OECD Economics Department Working Papers No. 1025

Boosting Productivity in Australia

Vassiliki Koutsogeorgopoulou,

Omar Barbiero

https://dx.doi.org/10.1787/5k4c0vt9xhf3-en

OECD

Unclassified **ECO/WKP(2013)17**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

18-Feb-2013

English - Or. English

ECONOMICS DEPARTMENT

ECO/WKP(2013)17
Unclassified

BOOSTING PRODUCTIVITY IN AUSTRALIA

ECONOMICS DEPARTMENT WORKING PAPER No. 1025

By Vassiliki Koutsogeorgopoulou and Omar Barbiero

JT03334778

Complete document available on OLIS in its original format

English - Or. English

ABSTRACT/RÉSUMÉ

Boosting productivity in Australia

Australia's productivity growth has decelerated markedly around the turn of the century. Part of the decline is probably temporary, but raising multifactor productivity is key to ensure that living standards continue to grow strongly, especially if the currently strong terms of trade weaken over time. Recent efforts by the government are welcome. Ensuring responsive, high quality, vocational and higher education systems is indispensable to long-term growth. Raising the completion rate of vocational students, and enhancing the level of collaboration among the key innovation players are priorities. The productivity-enhancing effects of infrastructure could be boosted by more effective and strategic planning, new sources of funding, and better use of existing capacity. Efficient pricing for infrastructure services and rapid progress towards harmonisation of regulations across states would boost competition and productivity.

JEL classification: O4; I21; O3; H43; L51; L91; L94; Q15.

Key words: Australia; productivity; multifactor productivity; education; vocational training; higher education; innovation; infrastructure; public-private partnerships; transport; user charges; water; energy; regulation.

This working paper relates to the 2012 OECD Economic Survey of Australia (www.oecd.org/eco/surveys/Australia).

****

Un nouvel élan pour la productivité en Australie

La croissance de la productivité a sérieusement fléchi en Australie à l'aube du nouveau siècle. Une partie de ce recul est probablement temporaire, mais il est primordial d'augmenter la productivité globale des facteurs pour garantir une forte progression des niveaux de vie, en particulier si les termes de l'échange, actuellement favorables, devaient s'affaiblir dans le temps. Les initiatives récentes des autorités sont encourageantes. La garantie de systèmes d'enseignement professionnel et d'enseignement supérieur de qualité et capables d'adaptation est indispensable à la croissance à long terme. L'augmentation du taux de réussite des élèves en filière professionnelle et le renforcement du niveau de collaboration entre les principaux acteurs de l'innovation sont des objectifs prioritaires. Les effets de rationalisation de l'infrastructure sur la productivité pourraient être amplifiés par une planification stratégique plus efficace, de nouvelles sources de financement et une meilleure utilisation des capacités existantes. Enfin, une tarification optimale des services d'infrastructure et l'évolution rapide vers une harmonisation réglementaire entre les États doperaient la concurrence et la productivité.

Classification JEL : O4 ; I21 ; O3 ; H43 ; L51 ; L91 ; L94 ; Q15.

Mots clés : Australie ; productivité ; productivité multifactorielle ; éducation ; formation professionnelle ; éducation supérieure ; innovation infrastructure ; partenariat privé-public ; transport ; péage routier ; eau ; énergie ; régulation.

Ce document de travail se rapporte à l'Étude économique de l'OCDE de l'Australie 2012 (www.oecd.org/eco/etudes/Australie).

TABLE OF CONTENTS

ABSTRACT/RÉSUMÉ 2

BOOSTING PRODUCTIVITY IN AUSTRALIA 5

A sharp downturn in productivity gains 5
What caused the productivity slump? 7
Sectoral aspects of the slowdown 7
More systemic factors also appear to be at work 10
Lifting productivity is essential to sustain future living standards and promote broader-based growth 11
Reforms to boost the long-term drivers of productivity 13
Enhancing human capital is at the core of productivity growth 13
Better innovation performance is key for productivity 19
Achieving better outcomes in infrastructure will help productivity 24
Ensuring efficient pricing mechanisms for infrastructure services 28
Swift implementation of regulatory reforms is required 32

