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THE FUTURE OF AUSTRALIA'S PRODUCTIVITY: SOME INSIGHTS FROM PRODUCTIVITY ANALYSIS

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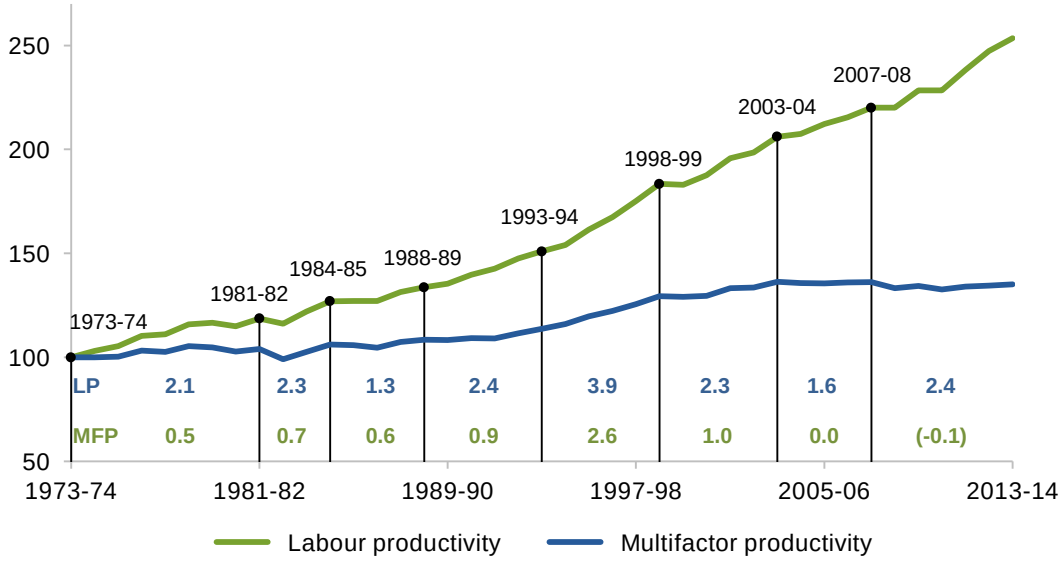
The Intergenerational Report (IGR) recently published by the Australian Government assumed that labour productivity would grow at an average annual rate of 1.5 per cent (Australian Government 2015). This is slightly lower than the growth in labour productivity over the last decade, but that has entirely come from capital deepening (growth in capital services rising faster than labour inputs), because multifactor productivity (the amount of output that Australia has been producing per unit input, as best it can be measured) has stagnated (figure 1).[1] Fortunately for Australia, a rising terms of trade — the price of exports relative to the price of imports — delivered strong growth in real incomes over much of this period. But the fall in the terms of trade since September 2011 is reversing this source of income growth. More relevant for predictions of labour productivity, investment tends to be strongly correlated with the terms of trade, and recent trends suggest investment is weakening (Atkin et al. 2014). Slowing investment growth reduces the rate of capital deepening, which will put downward pressure on labour productivity growth.

Clearly, restoring multifactor productivity growth is going to be critical to achieving the 1.5 per cent labour productivity growth, and with this growth in real wages. Moreover, ensuring strong growth in nominal GDP — which is the basis for government revenue generation — will be important for the sustainability of government expenditure.

Figure 1 **Trends in productivity growth, 1973-74 to 2013-14**

Index 1973-74 = 100 and average annual growth rates by productivity cycle (per cent)



1 The effect of this rapid growth in investment on national income, rather than national product, depends on the source of investment funding. The consequences of this are discussed in the final section of this paper.

Source: ABS (*estimates of Industry Multifactor Productivity, 2013-14,* Cat. no. 5260.0.55.002, December 2014); Commission estimates.

How likely is it that productivity growth will recover, nominal GDP growth targets be reached, and government service commitments be sustainable? The Productivity Commission program of studies on the productivity of different sectors — to date, Mining (Topp et al. 2008), Electricity, gas and water (Topp and Kulys 2012), and Manufacturing (Barnes et al. 2014) — provide some insight into what lies behind the past and current productivity performance. Three findings from this research have implications for long-term productivity growth in Australia and, for this and other reasons for nominal GDP growth. While they don't condemn Australia to a low productivity growth future, they point to the need for a more rigorous debate about how to stimulate income growth.

The drivers of productivity growth

Productivity growth, both conceptually and how it is measured, requires output to grow faster than inputs. This happens, at the firm and the economy levels, when the raw resources (labour and capital, but also land and water resources) are allocated to more efficient production technologies, or are organised more efficiently. This includes enhancing the productivity of inputs through labour or capital embodied technological change, or in the case of natural resources, with new discoveries of higher quality resources, and with the 'manna from heaven' of good rainfall. It also includes labour and capital saving technological change through better production, new products, and improvement in the average performance of firms.

Productivity has little to say about whether what is produced is what people want to consume, but it is relative rates of productivity in production that lies behind gains to trade.[2] Countries and households do best when they produce what they are relatively efficient at producing, and trading their exports for imports, or their labour and capital for the goods and services they want to consume. Firms too, do best when they focus on what they are most productive at, buying in services they need, and as part of global supply chains.[3] So improving productivity enhances the opportunities for gainful exchange and with this wellbeing.

Measured productivity growth has been described as an estimate of what we do not know — output growth that is not explained by input growth (Abramovitz 1956). But we do know that output can grow faster that inputs (Gordon, Zhao and Gretton 2015) through a:

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2 Opening markets also brings competitive pressure to improve the underpinning institutions — labour and financial market regulation, judicial systems, and demand for productive infrastructure to support trade.

3 Real income rises through improvements in allocative efficiency even if there is no productivity growth. Even though real income rises, it is possible for changes in the terms of trade to lead to lower measured productivity in the economy if it means that sectors that have a lower level of productivity expand relative to those that have higher productivity. However, this is likely to be a short-term experience.

