.0
1985–90	0.7	4.3	-3.5
1990–97	3.3	1.9	1.3
1997–2000	3.0	2.6	0.4
2000–06	3.8	3.9	-0.1
2006–09	0.5	3.7	-3.1
1978–2009	**2.5**	**3.2**	**-0.7**

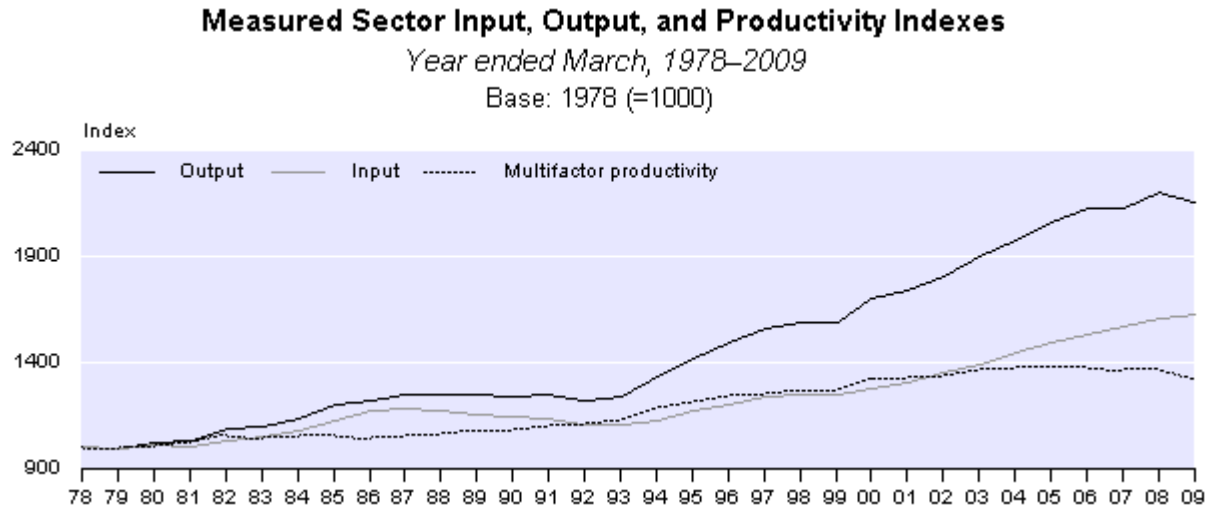
[1] The average annual growth rate values do not include the movement for the first year of each cycle, eg the 1978–82 average annual growth rate does not include the movement for 1978.
[2] Business services, and personal and other community services are included in the measured sector from 1996 onwards.
[3] Percentage changes are calculated on unrounded index numbers.

The decline in capital productivity over the 2006–09 period can be explained by the annual increase in capital input of 3.7 percent, relative to the small rise in output of 0.5 percent annually. In 2009, the capital input increase was driven by strong investment in IT-related assets. Although capital productivity declined sharply in 2009, it is possible utilisation of capital was at a low point. The productivity statistics do not adjust for changes in capacity utilisation, as a capital asset is assumed to be used at a constant rate over its life. Under conditions where utlilisation of capital is lower than average, growth in capital inputs may be artificially high and therefore growth in capital productivity may be artificially low. To partly counter this scenario, it is recommended that productivity is analysed using business cycles. A decline in capital productivity is seen in four of the seven cycles. Caution should be exercised in this comparison as the 2006–09 period is not a complete cycle.

Over the entire time series (1978–2009), capital productivity fell 0.7 percent on an average annual basis. This was due to annual capital input growth of 3.2 percent increasing by more than the annual growth in output of 2.5 percent.

Capital deepening is defined as the relative increase in capital inputs to that of labour inputs, or a rise in the capital-to-labour ratio. In the latest period, 2006–09, the capital-to-labour ratio has continued to increase with an annual growth rate of 2.8 percent, due to 3.7 percent annual growth in capital input coupled with 0.8 percent growth in labour input. The New Zealand economy has experienced capital deepening during the last 31 years. The annual growth in the capital-to-labour ratio was 2.6 percent over the entire 1978–2009 series. This was due to capital input growth of 3.2 percent, compared with 0.6 percent growth in labour input. The capital deepening figures only provide information on the growth rate in the capital-to-labour ratio. They do not shed insight into the level of capital per worker in the economy.

Multifactor productivity



Multifactor productivity (MFP) is measured as a ratio of output to total inputs. It can also be defined as growth that cannot be attributed to capital or labour, such as technological change or improvements in knowledge, methods, and processes. In the year to March 2009, MFP declined 3.1 percent, due to total inputs increasing (up 1.0 percent) while output decreased (down 2.2 percent).

The following table presents the annual average growth in MFP within the growth cycles identified for the series.

Multifactor Productivity Average Annual Growth Rates[1][2]
Year ended 31 March

Cycle	Output	Total inputs	Multifactor productivity
	Percent[3]		
1978–82	2.1	0.7	1.4
1982–85	3.4	3.2	0.2
1985–90	0.7	0.3	0.4
1990–97	3.3	1.1	2.1
1997–2000	3.0	0.9	2.0
2000–06	3.8	3.1	0.7
2006–09	0.5	2.0	-1.5
1978–2009	**2.5**	**1.6**	**0.9**

[1] The average annual growth rate values do not include the movement for the first year of each cycle, eg the 1978–82 average annual growth rate does not include the movement for 1978.
[2] Business services, and personal and other community services are included in the measured sector from 1996 onwards.
[3] Percentage changes are calculated on unrounded index numbers.

