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DEMYSTIFYING PRODUCTIVITY FOR BETTER INFORMED POLICY

ISSUES PAPER 1

PRODUCTIVITY POLICY RESEARCH PROGRAM

**HC Coombs
Policy Forum**

**ANU College of
Asia & the Pacific**

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THE HC COOMBS POLICY FORUM AND THE *PRODUCTIVITY* POLICY RESEARCH PROGRAM

The HC Coombs Policy Forum was launched in February 2011, following its announcement by the former Prime Minister, the Hon Kevin Rudd MP, in May 2010. The Australian Government's funding to establish the Forum at The Australian National University (ANU) enhances public policymaking by strengthening the substantial engagement between the public policy community and policy-relevant research expertise across ANU. To this end, the remit of the Forum is to:

- > improve the connection between the public sector and the best in public policy research from across Australia and world
- > foster innovative relationships between the public sector and relevant academic institutions in an open and facilitative way
- > build an enhanced evidence base on which policy practitioners can draw to develop future public policy
- > develop the capability of Australian public servants so they can identify and adopt best practice thinking and action and strive for the highest standards of professional achievement.

The Forum has established a set of *Policy Research Programs* (PRPs) using Crawford School of Public Policy as its hub. PRP's are framed by extensive consultation with government and play a key role in building cohesion and enhancing policy research capacity across (and beyond) the ANU. Within the PRPs a particular emphasis is placed upon forward-looking work that will identify, assess and develop potential responses to future policy challenges. These programs will provide mechanisms for coordinating the use of policy relevant research expertise in areas of priority interest to government, and wherever possible conducting this work in partnership with the Australian Government. The PRPs also serve to anchor other research and engagement activities, such as policy dialogues, roundtables, capacity-building workshops, public outreach and hosting international visiting fellows, to priority policy research activities.

Productivity in the Private and Public Sector is one of the PRPs set up under the Forum. The Productivity PRP will draw on international comparative studies and analysis to explore and identify new avenues to enhance Australia's long-term economic productivity. This PRP aims to contribute to:

- > enhancing policy thinking through research, inter-disciplinary and cross-sectoral engagement
- > emerging perspectives of the role and importance of innovation in both the private and public sectors
- > identifying the role of business, skills and education, and other relevant social policy and workplace reforms that will influence long-term productivity
- > future analytical work conducted by the Australian Government in support of the Treasury's Intergenerational Report.

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1. INTRODUCTION

This paper is presented as background to future policy dialogues on productivity, to be convened as part of the HC Coombs Policy Forum's Productivity PRP. The intention is to hold a series of Roundtables in order to identify and explore a range of issues that affect Australia's long-term productivity performance and the contribution productivity makes to the wellbeing of Australians. The paper is intended to provide some focus and structure for future discussion. It is not meant to limit discussion or matters that can be brought forward.

The principal aim is to build and exchange knowledge that will help to improve analysis and development of policy options.

In writing this paper, we also hope to:

- > embrace an interdisciplinary approach to better understand the productivity context and its importance for Australia
- > explore the relevance to, and the implications of, the mineral resources boom
- > stimulate long-term policy thinking
- > investigate the productivity related data and evidence while identifying any gaps.

The thought experiment underlying the PRP's objective is to take a longer-term view and to ask what needs to be addressed in analytical and policy terms in order to enhance Australia's productivity performance and the wellbeing of Australians over the coming decades.

One task for future dialogues is to identify policy-relevant themes for examination and discussion. Section 2 of the paper provides a smorgasbord of themes that relate to productivity. The list is intended to stimulate further thought.

A number of themes have been selected for closer examination and discussion in this Issues Paper. This paper also provides some background on each of the themes selected for discussion at the first Roundtable. This is intended only to stimulate thinking from a policy-relevant point of view. The themes covered in this paper are:

- > avenues for long-term productivity growth in Australia (section 3)
- > productivity and the mineral resources boom (section 4)
- > productivity, education and skills (in the context of the boom) (section 4).

The material presented on each theme is organised under the following headings:

- > key issues—what is relevant to Australia's long-term productivity performance?
- > resources—what data and analysis can be assembled to shed light on the relevant issues and are there centres of interest, knowledge and expertise which have been looking at this theme or any of the issues identified?
- > discussion.