- *utilisation effect* — there is an increase in the utilisation of the resources being used in production — this can vary over the business cycle, and is also why sudden structural change in an economy, in response to changes in prices or other events including weather, has major short-term impacts on productivity
- *complementarities effect* — investment in capital allows greater utilisation of labour resources (capital deepening), investment in education (human capital) allows greater utilisation of knowledge embedded in capital
- *returns to scale effect* — market growth means that more efficient technologies can be adopted
- *technological progress and organisational change effect* — firms innovate and find new and better ways to produce and/or introduce new products
- a *competitive dynamics effect* — less productive firms leave the market, more efficient firms enter the market or expand their market share, and incumbents improve their performance, which all directly raise average productivity.

Australia's strong productivity performance over the 1990s (figure 1) has been attributed to the considerable microeconomic reform program (National Competition Policy and a major program of corporatisation and privatisation) implemented in the early 1990s (PC 2005). The further liberalisation of trade and capital markets in the 1980s boosted investment, stimulated competition, and exposed Australian firms to better business practices. At the same time, growth in the share of the population completing tertiary education and year 12 (or equivalent) boosted human capital. Adoption of Information and Communication Technology (ICT) also played a role (PC 2004). So all five sources of productivity growth were at play — with competitive dynamics as driver, not just in the mathematically obvious way, but through greater incentives to improve utilisation, seek complementary investment in capital and in skills, increase scale to adopt more efficient technologies,[4] and innovate to maintain profitability in the face of considerable change.

An easing of Australia's productivity growth after the 1990s was to be expected — the gap that had emerged between Australia's productivity and leading countries prior to the 1990s provided the opportunity for a major 'catch-up'. But the on-going deterioration in productivity performance since then is a concern. The Commission initially identified three market sectors — Agriculture, Mining, and Electricity, gas and water, as the major contributors to the productivity slump (Parham 2012). But further analysis revealed that Manufacturing has also played a major role. Productivity in Agriculture has since recovered — the poor performance over the second half of the 2000s was strongly affected by a prolonged drought (figure 2). While there were special factors at work in the other sectors, there are broader trends with more widespread implications.

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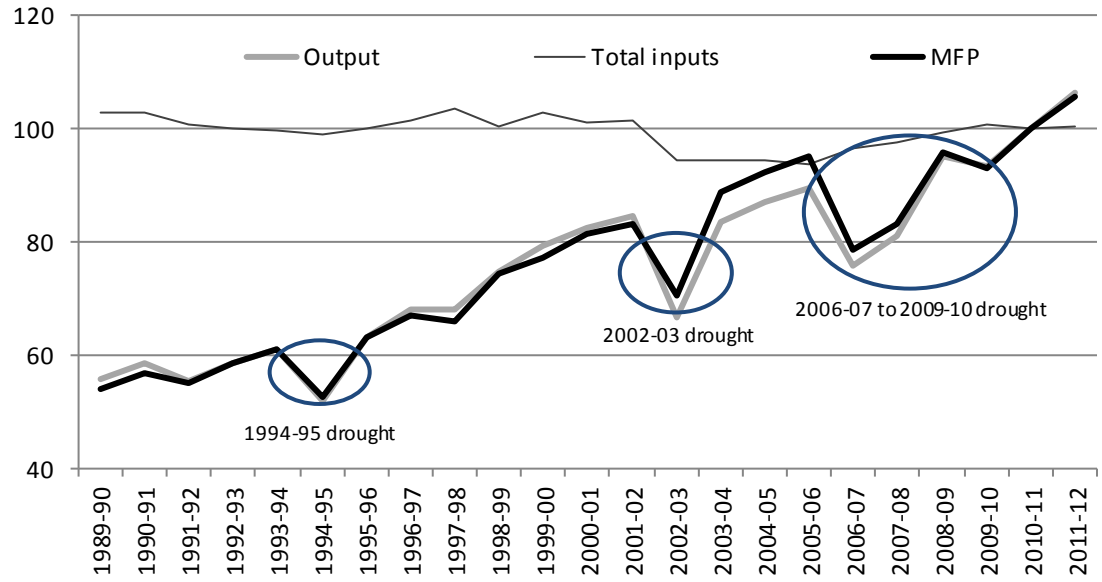
4 Forster (2015) took an econometric approach to estimating productivity growth over the period 1966 to 2004. He argued that economies of scale were the driving factor (and was critical of the growth accounting approach which assumes constant returns to scale in estimating productivity growth rates). However, his finding is not inconsistent with all five sources of productivity growth playing a role in driving productivity growth over the period estimated.

Figure 2 **Inputs, output and MFP in AFF**[a]

Indexes 2009-10=100



[a] Note that the MFP series in this figure is value added based MFP, where *Output* is real gross value added, and is defined as real gross output (production) less real intermediate inputs, and *Total inputs* is defined as the cost-share weighted average of labour and capital inputs, also measured in volume terms.

Data source: ABS 2012b (Estimates of Industry Multifactor Productivity, 2011-12, Cat. no. 5260.0.55.002, December 2012). Topp and Kulys 2014, figure 3.

Three findings on productivity with long-term implications

There are three findings with particular implications for long-term productivity, and national income more generally:

- *Natural resource depletion effect* — the number of greenfield sites for development, whether mineral deposits for mining, dam sites for water harvesting, or land for agricultural production and commercial production or for housing, declines with development. In mature economies new sites tend to be more expensive to develop — that is they require more inputs to yield the same output, so have lower productivity.
- *Capital lag effect* — investments that take time to be fully utilised dampen productivity growth during the investment phase, and boost productivity growth as they move into the full production phase. Periods of accelerated investment tend to see lower productivity growth, with rewards later — when the new capital utilisation rises. While most closely identified as a major factor behind the slump in Mining productivity associated with the Mining investment boom, the effect relates to many long-term investments, such as in utilities and other infrastructure, and in education and R&D.
- *Quality effect* — also known as the artisan baker or craft beer effect, this points to the improvements in the quality of goods and services which in a competitive market are largely captured by consumers. Where quality improvements are not fully reflected in prices, the true growth in productivity will be underestimated.