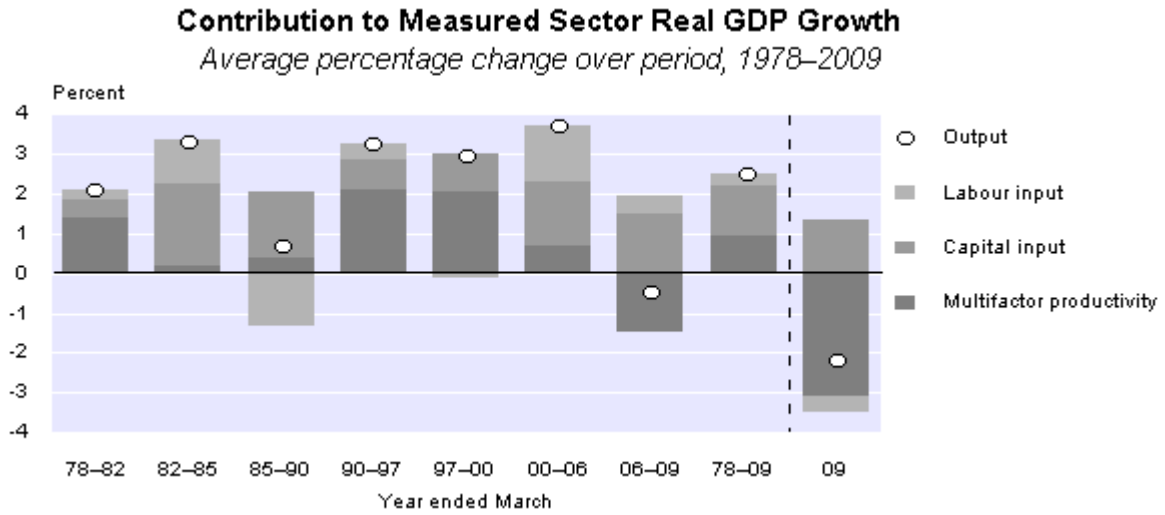
From 2006–09, MFP has declined for the first time across a cycle in the series, with an average decrease of 1.5 percent annually. Output rose 0.5 percent on an average annual basis, while

total inputs rose 2.0 percent. The main contributor to the growth in total inputs was capital input. Caution should be exercised in this comparison as the 2006–09 period is not a complete cycle.

The average annual increase of 0.9 percent in MFP over the entire 1978–2009 series was due to output (up 2.5 percent) rising more than input growth of 1.6 percent.

Growth accounting for real GDP

Growth accounting examines how much of the economy's growth in output can be explained by the growth of combined inputs. In particular, growth in real GDP (output) can arise from three different sources: an increase in labour input, an increase in capital input, or an increase in MFP. The following graph presents growth in output between 1978 and 2009 for the growth cycles identified in the series.



In the 2009 March year, output fell by 2.2 percent. This decline was driven by MFP (down 3.1 percent), and to a lesser extent by labour input (contributing -0.4 percent to output growth). These were partly offset by capital input, which contributed 1.3 percent to GDP.

The following table presents the annual average growth in output and its contributing factors for the growth cycles identified within the series.

Contribution to Measured Sector Real GDP Growth *Average annual growth rates* [1][2] Year ended 31 March				
Cycle	Real GDP	Contribution of capital input[3]	Contribution of labour input[4]	Multifactor productivity
	Percent[5]			
1978–82	2.1	0.5	0.2	1.4
1982–85	3.4	2.1	1.1	0.2
1985–90	0.7	1.7	-1.3	0.4
1990–97	3.3	0.8	0.4	2.1
1997–2000	3.0	1.0	-0.1	2.0
2000–06	3.8	1.6	1.4	0.7
2006–09	0.5	1.5	0.5	-1.5
1978–2009	**2.5**	**1.3**	**0.3**	**0.9**

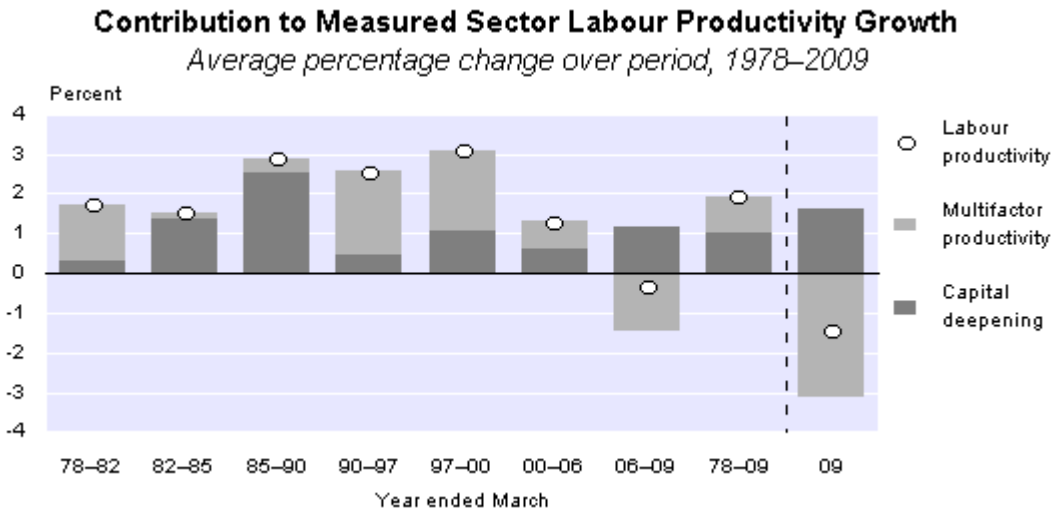
[1] The average annual growth rate values do not include the movement for the first year of each cycle, eg the 1978–82 average annual growth rate does not include the movement for 1978.
[2] Business services, and personal and other community services are included in the measured sector from 1996 onwards.
[3] Contribution of capital input is equal to the growth rate in capital input weighted by capital's share of total income.
[4] Contribution of labour input is equal to the growth rate of labour input weighted by labour's share of total income.
[5] Percentage changes are calculated on unrounded index numbers.

In the current cycle (2006–09) the average GDP growth rate is the lowest since the series began. The key industries which have been driving GDP down over this time are manufacturing (in 2007 and 2009), agriculture (2008), and construction (2009).

Over the entire 1978–2009 series, output growth averaged 2.5 percent. Capital input was the largest contributor, averaging 1.3 percent annually. Labour input contributed 0.3 percent to this rise in output and MFP contributed 0.9 percent.

Growth accounting for labour productivity

As with growth in real GDP (output), growth in labour productivity can be broken down into components. In particular, a change in labour productivity can come from two possible sources: a change in the weighted capital-to-labour ratio (that is, capital deepening or capital shallowing) and a change in MFP. The following graph presents the contributions to labour productivity growth between 1978 and 2009 for the growth cycles identified in the series.



