Recent Productivity Trends in NSW[1]

Harley Smith, David Buckland, Matias Vaira and Niall Cummings[2]

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This paper discusses the multifactor productivity trends for NSW industries. Unique multifactor productivity estimates for NSW industries, based on an analysis of ABS data, were developed. These productivity trends were compared with those at the national level. The results indicate that there is no difference between recent Australian and NSW productivity trends at the industry level. Further, it was investigated the assertion that, as for Australia, the recent poor productivity performance for NSW does not demand a specific government response. Declining productivity growth in NSW was found to be prominently influenced by several specific industries, especially mining and utilities. Statistical analysis indicates that commodity prices have had a significant role in explaining the productivity trends in the NSW mining industry. Likewise, the utilities industry is also influenced by sector specific drivers. The recent productivity trends in NSW are, therefore, found to have been influenced predominantly by factors that arise as a result of normal business and investment cycles.

Key words: causal effect, multifactor productivity, utilities industry, mining industry, NSW productivity.

1. Introduction

Following a period in the 1990s and early 2000s when Australia experienced unusually rapid productivity growth, trend productivity growth in Australia has slowed substantially over the latter part of the 2000s and into the 2010s (D'arcy & Gustafsson, 2012). This decline in productivity growth has sparked concern among some commentators and decision makers. However, a combination of well-reported phenomena, and doubts about the veracity of productivity measurement techniques, suggest that the recent stalling of productivity growth in Australia may not be as calamitous as some suggest.

The majority of the recent rapid productivity decline in Australia was reported to be primarily driven by specific developments in three key domestic market industries; mining, utilities and agriculture (Productivity Commission, 2009). Subsequent research indicates that the influence of mining and utilities continues, with manufacturing recently replacing agriculture as the other major cause of Australia's productivity decline (Productivity Commission, 2013).

Further detailed investigation has revealed that normal business and investment cycles within these industries appear to account for the observed changes in productivity. These cycles are a response to exogenous factors like commodity prices, drought and industry structural adjustment. Market

[1] The information contained in this publication is based on knowledge and understanding at the time of writing (March 2015). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Trade and Investment, Regional Infrastructure and Services or the user's independent adviser.

[2] Authors are at NSW Trade & Investment, Locked Bag, 21, Orange, NSW, 2800, Australia.

failure does not seem to be responsible for these downward productivity trends. Thus, specific government attention or a policy response is therefore not necessarily warranted.

In support of this postulation, the Australian Bureau of Resources and Energy Economics recently reported that it:

> *"does not recommend any industry specific policies to improve productivity growth in the mining sector above and beyond general public policies to improve productivity, such as investments in human capital. In other words, the apparently deteriorating productivity performance in mining is not an indication of a specific mining policy problem that necessarily requires a policy remedy, but is rather a result of factors, such as the strength of resource prices, that have contributed to endogenous resource depletion". (Syed, Grafton, & Kalirajan, 2013)*

Similar recommendations have also been made by the Productivity Commission, the Australian Treasury, and the Organisation for Economic Co-operation and Development (OECD).

Rather than advocating industry specific policy action, current literature predominately recommends broad based policy action. These recommendations include reforms to enhance investment in infrastructure and knowledge-based capital as well as to boost labour force participation (OECD, 2014). The recommendations predominately apply generally by ensuring that Australia has well-functioning, competitive and open markets.

Our research aims to discover to what extent the national productivity trends are replicated at the New South Wales (NSW) State level, and therefore, to what extent these recommended national policy actions might apply in NSW. Our analysis is based on Australian Bureau of Statistics (ABS) data, and draws on similar methodologies used by others to derive unique State-level productivity measures.

The results of our analysis indicate that the decline in NSW productivity growth is predominately influenced by mining (although to a lesser degree than for Australia), utilities and real estate services. Productivity growth in manufacturing does not appear to be a significant contributor to trend productivity declines at the NSW level. Productivity growth in the NSW mining industry was also found to be negatively correlated with commodity prices, thus supporting the postulation that factors outside of the government's control are the underlying cause.

This paper reports on whether the recommended policy actions at the national level are both applicable and appropriate to be replicated at the NSW level by the NSW government. Section 2 includes further background on productivity and the relevant NSW industries, section 3 includes an outline of this analysis methodology and approach, Section 4 reports on the findings of our analysis and section 5 includes a discussion on the findings.

2. Background

Productivity is a useful measure of the relative performance of an industry or economy. At the broadest level, productivity is a ratio of outputs to inputs that reports how efficiently resources are used to produce a given level of output (Green, Toner, & Agarwal, 2012). An increase in productivity,

therefore, would either imply that fewer inputs were required to produce the same amount of output, or more outputs could be produced with the same amount of inputs.

At the economy wide level, productivity growth is desirable because it contributes to improved living standards (Australian Treasury, 2009), through either increased incomes, reduced prices or increased leisure time (Productivity Commission, 2008). Improvements in productivity also result in a more efficient allocation of scarce resources throughout the economy (Green et al., 2012), and can help buffer the economy from external shocks and increased competition.

Improvements in productivity generally result from; better technology becoming available; the wider adoption of available technology; or optimising the use of available resources or capacity. However, measures of productivity often also reflect other factors, like; shifts between inputs (e.g. outsourcing); changes in the quality of inputs (e.g. improved worker qualifications and skills); changes to the scale of operations; the entry and exit of firms in a market, and other factors such as changes in climatic conditions (e.g. drought).

Many factors influence productivity growth and, as such, the Productivity Commission developed a productivity framework that explains the main causal factors and interacting relationships (see appendix 1). Price pressures (changes in costs and returns, declining terms of trade) and the associated competitive responses have been identified as the key drivers of improved productivity. Consequently, productivity growth is rarely supply driven, i.e., the mere generation of new knowledge will not in itself drive productivity improvements. It is an organisation's response, and capacity to respond, to the availability of new knowledge when terms of trade and business adjustment pressures occur, that leads to productivity growth (Productivity Commission, 2008).

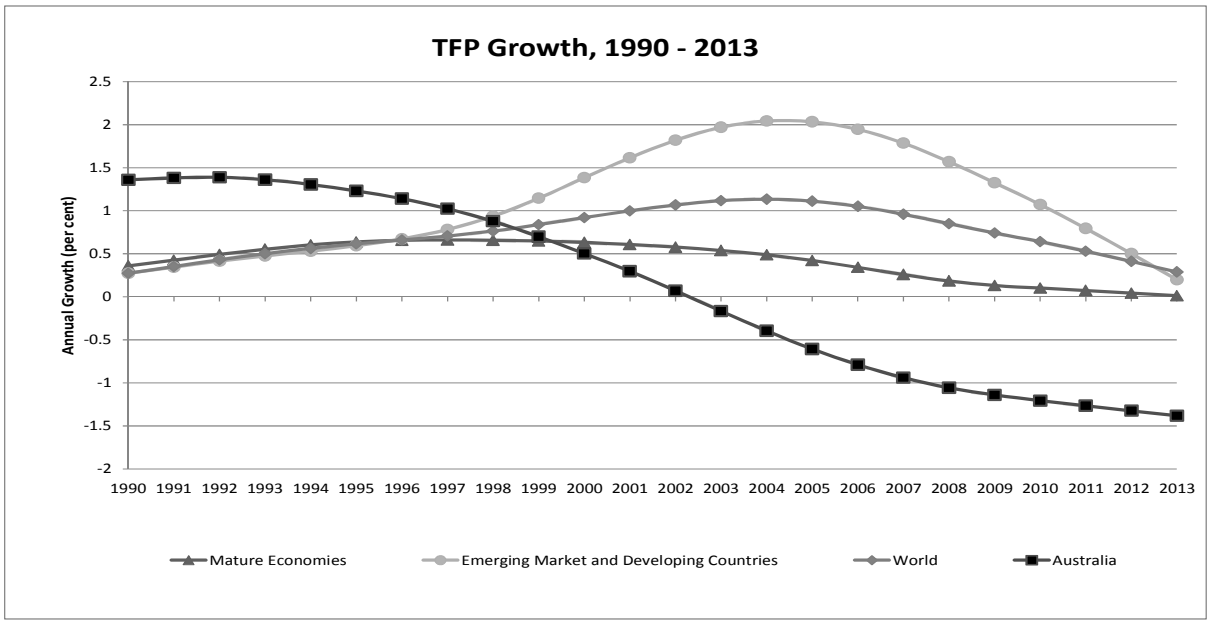
2.1 Productivity Measures

Measures of productivity typically include either; labour productivity (output by labour); multifactor productivity (MFP) (output by labour and capital); and/or, total factor productivity (TFP) (output by all measurable inputs) (New South Wales Treasury, 2002). In this paper, MFP has predominately been used to measure and assess productivity levels. MFP growth represents the part of economic growth that is over and above the growth in labour, capital, and intermediate inputs (Barnes, 2011).

2.2 Observed Global Productivity Trends

Productivity estimates by the Conference Board (The Conference Board, 2014a) show annual global TFP growth declining since 2005. Although the productivity growth trend in mature economies has been relatively stable (declining somewhat in the mid 2000's), this has been overshadowed by the dramatic decline in productivity growth of emerging economies since 2005 (see Figure 1). Australian productivity growth shows an even more dramatic decline than that of all mature economies combined.

Figure 1: TFP Growth 1990-2013 (trend estimates using Hodrick–Prescott (HP) filter[3])



Source: (The Conference Board, 2014a)

This observation and potential cause for alarm is also supported by other observations in current literature. "The story for both labour productivity (output per hour worked) and total factor productivity is the same. Declining global productivity growth rates are a result of a long history of falling productivity growth in advanced economies which is no longer more than offset by huge rises in the efficiency of emerging economies" (Giles, 2014).

The Conference Board 2014 Productivity Brief, discusses how the recent weak worldwide productivity growth is due mainly to lower levels of demand following the global financial crisis. This in turn has caused a decline in outputs relative to inputs (i.e. capacity under-utilisation) (The Conference Board, 2014b).

2.3 The situation in Australia

Despite reporting a dramatic fall in MFP growth over the past two decades (as shown in Figure 1), Australia has nonetheless enjoyed a similar period of steady increases in per capita income. This has been predominately driven by favourable terms of trade, and is the reason why the decline in measured productivity growth was formerly less of a concern than it is now. As Parham has asserted; "Now that the terms of trade have peaked, re-invigorated productivity growth is needed to boost income and living standards" (Parham, 2013).

