

Estimates of Queensland Mining Productivity Performance, 1989-90 to 2011-12

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Introduction

This report follows the release of *Queensland Productivity Update: 2011-12*. Queensland Treasury and Trade is expanding on its range of productivity performance measures by developing industry level estimates of multifactor productivity (MFP) for Queensland¹. Currently, the Australian Bureau of Statistics (ABS) produces experimental estimates of industry MFP² at the national level, but no industry estimates are available at the state level.

Queensland Treasury and Trade has developed a methodology to estimate mining industry MFP growth which provides a better understanding of industry productivity performance and how the industry's performance impacts on aggregate Queensland MFP. Mining industry MFP estimates enhance the set of currently available mining industry information and allow for better analysis of industry output growth and its components.

This report provides measures of mining industry MFP for Queensland and Rest of Australia over the period 1989-90 to 2011-12. It should be noted that the mining industry includes the recent development of the liquefied natural gas (LNG) industry in Queensland. Annual data on mining MFP and related measures are presented at Appendix 1.

Background

In 2011-12, mining industry output (as measured by gross value added) represented 10.6 per cent of Queensland economic activity, 0.1 percentage point down from 10.7 per cent in 2010-11³. Further, Queensland's mining industry accounted for 2.8 per cent of total employment in 2011-12⁴. Given the contribution of the mining industry to the Queensland economy, it is important to understand the drivers of growth within this industry.

While labour productivity is widely used to measure productivity performance, its ease of calculation is offset by its inherent shortcomings in accounting for only one factor

of production. As such, an increase in capital inputs will lead to an increase in measured labour productivity.

Another way of analysing productivity estimates is through the decomposition of labour productivity into its two components: MFP growth and the rate of capital deepening⁵. This decomposition is important as while labour productivity is a more commonly used measure, it can mask the true rate of change in productivity due to variations in capital deepening.

Therefore, an advantage of estimating MFP growth is that it allows output growth to be decomposed into the contribution from accumulation of inputs: labour and capital, and MFP. MFP, therefore, treats capital as an input into the production process rather than as a labour productivity gain. As such, MFP measures the efficiency with which these combined inputs, labour and capital, are being transformed into output.

A final point to consider is that short term movements in productivity should be interpreted with caution as productivity estimates are volatile from year-to-year. Such changes in measured productivity may not be truly indicative of productivity trends as these short term fluctuations may reflect the degree to which firms are utilising their capital stock or the fact that employment growth tends to lag output growth. Therefore, in this publication MFP is analysed from a long term perspective.

Long term trends

Figure 1 shows the indices for Queensland mining industry MFP, as well as Queensland economy-wide MFP⁶ between 1989-90 and 2011-12 (referenced to 1989-90 levels). As shown, mining industry MFP is more volatile than the economy-wide measure, which is a weighted average of all 19 industries in Queensland.

¹ This report complements the suite of Queensland Treasury and Trade's productivity publications: *An Historical Analysis of Productivity in Queensland*; *Estimates of Queensland Productivity Performance, 1985-86 to 2009-10*; *Queensland Productivity Update: 2011-12*; and *Methodology for Compiling State Estimates of Multifactor Productivity*. For further information, see <http://www.oesr.qld.gov.au/products/publications/estimates-qld-productivity-performance/index.php>.

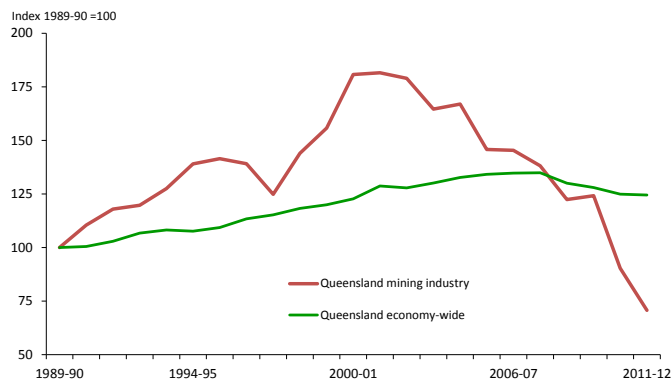
² Australian Bureau of Statistics, *Experimental Estimates of Industry Multifactor Productivity, 2011-12*, Cat no. 5260.0.55.002.