In the year to March 2009, labour productivity declined 1.5 percent. The annual contribution from capital deepening was 1.6 percent, which partly offset a decline of 3.1 percent in MFP.

The following table presents the annual average growth in labour productivity and its contributing factors for the growth cycles identified for the series.

Contribution to Measured Sector Labour Productivity Growth
Average annual growth rates(1)(2)
Year ended 31 March

Cycle	Labour productivity	Contribution of capital deepening(3)	Multifactor productivity
	Percent (4)		
1978–82	1.7	0.3	1.4
1982–85	1.5	1.4	0.2
1985–90	2.9	2.5	0.4
1990–97	2.6	0.5	2.1
1997–2000	3.1	1.1	2.0
2000-06	1.3	0.6	0.7
2006–09	-0.3	1.2	-1.5
1978–2009	**1.9**	**1.0**	**0.9**

(1) The average annual growth rate values do not include the movement for the first year of each cycle, eg the 1978–82 average annual growth rate does not include the movement for 1978.
(2) Business services, and personal and other services are included in the measured sector from 1996 onwards.
(3) Contribution of capital deepening is equal to the growth rate in the capital-to-labour ratio weighted by capital's share of total income.
(4) Percentage changes are calculated on unrounded index numbers.

Labour productivity over the latest 2006–09 period declined by 0.3 percent annually. This was driven by a decrease of 1.5 percent in MFP growth, offset by an increase in the contribution of capital deepening (up 1.2 percent). Capital deepening has shown fairly strong growth over the period, while MFP growth has largely been negative.

Over the entire 1978–2009 series, the average annual contribution to labour productivity growth from capital deepening was 1.0 percent. The average contribution of MFP growth was 0.9 percent on an annual basis. Labour productivity growth averaged 1.9 percent annually.

Composition-adjusted productivity

Within the suite of productivity measures, there are three labour input series. These are: the unweighted, unindexed measure of labour volume; the headline labour input index; and the composition-adjusted labour input index.

The composition-adjusted input series allows us to track changes in the skill level of the workforce over time. To do this, it needs to be compared with the unweighted labour volume series. The difference between these two series represents the change in the skill level – measured using qualification and experience proxies – of workers.

This composition-adjusted input series explicitly accounts for quality. It is generally considered to provide the most representative measure of labour input. Alternatively, the headline labour input series implicitly adjusts for quality. It does this by giving higher weight to industries with above-average wage rates.

In the year ended March 2009, composition-adjusted labour productivity decreased by 1.2 percent. This was due to adjusted labour input (down 1.0 percent) decreasing by less than the fall in output of 2.2 percent. Composition-adjusted multifactor productivity decreased by 2.9 percent, as adjusted total inputs rose 0.7 percent.

The table below shows the annual movements for each of the three labour input series. It begins in 1999, the first year in which composition-adjusted labour input movements are available.

Annual Percentage Change in Labour Input Series: 1999–2009

Year	Labour volume measure	Headline measure	Composition-adjusted measure
1999	-0.7	-0.9	-0.1
2000	1.4	0.8	1.9
2001	1.6	1.4	2.2
2002	2.9	3.0	2.9
2003	3.0	3.2	3.3
2004	3.1	3.0	3.8
2005	2.0	2.4	2.1
2006	1.4	1.7	1.6
2007	1.3	1.6	1.1
2008	1.4	1.5	2.2
2009	-0.8	-0.7	-1.0
Average 1999–2009[(1)]	**1.5**	**1.5**	**1.8**

[(1)] Calculated as the geometric mean growth rate across the period

The composition-adjusted series is clearly growing faster than either the unweighted labour volume series or the headline measure. As labour productivity is measured as residual output growth above labour input growth, the implication is that composition-adjusted productivity is growing slower than the other productivity measures.

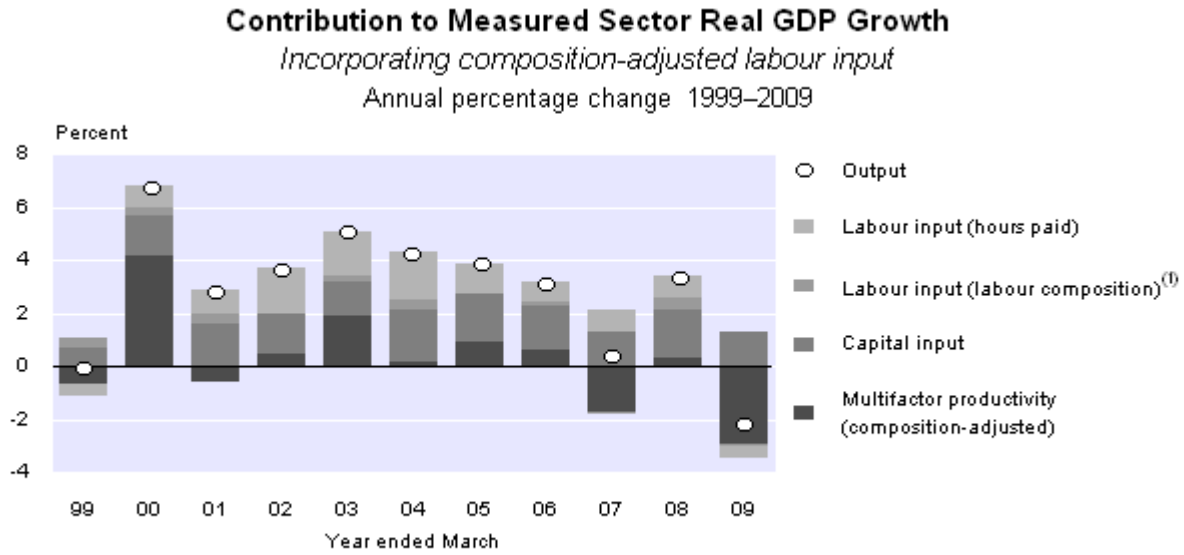
Comparing the composition-adjusted series with the labour volume measure, the only years in which it grows slower are 2007 and 2009. In 2002 they have the same growth rate. In all other

years, the labour input of higher-skilled workers, as measured using the education and experience proxies, is growing faster than that of lower-skilled workers. This implies that the average skill level of the workforce is increasing.