These three effects have some bad and some good news for governments concerned about boosting income growth, funding the budget, and delivering on the communities' expectations for government services.

Depletion of natural resources raises the cost of production

Depletion can have a major impact on productivity growth in industries that are dependent on natural resource inputs. As these inputs are not measured, any decline in the quality and/or availability of resource, will mean less output for any given input. Alternatively, it can take more inputs to extract any given quantity of output. Productivity suffers as the real cost of production rises in both these ways. Commission studies have found this influence at work in both the Mining and the Water and sewerage industries.

Topp et al. (2008) estimated that productivity growth in mining would have been 2.5 per cent per annum over 1974-75 to 2006-07 rather than 0.01 per cent if there had not been a resource depletion effect. Zheng (2010) put the estimate at 1.15 per cent over the same period, while Loughton (2011) for the period 1985-86 to 2009-10 estimated that productivity would have been 2.05 per cent instead of -0.15 per cent. Where resources are depleted to the point where production is no longer commercially viable, as may be occurring with oil production in Australia (barring any new major discoveries), the structure of the sector will change and the loss of the industry will boost overall productivity levels. But for other mining industries, productivity growth will remain dampened by ongoing depletion.

The major drought in the second half of the 2000s had a major effect on the supply of irrigation and urban water. The threat to urban water led governments to invest in desalination plants as dam levels fell. As manufactured water requires more inputs per unit of output (potable water) productivity falls with the shift from dam to manufactured water.[5] While drought delivers a short-term depletion effect, most cities have used up the best dam sites so a longer term depletion effect is also at work. Not only is the development of new dams more costly per unit of water delivered because of location related engineering costs, there is often major community resistance to new dams. This reflects the rising opportunity costs, at least in part of the community's view, of using natural resources for production purposes.

Regulation to protect valued environmental services lowers productivity or production

The depletion effect is not just physical — the natural resources being further way from ports, under greater layers of over burden, or of lower grade — it is also a consequence of regulation governing the use of natural resources. The Kuznet's curve, which traces how

5 But where the facilities ended up being mothballed, output, and productivity, are zero.

pollution rises then falls with per capita incomes[6], illustrates that the demand for living in a healthier environment and the capacity to manage emissions and waste rises with income. Some forms of resource use, such as some air and water pollution are reversible, but some are not — hence there is a depletion as well as a preference effect at work. The community's preferences are translated to regulation that restricts the use of natural resources. Purchased inputs replace the previous 'free' input, resulting in lower productivity growth during this replacement phase. Topp and Kulys (2012), found, for example, that productivity in the sewerage industry had fallen as tertiary processing replaced ocean outfalls. Cleaner beaches and a healthier local marine environment came at the cost of lower measured productivity.

To the extent that Australians value clean beaches and these are a free environmental input into marine and tourism related industries, the investment that lowered productivity in the sewerage industry has other, indirect, benefits. But only some are likely to boost nominal GDP through productivity improvements elsewhere. Most benefits accrue to those who get to enjoy the natural assets, and more generally to those who value environmental outcomes. Population growth will continue to put more pressure on the natural assets, and regulation to protect them will likely come with a cost to productivity as it requires more inputs to deliver the same measured output (and an environmental quality output that would be accounted for outside of the National Accounts). Alternatively, measured production will simply be lower where development does not go ahead. Clearly, the community will be willing to forgo some productivity, and with this income, for preferred environmental outcomes. The challenge for governments is getting this balance right — a difficult and often contentious task.

Capital lags defer productivity growth when investment accelerates

The Mining study identified capital lags as contributing around 25 per cent of the cyclical decline in productivity growth in the sector (Topp et al. 2008). The mining investment boom (figure 3) saw accelerating investment that led to falling rates of capital utilisation because it takes 2 to 3 years to develop a new mine and bring it up to full production. A growing share of greenfield investment contributed to the lag as it is usually quicker to bring brownfields investment into production due to the existing supporting infrastructure. This capital lag effect does not arise when investment rates are steady, as there is a steady supply of capital coming on-line from past investments.

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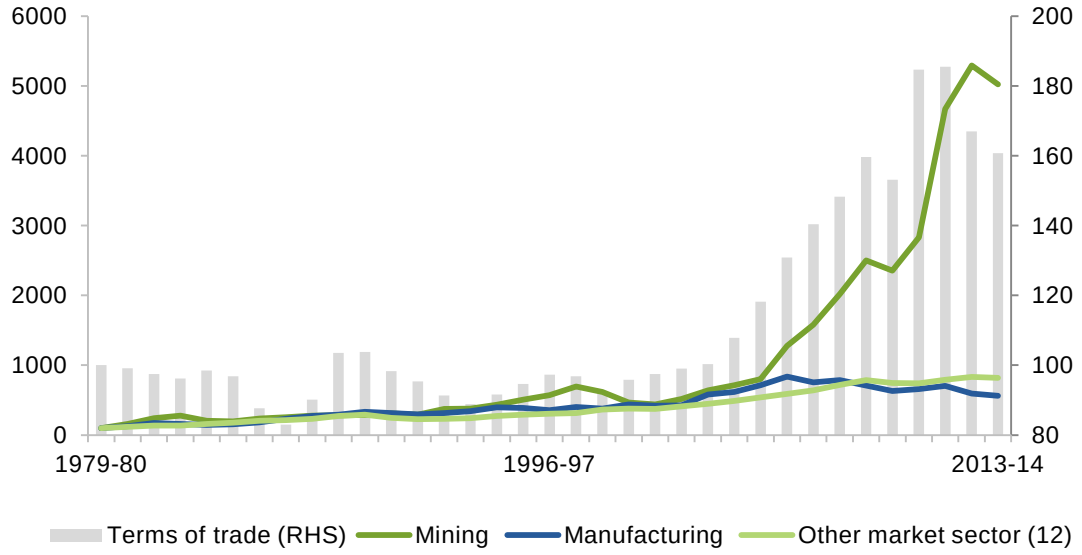
6 This relationship may be breaking down as developing economies are adopting developed country standards (Stern 2004). This reflects a growing demand for better environmental outcomes across the board.