BIBLIOGRAPHY 35

ANNEX A1 MEASURING AND INTERPRETING PRODUCTIVITY 43

Statistical issues in productivity measurement 43
What measure for productivity? 43
Productivity estimates are subject to measurement error arising from data limitations 43
Productivity growth is affected by cyclical factors 44
Overcoming some of the statistical problems 44
Computation of industry contributions to MFP 48
Theoretical Framework 48
Industry contributions to MFP growth 49
Discrepancy issues 49
Computation of Australia's industry contributions to market sector MFP growth 50
Computation of industry contributions for Canada and Norway 53
International comparison of industry contributions to productivity slowdown in resource-rich countries 53

BIBLIOGRAPHY 55

Figures

1. Productivity in the market sector 6
2. MFP growth by industry 6
3. Industry contributions to MFP slowdown 7
4. MFP growth slowdown 8
5. Industry contributions to MFP slump in resource-rich countries 8
6. MFP decomposition in the three sectors 9

7. MFP decomposition in other sectors 10
8. Product market regulation 11
9. MFP gap relative to the United States 12
10. Earnings and employment rate by education attainment 13
11. Higher education 16
12. Science and engineering degrees 18
13. Business performance improvements by innovation status 19
14. Innovation indicators 20
15. Barriers to innovation 24
16. Indicator values of PPP policy settings 26
17. Road freight developments 28
A1.1. Labour productivity growth 45
A1.2. MFP growth over productivity cycles in the market sector 45
A1.3. Australia's MFP growth according to different databases 47
A1.4. MFP gap relative to the United States 48

Boxes

Box 1. Recent reform initiatives in the vocational education and training sector 14
Box 2. Recommendations on boosting productivity 34

BOOSTING PRODUCTIVITY IN AUSTRALIA

By Vassiliki Koutsogeorgopoulou and Omar Barbiero[1]

Productivity growth is a key ingredient for future broad-based growth and maintenance of living standards. This paper will discuss the recent sharp slowdown in productivity growth in Australia, its determinants and potential solutions to improve productivity performance.

A sharp downturn in productivity gains

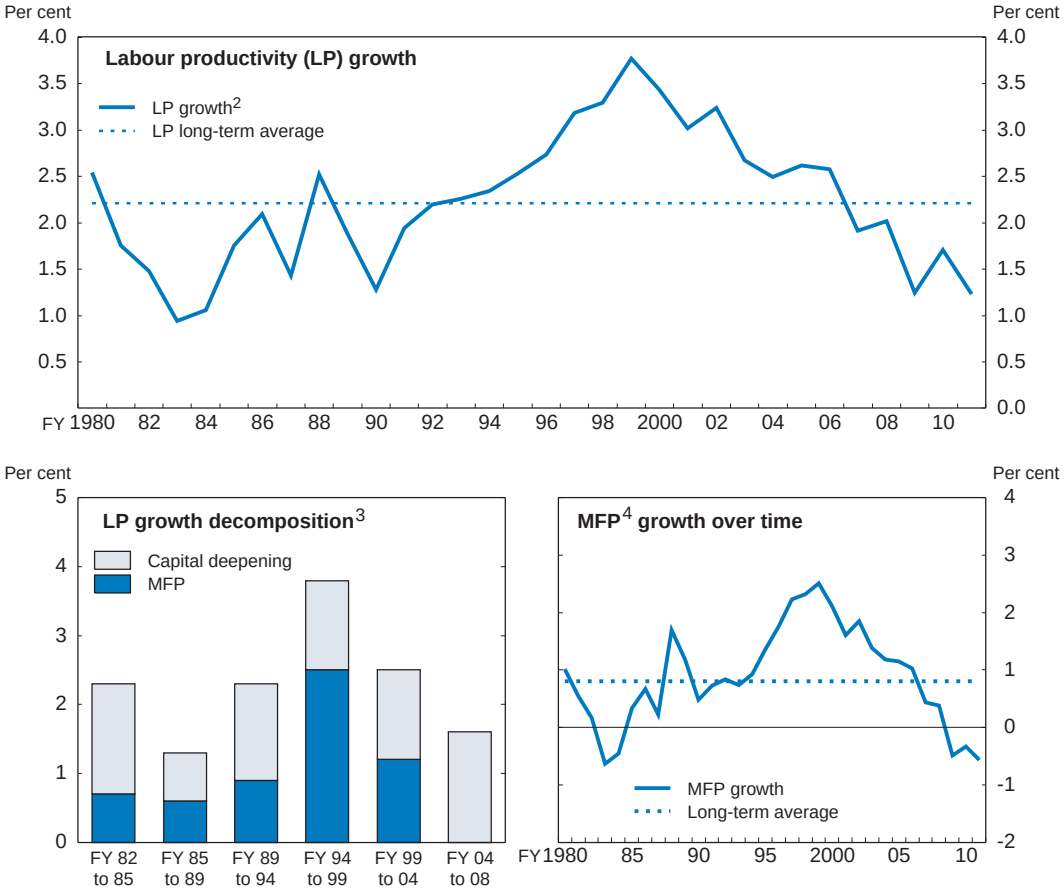
Australia's labour productivity growth – the main driver of income growth in the 1990s – has slowed markedly since around the turn of the century, coming off not only from its 1990s-peak but also falling below its long-run average. This trend is evident both for the whole economy and for the market sector (which accounts for approximately three quarters of total output) for which productivity is well measured (Figure 1). This reflects a sharp slowdown in multifactor productivity (MFP) growth, while strong business investment in the mining sector increased capital deepening. Comparisons across the Australian Bureau of Statistics (ABS) "productivity growth cycles", which abstract from the influence of the business cycle, suggest that after a peak of the 1990s MFP growth gradually fell to zero in the last complete cycle and has continued to decline since then (Figure 1).