Composition-adjusted productivity growth accounting for real GDP

The inclusion of a composition-adjusted labour input series allows for the decomposition of growth in real GDP (output) into capital input, hours paid, labour composition, and composition-adjusted MFP.

The following graph presents the contributions to annual growth in output for the adjusted series from 1998 to 2009. Labour composition changes have not been a major driver of increases in GDP over this time period.



(1) The series begins in 1998, meaning annual percentage changes can only be calculated from 1999 onwards.

In the year to March 2009, growth in output declined by 2.2 percent. This decline was driven by adjusted MFP, which fell 2.9 percent, and to a lesser extent by hours paid and labour composition (contributing -0.5 percent and -0.1 percent, respectively). Capital input contributed 1.3 percent to real GDP growth.

The contribution of labour composition to growth in output is positive in all years but 2002, 2007, and 2009. In all other years, highly-skilled labour is growing at a faster rate, and therefore the average skill level of workers is rising. Under an unadjusted labour input approach, this positive contribution of labour skill would remain part of the labour productivity and MFP residuals and is not explicitly shown. Explicitly accounting for the rising skill composition allows us to explain more of the residual growth in output.

Revisions

Updates in data sources and ongoing methodology improvements have caused a number of revisions to the previously published productivity series. Please refer to tables 7, 8, 1.7, and 1.8 in the downloadable Excel spreadsheets for the magnitude and direction of these revisions.

Regular revisions (due to updates in data sources) have arisen from the following:

- revised constant price GDP data, feeding into the output series
- revised current price national accounts data, with current price industry data now available for 2006 and 2007, feeding into the industry income-based weights
- revised current and constant price productive capital stock data for selected assets and industries for March years 2006, 2007, and 2008, feeding into the capital input series
- the addition of linked employer-employee data (LEED) to replace survey-based data for working proprietor counts for the March 2008 year, and employee counts for the March 2008 quarter, feeding into the labour input series.

Revisions resulting from improved methodology are:

- an improvement to the methodology for linking LEED data in 2000 to create a continuous labour series and a change to the use of LEED to make it more conceptually consistent with GDP data from the National Accounts
- the addition of business demography data for 1987, for most industries
- the addition of inventories to the set of assets within the capital input series, from 1987 onwards
- a change to the methodology for timber and livestock assets within the capital input series.

Due to the amount of provisional data that is used in productivity calculation for the most recent years, the last four years of the series are released with provisional status. While there have been revisions to some annual movements, the underlying trend of the productivity series has remained unchanged.

Comparison with Australia

Official New Zealand productivity data can be benchmarked against official Australian numbers. The use of the same industrial classification (Australian and New Zealand Standard Industrial Classification 1996, or ANZSIC96) has made such comparisons more valid since Statistics NZ began publishing productivity statistics.

However, the Australian Bureau of Statistics (ABS) is now publishing their national accounts and productivity data under ANZSIC 2006. Given that Statistics NZ will not publish under ANZSIC 2006 until 2012, this has distorted the comparison.

Under ANZSIC96, the ABS market sector had identical industry coverage to the Statistics NZ former measured sector. To maintain some continuity for their users, the ABS is now publishing an ANZSIC06-based series which is as close as possible to their market sector, and therefore as close as possible to the Statistics NZ former measured sector. This series, known as MFP12, dates back to 1974 and is currently the best series to use when undertaking a trans-Tasman comparison. The ABS ANZSIC96-based market sector series can still be used for comparisons up to 2008, and is available on their website, www.abs.gov.au.

In 2007, both the ABS' MFP12 series and the Statistics NZ former measured sector covered 63 percent of the economy. The table below shows which industries are included in each series.

Australia's MFP12 and New Zealand's Former Measured Sector	
Australia (ANZSIC 2006-based)	**New Zealand (ANZSIC 1996-based)**
A – Agriculture, forestry, and fishing	A – Agriculture, forestry, and fishing
B – Mining	B – Mining
C – Manufacturing	C – Manufacturing
D – Electricity, gas, water, and waste wervices	D – Electricity, gas, and water
E – Construction	E – Construction
F – Wholesale trade	F – Wholesale trade
G – Retail trade	G – Retail trade
H – Accommodation and food services	H – Accommodation, cafes, and restaurants
I – Transport, postal, and warehousing	I – Transport and storage
J – Information media, and telecommunications	J – Communication services
K – Financial and insurance services	K – Finance and insurance
R – Arts and recreation services	P – Cultural and recreational services

The table below compares the output, productivity, and input series for Australia and New Zealand, based on the MFP12 and former measured sector series, respectively. The Statistics NZ time series begins in 1978, so the comparison is over 31 years. A cycle comparison cannot be undertaken, due to each country having slightly different peaks in their cycles.

Comparison of Australia and New Zealand Productivity Data Australia's MFP12 and New Zealand's former measured sector *Average annual growth rates: 1978–2009*		
Variable	**Australia**	**New Zealand**
Output	3.1	2.4
Labour productivity	2.0	2.1
Capital productivity	-0.7	-0.6
Multifactor productivity	0.8	1.0
Labour input	1.1	0.3
Capital input	3.9	3.0
Total inputs	2.3	1.4
Capital-to-labour ratio	2.8	2.7

Based on the 63 percent of the economy covered by these statistics, Australia's and New Zealand's productivity performances have been very similar over the 1978–2009 period. New Zealand is slightly ahead in all three measures of productivity growth. Australia's output growth is significantly higher at 3.1 percent annually compared with New Zealand's 2.4 percent. However, this additional output growth is fully accounted for by input growth. Both Australia and New Zealand have experienced similar growth in capital deepening over the 31-year time span, with Australia nudging slightly ahead.

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Next release ...

Productivity Statistics: 1978–2010 is scheduled to be released in March 2011.

Related releases ...

Exploring the Possibility of Measuring Government Sector Productivity in New Zealand: A feasibility study will be released on 18 March 2010.

Industry Level Productivity Statistics: 1978–2008 is scheduled to be released in June 2010.

Technical notes

What is productivity?

Productivity is a measure of how efficiently inputs are being used within the economy to produce outputs. Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input. Growth in productivity means that a nation can produce more output from the same amount of input. Productivity growth is an important contributing factor to a nation's long-term material standard of living.