Figure 3 **Capital expenditure in Mining, Manufacturing and other industries[a] (LHS) and Terms of Trade (RHS)**

Index 1979-80 = 100



a Other industries include Agriculture, forestry and fishing; Electricity, gas, water and waste services; Construction; Wholesale trade; Retail trade; Accommodation and food services; Transport, postal and warehousing; Information media and telecommunications; Financial and insurance services; and Arts and recreational service. Capital expenditure is gross fixed capital formation from both public and private sources.

Source: ABS (Australian System of National Accounts, 2013-14, Cat. no. 5204.0, November 2014).

But productivity will not fully recover if the assets remain under utilised

Once industries transition from the investment to the production phase and investment growth slows, the average utilisation rate of capital should rise, and with this productivity should recover. The mining investment boom peaked in 2012, so the expectation is that productivity in the Mining sector will recover as the investments in mine development and supporting infrastructure become fully utilised. Unfortunately, this may take longer than expected (at least by those firms that made the investment) as the prices for major mining outputs (iron ore and coal, and most other minerals) have fallen dramatically from their peak in 2011 and there is pressure to cut production.[7]

There was also major investment in utilities over the 2000s — the desalinisation plants mentioned earlier, but also in electricity transmission (poles and wires), and in sewerage systems. Topp and Kulys (2012) found that these investments had contributed to the poor

7 The fall in prices will slow the depletion effect as the higher cost producers will close production. It exacerbates the utilisation effect, but raises the average productivity of the industry, reducing the depletion effect.

productivity growth in this sector. The time taken to construct major projects and the capital lag is part of the story, but in part low utilisation was due to the motivation for the investment — which was to increase supply security. As normal rainfall resumed, many of the desalination plants have been mothballed (PC 2011). The investment in poles and wires is now well understood to have been to meet the peak demand in electricity, which occurs only for a few days a year (PC 2013). This, combined with the uptake of roof-top solar and falling average demand in response to higher prices, has seen low rates of utilisation of this major investment. These impacts on utilisation should be offset over time with population growth, but long periods of low utilisation in long lived capital stock leave productivity well below potential during this transition period.

The mining investment boom was a response to the commodity price boom (2005 to 2011) and not the product of government policy. But the utilities, and their regulators, should have looked harder at future demand projections and asked what the impact of the supply response would be on prices. In the case of poles and wires for example, the importance of security of supply was not put to the market test — were consumers happy to pay higher prices to purchase a more secure product?[8] As highly regulated industries with cost based pricing formulas, firms (some government owned) had an incentive to over invest as their revenue was directly related to their asset base.

There are other areas of the economy where assets may be underutilised. One that has received recent attention is women — Australia has a relatively low female participation rate and a very high share of prime aged women work part time. As women graduate at higher rates from university than men, from a production perspective they are clearly an underutilised resource.[9] Time out of the labour force costs women future wages growth suggesting a detrimental impact on their productivity (although it could in part be wage discrimination).[10] From a productivity perspective, education is a long-term investment — but the market return depends on the labour force engagement of its recipients.

Boosting the labour force participation of mothers was a key focus of the recent Commission inquiry into Early Childhood Education and Care (ECEC) (PC 2014a). The other focus was on child development, with evidence pointing to major gains for developmentally vulnerable children from quality ECEC. This investment in vulnerable

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8 The Commission studies into urban water (PC 2011) and electricity (PC 2013) questioned the process for making these investment decisions, and pointed to the potential for pricing solutions to delay such large investments. Delaying major investments until they are needed raises productivity as it results in higher utilisation rates.

9 This is not to undervalue the contribution that women make to the non-market sector, not least in household production and the contribution that the mother's education makes to child development. However, the rebalancing in education investment has yet to be matched by a rebalancing in household production or in the workplace.

10 Estimates vary but around 5 per cent lower wages growth per year is not uncommon. Some of the main studies are summarised in appendix J of the childcare inquiry report (PC 2014a).

children can have long-term returns in the form of their higher productivity and workforce participation, as well as facilitating their mothers to participate in the workforce.[11]

There can be tension between participation and productivity when the workers induced into the labour force are less skilled than the average. In modelling the impact of the recommended ECEC reforms which targeted getting low income women into work through higher childcare subsidies, the Commission had to adjust for the change in average productivity when estimating the impact of the increase in the labour supply on GDP (PC 2014a).