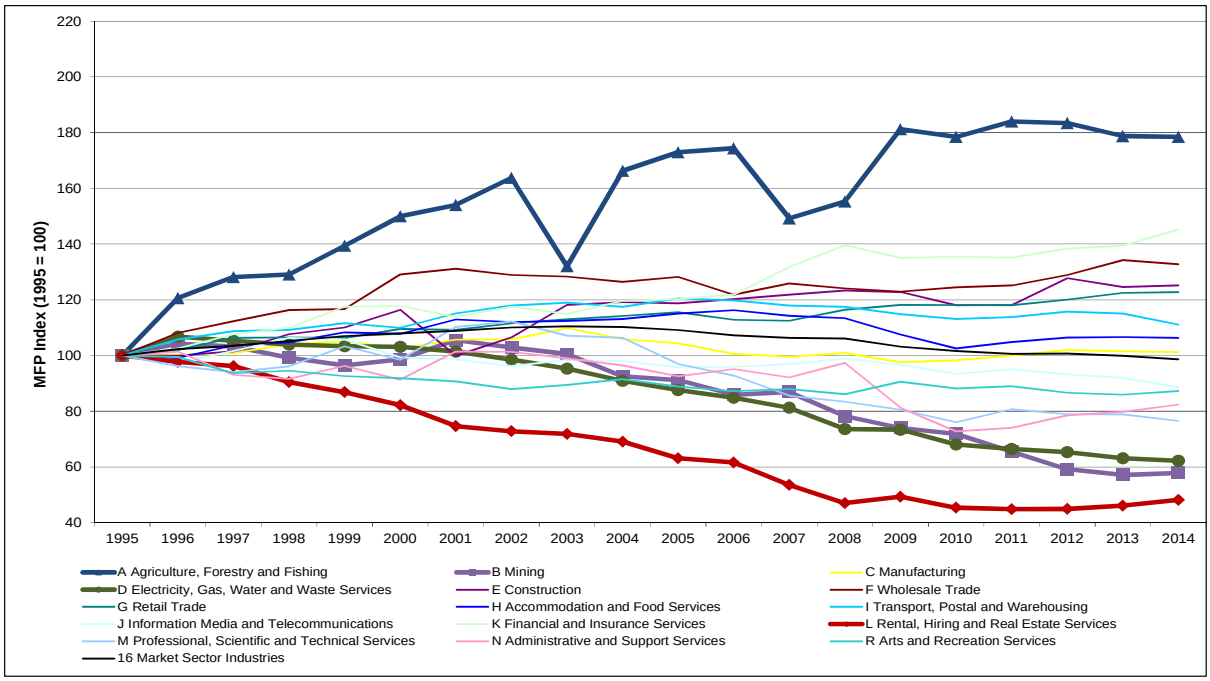
While developed economies share a number of common features with Australia, current literature indicates that Australia's recent productivity performance appears to be driven primarily by domestic factors rather than factors common to developed economies (Carmody, 2013). This postulation is supported by the Australian Government Treasury paper that states; "The broad-

[3] The Hodrick–Prescott (HP) filter is a mathematical tool used in macroeconomics, especially in real business cycle theory, to separate the cyclical component of a time series from raw data. It is used to obtain a smoothed-curve representation of a time series, one that is more sensitive to long-term than to short-term fluctuations

based slowdown has been attributed to lost momentum for reform; delays in output from investment associated with the commodities boom; drought; lumpy investments in utilities; and adjustment pressures as businesses respond to the high Australian dollar and higher prices" (Carmody, 2013).

This decline in Australia's MFP growth can be further examined by disaggregating the Australian productivity measurements into its constituent individual Australian industry sectors. By using an index approach, the trends of each of the 16 Australian and New Zealand Standard Industrial Classification (ANZSIC) codes for the market sector can be observed in isolation. See Figure 2.

Figure 2: Australian MFP by industry (market sector)



Source: T&I analysis, 2014, based on data from (Australian Bureau of Statistics, 2014b)

This figure shows that Mining (the Mining industry); Electricity, Gas, Water and Waste Services (the Utilities industry); and Rental, Hiring and Real Estate Services (the Real Estate Services industry) display the greatest decline in MFP index over this selected period. Considering also that because this is only an index approach, despite the fact that the trend line for Agriculture, Forestry and Fishing (the Agriculture sector) is considerably higher than the other lines, the starting point arbitrarily occurs in the trough of a drought and therefore the subsequent growth in productivity may not be as impressive as the graph suggests. Furthermore, the considerable declines portrayed for this sector in 2002 and 2007 occur during the worst years of the millennium drought and have easily identifiable explanations. Figure 2 also reveals that apart from these 'outlier' industries identified above, the remaining industry market sectors display a predominantly neutral (or slightly positive) growth in MFP.

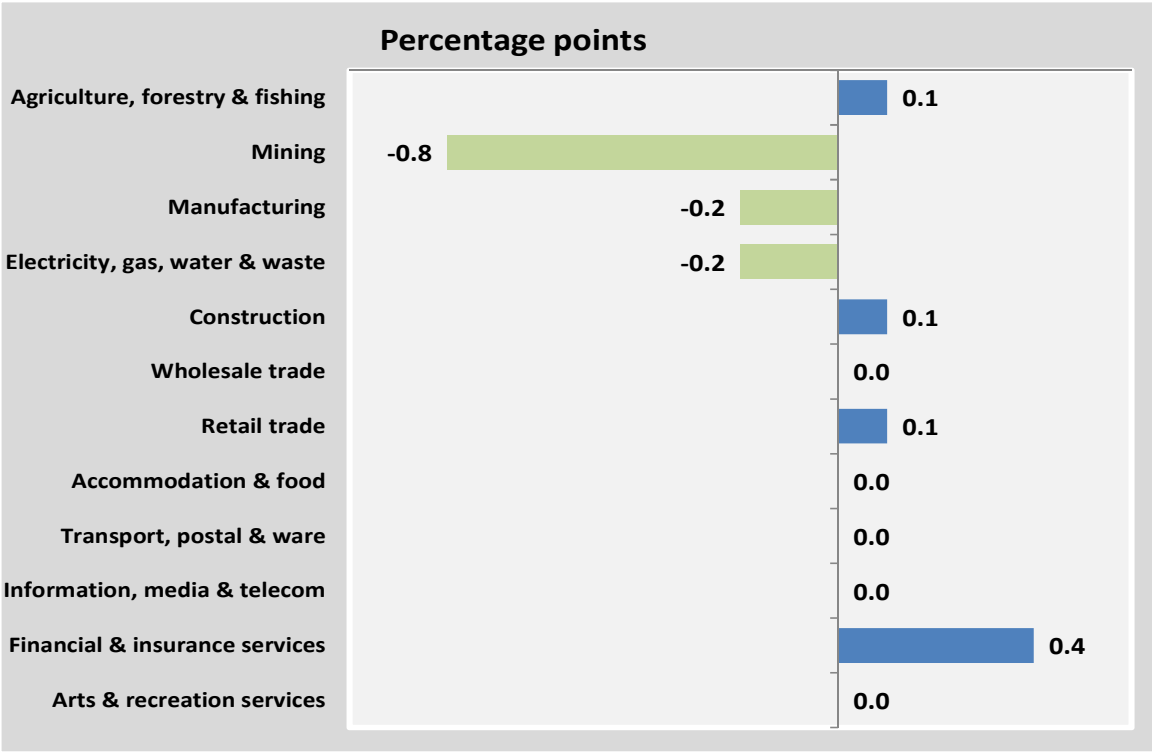
In 2013, the Productivity Commission determined that; "Once allowance is made for the different size of each industry (and hence the extent of their influence on the market sector average), three

industries are found to have contributed the most to the reduction in the aggregate result for the eight years since 2003-04: Mining; Manufacturing; and Utilities" (Productivity Commission, 2013).

Of these, mining has had the greatest influence on Australia's productivity trends with a substantial increase in commodity prices driving large capital investments that are only now resulting in greater output. This, coupled with a decline in the quality or grade of newly developed mines (i.e. resource depletion) has reduced productivity.

The influence of mining is clearly shown in Figure 3 below, with the contribution of Manufacturing and Utilities also prevalent. Other industries such as Agriculture and Real Estate Services have revealed anomalies with regard to reported MFP trends (see Figure 2 above) and are therefore further explained in due course.

Figure 3: Industry contributions to Australian market sector MFP growth over the period 2003-04 to 2011-12



Source: (Productivity Commission, 2013)

A further discussion of these most significant industries is given below.

2.3.1 Discussion of the Mining Industry

Throughout the 1990's a sharp increase in output from the Australian mining industry compared to a moderate increase in inputs led to productivity growth and an increase in national output and income. However, in the 2000s' a productivity growth slump occurred where output remained almost unchanged compared to a sharp increase in inputs.

Authors such as Parham (Parham, 2012), identified that the key reason for this productivity growth slump was record growth of inputs in mining, both capital and labour, in response to high output prices. Higher commodity prices triggered a large increase in mining investment as mining companies expanded into new areas or established infrastructure to extract poorer quality ore and/or ore that was more costly to extract.

Mining companies invested capital for future growth and attracted labour from other sectors and states by paying significantly higher wages, while output growth, though positive, was below the level of new investment. Productivity growth 'slumped', but national income increased significantly, though the distribution was uneven among the different industries and states of Australia.

While analysing the industry contributions to the aggregate MFP growth slump, Parham (2012), found that mining had contributed 40% to additional input accumulation and 37% to the productivity growth slump, whereas, the manufacturing sector while accounting for 17% of input accumulation, contributed only 0.5% to the total productivity growth slump (Parham, 2012).

2.3.2 Discussion of the Utilities Industry

The utilities industry has influenced the productivity decline in Australia through a combination of large capital investments and unfavourable climatic conditions. With regard to the large capital investments, "input use has risen to enhance the environment, amenity, safety and reliability of supply. These benefits are not captured in the measured volume of industry output, and thus measured productivity is lower" (Productivity Commission, 2013).

This scenario has been observed with specific reference to water utilities. In attempting to ensure the reliability of supply (through activities like the construction of water desalination plants) inputs have increased without a corresponding increase in output. Similarly, the underlying reduction in rainfall (particularly around 2002 and 2007) led to the situation of less water being available to sell. This has again equated to a reduction in output without a corresponding reduction in capital and labour input (Productivity Commission, 2009).