Productivity measures can be either single factor (ie relating a measure of output to a single measure of input), or multifactor (ie relating a measure of output to a bundle of inputs). Labour and capital productivity are single (or partial) factor productivity measures; they show productivity growth in terms of that particular input. Hence, productivity changes shown in these indexes may be due to a change in the mix of total inputs rather than a direct productivity increase from the relevant input. For example, if additional machinery (capital input) is used to assist in production, less labour input may be required to produce the same level of output. This will increase labour productivity, simply because the mix of the inputs has altered. On the other hand, multifactor productivity takes into account substitution between labour and capital inputs, and is therefore not directly affected by a change in the mix of total inputs.

The output measure chosen may be either gross output or value-added. The official productivity series all use constant price value-added as the output measure. Separate series are produced for labour productivity, capital productivity, and multifactor productivity (MFP).

Productivity measurement

The Statistics NZ method of estimating productivity statistics is based on OECD guidelines, as outlined in the OECD (2001) manual *Measuring Productivity–OECD Manual Measurement of Aggregate and Industry-level Productivity Growth* (available from OECD website, www.oecd.org). The approach adopted is referred to in the manual as "the index number approach in a production theoretic framework".

The calculation of productivity statistics begins by postulating a production function of the form:

$V = A(t) \times f(L,K)$

where V = value-added in constant prices
L = real labour inputs
K = real capital inputs
f(L,K) = a production function of L and K that defines an expected level of output
A(t) = a parameter that captures disembodied technical shifts over time, ie outward shifts of the production function allowing output to increase with a given level of inputs (= MFP)

Given the existence of index values for labour volume and value-added, it is possible to calculate labour productivity for the measured sector as:

$LP = V / L$

Where LP = an index of labour productivity. This is an index of value-added in constant prices divided by an index of labour inputs.

Similarly, a capital productivity index KP is calculated as:

$KP = V / K$

Where KP = an index of capital productivity. This is an index of value-added in constant prices divided by an index of capital inputs.

Care is needed in interpreting the partial measures of productivity. For example, labour productivity only partially measures 'true' labour productivity, in the sense of capturing the personal capacities of workers or the intensity of their efforts. Labour productivity reflects the level of capital available per worker and how efficiently labour is combined with the other factors of production. Labour productivity may change due to a substitution of capital for labour (capital deepening) or due to a change in technology, with no change occurring in the labour input itself.

The final productivity index that can be calculated is for multifactor productivity (MFP). The technology parameter that represents disembodied technological change (or MFP) cannot be observed directly. By rearranging the production function equation, it can be shown that the technology parameter can be derived residually as the difference between the growth in an index of outputs and an index of inputs:

$A(t) = V / f(L,K)$

Certain assumptions must be met for MFP to be a measure of disembodied technology change. The key assumptions are that the production function must exhibit constant returns to scale and all inputs need to be included in scope of the production function.

In practice, these conditions will not be met and the resulting MFP residual needs to be interpreted with some caution. Given the importance of technological progress as an explanatory factor in economic growth, attention often focuses on the MFP measure as though it was a measure of technological change. However, this is not always the case. When interpreting MFP, the following should be noted:

- Not all technological change translates into MFP growth. Embodied technological change, such as advances in the quality of capital or improved human capital, will be captured in the measured contributions of the inputs, provided they are measured correctly (ie the volume input series includes quality change).
- MFP growth is not necessarily caused by technological change. Other non-technology factors will be picked up by the residual, including economies of scale, cyclical effects, inefficiencies, and measurement errors.

Calculating labour, capital, and multifactor productivity therefore relies on appropriate output indexes, and labour, capital, and total input indexes to be created. The steps taken to calculate those indexes are described below.

Output series methodology

This is defined as constant-price value added. The annual value added for the measured sector is derived following the same procedures as used to derive constant price GDP, that is, as a chained Laspeyres volume index of the constant-price value added of the industries that comprise the measured sector.

Labour series methodology

The labour volume series

The labour volume series is an estimate of paid hours for all employed persons engaged in the production of goods and services in the measured sector in New Zealand. The series is compiled using a number of data sources, from which the best characteristics of each are used for productivity measurement.

Throughout the series, there are three components that are summed to an industry level:

- employees in industries covered by employment surveys
- employees in industries out of scope of employment surveys
- working proprietors.

For each of these components, the labour volume series is constructed by estimating:

- job/worker counts
- weekly paid hours per job/worker.

These are multiplied to give total weekly paid hours for the measured sector. An annual (March year) average of the weekly paid hours is calculated at the industry level. It is aggregated to the measured sector level, as published in tables 3, 1.3, and 2.3.

For the first of the three components, data from the Department of Labour (DoL) Employment Information Survey is used up to 1980, when it became the DoL Quarterly Employment Survey (QES). The DoL data is the sole source for employee counts and hours paid for this component until 1987, from which point annual business demography counts are rated forward by quarterly movements in employee counts from the QES. The resulting quarterly series of employee numbers is then multiplied by average weekly paid hours from the QES to achieve a quarterly series for paid hours. In 1989, Statistics NZ assumed responsibility for administering the QES. From 2000 onwards, monthly linked employer-employee data has replaced business demography as the sole data source for employee counts, and is combined with QES data on average weekly paid hours.

The second component includes employees in the following ANZSIC industries that are omitted from the coverage of the surveys above:

- A01 – Agriculture
- A02 – Services to agriculture
- A04 – Commercial fishing
- I6301 – International sea transport
- L7711 – Residential property operators
- M813 – Foreign government representation
- Q97 – Private households employing staff.

Prior to 2000, Census of Population and Dwellings data provides benchmarks for employee counts and average weekly hours for this component. Prior to 1986, counts are interpolated using data from the Agriculture Census where appropriate. From 1986 to 2000, quarterly estimates of change from the Household Labour Force Survey (HLFS) are used to interpolate weekly hours between census benchmarks. From 2000 onwards, LEED provides monthly data on employee counts, while the average hours methodology remains unchanged.

For working proprietors, the third component, prior to 1986, census benchmarks are used to calculate both counts and average hours for almost all industries, supplemented by data from the DoL employment surveys and the Agriculture Census where appropriate. From 1986 to 2000, both hours and count data are benchmarked using totals from the census and interpolated using data from the HLFS, as in the previous component. From 2000 onwards, LEED provides annual benchmarks for working proprietor counts, supplemented by data from the HLFS and QES. Census data continues to provide average hours benchmarks during this period.