³ Australian Bureau of Statistics, *Australian National Accounts: State Accounts, 2011-12*, Cat no. 5220.0.

⁴ Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly, Dec 2012*, Cat no. 6291.0.55.0030.

⁵ Defined as the ratio of the growth in capital to the growth in labour.

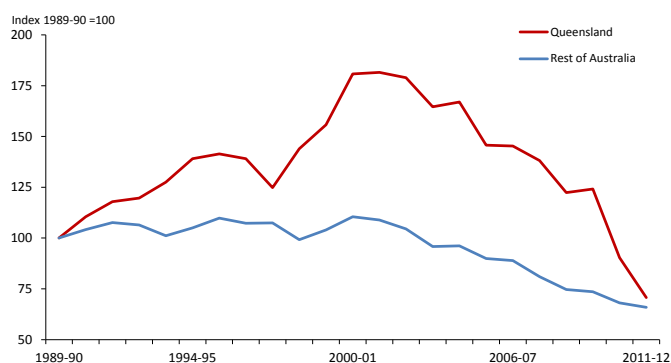
⁶ For a more detailed analysis of Queensland's all-economy MFP performance see *Queensland Productivity Update: 2011-12*.

Figure 1: Mining and economy-wide MFP indices, Queensland, 1989-90 to 2011-12⁶


Source: Queensland Treasury and Trade estimates

Queensland mining industry MFP increased by an average annual 5.1 per cent between 1989-90 and 2001-02, 3.0 percentage points higher than average annual growth in economy-wide MFP of 2.1 per cent over this period. As shown above, despite short term fluctuations, the mining industry generally outperformed the State average measure throughout the 1990s. Since 2001-02, however, the slowdown in mining industry MFP occurred at a faster pace, resulting in a weaker productivity performance on average over the long term. Over the 10 years to 2011-12, Queensland mining industry MFP declined by 9.0 per cent per annum, 8.7 percentage points lower than the average annual decline of 0.3 per cent in economy-wide MFP.

Figure 2 compares mining MFP indices for Queensland and Rest of Australia over the period 1989-90 to 2011-12.

Figure 2: Mining MFP index, 1989-90 to 2011-12


Source: Queensland Treasury and Trade estimates

Queensland mining MFP peaked in 2001-02, 81.5 per cent higher than 1989-90 levels recording average annual growth of 5.1 per cent per annum. Since 2001-02, however, Queensland mining MFP has declined 61.1 per cent or by 9.0 per cent per annum over this ten year period. Rest of Australia MFP peaked a year earlier than Queensland, however, for comparison purposes Rest of Australia MFP

only increased by 8.9 per cent over the period 1989-90 to 2001-02 recording average annual growth of 0.7 per cent per annum. Since 2001-02, MFP in the Rest of Australia has declined by 39.5 per cent or by an average 4.9 per cent per annum.

MFP in the Queensland mining industry fell in the late 1990s, partly as a result of strong growth in capital investment which was not fully implemented and operational until the early part of the subsequent decade.

The main destination for Queensland coal exports during the late 1990s was Asia, with most economies in this region being impacted upon by the onset of the Asian financial crisis. Most recently, Queensland mining output was severely impacted by heavy rain and Cyclone Yasi in 2010-11 and output has not yet recovered to the pre-flood level. In addition, the significant capital investment in LNG projects over the past 2 years with no corresponding increase in output has further reduced Queensland MFP.

Table 1 summarises estimates of long term (1989-90 to 2011-12) output growth for the mining industry in Queensland, Rest of Australia and Australia and provides a decomposition of mining industry performance. Output growth in Queensland's mining industry has averaged 3.7 per cent per annum over the period, 0.3 percentage point above average annual growth in mining output recorded in Rest of Australia (3.4 per cent).