The Productivity Commission have noted that: "Some of these influences are expected to be temporary in nature, in the sense that the MFP 'losses' they caused should be recovered or regained in coming years. In other cases the influences are likely to be structural, and reflect increases in input intensity in this industry that will be more enduring." (Productivity Commission, 2013).

Thus, the productivity growth of the utilities industry has shown a significant fall in recent times. This fall has been predominantly driven by a combination of market sector forces and environmental conditions. As the industry adjusts to this new market environment and climatic conditions improve, it is expected that the measured fall in MFP will be arrested (and potentially reversed) in the near future.

2.3.3 Discussion of the Manufacturing Industry

The Productivity Commission includes the manufacturing industry amongst the contributing factors leading to the decline in Australia's MFP growth (Productivity Commission, 2013). In contrast, ABS statistics (shown in Figure 2 above) indicate that the growth in measured MFP for Manufacturing has

been relatively neutral over the analysis period. This difference in perception can probably be attributed to the dichotomous forces that are at play in the manufacturing industry and the differing ways the MFP has been estimated.

In recent times, while some manufacturers increased production in order to meet the additional demand created by the boom in the mining sector, others have been forced to reduce output due to the impacts of the global financial crisis (circa 2008) and conversely the adverse impacts of higher terms of trade as an indirect impact of this mining boom (Dutch disease). Another effect of these higher terms of trade has been to shift some manufacturing offshore where it can be undertaken at lower cost.

Productivity growth at the aggregate Australia wide level in the manufacturing industry has fallen in recent years (Productivity Commission, 2013). However,, the trend of manufacturing firms exiting the industry (either closing down or being transferred overseas) is actually reported as a positive contribution to measured MFP. This has dampened the trend of overall falling MFP growth. Either way, it is clear that the manufacturing sector has been primarily influenced by market forces with particular emphasis on the prevailing terms of trade.

2.3.4 Discussion of the Agriculture Industry

Productivity growth in the agriculture industry has reported large fluctuations in recent times, coinciding with periods of drought throughout Australia. Despite typically being above the level of other industries, the observed growth in productivity for agriculture demonstrated dramatic declines (and subsequent rebound) during the periods of severe drought in 1997/98, 2002/03 and 2006/07.

In particular, the agriculture industry was slow to rebound from the 2006/07 drought, which contributed to the overall downturn in state wide levels of reported productivity growth at that time (Productivity Commission, 2013). This period of post-drought lower productivity growth in Agriculture was featured prominently in literature at the time. However, since the rebound in 2009, productivity growth in Agriculture has remained relatively high, thus not warranting further investigation in this paper.

2.3.5 Rental, Hiring and Real Estate Services

The Real Estate Services industry has shown the greatest decline in MFP growth of all ANZSIC industries (see Figure 2). MFP growth for this industry is reported to have declined rapidly in the late 1990's, continuing through to 2008 where it has remained stable at very low levels.

The Real Estate Services sector is not included by the Productivity Commission in their estimations of the 12 industry market sector, nor has it been considered in current literature to be of significant concern with respect to falling productivity trends. The reason for this seems to be due primarily to measurement issues. As with other service based industries, problems exist in accurately measuring the productivity of this industry especially because changes in quality are not well captured in reported output measures.

The explanation of measurement issues is supported by considering that in 2007/08 the ABS changed their survey methodology to more accurately portray changes in productivity. This resulted

in an immediate flattening of the indexed MFP trend (in keeping with other service based industries). The implication of this is that it appears likely that the difficulties experienced in accurately measuring MFP for this industry have been artificially influencing the reported MFP growth (Burnell, 2014).

It is the opinion of the authors that the reported low MFP growth for this industry can be predominantly attributed to a measurement anomaly and thus further investigation of this industry is not pursued in this paper.

3. Methodology

With a wealth of contemporary literature providing an extensive and well supported analysis of productivity trends at the national level, our research is targeted at discovering to what extent these national productivity trends are replicated at the NSW State level, and therefore to what extent these recommended national policy actions might apply in NSW.

In Australia, the ABS produces a comprehensive suite of productivity statistics (Productivity Commission, 2013). These statistics include estimates of MFP by industry at the national level; however, no productivity measures are currently published by the ABS at the State level.

An early attempt at estimating sub-national productivity was developed by Queensland Treasury (Queensland Treasury, 2011). This study estimated market sector MFP for Queensland and for the Rest of Australia. Estimates of capital inputs were based on apportioning ABS capital stock and then scaling using ABS capital inputs scaling factors. The limitations of this study are that it did not estimate MFP by industry, and that the estimates are not readily repeatable given the manual apportioning of capital stock.

Cunningham (Cunningham & Harb, 2012) then derived MFP estimates by state by industry for all of Australia. This study estimated capital inputs based on independent capital stock estimates that were decomposed to industries using ABS scaling factors and apportioned to annual capital inputs proportionate to net capital stock. The limitations of this study are that estimates are not readily repeatable given the manual apportioning of capital stock, and that estimates were only available up to 2011.

More recently Syed (Syed et al., 2013) estimated MFP for the mining industry in each Australian State for the purpose of showing that measured productivity rises after production lags and the depletion of resources were accounted for. This study estimated capital inputs based on survey sources other than the ABS national accounts. The limitations of this study are that estimates are only for the mining industry, and that survey sources other than ABS national accounts were used to form the output and input indexes.

As the above estimates were generally unsuitable for discovering to what extent national productivity trends are replicated at the NSW level, a readily repeatable methodology was developed relying on published ABS data. Using reports like Productivity Commission (Productivity Commission, 2013) and Barnes (Barnes, 2011) as a basis, and applying an extension on the

methodology outlined in Cunningham (Cunningham & Harb, 2012), our analysis calculates individual industry and total market sector MFP at state level using published ABS data (various catalogues).

This approach results in MFP estimates by State by industry that show sub-national industry level productivity trends. It is readily repeatable and updatable as it relies on regularly published ABS data. The resulting estimates are readily comparable to ABS estimates of MFP for Australia, but provide greater texture and show State differences.

The estimation of industry MFP for each state has been determined as the ratio of an index of industry value added (IVA) to an index of the combined inputs of labour and capital (I).

(1) $MFP_s^i = \frac{IVA_s^i}{I_s^i}$

Where IVA_s^i is an index of the volume of each industry value added (i) for each state (s) based on chain volume measure IVA values published by the ABS (cat 5220.0). I_s^i is an aggregation of an index of capital input (K_s^i) and an index of labour input (L_s^i). However, not all of the required data indexes are available at the industry and state level from the ABS. Consequently, for the index of capital, an apportioning method was used based on the index of capital services per industry for Australia, published by the ABS.

Although this methodology is subject to restrictive assumptions, the estimations from this paper constitute one of the few attempts to provide a new set of measurements for MFP in each of the Australian states and territories at an industry level.

The aim of this analysis is threefold: to identify the productivity trends for NSW separately from the Australian trends; to identify the productivity trends in NSW by industry; and to estimate if there is a statistically significant causal effect of various factors, including the influence of commodity prices on the reported productivity trend, especially for Mining.

As such, a regression analysis has been undertaken to clarify the main factors that may have a causal relationship with MFP nationally and at state level. The analysis is based on two separated regressions, one with the mining sector MFP and the other with the market sector MFP as dependant variables. In both cases the results were obtained for NSW individually and for Australia as a whole. In response to the presence of longitudinal data (8 states observed over a period of 19 years), panel-data techniques were applied for Australia's regressions while a simple Ordinary Least Square (OLS) method was applied in the case of NSW. A more in-depth explanation of the methodology is available in Appendix 2 and Appendix 3.

4. Analysis Findings

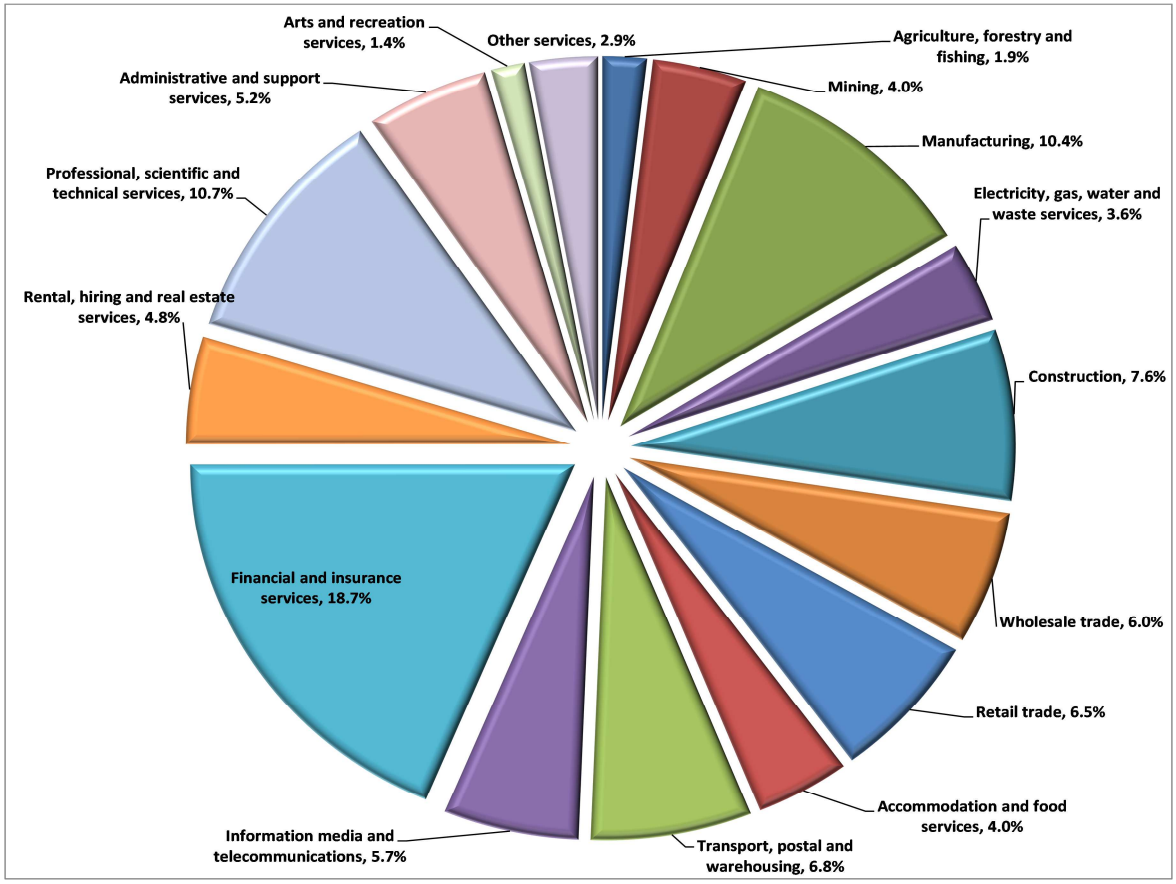
4.1 Productivity Trends

The fundamental reason for undertaking this analysis is that MFP trends for NSW industries are not otherwise available. The benefit of having this information is that any potential NSW government responses to changing productivity performance over time can be far more accurately tailored to the industries and relevant causal factors than would otherwise be the case. The following figures and

associated discussion present the pertinent findings of the analysis. Further results are also included in Appendix 4.