The multifactor productivity slump was felt broadly across the economy (Figure 2). MFP growth fell in most industries, although contributions vary (Figure 3). Manufacturing (0.5 percentage points) and mining (0.4 percentage points) contributed most to the deceleration of aggregate MFP between the last two complete cycles, according to OECD analysis (Annex A1). But other industries such as agriculture, utilities (electricity, gas, water and waste services) and retail trade also contributed to the slowdown. Inter-state comparisons, though difficult to achieve because of the different industry structures, provide further evidence that the productivity slowdown was felt broadly across the economy (VCEC, 2011; Cunningham and Harb, 2012).

---

1. Vassiliki Koutsogeorgopoulou is an Economist in the Economics Department of OCED. Omar Barbiero, is an MSc student at Bocconi University, and an intern in the Department at the time of the preparation of the Economic Survey. This Working Paper is based on Chapter 2 of the OECD's 2012 Survey of Australia, which was prepared under the responsibility of the Economic and Development Review Committee (EDRC). It further includes a technical annex, providing background analysis, which was circulated to EDRC for information. The author is grateful for the valuable comments received on earlier drafts from Andrew Dean, Robert Ford, Piritta Sorsa, Claude Giorno, colleagues in other OECD Departments, as well as the Australian government officials. Special thanks for statistical assistance go to Isabelle Duong and to Didi Claassen for editorial assistance.

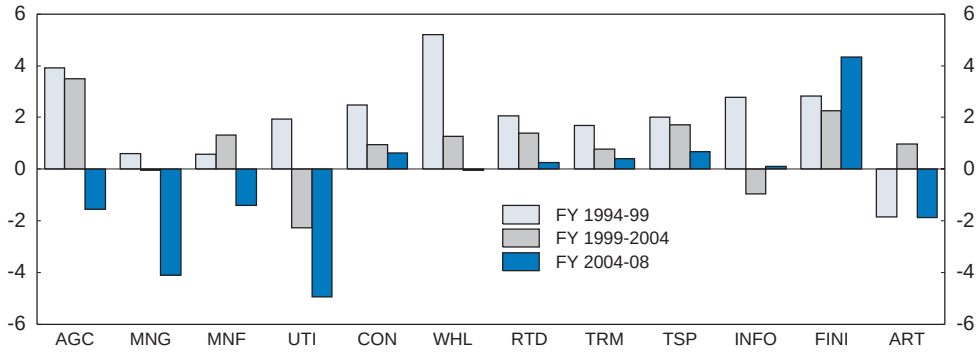
Figure 1. **Productivity in the market sector**[1]



1. Twelve-industry market sector. The market sector includes the whole economy apart from health, education, defence, public administration, as well as property, business and personal services within the business sector which are difficult to measure.
2. Five-year moving average.
3. Only complete productivity cycles are shown.
4. Multifactor productivity.

Source: ABS, *Cat. Nos. 5204.0* and *5206.0.55.002*.