The material presented in the current form of the paper should be regarded as 'a starter' (indeed, there are substantial gaps). The paper may be revised after the dialogue to synthesise any new material and discussion that emerges.

2. THE MENU: A RANGE OF POLICY-RELEVANT THEMES FOR CONSIDERATION

This section outlines a menu of themes for consideration and discussion. Further items on the menu are likely to emerge over time as the Productivity PRP progresses.

Improving understanding of productivity concepts

Many things are now included under the productivity heading. A simple online search on the term results in over 43 million hits which range in topics that include definitions, individual productivity, labour productivity, industry productivity, statistics, measurement, tools and technological products that boost productivity – to name a few. Similarly, if we consider the media's interest in productivity – a search on Google news will find you close to 95,000 hits. These hits encompass news about Australia's lagging productivity growth, productivity wages growth and its link to our long-term improved standard of living, the need for European nations to lift their productivity levels, the strong labour productivity growth in the US and how this might interact with new jobs growth and so on. Parham (2012) notes how cyclical investment, technological and quality changes have had an influence on the productivity of the Electricity, Gas, Water and Waste Services sector. Hence, there are many elements that can impact on productivity.

Equally, the concept is often given a narrow (and sometimes negative) interpretation. And there are gaps in the appreciation of what needs to be done to raise productivity performance. Productivity is often thought of in a mechanistic way. For example, it is sometimes misconstrued as having to *work harder (for and with less)*. The need to foster dynamism, entrepreneurship, creativity and experimentation – and that these cannot be directly controlled – is mostly not understood or is overlooked.

So what does 'productivity' really mean? Is it more than volume of goods produced to a measure of input? How does productivity improvement come about? Is it only about using fewer inputs to achieve higher outputs? Or are we in fact concerned about 'productive efficiency' – using fewer inputs to produce more valuable outputs? How does this relate to improved living standards and wellbeing?

The key question here is whether there is a case for improving broader community understanding of productivity in order to improve debate and policy discussion. If so, how should this be addressed?

Avenues for long-term productivity growth

What does long-term productivity growth constitute and why is it important? Is it merely a policy objective for government or does society, more generally, have an important role to play? Many authorities and commentators (*Business Spectator* 2012) have been calling for structural policy reform and a heightened focus on productivity if Australians are to maintain future prosperity levels at the same level that was experienced over the past two decades. Treasury's forecasts also indicate that the higher terms of trade enjoyed by Australia now will begin to decline by about 20 per cent over the next 15 years. This will undoubtedly have an impact on our Gross Domestic Income (GDI) with a potential overflow impact on income per capita and ultimately living standards. Combine this issue with an ageing population, an increasingly globally competitive and fiscally constrained environment - it becomes clear why maintaining strong productivity growth is vital.

So in such a context, what are the broad directions of future opportunities for productivity growth? How much of the current or recent growth rates can be sustained into the future and which policy levers might enable this trend? Which are most relevant to Australia?

Productivity in a resource-driven economy

Australia is riding the benefits of a minerals resource boom – this is a known fact. Given the demand from emerging economies such as China and India, Australia's resource trade levels have been on an upward trajectory – referred to as the 'Millennium Mining Boom' (Grafton 2012). Capital and infrastructure investments over the past years in the mining sector are yet to result in full or optimum production levels. However, with the recent reduction in commodity prices there is also evidence to suggest that resource-trading levels in Australia have already peaked.

Simultaneously, with a higher exchange rate, slowing down of manufacturing, tourism and international education sectors, Australia has also been running a two-speed economy. So what does it mean to boost productivity in a resource driven economy? What are the ongoing implications for Australia's productivity growth that could emerge from a structural shift towards mining? What could a slow-down in China and India's economies mean for Australia's resources sector and wealth? What could a further price drop to \$100 per tonne from \$140 per tonne of iron ore mean for the Australian economy?