The different data sources are linked together to remove discontinuities in the time series. For example, two main points requiring linking are 1987/88 with the introduction of business demography data, and 2000, with the introduction of LEED. In 1987/88, employee count data are linked at the ANZSIC 3-digit level, with the business demography level being preferred to the pre-1987/88 level originating from the DoL QES. In 2000, data are linked at the ANZSIC 3-digit level, separately for both employees and working proprietors. The LEED level is preferred to the pre-2000 level, based on business demography data. This implies that any revisions in LEED in 2000 (the June 1999 quarter for employees, or the March 2000 year for working proprietors) will result in revisions right back to the start of the series.

Use of LEED

LEED is the main data source of counts of employees and working proprietors from 2000 onwards. The LEED dataset is created by linking a longitudinal dataset from the Statistics NZ Business Frame with longitudinal data from administrative taxation sources. Statistics NZ sees LEED as the best available data source for measuring labour counts for the reasons outlined below.

For measurement of employees, LEED data differs to the previous Business Demography Database (BDD) in the following ways:

- LEED employee count data is monthly, whereas under the previous approach, quarterly data was used. Therefore LEED captures the seasonality of labour volume better.
- Unlike the previous approach, LEED counts are not interpolated using survey information, reducing the effect of sample error on the series.
- LEED data includes information about secondary jobs for industries outside of the scope of the Quarterly Employment Survey (QES). These jobs were previously excluded from the series.

For measurement of working proprietors, LEED data differs to the previous census/HLFS measurement in the following ways:

- The majority of the working proprietor data is based on LEED annual benchmarks, based on a working proprietor's main income source over the year, that is, it is not a point-in-time estimate. It is modified to incorporate seasonality using the HLFS and QES, however the annual average counts remain the same.
- LEED data includes information about people with secondary jobs (based on income) as a working proprietor. These jobs were previously excluded from the series.
- Under the previous methodology, census benchmarks could be extrapolated forward for up to five years before being finalised. However, LEED provides annual benchmarks and at most, it is only the latest year which will be extrapolated forward.
- Working proprietors who pay themselves a salary can now be identified more accurately using LEED.

New to this release, LEED is now being used in a different manner. The data is collected at the geographic unit (GEO) level, which represents a business location engaged in one, or

predominantly one, kind of economic activity at a single physical site or base. However, to be consistent with the BDD and the QES, LEED has been aggregated to the kind-of-activity (KAU) level. A KAU is engaged in predominantly one activity for which a single set of accounting records is available. This improved and more consistent use of LEED has resulted in minor revisions to the labour volume series.

Quality assurance of the industry labour volume series

As a quality assurance measure for the upcoming release of industry level productivity measures, several coherency adjustments were made to the employee count and hours series that feed into the measured sector labour volume series (LVS). The main data sources used in the construction of the LVS are sourced independently of the estimates of compensation of employees (CoE) from the National Accounts. CoE estimates are primarily derived from the Annual Enterprise Survey, while LVS estimates are compiled using a number of different sources as discussed above. Current price CoE estimates were deflated using the QES average hourly earnings measure to provide an implicit LVS. This provided a benchmark for comparing against the LVS at an industry level. Adjustments were made to the industry data, based on alternative labour data sources in years where the LVS showed a significantly different movement to the deflated CoE series. The data published in this release is completely consistent with that to be published in the forthcoming industry level productivity release.

Rating forward the Labour Volume Series to calculate 2009 values

LEED employee count data is unavailable for the last quarter of the series and LEED working proprietor count data is unavailable for the last year of the series, apart from some working proprietors who are included in the employee data. Therefore, both are rated forward. Employee counts are rated forward using QES movements, and HLFS movements are used for industries outside the QES scope. Working proprietor counts are rated forward using HLFS movements. Adjustments are made to the HLFS data where necessary. Average hours worked per industry is calculated as in previous years, however the data is adjusted to account for the proportion of secondary jobs for employees in industries out of scope of the QES and working proprietors.

The labour input index

The industry volume series are aggregated to the measured sector level by means of a chained Törnqvist index. The quantity relatives in the index are two-period ratios of industry labour volumes. Industry two-period mean shares of measured sector nominal labour income form the exponential weights.

Composition-adjusted labour input

Composition-adjusted productivity measures account for the impact of changes in the skill-composition of workers. These are theoretically better measures of productivity as they allow output growth to also be explained by changes in labour composition, thereby reducing the contribution of the residual (ie MFP) to growth.

Composition-adjusted labour is calculated by adjusting the Labour Volume Series using movements in a labour composition index, which estimates changes in skill composition using proxies for skill, namely education attainment and work experience. The labour composition index is calculated using the HLFS to estimate the proportions of each skill category of worker, while the New Zealand Income Survey (NZIS), an annual supplement to the HLFS, is used to compile income shares for each of these groups.

Due to the availability of NZIS data, the composition-adjusted series runs from 1998. For further background on composition-adjustment, and details on the methodology, consult the Statistics NZ information paper *Accounting for Changes in Labour Composition in the Measurement of Labour Productivity*, available on www.stats.govt.nz.

Capital input series methodology

The capital services input index measures the flow of capital services generated by the use of the stock of capital assets for a given March year. No allowance is made for differences (across industry and time) in asset capacity utilisation rates.

As capital service flows cannot be directly measured, industry level flows are modelled, based on the productive capacity of industry capital stock. The industry level flows are aggregated to the measured sector level using industry shares of the measured sector current-price capital income as weights. More specifically, the following steps occur:

- The starting point is the annual constant-price productive capital stock series. An asset's productive capital stock is its gross capital stock adjusted for the decline in its efficiency. Measured in constant prices, the productive stock represents standardised efficiency units and can be interpreted as a measure of the potential capital services that the asset can contribute to the production process. The productive capital stock series are built up using a perpetual inventory model (PIM) that generates productive capital stock estimates for 26 asset types by industry, of which only 24 are used in the capital services index. The model specifies for each asset type a mean expected useful life, a retirement function based on a distribution about this life and its pattern of (hyperbolic) efficiency decline. These parameters, and gross fixed capital formation in constant prices, are used to estimate an asset type's productive capital stock in constant prices.
- In addition to the PIM-derived fixed asset stocks, the range of capital included in the productivity measures is supplemented by estimates for eight other assets, namely livestock, exotic timber grown for felling, inventories, and six different types of land: agricultural, forestry, commercial, industrial, mining, and other land.
- Capital service flows are assumed to be proportional to these productive stock estimates, and are aggregated to the industry level using a Törnqvist index, with weights based on implicit rental prices (or user costs) which are a function of an exogenous rate of return, depreciation, net taxes on production, and asset price changes.