Investment in infrastructure and R&D are also particularly important for productivity — but investment alone does not deliver productivity growth. Governments can invest too much in infrastructure, R&D, and education — or too much in a type that will be underutilised, and too little in the type that will be fully utilised. In infrastructure there is a tendency for investing in major projects, often with uncertain utilisation and long build times, at a cost to smaller investments in upgrades that would facilitate utilisation of the rest of the network (PC 2014b). In R&D, the Commission has argued the case for investment in basic science research as, while eventual utilisation can be hard to track, it is adding to the common pool of knowledge and available for utilisation by all (PC 2007). Public funding for private R&D (such as the R&D tax concession) may or may not induce much additional research, but more problematically the knowledge generated will be less widely used.[12]

Improvements in the quality of products increases productivity, but not always in a way that increases production or measured productivity

The 'artisan bread' analysis in the Commission's study on productivity in the manufacturing sector (Barnes et al. 2014) generated considerable media comment. This study found that there was an increase in inputs relative to outputs as production shares shifted from large factory baked products to products from 'in-house' and smaller 'artisan' bakeries. As the study made clear, this shift was in response to changes in consumer preferences, and it was more a matter of real output measures not reflecting the improvement in quality. [13]

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11 There is a further financial (and as well as the social) return from investment in children in the most disadvantaged households. Reducing disadvantage lowers expenditure on 'regrettables', which are public and private spending on things like dealing with drug and alcohol dependence, domestic violence, homelessness, and criminal activity (OECD 2013).

12 It may be embedded in products that are widely used, but the utilisation of the knowledge generated by the R&D is usually restricted through IP and secrecy arrangements.

13 Small winemakers and boutique beer were also identified (Barnes et al. 2014). And as Crikey noted "Small wine makers are a drag on efficiency because they are ignoring market signals and remain in business. Artisan bakers and brewers are also a drag because it takes more bakers and brewers to produce their products than the likes of Goodman Fielder or Foster's. It's rather unfair on these small businesses, because there are other reasons why they do what they do, from lifestyle, to job satisfaction, to tradition or family reasons." (Crikey, April 29, 2014) Indeed, these kinds of non-market outcomes are not measured as production, so to the extent that firms trade-off profits, nominal GDP will also be lower.

A trend toward quality enhancing productivity growth rather than volume enhancing productivity growth can also affect nominal GDP growth. With volume enhancing productivity improvements, resources can shift to other uses, so the output growth at a firm or industry level does not have a big downward effect on prices — nominal GDP growth largely reflects the output growth. However, with quality improvement, the effect on nominal GDP depends on what happens to prices. If the market is competitive, prices rise less than the value added for consumers (consumers could capture much the improvement in quality – a better product at the same price — or in some cases a lower price[14]). If this is the case, then the growth in nominal GDP is lower than the growth in productivity. If the same inputs per unit output (quality aside) are required (or more in the case of artisan bread) there is no shift of resources to boost output in other parts of the economy. This suggests that, to the extent that an increasing share of productivity growth is in improved quality, nominal GDP growth will be commensurately slower.

The ABS are limited in the quality adjustments they are able to make in estimating real output. Not adjusting for improvements in quality means that inflation tends to be overstated and real output understated in the National Accounts. This is not an issue at the aggregate level if the rate of unadjusted quality improvement is stable over time (that is it is a level and not a growth effect). Indeed, the interesting thing is not that productivity growth is underestimated where there are substantial changes in the quality of the products consumed, but that this type of productivity growth is not delivering higher nominal GDP. Adjusting the productivity statistics for quality improvements will not alter nominal GDP — and where more productivity growth comes through in quality improvements rather than quantity in this way, nominal GDP growth will be commensurately lower. This matters for government with their tax base dependent on nominal GDP.

Implications for productivity and income growth

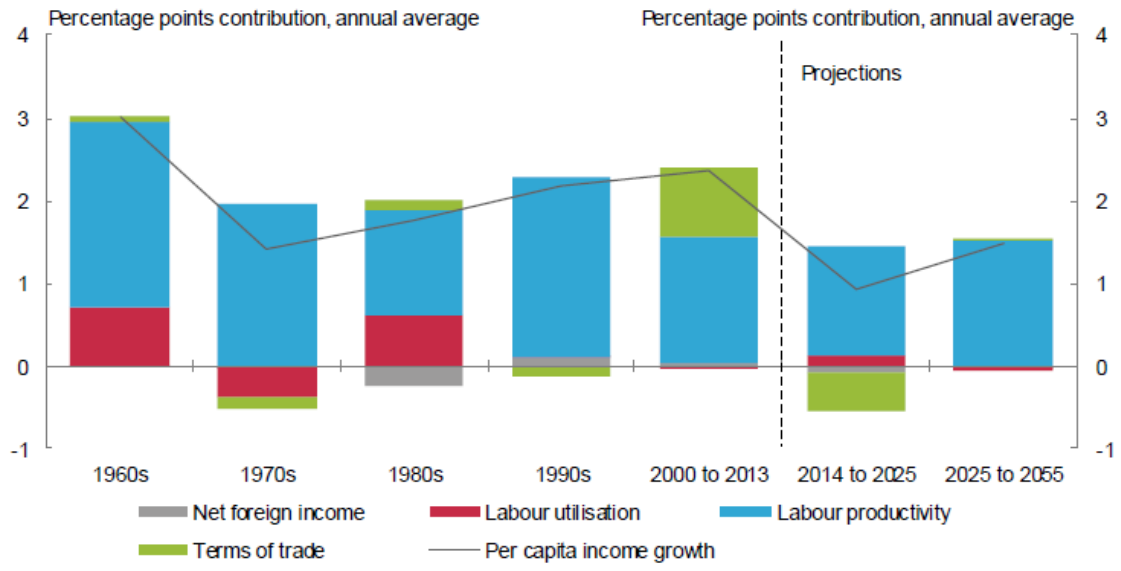
The 2015 IGR report projects average labour productivity growth of 1.5 per cent, wages growth of 4 per cent, inflation of 2.5 per cent, and nominal GDP growth of 5.25 per cent between 2015 and 2055 (Australian Government 2015). This is projected to deliver a 1.4 per cent increase in per capita Gross National Income (GNI), which the report estimates will see the real GNI per capita rise from the current $66 400 to $117 300 in 2054-55.