Productivity, knowledge accumulation and innovation

In Australia, innovation within and across industries has generally been lagging. The INSEAD *Global Innovation Index 2012* report (2012) places Australia at 21 in the world much below the United States (7), Canada (8) and United Kingdom (10) – countries that Australia would count as its peers for comparison. Former Australian Chief Scientist Professor Robin Batterham (2012) in his keynote speech at the Cooperative Research Centres (CRCs) Association Conference in May 2012 said that Australia's innovation performance was appalling and that this concerning trend was also visible in Australia's business and higher education collaboration. It is no surprise then as to why Productivity Commission Chairman Gary Banks (2012) has been advocating for a heightened focus on innovation to lift productivity and reach for higher prosperity levels.

Elisabeth Kremp and Jacques Mairesse (2004) in the National Bureau of Economic Research (NBER) working paper series have shown that a relationship exists between knowledge management and innovation within French manufacturing firms, and the firm's productivity levels. So what lessons can we learn from other leading economies that innovate and collaborate better than us? What kinds of innovation are relevant to Australia? What are the key mechanisms for accumulation and transfer of knowledge? How can we make better use of technology to innovate? Does the heightened focus on innovation extend to the renewal of interest in industry innovation clusters and precincts? Is there an optimum balance of sector-based firm concentration for such precincts to be productive?

Productivity in services industries

The services sector has been growing in importance for some time and now accounts for the major part of output and employment in the Australian economy. As such, productivity in services industries has important implications for the productivity performance of the whole economy.

Traditionally, productivity growth in services industries has been thought to have possibilities for productivity growth that fall behind other sectors, especially in manufacturing. There are thought to be relatively few opportunities to change the basic production processes of providing haircuts or performances by string quartets. This issue was famously captured in the concept of ‘Baumol’s disease’, which says that services will account for a greater proportion of expenditure in part because services have fewer opportunities to lower output prices through productivity gains.

The ICT revolution opened up new opportunities for productivity growth in services industries. Baumol’s disease was declared to be cured (Triplett & Bosworth 2003).

What are the key drivers of productivity growth in services industries? Are there common themes? What policies and institutional settings can help to foster productivity growth in services industries?

Productivity, business transformation and society

The Society of Knowledge Economics (SKE) (Boedker et al 2011) in a ‘High Performing Workplaces (HPW)’ project commissioned by the Australian Government surveyed over 75 firms and 5,500 employees in the services sector. The study measured firms on six performance indicators – innovation, employee, fairness, leadership, customer and financial performance. It found that firms identified as HPWs tend to have 12 per cent higher total factor productivity than firms that are not as high performing. In addition, HPWs also displayed higher innovation levels and had an average profit margin 15 per cent higher than the lower performing firms.

To what extent does productivity performance vary among firms or sectors and why? How significant are workplace arrangements? How does Australia foster the transformation of organisations in order to produce better goods and services subsequently realising higher profits? Do we need government policy interventions or is this best left to competition and markets? How do workplace needs fit with household needs?

Productivity, education and skills

‘Removing barriers to work and lifting skills boosts productivity and creates wealth’, was the message from Treasurer, the Hon Wayne Swan MP (2012), in his 2012 budget speech. Supported by research evidence, the SKE in its HPW report (2011) also identified skills utilisation as a key management practice that correlated with HPWs in the services sector. Similarly Nicholas Bloom from Stanford University and his co-authors of the report *Management Practice and Productivity: Why They Matter?* (2007) were able to link effective management practices underpinned by highly qualified employees with higher productivity levels in over 4,000 mid-size manufacturing firms which they surveyed.

So there is no question that education and skills are important for productivity growth. But do we know enough about the mechanisms and which types of education and skills will be required to sustain long-term growth? Should the resources boom slow down, how do we transition individuals who are currently being up-skilled for the mining sector, to other sectors of the economy?

Productivity and infrastructure

Communications, networks, transport and simply bricks-and-mortar infrastructure investments — soundly based — are all vital to enhance growth potential. And, there is evidence acknowledging how infrastructure (roads, ports, communications, energy,

water) plays an important enabling role in productivity growth. For instance, Dr Clifford Winston, scholar at Brookings Institution, in his lecture (2012) at the ANU earlier this year talked about how the US economy spent about \$2.5 trillion on improving transport infrastructure to reduce related productivity inefficiencies. Some have argued that Australia faces an infrastructure shortage, which is negatively impacting its productivity growth and international positioning when compared to other OECD economies.