In order to present the productivity trends in their appropriate context, it is first imperative to gain an understanding of the relative share of the market sector for each of the 16 NSW industry groups. Figure 4 provides a visual comparison of how much weighting each ANZSIC industry group is contributing to the overall observed productivity trends. Based on discussion from the previous sections of this paper, the industry sectors of particular interest include Mining (4.0% share), Utilities (3.6% share), Agriculture (1.9% share), Real Estate Services (4.8% share), and Manufacturing (10.4% share) of total NSW output.

Figure 4: 2014 NSW Gross Value Added (CVM) by industry (16 industry market sector)

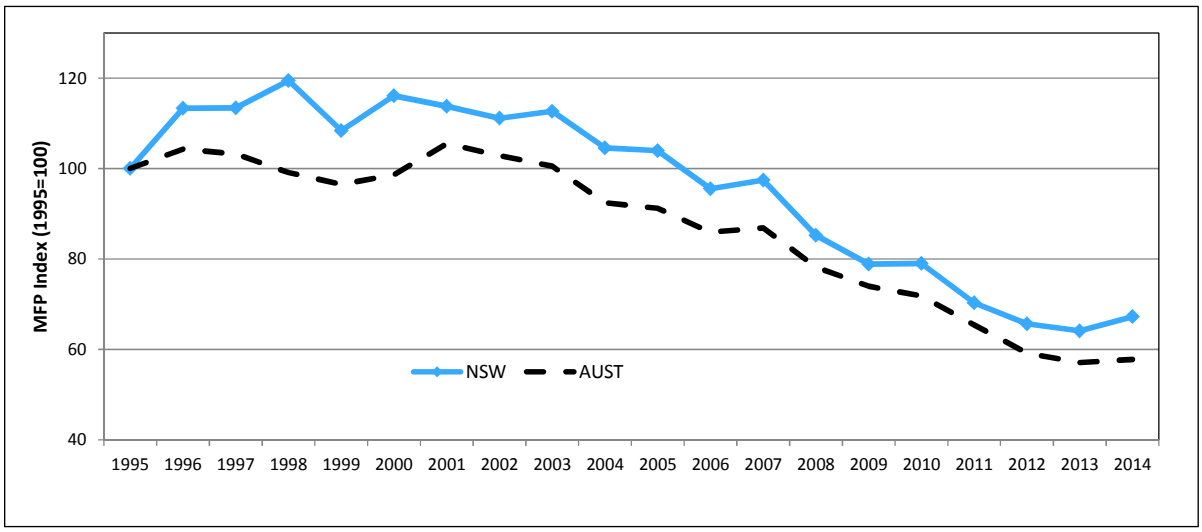


Source: (Australian Bureau of Statistics, 2014a)

From Figure 4, NSW mining can be seen to represent 4% of total market sector GVA (16 industries). At the national level, however, the comparable share of mining is 15% of GVA (see Appendix 5). The implication of this is that the mining industries in NSW and Australia are shown to differ in their relative size and therefore influence of MFP trends.

Using the analysis methodology detailed above, the productivity trends for Mining and a variety of other relevant NSW industry market sectors have been able to be estimated. As such, figure 5 shows the productivity trend for the NSW mining industry in comparison to that for the Australian mining industry.

Figure 5: MFP for the Mining industry in NSW and Australia



Source: T&I analysis, 2014

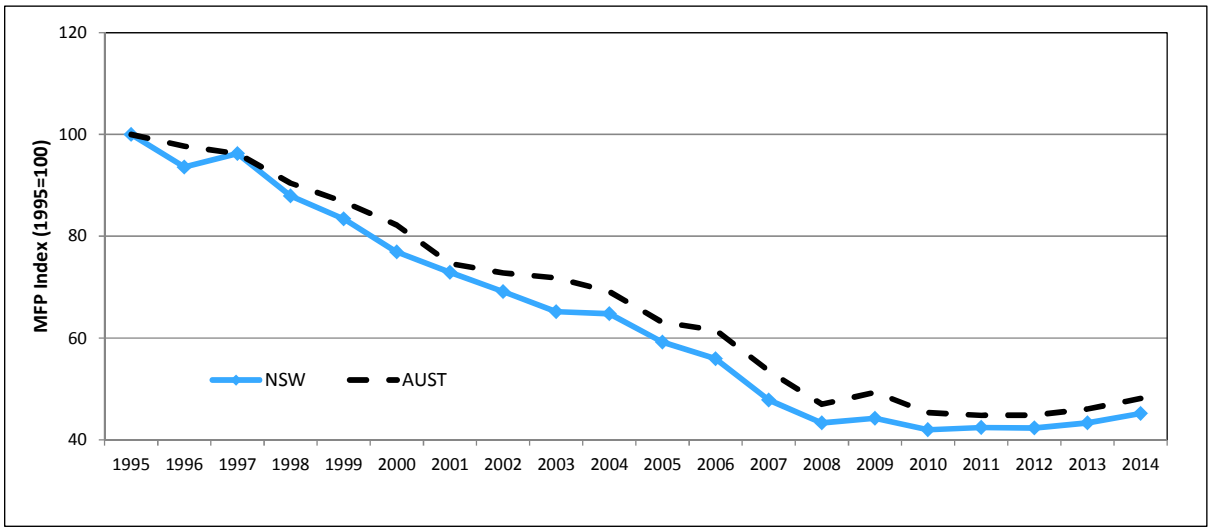
Despite the fact that the MFP of NSW mining is contributing to less than half of the influence of the productivity decline experienced throughout the Australian mining industry, the MFP trends are still quite similar. The implication for this is that at a broad scale it would seem quite likely that any policy action recommended at the national level may equally apply at the NSW state level.

Similarly, the productivity trends observed for the NSW manufacturing and utilities industries are also in keeping with those observed for Australia (see appendix 4). Unlike for mining, however, these industries represent a similar share of the (16 industry) market sector contribution to GVA in both NSW and Australia. While this implies that the influence of productivity trends in these industries in NSW is similar to that at the national level, the productivity trend for Manufacturing is observed to be relatively neutral, and is therefore not discussed further. The Utilities sector, on the other hand, shows a distinct downward trend. The Utilities sector is deemed to be primarily influenced by state-specific factors and as such, these are discussed further in section 5.

Another industry that displays significantly declining productivity trend is the Real Estate Services industry. Figure 6 shows the productivity trend for the NSW Real Estate Services industry in comparison to that for the Australian Real Estate Services industry. Again this industry represents a similar share of the (16 industry) market sector in both NSW and Australia.

As discussed earlier, estimating productivity trends for this industry is beset with measurement problems including the changes in quality that have historically not been well captured and also the inconsistency in deflating inputs and outputs. As such, despite the apparent downward trend, Figure 6 implies that the same processes (measurement issues) applying at the national level are likely to be equally applying at the state level. This finding adds support to the derived conclusion that the NSW Real Estate Services industry be disregarded as an area of potential concern.

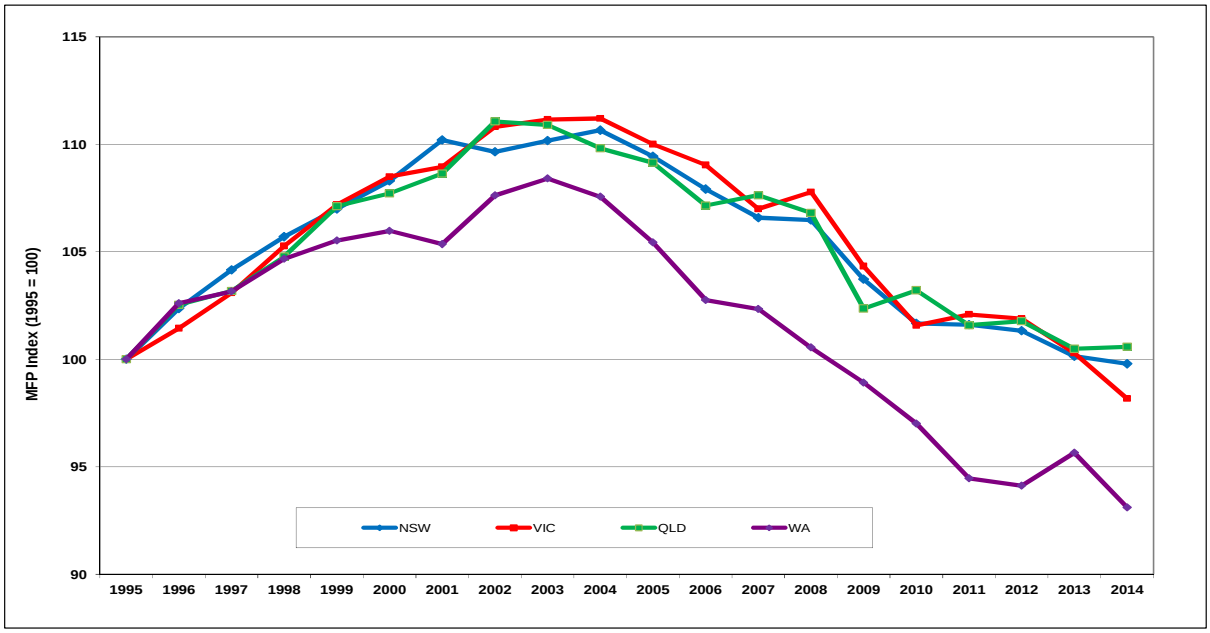
Figure 6: MFP for the Rental, Hiring and Real Estate Services industry in NSW and Australia



Source: T&I analysis, 2014

When all of these 16 market sector industries are aggregated to create an overall NSW market sector productivity trend, NSW is observed to be reporting similar productivity trends to that of the other comparable states. Of this targeted selection of states, shown in Figure 7, Western Australia is shown to display the greatest divergence to the NSW MFP trends, which is most probably due to the greater contribution of mining to the total market sector GVA (42% in 2013) (Australian Bureau of Statistics, 2014b).