The sources of this growth are shown in IGR chart reproduced in figure 4. As can be seen from the figure, by 2025-55 all income growth is derived from labour productivity. This in turn comes down to capital deepening and productivity.

[14] Andes and Muro (2014) point to declining product prices from a number of technology intensive industries in the United States as a key factor offsetting a declining real wage.

Figure 4 Sources of growth in real national income per person

subtitle



Data source: 2015 IGR, chart 1.24, p.33, Australian Government (2015)

The prospects for capital deepening are good — but because capital is getting cheaper

Much of the capital deepening in Australia over the last decade has been due to investment in mining (figure 3). Capital expenditure by manufacturing has fallen since 2005, and overall investment is now declining. This pattern is very different to the United States, where, until recently, capital deepening has been more widespread.

The decline in mining investment is to some extent being offset by rise in housing investment (Jericho 2014), but housing does not have the same kind of complementarities that capital deepening in technology intensive sectors has on labour productivity.

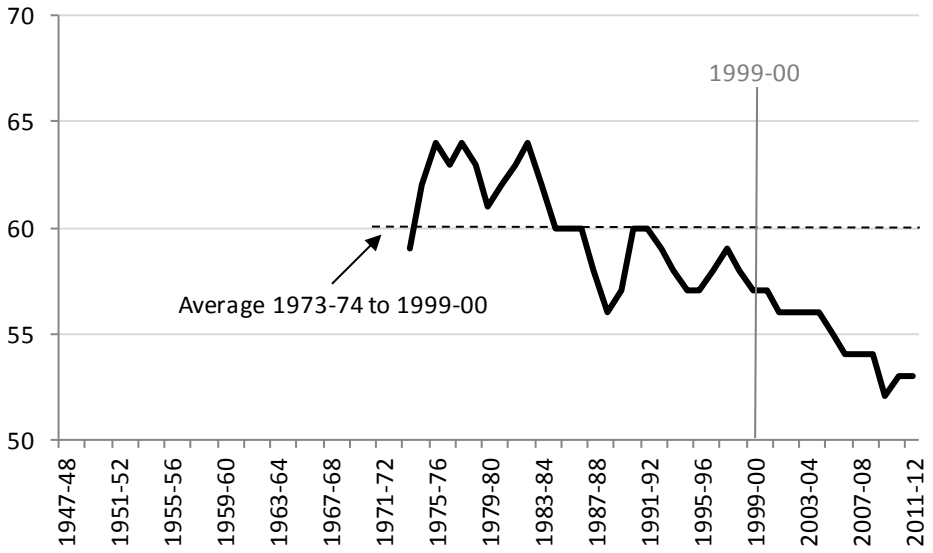
Changes in capital investment can affect the tax base beyond the effects on nominal GDP

Capital deepening over the past decade has been associated with a declining labour share of income (figure 5). Historically, real wages tended to rise in line with labour productivity and so labour's share of income remains roughly constant. But over the last decade, and beginning before the GFC, labour's share of income has been declining. A study by Parham (2013) explained this outcome for Australia in terms of the mining investment boom. As product prices grew faster than consumer prices workers experienced strong growth in real wages despite the decline in labour's share of income. But in the US, other

factors appear at work, many related to an increasing substitutability of capital for labour (box 1). More recently, work by Frey and Osbourne (2013) found that around 47 per cent of total US employment is at risk of computerisation, and that this is already and will further impact on lower skilled and lower paid workers more than on the highly paid and educated workers. The question for Australia is whether, post the mining investment boom, labour's income share will recover or whether it will follow the US pattern.

Figure 5 **The labour income share in Australia's market sector**[a]

per cent



a 12-industry market sector.

Data source: ABS (Cat. no. 5260.0.55.002)., Figure 3.3 Parham (2013).

Box 1 Explanations for the falling US labour share of income

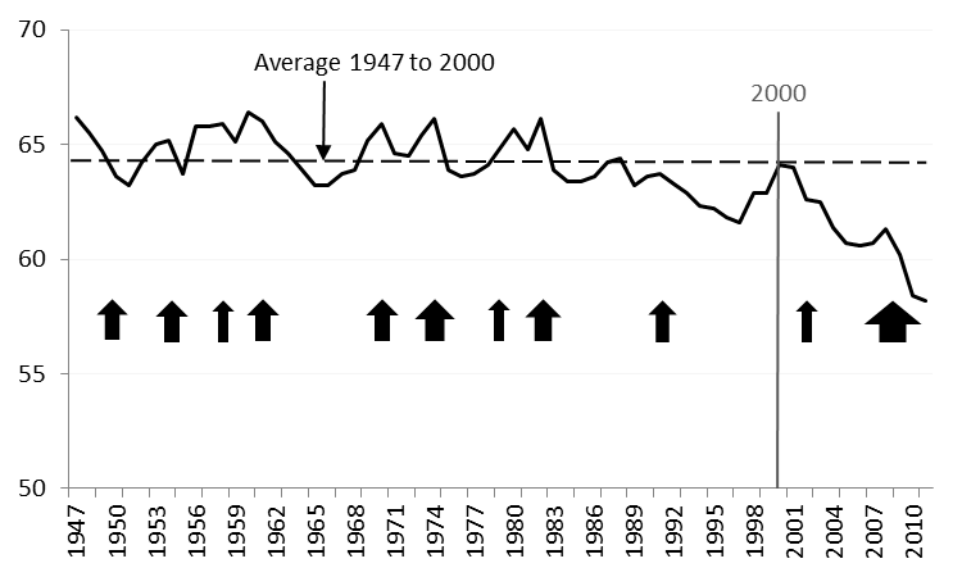
Parham (2013) summarises the main explanations for the decline in the US labour income share as:

- a 'decoupling' of the real purchasing power of wages from productivity growth, according to which the typical worker has not received the gains from productivity growth (Sharpe et al.. 2008; Michel and Gee 2012)
- a concentration of earnings growth among high-income earners (CBO 2011; Brynjolfsson and McAfee 2012)
- a 'hollowing out' of the middle class through loss of job opportunities for middle-income and middle-skill workers, while opportunities have grown in low-pay jobs (Autor, Katz and Kearney 2008)
- an increase in unemployment and decline in participation in the wake of the global financial crisis. (Parham 2013, p.42)

The OECD (2012) identified skill based technological change, mainly in information and communication technologies, as a major factor, along with globalisation of production. The developments in ICT have lowered the real cost of capital as knowledge intensive capital has low marginal costs of production. It is also better able to substitute for workers in the service sector (Karabarbounis and Neiman 2013).