So how important is infrastructure to productivity growth? What determines the effects that infrastructure has on productivity? What forms of infrastructure matter? In an age that is technology and network driven how vital is investment in bricks-and-mortar type infrastructure? Should there be a balance between bricks-and-mortar infrastructure versus investment in digital infrastructure or should one supersede the other? How productive and effective are our current nation building infrastructure decisions?

Do we know enough about productivity in sectors where government plays a dominant role in the provision of services or even where it has a major regulatory oversight eg utilities?

Productivity in a lower-carbon economy

The issue of a low carbon economy is the latest to be added to the suite of productivity matters. The issue here is not whether we should or should not be moving toward a lower-carbon economy. The issue is, if we are moving in that direction, What are the productivity implications? Will productivity, as we have measured it, decline? What does this mean? Should we adapt productivity measures? How is the economy likely to adapt to lower-carbon measures and what implications will these have for productivity?

As Eric Beinhocker and Jeremy Oppenheim, from McKinsey's Climate Change Special Initiative, point out (2008), promoting or aspiring to a lower-carbon economy means to generate 'carbon productivity'. So how do we make place for carbon productivity in addition to existing complexities with capital and labour productivity? What effects will reducing carbon emissions have on productivity? Are there measurement implications?

Productivity, health and ageing

It is well known that the population is ageing – a higher proportion of the population is moving into retirement age and people are living longer. This has a number of implications for productivity. While developments in science and technology have improved longevity in most developed economies, productivity growth is needed to counter any detraction that may occur as a result of a rapidly growing ageing population. The Intergenerational Report from the Australian Government's Treasury Department projects an increasing GDP spend from 22 to 27 per cent over the coming decades on health costs as a result of an ageing population. Maintaining growth in living standards throughout the community may thus require stronger productivity and income growth from the smaller proportion of the population of working age. The health demands of an ageing population will involve increasing cost burdens in the community, which can be ameliorated with added productivity growth in health services. There is also the issue of better understanding how to productively engage aged people.

What are the productivity implications of an ageing population – not just negative but positive alike? Can we embrace a change in mindset wherein retirement is no longer a concept? What can be done to meet growing health needs in a productive fashion? Is it possible to rebalance responsibilities between government and the civil society in order to create new avenues for long-term health care? How can our health system be made more productive e.g. patient-centred care and safety, quality of healthcare etc?

Productivity measurement and analysis

Many of the issues identified above clearly have a measurement aspect attached to them. The concept of productivity itself is data, measurement and analysis loaded. It is relatively simple when the only challenge is identifying tangible input and output measures. The commonly cited ‘complexity in productivity’ story is where two labourers are tasked with producing pins in a factory - 100 pins each a day. One day they decide to streamline the process of making pins where one shapes and the other finishes, they collectively produce 250 pins – an increase of 50 pins a day, and improved output. But, how do we measure the change in the input process – the innovation? On the flip side, does the measurement of innovation really matter as long as the productivity objective is achieved? Well, many in the public policy camp would argue that it is vital to measure and source data that influences productivity – at the very least since this significantly influences the manner in which government will drive policy choices.

So what do and do not productivity measures capture? What data and analyses are needed for better policy formulation in the productivity area? For various productivity measurements – capital, labour, multifactor productivity – do we need to add new elements to how we measure productivity? Do we (and, if so, how do we) capture concepts such as ‘digital’ and ‘carbon’ productivity?

The two key questions here are about how far we take measurement for policy purposes and what we do policy-wise in the areas that are not well measured. Measurement (and other) difficulties mean that it is hard to express policy objectives in empirically verifiable ways. This is a recurrent theme and is likely to emerge in discussion in each of the other themes.

3. OPPORTUNITIES FOR LONG-TERM PRODUCTIVITY GROWTH IN AUSTRALIA

This is the first of the policy-relevant themes to be discussed. This theme sets the scene for further Roundtable discussions. It is about what the future *could* bring in terms of productivity growth. The longer-term rate of productivity growth can be thought of as a combination of:

- > the evolution of opportunities for productivity growth
- > the ability to realise those opportunities.

What constraints may get in the way or what might need to be done or put in place in order to fully realise the opportunities will form themes in subsequent discussion.