Table 1: Mining long run productivity growth, 1989-90 to 2011-12^(a)

Average annual growth	Queensland	Rest of Australia	Australia
	Per cent		
Output^(b)	3.7	3.4	3.5
Multifactor productivity	-1.6	-1.9	-1.8
Labour productivity	-0.7	-0.5	-0.6
less Capital deepening	0.9	1.4	1.3
Combined labour and capital inputs^(c)	5.4	5.4	5.4
Hours worked	4.5	4.0	4.1
Capital services	6.3	6.0	6.1

(a) Sum of component contributions to growth may not add due to rounding

(b) Output is measured as mining industry Gross Value Added

(c) Weighted in terms of labour and capital income shares

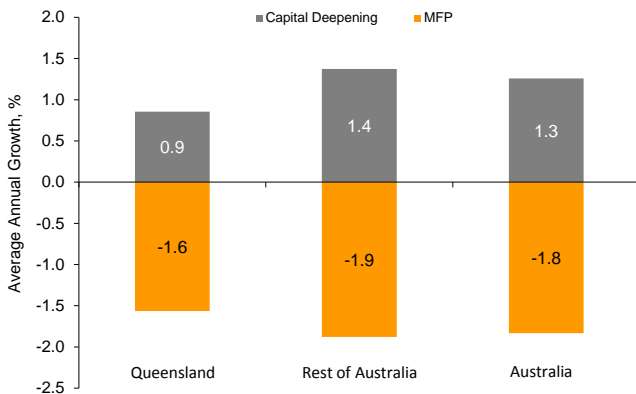
Source: Queensland Treasury and Trade estimates

Over the period 1989-90 to 2011-12, strong output growth in Queensland's mining industry was primarily due to growth in combined labour and capital inputs of 5.4 per cent in average annual terms. This increase was driven by 6.3 per cent growth in capital services with hours worked increasing an average annual 4.5 per cent over this period. Combined labour and capital inputs growth for Queensland

between 1989-90 and 2011-12 was the same as that of Rest of Australia's growth of 5.4 per cent.

Queensland's mining industry recorded average MFP decline of 1.6 per cent per annum between 1989-90 and 2011-12, compared with an average annual decline of 1.9 per cent for Rest of Australia. Figure 3 shows the rate of capital deepening and the respective MFP performances of Queensland, Rest of Australia and Australia between 1989-90 and 2011-12.

Figure 3: MFP and capital deepening, 1989-90 to 2011-12



Source: Queensland Treasury and Trade estimates

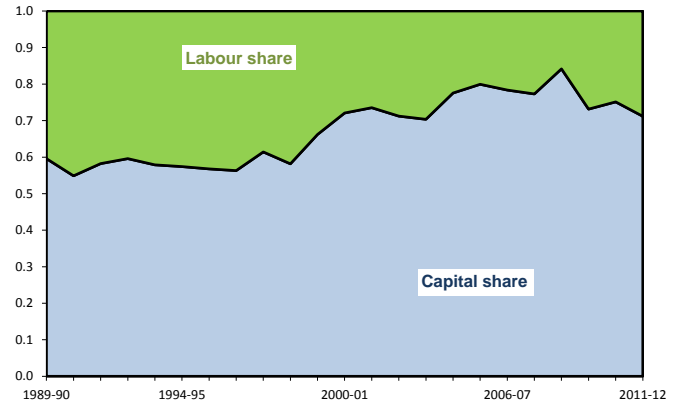
As previously indicated, labour productivity can be decomposed into its two components: MFP growth and the rate of capital deepening. Queensland mining industry labour productivity decline on average by 0.7 per cent per annum between 1989-90 and 2011-12. The major contributor to the decline in labour productivity was MFP (-1.6 percentage points) with capital deepening contributing 0.9 percentage point. This highlights that, while there has been an increase in worker's access to capital, there has not been the corresponding increase in the industry's production efficiencies.