Figure 7: MFP (market sector) for selected states

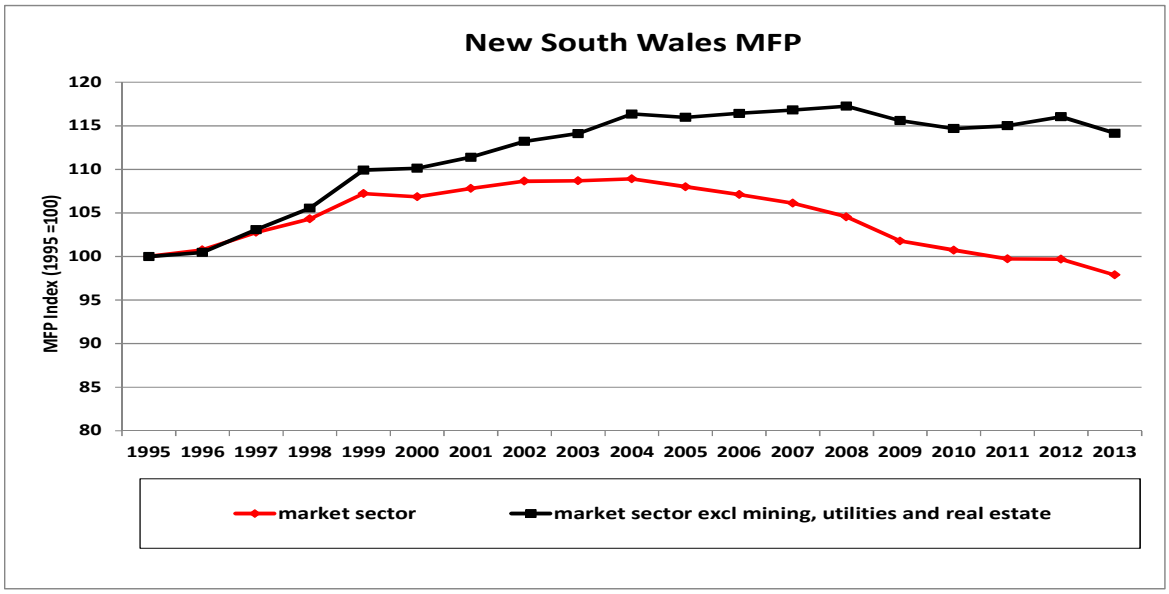


Source: T&I analysis, 2014

When isolating the constituent parts of this aggregated NSW market sector MFP trend, the impact of the Mining, Utilities, and Real Estate Services sectors can be shown diagrammatically (see Figure 8 below) by comparing the MFP trend for the NSW (16 industry) market sector with a representation of the MFP trend where these three industries have been excluded. The implication of this figure is

to give weight to the assertion that the observed decline in NSW MFP is being primarily driven by specific industries that are themselves being influenced by certain market and environmental forces.

Figure 8: MFP market sector and market sector excluding mining, utilities, real estate



Source: T&I analysis, 2014

Figure 8 shows that when the dominating influences of mining, utilities and real estate are removed from the NSW aggregate market sector MFP trend, the remaining portion of the state level MFP flattens out to become neutral.

At the Australian level, the Productivity Commission concur with these NSW findings (save their inclusion of Manufacturing) similarly stating that, "when the influences of Mining, Manufacturing and Utilities are removed, the average rate of MFP growth in the remaining industries is positive, although still lower than the longer term average for the market sector as a whole" (Productivity Commission, 2013).

4.2 Underlying Factors driving productivity

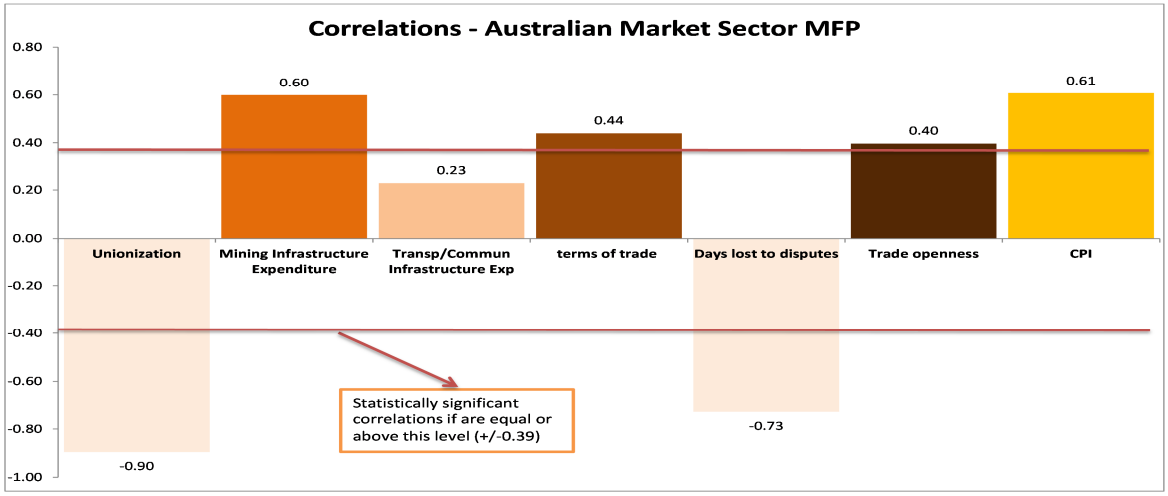
The main objective of the economic analysis in this paper is to identify the MFP trends for NSW so as to compare them to the national trends. However, this paper also attempts to identify the underlying causal factors that can be shown to be of greatest influence to the MFP trends nationally and at the state level. As such, a correlation analysis has been undertaken to identify the underlying factors that are likely to be related to movements in MFP. Subsequently, a set of regressions were run (Appendix 3) to investigate the extent of causal relationship between MFP and each of those factors. This was performed using mining MFP and the whole market sector MFP as the dependent variables for NSW and also for Australia as a whole.

Although correlation does not imply causation, a preliminary step to determine the causes of changes in MFP is identifying the main factors that may vary in the same or the opposite direction to the observed productivity trends (correlation coefficient). According to accepted statistics convention, given the number of data points available for this study (19 observations), the

associated correlation figures therefore only have a statistically significant meaning if they are equal or larger than 0.388 (Keller, 2005).

Figure 9 shows the results of a correlation analysis for the observed Australian market sector MFP. The coefficient of this figure refers to how closely the two sets of data are related. The Y axis values range between -1 and 1, where a negative value indicates an inverse relationship and a positive value reflects a positive relationship.

Figure 9: Correlation of various factors with Australian Market Sector productivity trends



Source: T&I analysis, 2014

Figure 9 shows that most of the factors that may explain movements in Australian market sector MFP, display a correlation coefficient of 0.39 or greater, indicating a statistically significant relationship. This is especially true of; mining infrastructure expenditure, the consumer price index (CPI), days lost to disputes and the degree to which the labour force is unionised (number of employees who are members of a union).

Together with these, trade openness is also shown to be correlated with MFP. Trade openness is defined as the ratio of combined imports and exports over GDP. Berg and Krueger (Berg & Krueger, 2003) support the idea that trade openness is a relevant indicator requiring consideration when analysing productivity. This is especially because an increase in openness would most likely increase competition, which is a major driver of productivity growth.

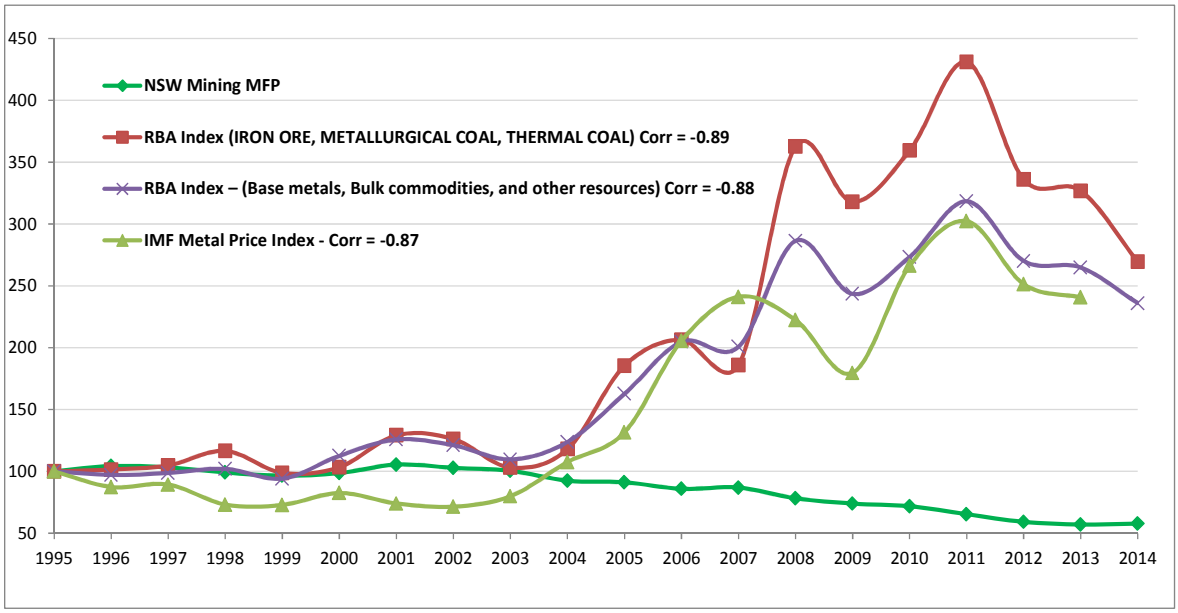
It is also worth mentioning that the 'terms of trade' also displays a statistically significant correlation. The 'terms of trade' is calculated as the ratio of export prices to imports prices. Thus, an increase in the 'terms of trade' would therefore reflect the ability to purchase more imports from the same amount of exports. Even though the correlation coefficient with MFP is not very large and it is just in the margin of significance, 'terms of trade' is one of the indicators that previous studies have considered as relevant for productivity analysis (Connolly & Fox, 2006; Shanks & Zheng, 2006).