3.1 Background and issues

The Treasury’s Intergenerational Report (2010) provides a good starting point. The IGR extrapolates Australia’s economic conditions to 2050 in the 3Ps framework – population, participation, and productivity.

Productivity is cast in terms of GDP per hour worked — a broad measure of labour productivity. The current productivity performance refers to the average annual rate of productivity growth over the 2000s. Other past performances, not included in the table, are: 2.1 per cent a year over the 1990s, 1.3 per cent a year over the 1980s and 1.8 per cent a year from the mid-1970s to 2009-10.

	Current	Forecast (to 2050)
Gross Domestic Product (GDP) growth	3.3% average (over the past 40 years)	2.7% average (over the next 40 years)
Population Growth	1.4% (over the past 40 years)	1.2% (over the next 40 years)
Productivity Performance	1.4% average (over the past 10 years)	1.6% average (over the next 30 years)
Workforce Participation	65%	61%
Average hours worked per week per worker	34.1 (down from 35.7 in 1997-1998)	33.6
Government spending on aged care, health services and aged pensions	22.4% of GDP	27.1% of GDP
Ratio of working people to an aged person (over 65 years)	5:1	2.7:1

Source: Adapted (Vas 2012) from the IGR 2010

The future projection of 1.6 per cent a year is based on past performance. The rate is a mild improvement on what has been achieved in the last decade, but slightly less than what has been achieved over the long term (from the mid-1970s). While the projection should technically be viewed as a realisation – what might be achieved and not what is possible – it nevertheless provides a starting point for discussion. It implies that future productivity growth will be well below what was achieved in the 1990s, but a small improvement on the 2000s results.

The interest here, however, is about what might be possible. It is not so much about what priority should be given to productivity, perhaps to the exclusion of other broader objectives.

3.1.1 Some ways of thinking about future opportunities

There are several headings that can be used to guide thinking about future opportunities for productivity growth.

New knowledge and technological advance

The accumulation of knowledge is often used to encompass both technological and non-technological advances. Non-technological advances, such as in management and organisational innovation, are also important sources of productivity growth. They are more about the non-technical way in which production is organised.

Advances in technology have been a major, if not the major, source of productivity growth over the long-term. Advances in technology shift the frontier of what is possible (in a science and engineering sense) to produce from available resources.

Technological advances have traditionally had the greatest application in the manufacturing sector. There have been major advances, for example, in aeronautics, machinery and equipment, chemicals, pharmaceuticals and computers and electronic equipment.

Australia has not been a major participant in many of the large technological advances in manufacturing industries. Australia has not had the production scale (or even presence of some industries), or history in the development of specific research infrastructure and expertise, to be a major player in the advance of technologies. While there have been niche developments and adaptations, Australia has largely benefited from importing technologies developed elsewhere. From a productivity point of view, imported technologies, if correctly measured, are enhancements of the quality of inputs — intermediate and capital goods.

The main areas for the development of technological opportunities of relevance to production in Australia would appear to be in agriculture, mining and health and biotechnology.

Non-Technological

Developments in information and communications technologies in recent decades have provided platforms for *users* to introduce innovations in how they go about their business. Australia has been a successful participant in this form of innovation. The fruits have been seen in part of the historically-high productivity growth in the 1990s, especially in wholesaling and financial services. The ICT platform, however, provides opportunities for innovation and productivity growth across the range of industries that are not dependent on the scale of production.

Structural change

Structural change can also affect the evolution of a nation's productivity possibilities. The flexibility, responsiveness and dynamism of businesses and other economic agents matter for productivity growth. Changes in the structures of production are inevitably linked to these characteristics.

Industry

Aggregate productivity growth is not only a function of the opportunities for productivity growth within a sector, but also the relative growth in sectors. For example, greater opportunities for productivity growth in mining will have even greater implications for national productivity growth, if the mining sector continues to expand relative to others.

Firm

Average productivity, for example in an industry, is partly a function of creative destruction - the entry and growth of more-productive firms and the decline and exit of less-productive firms.

Globalisation

Increased globalisation of production has also influenced where the opportunities for productivity growth lie in advanced economies. Globalisation brings increased international specialisation. Increasingly, while high-skill and high-value-adding activities such as design are retained in advanced economies, the production of standardised manufacturing and service elements is being located in other countries. On the other hand, rapid growth and development in Asian countries have brought opportunities for growth in high-value exports, including in services.