Similar to that of Queensland, mining industry labour productivity in Rest of Australia also fell, by 0.5 per cent in average annual terms between 1989-90 and 2011-12. This was driven by a fall of 1.9 per cent average annual growth rate in MFP, which more than offset a 1.4 per cent average annual increase in capital deepening.

The strong growth in capital investment since the mid-to-late 1990s has led to an increase in the use of capital relative to labour as a factor of production in the Queensland mining industry. Figure 4 illustrates labour and capital shares within the mining industry since 1989-90. These shares represent the respective factor cost proportions and highlight the relative weights of labour and capital in the mining industry. As shown, the Queensland mining industry was already capital intensive in 1989-90 but

the significant investment in new capital that has taken place over recent years has led to a further deepening of capital relative to labour inputs.

Figure 4: Labour and capital shares, Queensland, 1989-90 to 2011-12



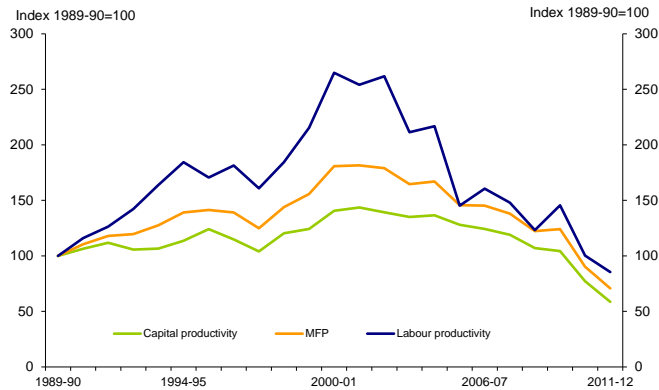
Source: Queensland Treasury and Trade estimates

As described above, MFP is a measure of how efficiently labour and capital inputs are being transformed into output. As such, MFP performance will be influenced by labour and capital productivity respectively. How these two elements combine to form an MFP estimate depends on the labour and capital intensity. The increase in capital share highlighted in Figure 4 implies that, over time, capital productivity growth will more closely reflect changes in industry MFP. Conversely, labour productivity growth is less likely to be closely aligned with MFP performance.

The capital intensive nature of mining results in the industry having a high labour productivity level relative to other industries. It also implies that measured labour productivity in the mining industry tends to be more volatile in comparison to other, more labour intensive industries. These characteristics of the Queensland mining industry further emphasise that using labour productivity to understand the industry's productivity performance can be misleading.

To illustrate this point, Figure 5 shows different productivity performance measures for mining, labour, capital and multifactor productivity. Due to the capital intensity of the Queensland mining industry, the efficiency with which capital is used in the production process is the major determinant of MFP performance.

Figure 5: Mining productivity measures, Queensland, 1989-90 to 2011-12



Source: Queensland Treasury and Trade estimates

Factors influencing recent performance

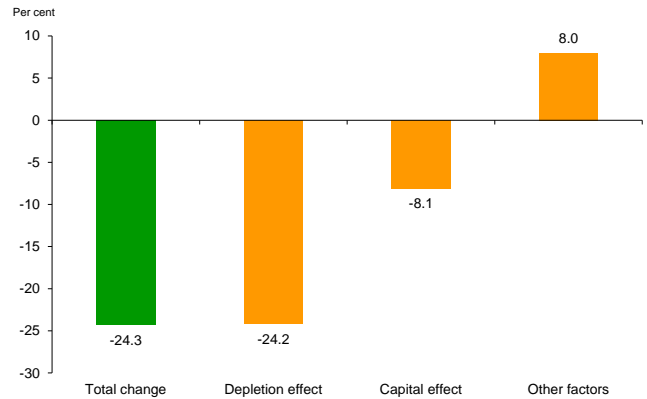
Analysis by the Productivity Commission⁷ suggests possible reasons for the observed moderation in Australian mining industry MFP growth. The Commission found that the significant decline in Australia’s mining industry MFP was due to:

- firms taking profit opportunities due to higher export prices by utilising more labour in existing mines to lift output quickly;
- capital investment in expanded and new mines that will only lift output in the future; and
- declining resource quality.