Figure 6 Labour income share in the US non-farm business sector[a]

per cent



a Arrows indicate timing (and duration) of recessions as designated by the National Bureau of Economic Research.

Data source: Fleck, Glaser and Sprague (2011).

Source(s): Parham 2013

Given that the decline in the TOT passes through into lower real wages, if labour's share of income does continue to decline (or not recover), real wage growth is likely to be low. Moreover if computerisation does erode income for the lower and middle income groups who consume most of their income, consumption growth will slow. To the extent that Australian governments rely on labour income and consumption taxes, these trends will affect the composition of the tax base as well as aggregate revenues. Growth is more likely in the more lightly taxed parts of the economy.

There are other factors complicating the tax revenue picture. A widening distribution of labour income could see labour income tax revenues rise — as a higher share of income accrues to those in the highest marginal tax brackets. Australia is traditionally a net capital importer so part of the income generated from capital deepening returns to the foreign owners of capital. So how much this contributes to Australia's tax base depends largely on company tax rates. Given the limited ability to expand domestic savings to fund capital investment, improving the productivity of labour through multifactor productivity growth rather than capital deepening will have the bigger impact on national income, and on government revenue.

The prospects for productivity growth are mixed

There is potentially an exciting story for productivity from disruptive technologies, although how this will play out in the future is unknown. Digital platform technologies, such as Uber X and Air BNB, enable a much greater utilisation of a whole range of assets. This includes bringing household assets, such as cars and homes, into the market economy. Open data and big data are a new resource that can be mined for a whole range of new value adding services, and the knowledge generated has potential to transform how things are produced. Better informed consumers may be able to demand better goods and services from firms, forcing them to improve their productivity. But how disruptive technologies will impact on nominal GDP is highly uncertain in part as they will also enable the barter economy or operate outside the formal economy.

These sources of productivity growth aside, as the previous discussion flagged, there are some long-term challenges to productivity ahead. The good news is that even though it does not fully appear in productivity statistics, consumers are benefiting from higher quality products, which compensates for slowing wage growth. For governments there is also good news in that capital utilisation rates should rise for mining and some utility sectors, although this could be slow.

There is also some bad news. The depletion effect is real and increasing the real cost of production for many industries that rely on natural resource inputs. Like climate variability and periodic droughts, climate change will affect agricultural and utility productivity over time (Garnaut 2011). Regulation to protect the environment comes with a productivity cost, while failure to protect the environment (renewable resources) can impose costs to future productivity through a deterioration in the quality of these inputs. Preferences for non-market outcomes — whether environmental, or social, such as life-style and cultural

choices — could see a shift in the output mix toward production that sacrifices efficiency in producing the main product for more of the non-market joint product. Like quality for consumers, this trade-off is welfare enhancing, but it does not necessarily add to nominal GDP, nor to measured productivity.

And there are opportunities. The most obvious is to better utilise investments in education and skills by raising participation rates and hours worked for mothers and older workers.[15] New disruptive technologies should enhance the opportunities for these under-represented groups to work in different ways. There are also opportunities to make wise public investments in education, infrastructure, and R&D, and to set the policy environment to encourage wise private investment in each of these areas. Just how to do this has been the topic of many reviews, but technology and open data should enable more informed choices. For infrastructure, competition at prioritisation stage based on cost-benefit assessment, aligning incentives and risk with the capacity to control, and regulatory and other policy certainty emerges as the most important features (PC 2014b).

The prospects for sustainable government services

Sustainable government revenue is key to sustainable funding of government services. Some developments, notably consumer's capture of quality and trade-offs in production for jointly produced non-market outcomes, to the extent that they continue to grow as a share of production, point to slower GDP growth, but not to welfare growth. Other developments, most notably the depletion effect, impact negatively on real costs and productivity growth, although some sources, such as protecting the environment, can have an offsetting gain to welfare. But all lower nominal GDP growth and with this government revenue.

Unless disruptive technologies deliver a major productivity boost to production as well as to consumption quality and price, developed economies are facing a low nominal GDP growth future. Current tax settings, which favour taxes on labour income and consumption, also interact with the trend in capital deepening and declining labour income share to erode the tax base. Governments will face the choice of changing how they raise tax revenue or substantially lowering the services they fund in the future.

This situation makes it even more imperative to improve productivity in the delivery of government services — in particular the human services of education, health, and social services. Technology will play a role, but productivity has to be driven by incentives to adopt, adapt, and invest in developing new technology, or to reorganise production, or to develop new services that better match needs. Part of the solution lies in empowering consumers to drive welfare enhancing market solutions through client directed subsidies, forcing firms to compete for clients. But there are areas of human services where markets will not provide solutions. Different ways need to be found to drive productivity growth in

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[15] This has a cost to leisure and non-market production, but many mothers express a desire for greater workforce participation (PC 2014a).

these services. Competition might be able to help improve incentives for efficiency, but may undermine efficiency in other areas or affect equity, so caution is needed in progressing reforms (Harper Review 2015). It should, however, be a priority as human services are a growing share of the Australian economy and the gains from productivity growth in these services will stretch government dollars further, and deliver better and more affordable services for all Australians.