As a sub set of the CPI, commodity prices can be shown as being highly correlated (i.e. significantly greater than 0.39) with particular reference to Mining MFP. This correlation occurs with a range of alternative measures of commodity prices and in each case is proven to be highly significant (over

0.85 in any example). This finding provides an indication of the importance of commodity prices as a determinant of MFP in the mining industry. Furthermore, these commodity prices are subject to the fluctuations of world demand and the degree of extraction scarcity and are therefore determined by market forces and not government policy.

Figure 10 shows the evolution of these main commodity price indexes and the corresponding correlation coefficients (especially iron ore and coal). This figure illustrates that an upward trend in commodity prices since 2004 corresponds with falls in observed MFP growth over this same period. All the other commodities have also experienced increases in prices, but are not necessarily as relevant as iron ore and coal for the Australian market, but are considered in the construction of the metal price index.

Figure 10: Evolution of NSW Mining MFP and alternative Commodity Price Indexes



Source: T&I Analysis, 2014

This analysis further supports the hypothesis that market forces are driving the NSW mining MPF trends and that the mining industry is prominently influencing the total observed MFP for NSW.

5. Discussion

Declining productivity growth in NSW seems to be prominently influenced by several specific industries, especially Mining and Utilities. However, the observed downward trend should not be interpreted as a problem as such because this downturn in productivity is being driven by a combination of market forces and measurement issues. Furthermore, these market forces are predicted to reverse the downward trend in the near future (Giles, 2014; OECD, 2014).

The Productivity Commission, together with many other productivity commentators, forecast that MFP growth should improve in the near future as investment in new capacity slows, and this newly installed capacity is more fully utilised (Productivity Commission, 2013). As such, little by the way of

suggested policy actions have been recommended in the current literature relating specifically to these observed industries.

Rather, productivity commentators have put forward suggestions (at the national level) pertaining to broad-based more general recommended policy actions, such as, continuing reforms to enhance investment in infrastructure and knowledge-based capital as well as to boost labour force participation (OECD, 2014).

Likewise, and in keeping with the Productivity Commission framework (appendix 1), Banks (Banks, 2012) advocates that governments only have the potential to influence future productivity through three main policy channels; incentives policy, capability policy and flexibility policy. Banks goes on to list an exhaustive number of possible policy suggestions from each of these main policy channels. A selected number of actions from these three policy channels are discussed below.

i. Incentive policies focus on trade and competition, mainly at a national level. Suggested actions include; abolishing remaining tariffs, ending selective industry subsidies, and introducing a second round of National Competition Policy reviews (Banks, 2012). The NSW Government is also already actively contributing to incentive policy actions by, for example, continued energy market reform, and the ending of subsidies to the solar industry.

ii. Capability policies aim to support firm-level innovation. Suggested actions include improving human capital, enhancing the innovation system, and the more efficient provision and use of infrastructure (Banks, 2012). Many of these actions are already receiving attention at a national level, in part prompted by the Productivity Commission. Examples include the recent Commission Inquiries on Public Infrastructure and Childcare and Early Childhood Learning where significant focus was directed at delivering potential productivity gains.

iii. Flexibility policies relate to the scope for firms to make the changes needed to realise their productive potential. As such, regulation has been given particular focus due to the way regulations shape firm behaviour (Banks, 2012). The national workplace relations system makes industrial relations regulations primarily the domain of the Australian Government. The NSW Government is, however, currently active in the review or reform of several other regulations mentioned by Banks, including in the areas of native vegetation, planning and zoning, and rural water management in the Murray Darling Basin.

In summary, many of the policy suggestions raised by Banks (Banks, 2012) and others are mainly only applicable to the Australian Government. Other suggested policy actions (that may have scope for a state government involvement) already appear to be under the consideration of the NSW Government, which is currently addressing many of these tabled recommendations.

Furthermore, Parham (Parham, 2014) recognises the difficulties faced by governments in trying to influence market sector productivity, stating that: “Governments have no direct policy levers to improve market sector productivity, so they need to operate indirectly by fostering favourable conditions for businesses to be more productive” (Parham, 2014).

Despite the fact that there is little that the NSW government (or even the Australian government) can do to directly enable change in specific industry circumstances, finding new measures of productivity at state level for each industry is an important step in the process of developing evidence that will improve understanding of when these different sources contribute to productivity growth, and whether government policy, beyond promoting the process of competitive dynamics, can make a difference.

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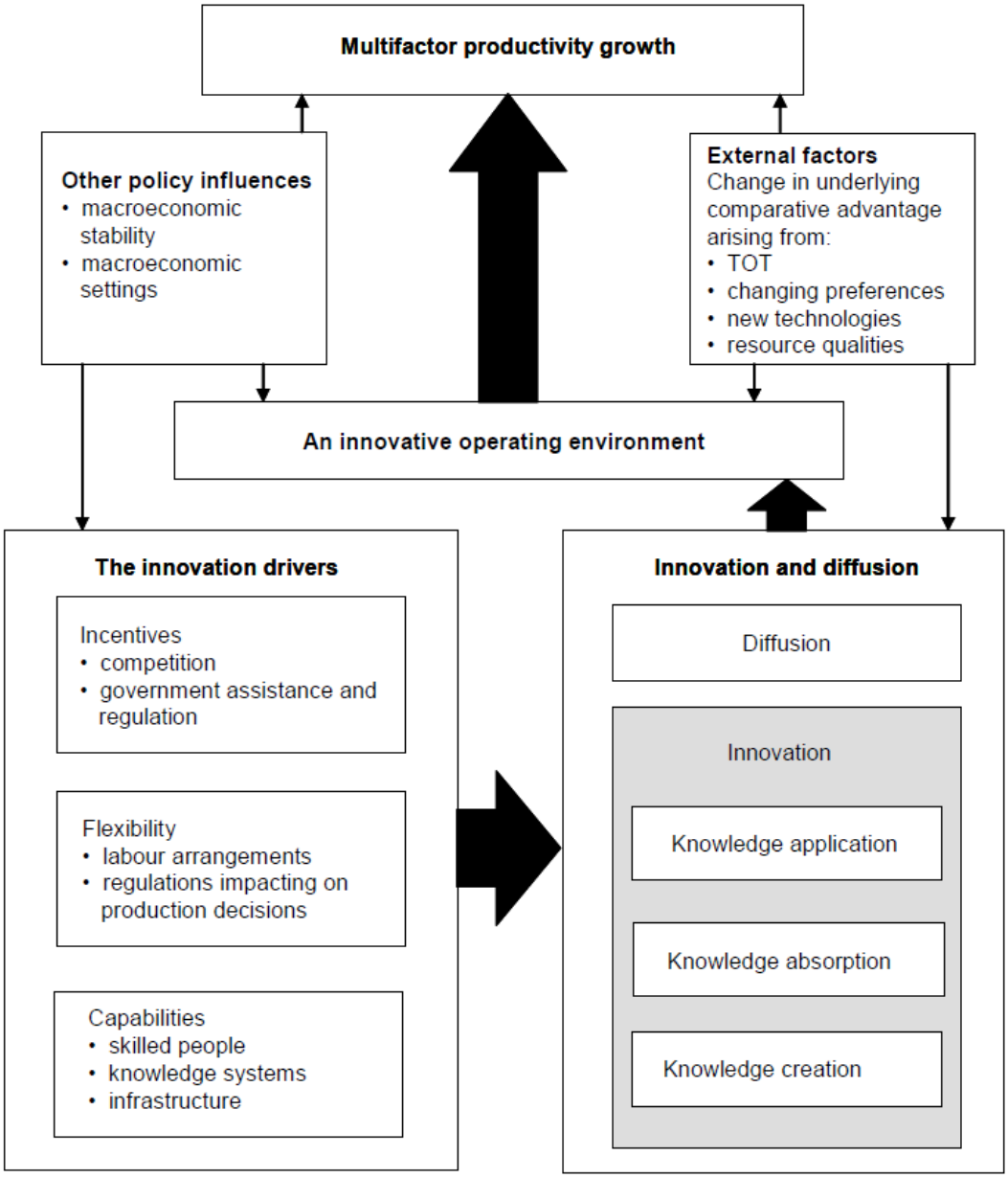
Appendix 1: Drivers and Enablers of Productivity



Source: (Productivity Commission, 2008)

Appendix 2: Methodology

The approach to measuring productivity at the state and industry level follows a similar methodology to the index-number methodology used by the Australian Bureau of Statistics (ABS) in estimation of aggregate and industry productivity for the national accounts. This paper has developed a unique methodology to calculate multi-factor productivity (MFP) at state level using regularly published ABS data (various catalogues). The method is as follows:

The estimation of industry MFP for each state has been determined as the ratio of an index of industry value added (IVA) to an index of the combined inputs of labour and capital (I). (1)

$$MFP_s^i = \frac{IVA_s^i}{I_s^i}$$

Where IVA_s^i is an index of the volume of each industry value added (i) for each state (s) based on the IVA published by the ABS (cat 5220.0) and I_s^i is an aggregation of an index of capital input (K_s^i) and an index of labour input (L_s^i).

The combined index of capital and labour inputs (I_s^i) is obtained by adding the input indexes using a Tornqvist[4] methodology, where the capital share (w_{ks}^i) and labour share (w_{ls}^i) of income are the weights for each of the indexes. These weights for each industry and state are calculated using data published by the ABS (Australian Bureau of Statistics, 2014b). The labour share of income is defined as the portion of the total factor income[5] paid to employees as remuneration in return for work done (wages) while the remaining portion is the capital share, assumed as the sum of the gross operation surplus and gross mixed income.