The measured sector capital services index is calculated, in turn, as a Törnqvist index of the industry indexes, with mean two-period industry shares of the measured sector current-price capital income providing the weights.

Enhancements to the capital input series methodology for this release

The methodology underlying the capital input series has been altered for this release. Two enhancements have been incorporated into the series, namely:

1. Inclusion of inventories
   Inventories are now included within the scope of capital assets. They have been included from 1978 for the agriculture and forestry industries, and from 1987 onwards for the manufacturing; wholesale trade; retail trade; and accommodation, cafes, and restaurants industries, reflecting the availability of source data. The price and volume data for estimating the productive capital stock of inventories are sourced from Statistics NZ's national accounts.
2. Treatment of livestock and timber assets
   With the inclusion of inventories in the capital asset scope, the treatment of livestock and

timber assets has changed. Timber and livestock assets are now sourced from the National Accounts as a part of the inventories series from 1980 onwards. Prior to 1980, movements are calculated using the previous methodology, and are linked on to the National Accounts-sourced series at this point.

Capital and labour income shares

The measured sector capital and labour nominal income shares are calculated as the ratio of capital and labour income, respectively, to total income. Capital and labour nominal income totals are calculated at the industry level, and are derived from the income measure of GDP within the national accounts.

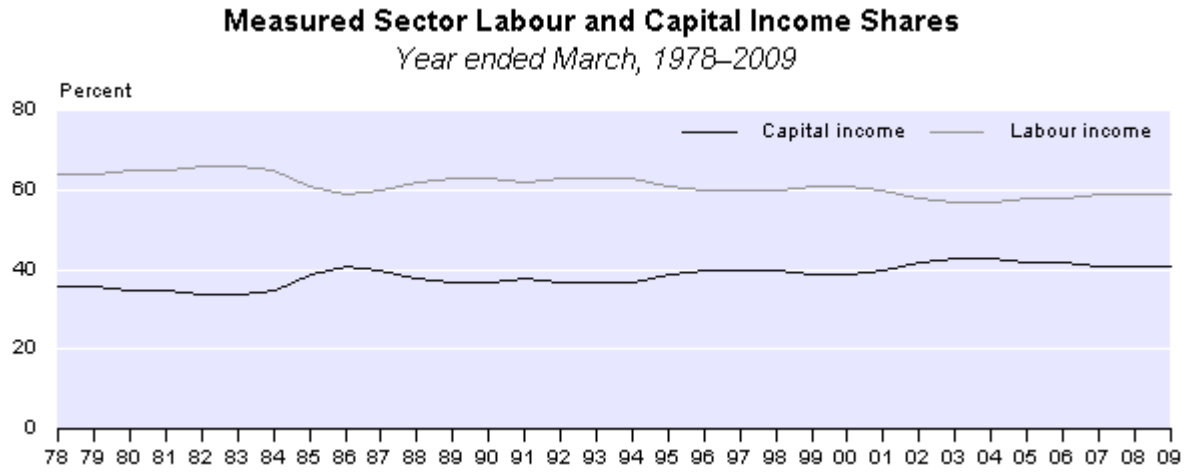
The income measure of GDP is calculated as compensation of employees plus gross operating surplus plus taxes on production and imports less subsidies (taxes less subsidies are known as net taxes). Included within gross operating surplus is the income of working proprietors, which is termed mixed income.

Mixed income is split into labour and capital components by calculating the labour income of working proprietors directly, and deriving the capital income of working proprietors residually.

Net taxes on production and imports are split into labour and capital components according to existing industry income shares.

Labour income is calculated as compensation of employees plus labour mixed income plus net taxes on production and imports attributable to labour. Capital income is calculated as gross operating surplus plus capital mixed income plus net taxes on production and imports attributable to capital.

Capital and labour income shares are used as weights within the productivity series. Mean two-period industry income shares are used to weight the capital and labour input indexes from the industry level to the measured sector level. Mean two-period measured sector income shares are then used to weight capital and labour when deriving the total inputs index, which is used in the calculation of MFP. Capital and labour income shares are also used to weight the contribution of capital input and labour input, respectively, within the growth accounting framework.



The average capital and labour income shares remain relatively stable over the 1978–2009 period, with the capital share at approximately 40 percent of total income and the labour share at approximately 60 percent of total income. The increase in the capital income share in 1984 is due to the significant capital and infrastructural investment following the 'Think Big' projects. The

small level shift in the series in 1996 is due to the introduction of business services, and personal and other community services into the measured sector.

Total input series methodology

A composite total input index is constructed by combining the labour and capital input indexes at the measured sector level. The total inputs index is a Törnqvist index, with the industry factor income shares providing the weights.

Calculating the productivity indexes

The construction of output, labour input, capital input, and composite total input indexes then allows for the calculation of the labour productivity, capital productivity and multifactor productivity measures, using the formulae in the 'Productivity measurement' section of these 'Technical notes'.

Growth accounting decomposition

Growth accounting is the decomposition of output growth into its contributing factors. For a given production function, changes in output are due to changes in the volumes of labour and capital, and/or changes in the multifactor productivity term. Under the composition-adjusted approach, changes in output can also come from a change in the skill composition of labour.

The growth accounting decomposition for output (ie value added, or real GDP) is presented as follows:

V = (L ^ W L) x (K ^ W K) x MFP

V = the change in value added (over one period)
L = the change in labour input (over one period)
K = the change in capital input (over one period)
MFP = the change in MFP (over one period)
W L = labour's share of total income
W K = capital's share of total income

As can be seen, the changes in labour input and capital input are exponentially weighted by their respective shares of total income. This gives the contribution of labour input and capital input, respectively, to output growth.