Standard productivity accounts do not make allowance for changes in the quality of natural resources and the fact that there exists a lag between the accumulation of capital stock and a production response.

The Productivity Commission quantified the impact of the investment-output lag and declining resource quality on mining productivity performance at the national level⁸. Figure 6 shows that between 2000-01 and 2006-07, MFP in the Australian mining industry fell a total of 24.3 per cent.

Figure 6: Contributions to the decline in mining MFP, Australia, 2000-01 to 2006-07⁹

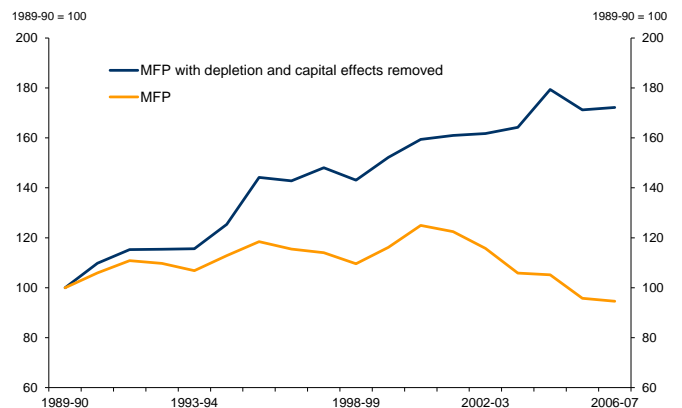


Source: PC, Topp, Soames, Parham and Bloch (2008)

A reduction in the quality of resources, or depletion effect (as measured by the change in yield of these mining operations), almost accounts for the entire decline in MFP over the six years to 2006-07, detracting 24.2 percentage points from MFP growth. Further, the capital effect (or impact of investment which is included as inputs but not yet used to increase output) detracted 8.1 percentage points from MFP growth. Other factors, such as technology advances and improved management practices or skills contributed 8.0 percentage points to MFP growth between 2000-01 and 2006-07.

Accounting for resource quality and the lag between investment and output, the Productivity Commission estimated that MFP growth was positive in the Australian mining industry between 1989-90 and 2006-07 (Figure 7).

Figure 7: Mining MFP with depletion and capital effects removed, Australia



Source: PC, Topp, Soames, Parham and Bloch (2008)

⁷ Productivity Commission Submission to House of Representative Standing Committee on Economics, *Inquiry into Raising the Level of Productivity Growth in the Australian Economy*, 2009.

⁸ *Productivity in the mining industry: measurement and interpretation*, Productivity Commission (December 2008)

⁹ Estimates by Topp, V., Soames, L., Parham, D. and Bloch, H. 2008, *Productivity in the Mining Industry: Measurement and Interpretation*, Productivity Commission Staff Working Paper, December.

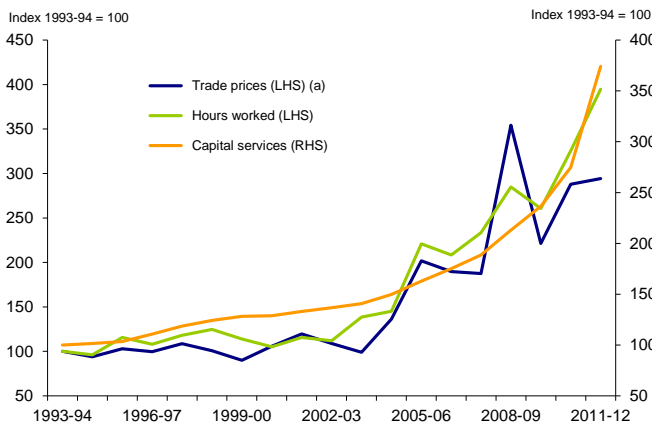
A Queensland perspective

The remainder of this report focuses on the recent MFP performance of the mining industry in Queensland and is split into three sections. Each section summarises a different factor currently influencing the productivity performance of Queensland’s mining industry.