(2) $$I_s^i = w_{ks}^i K_s^i + w_{ls}^i L_s^i$$

The labour input index (L_s^i) is constructed as a basic index using hours worked data from the Labour Force Survey published by the ABS (Australian Bureau of Statistics, 2014c). Hours worked for each industry are available quarterly from the ABS, measuring the hours actually worked in a reference week from the quarter in question. Thus, the average of the hours actually worked for each quarter has been multiplied by 365.25/7, in order to obtain an annual number as follows:

(3) $$Hours_s^i = \frac{365.25}{7} \times \frac{1}{4} \times \sum_{k=1}^{4} hours_{i,s,k}$$

The capital services index as published by the ABS (Australian Bureau of Statistics, 2013) is only disaggregated by industry for Australia as a whole. Therefore, to obtain the index of capital input

[4] Tornqvist methodology refers to indexes that are constructed as a weighted sum of the growth rates of the various components, where the weights are the component's shares in total value. In this case it is assumed that there are only two components (inputs) and are the only inputs contributing to the total industry value added.

[5] Total Factor Income is the part of the cost of producing the gross domestic product which consists of gross payments to factors of production (labour and capital). It represents the value added by these factors in the process of production (ABS cat. 5220.0 glossary)

(K_s^i) by industry at state level the ABS capital services index was then apportioned by multiplying it by the ratio of IVA for each industry in each state to the relevant Australian industry value added. The amount of capital inputs is thus assumed to be homogeneous across an industry regardless of scale, location, or stage in industry life-cycle.

The main limitation of the methodology is associated with the calculation of the capital services index for each state and industry. It uses a proxy to apportion the capital index to each of the Australian states. This has been done in order to keep consistency regarding the use of only ABS data for the calculations. The original data of capital services is not publically available from the ABS, neither the capital stock, which constitute the raw data required to estimate this index. Despite this limitation, we consider the MFP obtained by this methodology as a good approximation for the states productivity by industry since two of the three main components of the MFP formula (IVA_s^i , L_s^i , and K_s^i) are obtained from the raw data published by the ABS.

Appendix 3: Econometric Analysis of Multi-Factor Productivity determinants

This appendix provides with an econometric approach to clarify which factors may have a causal relationship with multi-factor productivity (MFP) nationally and at state level. Table 1 and Table 2 shows the estimation results for four different dependent variables:

- Mining Sector MFP for all the states
- Mining Sector MFP for New South Wales
- Market Sector MFP for all the states
- Market Sector MFP for New South Wales

Given the longitudinal feature of the dataset when all the states are considered together, we apply panel data estimation techniques to take unobserved individual specific effect, (μi), into account. By so doing, we reduce the effect of heterogeneity across states and limit the estimation bias arising from omitted variables. Within the econometric models available for panel data we performed ordinary least squares (OLS) regressions applying fixed effect (FE) or a random effect (RE) methodology. Since there is a cross section dataset in the case of NSW MFP in the mining industry and the whole market sector, we estimated a basic OLS model to identify the main factors driving changes over time.

Table 1: Regression Analysis - Dependant Variable: Mining MFP

	All Australian States			**New South Wales**	
ESTIMATION MODEL	*Pooled OLS*	***FE*** ***Fixed Effect***	*RE* *Random Effect*	*OLS 1*	*OLS 2*
ratio imports plus exports to GDP (openness)	-41.184*	259.26***	139.43***	462.32**	306.336
	(24.186)	(64.030)	(51.356)	(258.49)	(233.839)
Terms of trade					**-1.4137*** **
					(0.3958)
Unionization (employees members of unions)					-0.1401
					(0.0824)
days lost labour disputes	-0.01213	0.1158*	0.1063	-0.02887	
	(0.04980)	(0.07584)	(0.06871)	(0.408487)	
Metal Price Index (commodity prices)	**-0.4950*** **	**-0.4555*** **	**-0.4407*** **	**-0.2550*** **	
	(0.08371)	(0.05424)	(0.05596)	(0.08851)	
Fixed capital formation (comm and transport)	0.03843			-0.0478	-0.00082
	(0.04761)			(0.0475)	(0.04730)
Effect of commodity prices in WA	0.08845	-0.2157*	-0.4877***		
	(0.09342)	(0.1378)	(0.1507)		
Effect of commodity prices in QLD	0.04020	-0.04195	-0.3591***		
	(0.07084)	(0.1236)	(0.1282)		
Effect of commodity prices in NSW	-0.02038	0.1608	-0.2032		
	(0.08167)	(0.1324)	(0.1339)		
Dummy if year 2008	12.038			-9.2184	9.5153
	(13.833)			(16.9316)	(16.883)
Constant	210.22***	89.284***	122.25***	55.4705	242.1157***
	(9.8857)	(18.435)	(17.636)	(74.7723)	(0.8336)
Observations	148	148	148	19	19
Number of states	8	8	8	1	1
R-squared	0.093	0.509	0.3517	0.763	0.81
F test		11.06		8.4	10.905
Rho		0.785			
Hauman test		35.85***			

Standard errors in parentheses

*** statistical significance at 1 per cent or greater. ** statistical significance at 5 per cent or greater. * statistical significance at 10 per cent or greater. The F test indicates that there are significant individual effects (state level) inplying that pooled OLS would not be appropiate

Source: T&I analysis (2014)

Table 2: Regression Analysis - Dependant Variable: Market Sector MFP

ESTIMATION MODEL	**All Australian States**			**New South Wales**	
	Pooled OLS	***FE*** ***Fixed Effect***	*RE* *Random Effect*	*OLS 1*	*OLS 2*
ratio imports plus exports to GDP (openness)	2.0846	50.145***	2.0846	44.3916	51.3616
	(3.8126)	(8.1256)	(3.8126)	(40.9915)	(50.6418)
Terms of trade	**-0.1018****	**-0.1528*****	**-0.1018****	**-0.2894*****	**-0.1848*****
	(0.04709)	(0.03971)	(0.04709)	(0.0693)	(0.0644)
Unionization (employees members of unions)				-0.0348**	
				(0.0144)	
days lost labour disputes	-0.01223	-0.02530**	-0.01223		-0.005
	(0.009255)	(0.01013)	(0.009255)		(0.0079)
Fixed capital formation (comm and transport)	6.233e-04	-6.815e-04	6.233e-04	-0.0019	-0.0075
	(0.007535)	(0.005928)	(0.007535)	(0.0082)	(0.0093)
Effect of terms of trade in NSW	0.01986	-0.1324*	0.01986		
	(0.02403)	(0.07079)	(0.02403)		
Effect of terms of trade in WA	-0.1068***	0.03005*	-0.1068***		
	(0.02816)	(0.06864)	(0.02816)		
Effect of terms of trade in QLD	-0.008039	0.01823	-0.008039		
	(0.02134)	(0.06267)	(0.02134)		
Effect of terms of trade in VIC	0.005085	0.09584	0.005085		
	(0.02359)	(0.06925)	(0.02359)		
Dummy if year 2008	1.3454	-1.2820	1.3454	0.1725	-1.3452
	(2.2098)	(1.7980)	(2.2098)	(2.9596)	(3.5157)
Constant	111.13***	100.66***	111.13***	135.804***	106.0809***
	(2.4726)	(2.9941)	(2.4726)	(18.6427)	(16.0803)
Observations	148	148	148	19	19
Number of states	8	8	8	1	1
R-squared	0.241	0.406	0.241	0.853	0.794
F test		11.06		15.13	10.03
Rho		0.901			
Hauman test		90.46***			

Standard errors in parentheses

*** statistical significance at 1 per cent or greater. ** statistical significance at 5 per cent or greater. * statistical significance at 10 per cent or greater. The F test indicates that there are significant individual effects (state level) inplying that pooled OLS would not be appropiate

Source: T&I analysis (2014)

Both tables present alternative econometric models for the mining and market sector MFP. The Hausman test has been used to determine the most appropriate model for the longitudinal data (8 states over 19 years). If the explanatory variables are not correlated with the error term, (μi), the FE estimator is better than the RE. Since the result of the Hausman test is a rejection of the null hypothesis of no significant difference in the coefficient estimates, FE is the best fitted model for our study.

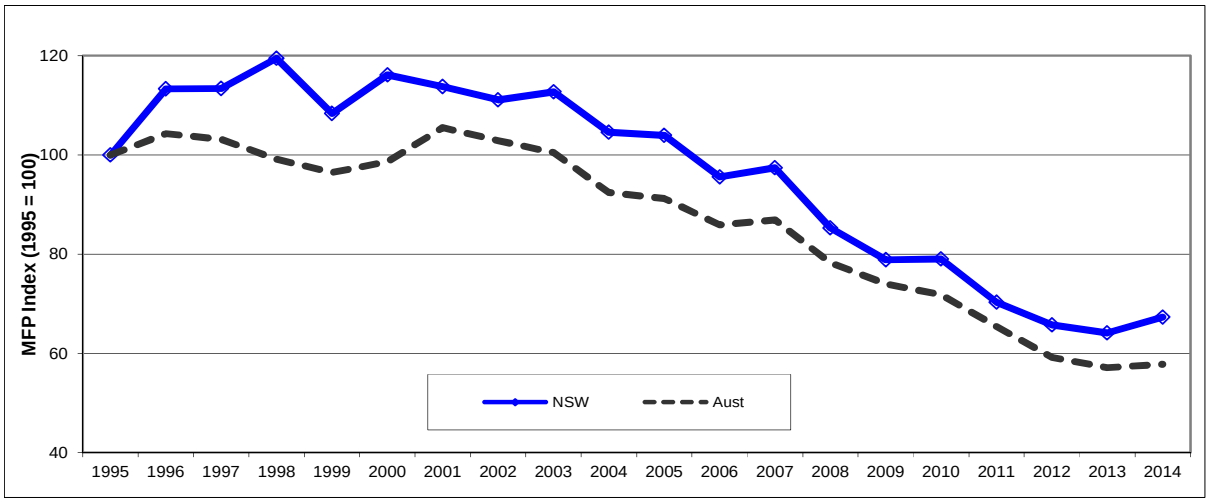
The results from table 1 suggest that commodity prices (metal price index) are highly statistically significant and appear to be one of the most important causal factors explaining changes in mining MFP, for both all States and NSW considered individually. For instance, holding everything else constant, for a one unit increase in the metal price index, NSW mining MFP will decrease by an average of 0.255 units.

Table 2 shows similar results for the market sector MFP. The effect of price changes has been replaced by the terms of trade (ratio of exports to imports prices), since we have 16 different sectors as forming the market MFP, which are not necessarily affected by metal prices. The coefficient

suggests a highly significant negative relationship between the terms of trade and market sector MFP. According to the results for NSW, for a one unit change in the terms of trade, MFP will change by an average of 0.289 units in the opposite direction.