Under the composition-adjusted approach, output growth is decomposed into an additional variable, namely the skill composition of labour. This is presented in the equation below:

V = (L ^ W L) x (S ^ W L) x (K ^ W K) x MFP

S = the change in skill composition (over one period)

To obtain the contribution of skill composition towards output, it also needs to be exponentially weighted by labour's share of total income.

The growth accounting technique can also be used to decompose the changes to labour productivity. The change in labour productivity can be accounted for by the weighted amount of capital per worker and the change to MFP.

Estimating growth cycles

This release contains productivity data presented as annual averages within growth cycles. These estimates acknowledge the variations in asset capacity utilisation rates across cycles, that are not accounted for in the productivity model described above. A range of univariate filters were used to generate cycles within the series, and the Hodrick-Prescott filter was determined to be the most appropriate filter. The cycles are chosen as 'peak to peak' and their starting points are determined by a number of factors, such as where output growth and multifactor productivity growth are at their highest deviation from trend, and where capacity utilisation is at its highest point. The final growth cycles selected also take into account economic events throughout the time period. For further detail on the methodology and associated economic commentary used for determining the growth cycles, refer to the Statistics NZ information paper *Extracting Growth Cycles from Productivity Indexes*, on Productivity statistics – Information releases webpage, available on the Statistics NZ website www.stats.govt.nz.

Industry coverage – the measured sector

The productivity measures do not cover the entire economy. The industry coverage of the statistics is defined as the 'measured sector', consisting of industries for which estimates of inputs and outputs are independently derived in constant prices. Excluded are those industries for which real value-added in the national accounts is largely measured using input methods, such as number of employees. These are mainly government non-market industries that provide services, such as administration, health, and education, free or at nominal charges. The measured sector is defined in the following table.

Productivity Industry Coverage[1]	
Measured sector industries	**Omitted industries**
A Agriculture, forestry, and fishing	LA Property services
B Mining	LB Ownership of owner occupied dwellings
C Manufacturing	M Government administration and defence
D Electricity, gas and water supply	N Education
E Construction	O Health and community services
F Wholesale trade	
G Retail trade	
H Accommodation, cafes, and restaurants	
I Transport and storage	
J Communication services	
K Finance and insurance	
LC Business services [2]	
P Cultural and recreational services	
Q Personal and other community services [2]	

[1] Based on the Australian and New Zealand Standard Industrial Classification 1996 (ANZSIC96).
[2] Included from March 1996 onwards in the measured sector

Since the Productivity Statistics: 1978–2007 release, the measured sector has been expanded to include business services, and personal and other community services from March 1996 onwards.

The former measured sector tables, now published as supplementary to this release, cover industries A to K and P. They maintain continuity with the previously released series. They are the best series for comparing with the official Australian productivity statistics, which are now based on ANZSIC 2006.

Published series

The productivity indexes now have an expression base year ended March 1978=1000, consistent with the first year of the series. The composition-adjusted productivity indexes have an expression base year ended March 1998=1000, consistent with the first year of the series. The measured sector GDP data used to calculate productivity indexes from 1978 to 1988 is currently provisional.

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Further information

The information paper Productivity Statistics: 1988–2005 was released in March 2006 and provides additional material on the nature of the productivity measures, their construction, and comparisons with similar productivity statistics published by the Australian Bureau of Statistics and the OECD.

The information paper Accounting for changes in labour composition in the measurement of labour productivity was released in December 2008. It provides background to, and application of, adjusting for compositional change in the labour productivity series. The primary output of the paper is the experimental composition-adjusted productivity series, which have now been updated to include 2009, and incorporated into this release.

Two technical papers are also available on Productivity statistics – Information releases web page, on the Statistics NZ website (www.stats.govt.nz). Productivity Statistics: Sources and Methods details the sources and methods used to compile the series and Estimating Growth Cycles from Productivity Indexes details the methodology used to derive growth cycles for the published series from 1978–2007.

Timing

Timed statistical releases are delivered using postal and electronic services provided by third parties. Delivery of these releases may be delayed by circumstances outside the control of Statistics NZ. Statistics NZ accepts no responsibility for any such delays.

Tables

The following tables are printed with this Hot Off The Press and can be downloaded from the Statistics New Zealand website in Excel format. If you do not have access to Excel, you may use the Excel file viewer to view, print, and export the contents of this file.

1 Productivity in the measured sector, productivity indexes and output measure
2 Productivity in the measured sector, productivity indexes and output measure – annual percentage change
3 Productivity in the measured sector, input measures
4 Productivity in the measured sector, input measures – annual percentage change
5 Productivity in the measured sector, growth accounting analysis – contributions to output growth
6 Productivity in the measured sector, growth accounting analysis – contributions to labour productivity
7 Productivity in the measured sector, productivity indexes and output measure, revisions summary
8 Productivity in the measured sector, productivity indexes – annual percentage change, revisions summary

Additional tables

The following tables can be downloaded from the Statistics New Zealand website in Excel format. If you do not have access to Excel, you may use the Excel file viewer to view, print, and export the contents of these files.

Former measured sector

1.1 Productivity in the former measured sector, productivity indexes and output measure
1.2 Productivity in the former measured sector, productivity indexes and output measure – annual percentage change
1.3 Productivity in the former measured sector, input measures
1.4 Productivity in the former measured sector, input measures – annual percentage change
1.5 Productivity in the former measured sector, growth accounting analysis – contributions to growth
1.6 Productivity in the former measured sector, growth accounting analysis – contributions to labour productivity
1.7 Productivity in the former measured sector, productivity indexes and output measure, revisions summary
1.8 Productivity in the former measured sector, productivity indexes – annual percentage change, revisions summary

Composition-adjusted

2.1 Composition-adjusted productivity in the measured sector, productivity indexes and output measure
2.2 Composition-adjusted productivity in the measured sector, productivity indexes and output measure – annual percentage change
2.3 Composition-adjusted productivity in the measured sector, input measures
2.4 Composition-adjusted productivity in the measured sector, input measures – annual percentage change
2.5 Composition-adjusted productivity in the measured sector, growth accounting analysis – contributions to growth
2.6 Composition-adjusted productivity in the measured sector, growth accounting analysis – contributions to labour productivity