Impact of higher export prices

The recent increases in the prices received for Queensland’s mining industry exports have coincided with a substantial moderation in MFP. Sharp increases in international commodity prices have led to a significant increase in both capital investment and the demand for labour hours in the Queensland mining industry (Figure 8). Despite being down from the 2008-09 peak, trade prices (predominately prices received for coal exports) are still 197 per cent higher than the 2003-04 level.

Figure 8: Mining indicators, Queensland, 1993-94 to 2011-12



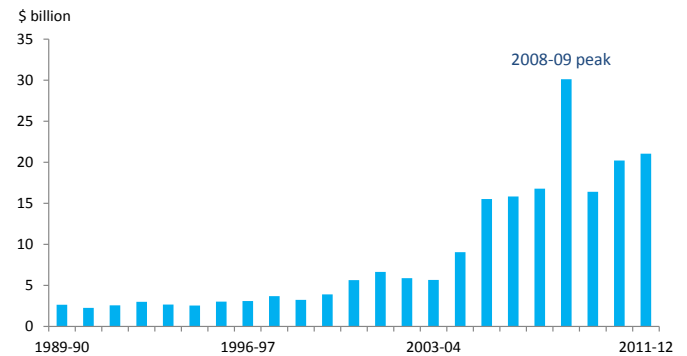
(a) Coal, coke and briquettes and Metal ores and minerals
Source: Queensland Treasury and Trade estimates, ABS 6291.0 and unpublished data

Similarly, capital services and hours worked in the Queensland mining industry have risen 166 per cent and 185 per cent respectively between 2003-04 and 2011-12. In contrast, real output in the mining industry has grown by 15.3 per cent over this period. It is this combination of strong growth in inputs and more moderate output growth that has led to the weaker MFP performance in recent years.

To the extent that firms are profit maximisers, productivity growth is usually targeted as a complementary objective. However, the period since 2003-04 has been characterised by an increase in mining profits, despite the decline in MFP, as mining firms are benefiting from extraction of more marginal deposits.

Figure 9 shows that profitability, measured here as mining industry gross operating surplus and mixed income, is 270 per cent higher in 2011-12 than the 2003-04 level.

Figure 9: Mining industry profits, Queensland, nominal^(a)



(a) Proxied by mining industry gross operating surplus and mixed income
Source: ABS 5220.0

Queensland mining industry profits rose by 59 per cent in 2004-05, followed by a 72 per cent increase in 2005-06 and then a further 79 per cent to the peak in 2008-09. Since 2005-06, mining industry profit has remained elevated and coincides with the period of lower MFP.

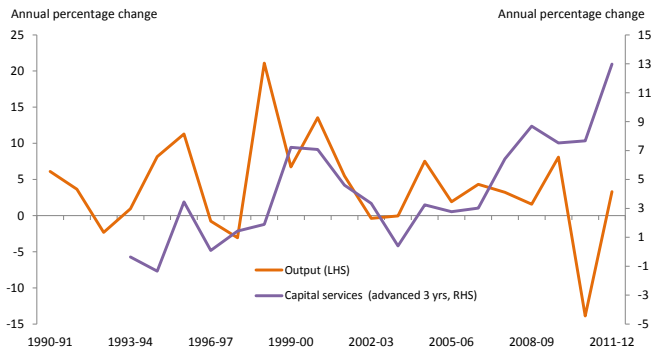
While there are other factors which will influence productivity performance and profits, this outcome supports the notion that profit maximising firms are willing to forgo short term productivity performance in response to strong commodity price increases.

Lag between investment and output

Official statistics on capital inputs are collected at the time of installation rather than at the time they become fully utilised. Because capital can sit idle for some time before becoming fully operational, the collection of data at the time of installation can result in a lag between investment and output growth. This measurement issue is accentuated when growth in capital investment is accelerating.

Figure 10 shows output growth and capital services (advanced three years) for the Queensland mining industry. While there is generally a lag between investment and output, their relationship has broken down in recent years. Demand for Queensland’s mining output in 2008-09 was heavily affected by the onset of the global financial crisis, and while there was a bounce in 2009-10, recent flooding of mines and related disruptions to transport corridors has impacted production levels for 2010-11.