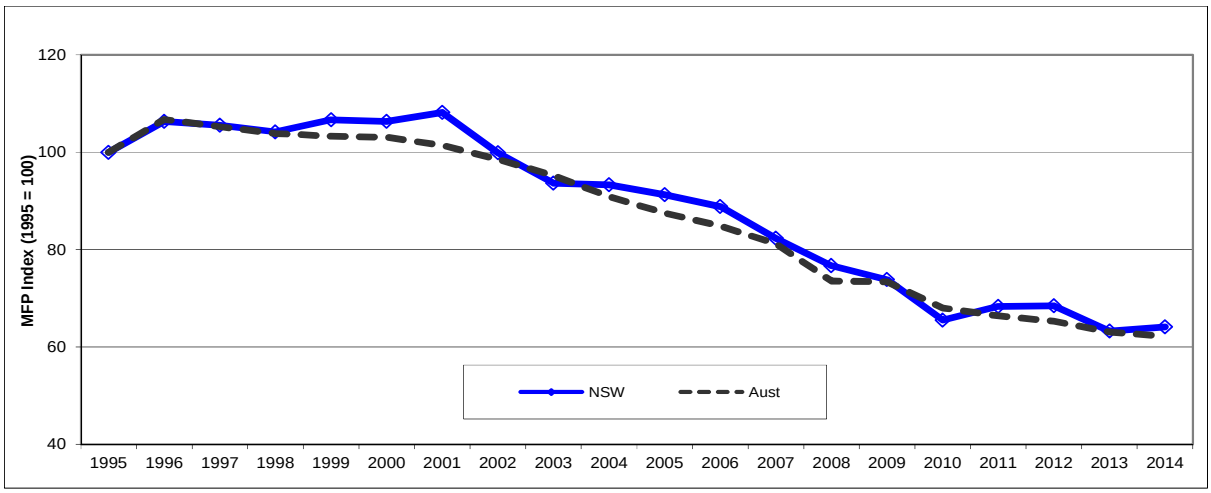
Appendix 4:

Figure A: MFP for the Mining industry in NSW and Australia



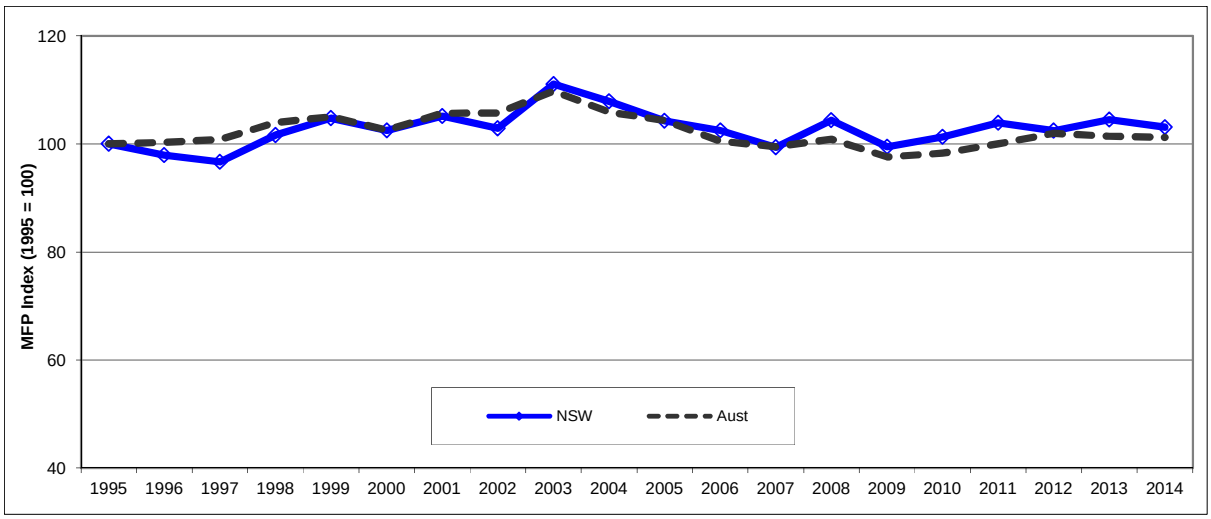
Source: T&I analysis, 2014

Figure B: MFP for the Utilities industry in NSW and Australia



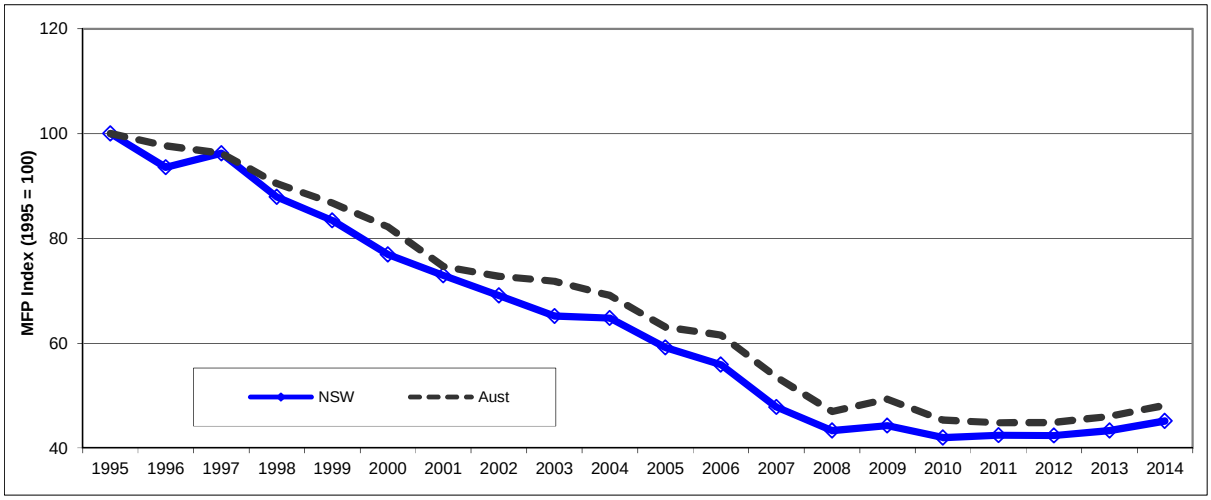
Source: T&I analysis, 2014

Figure C: MFP for the Manufacturing industry in NSW and Australia



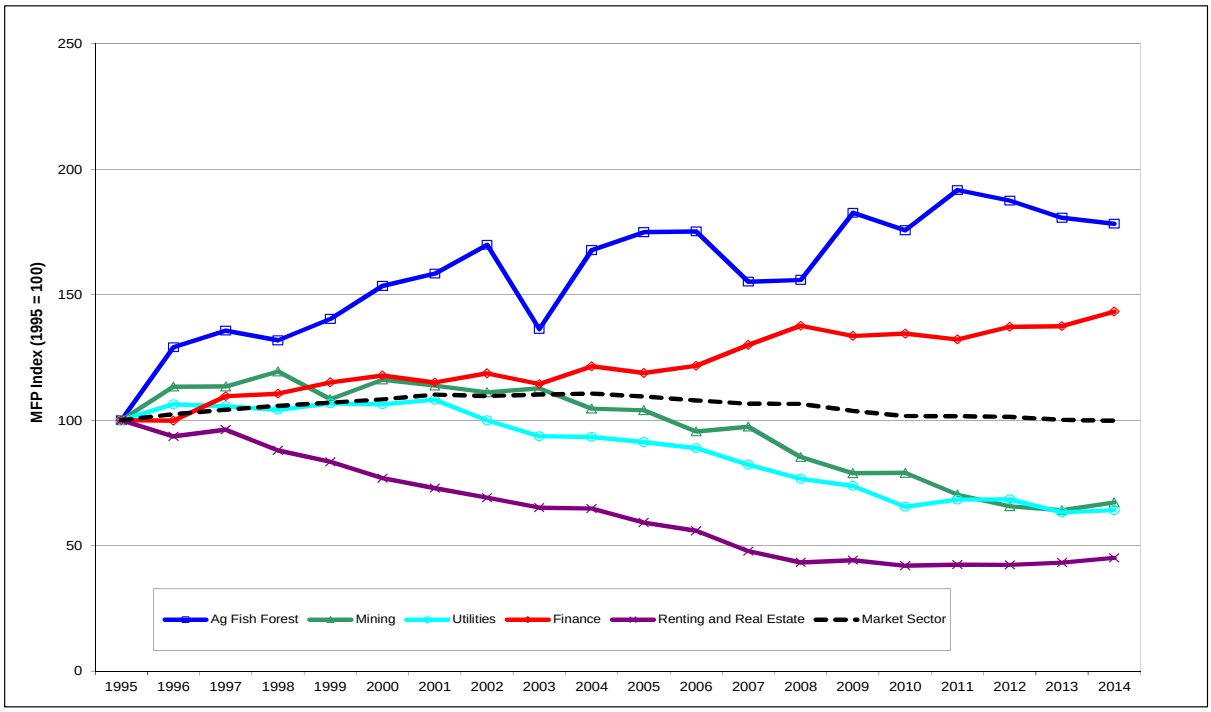
Source: T&I analysis, 2014

Figure D: MFP for the Rental, Hiring and Real Estate Services industry in NSW and Australia



Source: T&I analysis, 2014

Figure E: MFP by industries in NSW



Source: T&I analysis, 2014

Appendix 5

PARTICIPATION OF EACH INDUSTRY IN TOTAL IVA (2014)

INDUSTRY	AUSTRALIA	NEW SOUTH WALES
Agriculture, forestry and fishing	3.1%	1.9%
Mining	15.0%	4.0%
Manufacturing	9.3%	10.4%
Electricity, gas, water and waste services	3.3%	3.6%
Construction	11.0%	7.6%
Wholesale trade	5.8%	6.0%
Retail trade	6.4%	6.5%
Accommodation and food services	3.2%	4.0%
Transport, postal and warehousing	6.6%	6.8%
Information media and telecommunications	3.9%	5.7%
Financial and insurance services	11.8%	18.7%
Rental, hiring and real estate services	3.8%	4.8%
Professional, scientific and technical services	9.0%	10.7%
Administrative and support services	4.2%	5.2%
Arts and recreation services	1.2%	1.4%
Other services	2.5%	2.9%
TOTAL	100.0%	100.0%

Source: T&I analysis (2014) based on ABS cat. No 5206.0 – Table 33: Industry Gross Value Added