International benchmarking

Another way to think about possibilities for productivity in Australia is to consider our productivity levels against the levels of other countries. Is there scope to catch up, at least to some extent? There may be features of the Australian operating environment that mean full catch-up is not feasible. In what industries could we catch up? What does the degree of catch-up depend on?

Somewhat related, to what extent is there an international slowdown in productivity growth?

3.2 Resources

3.2.1 Data and analysis from other centres of interest

Australian Government Treasury

- > Projections incorporated in Intergenerational Reports, based mainly on continuation of productivity growth at a long-term historical average rate
- > Future productivity growth opportunities by broad industry sector also considered as input to carbon emissions modelling (not published)
- > Various articles published in the Economic Roundup and elsewhere on the Treasury website.

3.3 Discussion

Some specific questions that might help to guide discussion are:

- > Is it possible for Australia to do better than its long-term historical average on productivity growth?
- > Where are the main technological and non-technological opportunities for productivity growth likely to come from?
- > Which industries or what generic advances? Infrastructure developments?
- > What is the likely relevance of business transformation in Australia and tapping into global supply chains, especially in Asia?
- > Will structural changes in the domestic economy affect aggregate productivity possibilities?
- > What more could, or should, be done to develop understanding about this theme?
- > What other agencies or research institutions are scanning the horizons (with particular reference to Australia) for what future productivity opportunities might be and where they might be applied?

4. PRODUCTIVITY AND THE MINERAL RESOURCES BOOM

Australia has been undergoing substantial structural change as a result of the minerals resource boom. The boom has brought very substantial gains in terms of profits, employment and wages. However, to date, the effect on productivity growth in the sector and nationally has been negative.

4.1 Background and issues

4.1.1 Productivity determinants

Productivity in Australia's mining sector has shown long swings. From available multi-factor productivity (MFP) estimates (Topp et al 2008), mining productivity was in decline in the 1970s, trended upward through the 1980s and 1990s, but has been in decline since the turn of the millennium. The level of MFP in mining is lower now than it was in the mid-1970s.

The 'steady state'

In the ordinary course of events, productivity growth in mining tends to be the result of the interplay of:

- > Resource depletion, which has a negative effect on productivity:
 - As deposits are depleted, more effort is required to extract saleable minerals, either from existing deposits or from new lower-quality deposits
 - Depletion of reserves had become a major influence on mining productivity before the boom got underway. Existing oil and gas reserves had run low and coal mining had begun to face larger overburdens on deposits
- > Discovery of new higher-quality deposits, which is productivity enhancing:
 - Lower extraction effort for the same yield means higher productivity
- > Technological advances and improvements in the organisation of inputs (such as work arrangements and provision of infrastructure)
- > Investment lags if major development works are required to access major new deposits (the North-West Shelf can be thought of an example), which detracts from measured productivity:
 - The development phase of major projects can add noticeably to capital inputs in mining for a number of years before the output comes on-stream.

The boom

The boom in minerals prices, especially for coal and iron ore, was unexpected in timing and extent. The lift in prices raised resource rents¹ and profit expectations, which heightened two negative effects on mining productivity:

¹ Resource rents are revenues above the costs of extraction, where costs include a normal or satisfactory return on capital.

- > the depletion effect - higher rents and profit expectations made it worthwhile for miners to step up work on deposits that are of lower quality in some sense - depleted, further away, less pure, deeper
- > the capital lag effect - the boom in investment (increasing mining capacity through development of new mines, expansion of existing mines and enhancement of associated infrastructure) brought increases in capacity - and measured capital inputs - before mines were completed and became operational.

The scale of the boom likely also had negative effects on productivity in miners' eagerness to develop mines and extract resources as quickly as possible. Shortages of labour and intermediate inputs meant that things have not been done as efficiently as possible or as they may have been done in the past. Australia is increasingly being seen as a high-cost country for major projects (Business Council of Australia 2012).