Figure 10: Lag between capital services and output growth, Queensland, annual percentage change



Source: Queensland Treasury and Trade estimates, ABS 5220.0

As shown above, output growth has not yet responded to the high levels of investment in capital. The continued investment and demand for labour may be due to business expectations of sustained high export demand, and consequently sustained high prices. Further, the strong growth in capital investment over the past 2 years relates to LNG projects with the corresponding output not expected to be recorded until 2014. It may also be partly explained by the depletion of natural resources which results in more inputs being required to generate the same level of output (this concept is discussed in more detail in the following section).

If the high level of investment results in a corresponding increase in output, there will be a substantial boost to industry MFP relative to current levels. However, any long term trend in MFP is dependent upon whether or not new investment results in more or less efficiency in the mining process.

Declining resource quality

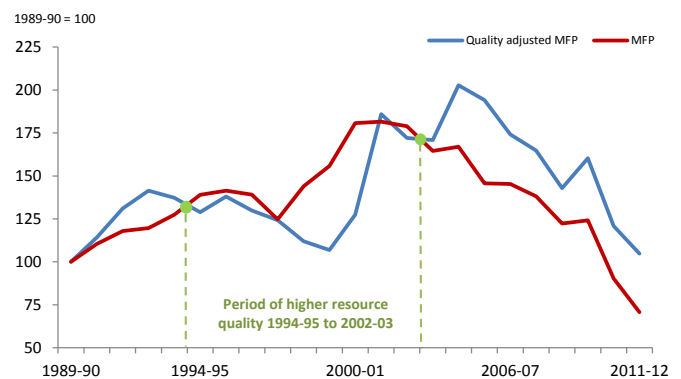
The depletion of scarce natural resources results in the need to exploit deposits of lower quality and in more difficult to access locations (both the remoteness of mine sites and the fact that deposits may lie deeper underground). In each case, more inputs are required to generate a given level of output. Further, higher commodity prices encourage the extraction of lower grade ores and increases the economic viability of otherwise marginal ventures.

Figure 11 shows the original estimate of Queensland mining MFP along with an adjusted MFP series which accounts for declining resource quality faced by Queensland miners. Due to data availability and quality, adjustments were only undertaken for the coal mining industry, which accounted for approximately 71 per cent of Queensland mining production value in 2010-11. These resource quality

changes were assumed to be representative of the broader Queensland mining industry.

The adjusted MFP series compensates for changes in both the quality of mine deposits, using the ratio of saleable coal to raw coal output, and the amount of overburden excavation required prior to mine operation. Accounting for changes in the quality of resources effectively strips out this element so a more targeted measure of MFP can be estimated. When the quality of resources increases (declines), adjusted MFP is below (above) that of the original MFP series.

Figure 11: Mining MFP adjusted for quality of resource changes, Queensland



Source: Queensland Treasury and Trade estimates, ABS 5220.0

With the exception of one year (2001-02), the period from 1994-95 to 2002-03 was characterised by quality adjusted MFP below that of the original series. Therefore, over this period resources were of higher quality compared to 1989-90 levels and this exacerbated the late 1990s decline in the standard MFP measure. That is, the use of combined inputs increased over this period despite an increase in the quality of mine resources. In each year since 2003-04, however, the quality of resources has been below the level recorded in 1989-90 with resource quality in 2011-12 down 28.6 per cent on 2002-03 levels. This has resulted in a better productivity outcome for the quality adjusted MFP series compared to the original MFP series.

Once the impact of declining resource quality is accounted for, Queensland's mining MFP grew by an average annual 0.2 per cent over the period 1989-90 to 2011-12, 1.8 percentage points per annum stronger than the decline in the standard MFP measure of 1.6 per cent.

Figure 11 also shows that, despite the adjustment for declining resource quality, MFP has trended down since 2004-05.

In summary, declining resource quality explains some, but not all, of the recent fall in Queensland mining industry

MFP. A number of other factors are likely influencing the recent productivity performance. Firstly, the lag between investment and the corresponding output growth may be significant with mining investment in Queensland at record levels and an expected increase in production capacity yet to materialise.