References

Abramovitz, Moses, "Resource and Output Trends in the United States Since 1870," *American Economic Review*, May 1956, 46(2), 5-23

Andes, S., and Muro, M., 2014, How does innovation support lower and middle class families? Look to the price index, Brookings blogs, http://www.brookings .edu/blogs/the-avenue/posts/2014/11/25

Atkin, T., Caputo, M., Robinson, T., and Wang, H., 2014, Australian after the terms of trade Boom, *Reserve Bank of Australia Bulletin*, March Quarter.

Australian Government, 2015, *2015 Intergenerational report: Australian in 2055*, Commonwealth of Australia, March.

Autor, D., Katz, L. and Kearney, M. 2008, 'Trends in US Wage Inequality: Revising the Revisionists', *Review of Economics and Statistics*, vol. 99, no. 2, pp. 300-323, May.

Barnes, P., Soames, L., Li, C. and Munoz, M. 2013, *Productivity in Manufacturing: Measurement and Interpretation*, Productivity Commission Staff Working Paper, Canberra.

Brynjolfsson, E. and McAfee, A. 2012, *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity and Irreversibly Transforming Employment and the Economy*, Digital Frontier Press, Lexington.

CBO (Congressional Budget Office) 2011, 'Trends in the Distribution of Household Income Between 1979 and 2007', CBO Study, Congress of the United States, Washington, October.

Crikey, 2014, Beyond bakeries, Productivity Commission shows who's dragging the chain, April 29, http://www.crikey.com.au/2014/04/29/beyond-bakeries-productivity-commission-shows-whos-dragging-the-chain/?wpmp_switcher=mobile

Fleck, S., Glaser, J. and Sprague, S. 2011, 'The Compensation-Productivity Gap: A Visual Essay', *Monthly Labor Review*, January, pp. 57-69.

Forster, J., 2015, The Australian multifactor productivity growth illusion, *Australian Economic Review*, vol. 48, no. 1, pp. 33-42.

Frey, C.B., and Osbourne, M.A., 2013, The future of employment: how susceptible are jobs to computerisation, *Oxford Martin School Working Papers*, Oxford University.

Garnaut, R., 2011, The Garnaut Review 2011: Australia in the Global Response to Climate Change, http://www.garnautreview.org.au/update-2011/garnaut-review-2011.html

Gordon, J., Zhao, S. and Gretton, P. 2015, *On productivity: concepts and measurement*, Productivity Commission Staff Research Note, Canberra, February.

Harper Review, 2014, The Australian Government Competition Policy Review, Draft Report, 22 September 2014, Commonwealth of Australia.

Jericho, G., 2014, The mining investment boom is over so where to now?, *The Guardian Australian Edition*, 29 August,

http://www.theguardian.com/business/grogonomics/2014/aug/29/mining-investment-boom-is-over-so-where-to-now

Karabarbounis, L. and Neiman, B. 2013, 'The Global Decline of the Labor Share', *NBER Working Paper*, No 19136, NBER, Cambridge, June.

Loughton, B. 2011, *Accounting for National Resource Inputs in Compiling Mining Industry MFP Statistics (Draft)*, Australian Bureau of Statistics staff paper presented at the 40th Annual Conference of Economists, Canberra, July.

Michel, L. and Gee, K. 2012, 'Why Aren't Workers Benefiting from Labour Productivity Growth in the United States?', *International Productivity Monitor*, no. 23, Spring, pp. 31-43.

OECD (Organisation for Economic Cooperation and Development), 2013, *How's Life? 2013 Measuring Well-Being*, Paris

—— 2012, 'Labour Losing to Capital: What Explains the Declining Labour Share?', Chapter 3 in *OECD Employment Outlook*, OECD Publishing, Paris.

Parham, D. 2013, *Labour's Share of Growth in Income and Prosperity*, Visiting Researcher Paper, Productivity Commission, Canberra.

Parham, D. 2012, *Australia's Productivity Growth Slump: Signs of Crisis, Adjustment or Both?*, Visiting Researcher Paper, Productivity Commission, Canberra.

PC (Productivity Commission) 2004, *ICT Use and Productivity: A Synthesis from Studies of Australian Firms*, Commission Research Paper, Productivity Commission, Canberra.

—— 2005, *Review of the National Competition Policy Arrangements*, Inquiry Report No. 33, Canberra.

—— 2007, *Science and Innovation*, Research Report No. 62, Productivity Commission, Canberra.

—— 2011, *Australia's Urban Water Sector*, Inquiry Report No. 55, Productivity Commission, Melbourne.

—— 2013, *Electricity Network Regulation*, Inquiry Report No. 62, Productivity Commission, Canberra.

—— 2014a, *Childcare and Early Childhood Learning*, Inquiry Report No. 73, Productivity Commission, Canberra.

—— 2014b, *Public Infrastructure* Inquiry Report No. 71, Productivity Commission, Melbourne.

Sharpe, A., Arsenault, J., and Harrison, P. 2008, 'The Relationship between Labour Productivity and Real Wage Growth in Canada and OECD Countries, *CSLS Research Report*, No. 2008-08, Centre for the Study of Living Standards, Ottowa.

Stern, D.I., 2004, The rise and fall of the environmental Kuznets cureve, World Development, Vol. 32, No. 8, pp. 1419-1439.

Topp, V., and Kulys, T. 2012, *Productivity in Electricity, Gas and Water: Measurement and Interpretation*, Productivity Commission Staff Working Paper.

—— 2013, *On productivity: the influence of natural resource inputs*, Staff Research Note, Productivity Commission, Canberra.

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

Zheng, S. 2005, *Estimating Industry Level Multifactor Productivity: Methods and Experimental Results*, Research paper, Cat. no. 1351.055.004, ABS, Canberra, July.