4.1.2 Productivity outlook

Against this background, the outlook for mining productivity will depend on:

- > the commodity price outlook, which will affect further investment plans and even whether some marginal operations are closed or remain open
- > the existing investment pipeline
- > the extent to which output will grow as production from recent mining developments comes on stream
 - most of the increases in capacity will reportedly be operational by 2015
- > the other steady state factors of ongoing depletion, new discoveries, technological advances and organisational improvements.

It is expected that productivity growth will resume from a level of productivity lower than it was before the boom.

Technological advances

Technological advances can introduce improvements that make extraction of minerals more efficient (less wasted effort, better use of equipment, less use of materials and energy) and provide better safety and environmental outcomes.

Fisher and Schnittger (2012) highlight that the development of remotely operated and autonomous mining equipment and systems has become a recent focus of innovation effort. These technologies allow humans to communicate with, and control, machinery from long distances. Advantages can include better utilisation of equipment, greater precision, reduction in health and safety risks and less need to mobilise workers in remote locations.

4.1.3 Effects on other industries

The investment phase of the boom has had a mixture of effects on other industries that could have had further productivity implications. Effects have been:

- > positive for the construction industry, which has participated in mine and infrastructure development; some parts of manufacturing related to mining (such as gas liquefaction, explosives and other mining supplies) and transport (of minerals and workers)

- > negative for other industries through indirect linkages such as the higher exchange rate (negative for many parts of manufacturing and traded services) and pressures on labour markets (higher wages, skill shortages and some general labour shortages (especially in WA)).

The impact of the mining boom on productivity performance has not been systematically investigated. There has not, however, been any acceleration in productivity growth in the construction industry. While productivity growth in manufacturing has declined, the extent to which this is linked to the mining boom has not been ascertained.

4.1.4 Mining, education and skills

Education and skills have a major influence on productivity. Here we focus discussion on the mining boom and its implications for education and skills.

National Resources Sector Employment Taskforce

The NRSET was set up in 2009 to investigate how the projected demand for more than 70,000 additional skilled workers needed for major resources projects would be met over the following five years.

Australia's labour shortage	
\$140,000	average annual salary for Australian oil and gas sector workers in 2011
\$76,000	global average annual salary for oil and gas sector workers in 2011
36,000	expected shortage of skilled workers in Australia's resources sector by 2015
35,000	approximate number of skilled workers currently in Australia's resources sector
75,000	expected demand from Australian resources sector by 2015
70%	percentage of new resources sector investment that will go to oil and gas projects

Sources: Manpower Group and Australia's National Resources Sector Employment Taskforce

The NRSET (2010) put the mining operations workforce at about 185,000 in 2010, or about 1.6 per cent of the total workforce. It expected employment growth in mining operations of 4.9 per cent per annum to 2015, creating around 61,500 new jobs by 2015 due to increased production. There has been a rapid expansion in employment in mining, from a relatively small base. ABS industry survey data suggest employment in mining has risen from around 83,000 in 2001-2002 to 144,000 in 2009-2010.

There has also been expansion in construction employment associated with the investment and development phase of the boom. The NRSET estimated that there were about 30,000 construction workers on mining projects in 2011 and projected this to peak at around 45,000 in 2012 or 2013. The mining boom has created a number of stresses in labour markets, with rise in demands for:

- > engineers and construction workers
- > support services
- > regional employment.

The Taskforce reported that:

The right approach to the sector's skill needs must be demand driven and include improving our schools, developing our apprenticeship system, strengthening our universities and creating a more efficient labour market. It can also help address the unemployment and social disadvantage that persist in some segments of the community, most notably among Indigenous Australians. Effective strategies could also go some way towards addressing the average income differences between male and female workers and between metropolitan and regional areas. (p.2)

The Taskforce was told of a strong need for better workforce planning to enable regions and states to better connect, prepare, train and house workers. Australia will need more skilled tradespeople, engineers and geoscientists in the future, and improvements in apprenticeship and engineering education will be needed. (p.3)

4.1.4 Mining, living standards and overall wellbeing

We usually think of productivity growth as being the prime source of growth in average income and living standards. A strict application of this thought would raise concern, in light of the evidence that the mining boom has led to lower productivity, that the boom has been a negative for living standards.