Secondly, the appropriate output measure in the calculation of MFP is Gross Value Added in real (or volume) terms. This allows for an analysis of how many physical units are produced for a given volume of inputs. However, firms respond to output prices and target productivity growth as a means to maximise profits. While gains in productivity are usually paralleled by improvements in profitability, there are times when firms choose to maximise profits at the expense of productivity gains in the short term.

Appendix 1 – Long term indexes of Mining productivity and related measures (2010-11 = 100)

	Productivity				Output		Inputs					
	MFP		Labour		QLD	ROA	Total inputs		Hours worked		Capital services	
	QLD	ROA	QLD	ROA			QLD	ROA	QLD	ROA	QLD	ROA
1989-90	110.7	146.9	99.7	99.0	46.3	51.0	41.8	34.7	46.4	51.5	35.8	30.1
1990-91	122.3	153.0	115.6	112.0	49.1	53.9	40.1	35.2	42.5	48.1	35.6	31.5
1991-92	130.6	158.1	126.0	124.7	50.9	56.5	39.0	35.7	40.4	45.3	35.1	32.8
1992-93	132.5	156.3	141.9	125.8	49.7	57.5	37.5	36.8	35.0	45.7	36.4	34.0
1993-94	141.2	148.6	163.4	114.5	50.2	58.6	35.5	39.4	30.7	51.2	36.4	35.9
1994-95	154.0	154.2	183.7	125.5	54.3	62.6	35.2	40.6	29.5	49.9	36.9	37.7
1995-96	156.6	161.2	170.0	144.0	60.4	68.0	38.6	42.2	35.5	47.2	37.6	40.4
1996-97	154.0	157.6	180.8	144.4	59.9	69.2	38.9	43.9	33.2	47.9	40.3	42.4
1997-98	138.2	157.9	160.3	158.7	58.1	72.6	42.0	46.0	36.3	45.7	43.2	45.8
1998-99	159.4	145.6	183.8	154.3	70.4	68.9	44.1	47.3	38.3	44.6	45.2	48.0
1999-00	172.5	152.8	214.7	169.7	75.1	71.8	43.5	47.0	35.0	42.3	46.7	48.3
2000-01	200.2	162.3	264.0	182.3	85.3	76.6	42.6	47.2	32.3	42.0	46.9	48.7
2001-02	201.0	160.0	253.3	186.1	90.0	75.8	44.8	47.4	35.5	40.7	48.4	49.2
2002-03	198.2	153.5	260.8	163.0	89.6	76.5	45.2	49.8	34.4	46.9	49.7	50.7
2003-04	182.3	140.7	210.7	148.9	89.6	73.6	49.2	52.3	42.5	49.5	51.2	53.1
2004-05	184.9	141.3	216.1	141.4	96.3	76.9	52.1	54.5	44.6	54.4	54.5	54.5
2005-06	161.4	132.1	144.7	129.8	98.2	78.4	60.8	59.4	67.8	60.4	59.3	59.2
2006-07	160.9	130.6	160.1	127.8	102.4	86.1	63.7	65.9	64.0	67.3	63.7	65.6
2007-08	152.9	119.0	147.5	124.9	105.7	87.5	69.1	73.6	71.7	70.0	68.6	74.3
2008-09	135.5	109.7	122.8	113.7	107.4	90.6	79.3	82.6	87.5	79.7	77.5	83.2
2009-10	137.5	108.0	145.1	113.7	116.1	97.7	84.5	90.4	80.0	85.9	86.1	91.3
2010-11	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2011-12	78.3	96.8	85.2	88.5	103.3	107.6	132.0	111.2	121.2	121.6	136.2	109.3
Average annual growth over full period (%)												
1989-90 to 2011-12	-1.6	-1.9	-0.7	-0.5	3.7	3.4	5.4	5.4	4.5	4.0	6.3	6.0

Source: Queensland Treasury and Trade estimates