But that is not the case. In brief, productivity is about the *volume* of goods produced and not the *value* of goods produced. The higher prices received for mining commodities means that extraction generates more income than increases in volumes would suggest. Australians also gain from the fact that the purchasing power of their incomes rises. Because of exchange rate appreciation, they are able to purchase cheaper imports – cheaper motor vehicles, TVs and overseas holidays. In short, Australians benefit from terms of trade gains (increases in export prices relative to import prices) that are independent of productivity gains.

Other factors that influence overall wellbeing include: the distribution of resource rents, worker safety and environmental and social effects.

4.2 Resources

4.2.1 Data and productivity estimates

Australian Bureau of Statistics (ABS):

- > Annual estimates of labour productivity and MFP for the mining statistical division from 1985-86 to 2010-11, according to national accounts methodology.
- > Published in industry productivity data cube, Cat. No. 5260.0.55.002, *Experimental Estimates of Industry Multifactor Productivity, Australia: Detailed Productivity Estimates*.
- > No estimates below the sector level.

Productivity Commission

- > Topp, V., Soames, L., Parham, D. and Bloch, H. (2008), *Productivity in the Mining Industry: Measurement and Interpretation*, Productivity Commission Staff Working Paper.
- > Annual estimates of MFP for 8 sub-sector industries from 1974-1975 to 2006-2007, using a methodology very close to the ABS national accounts approach.

- > Underlying data used in estimates drawn from ABS survey data published in Cat. No. 8145.0, *Mining Operations* (publication ceased with 2006-07 issue).

Bureau of Resource and Energy Economics (BREE)

- > Recently constructed MFP estimates for 3 sub-sector industries (coal, oil and gas, metal ores) for 2001-2002 to 2009-2010, using a method very close to ABS national accounts approach.
- > Underlying data used in estimates were drawn from industry survey data published in ABS Cat No 8155, *Australian Industry*.

4.2.2 Analysis

Topp et al (2008) [Productivity Commission]

- > Attribute the decline in mining sector productivity to sub-industries.
- > Analyse the contributions of resource depletion and capital lag effect (increase in capital inputs before mines become operational) to the decline in measured productivity.
- > Find large depletion effects (except coal). Capital lag effect is also important. MFP growth would have been positive without these two influences.

Zheng and Bloch (2010) [Curtin University]

- > Analyse resource depletion (natural resource inputs), capital lag (capacity utilisation) and returns to scale effects on MFP. They used an econometric framework.
- > Find two per cent a year MFP growth, rather than 0.01 per cent a year from published index, where over half the difference is due to resource depletion.

Loughton (2011) [ABS]

- > Used cumulative extraction as a method to allow for resource depletion.

Syed and Grafton (2011) [BREE]

- > Review trends in labour, capital and multifactor productivity in Australian mining. Offer reasons for decline, based on other studies. Resource depletion the major contributor.
- > Report similar downward productivity trend in Canada and US.

4.2.3 Centres of interest and expertise

Bureau of Resource and Energy Economics (BREE)

- > Ongoing measurement of productivity in sector sub-industries, states.
- > Ongoing analysis of factors affecting productivity in the mining sector.

Australian Workforce and Productivity Agency (AWPA)

- > Following on from the work of the National Resources Sector Taskforce, APWA is to provide an annual report on the status of skills shortages in the resources sector.

4.3 Discussion

Some specific questions that might help to guide discussion are:

- > Does the above discussion capture the essential determinants of productivity in mining?
- > What is the productivity outlook for mining in the long-term? Do we know about:
 - Prices - ongoing demand and looming supply competitors.
 - Deposits - will resource depletion be significant over the long-term?
 - Costs - will there be ongoing shortages and bottlenecks that warrant further attention?
 - How important are technological advances likely to be?
- > What are the likely ongoing productivity implications for other industries?
- > Are there social and environmental factors that also need to be considered?
- > What can be done to optimise broad-based productivity growth and wellbeing for the Australian community?
- > What more do we need to know to assess the relevant productivity factors around mining?

Some specific questions that might help to guide discussion on education and skills are:

- > In what occupations and regions are labour shortages likely to persist?
- > Are skill needs likely to persist or alter?
- > What implications are there for other industries?
- > Are there innovative ways to deal with the skill needs of the mining industry?
- > Are there regional and social issues that also need to be addressed?

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