Figure 2. **MFP growth by industry**[1]
Annual average growth in log changes

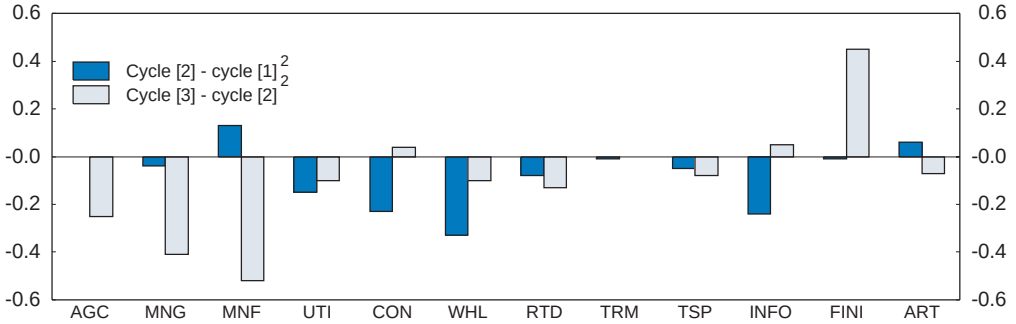


1. Twelve-industry market sector. AGC: agriculture; MNG: mining; MNF: manufacturing; UTI: utilities; CON: construction; WHL: wholesale trade; RTD: retail trade; TRM: accommodation & food services; TSP: transport; INFO: information and technology; FINI: finance and insurance; ART: art & recreational services. Only complete productivity cycles are shown.

Source: ABS, *Cat. Nos. 5204.0 and 5206.0.55.002* and unpublished ABS data.

Figure 3. **Industry contributions to MFP slowdown**[1]

Annual average growth in log changes



1. Twelve-industry market sector. AGC: agriculture; MNG: mining; MNF: manufacturing; UTI: utilities; CON: construction; WHL: wholesale trade; RTD: retail trade; TRM: accommodation & food services; TSP: transport; INFO: information and technology; FINI: finance and insurance; ART: art & recreational services. Only complete productivity cycles are shown.
2. Cycle [1]: FY 1994-99; cycle [2]: FY 1999-2004; cycle [3]: FY 2004-08.

Source: ABS, *Cat. Nos. 5204.0 and 5206.0.55.002* and unpublished ABS data.

What caused the productivity slump?

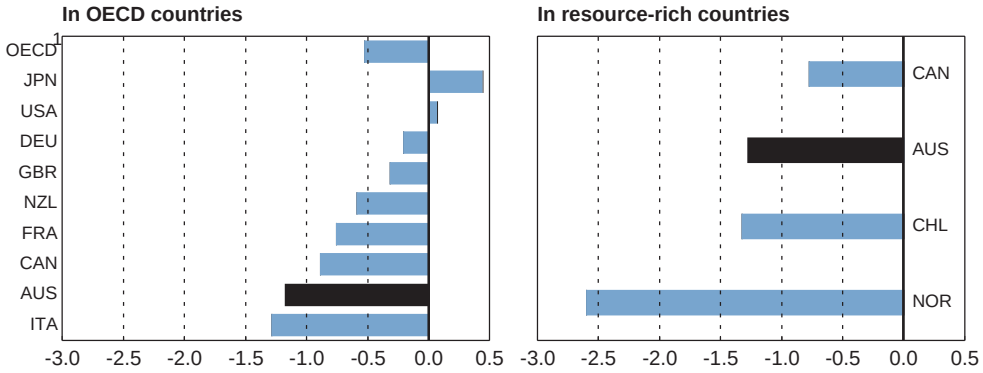
There is no single explanation for the deterioration of Australia's productivity performance in the 2000s. Rather, the decline in MFP growth seems to reflect a combination of factors ranging from special developments in a few key industries to more systemic factors, although the relative contributions of potential drivers is subject to some debate. Overall, much of the slowdown in MFP growth can be attributed to the mining boom and induced structural adjustment of the economy, but other factors such as the fading of the impact of the reforms undertaken in the 1990s, or capacity constraints within the economy, also need to be taken into account. Measurement error may also be explaining some part of the weakening in productivity (Annex A1).

Sectoral aspects of the slowdown

Sectoral explanations of the slowdown tend to emphasise the sharp productivity declines in mining, agriculture and utilities driven largely by special circumstances (Eslake, 2011). The three sectors collectively are estimated by OECD to account for about half of the decline in MFP growth between the two last productivity cycles (Table A1.2). This is calculated as a share of the group of industries that made a negative contribution, based on the Parham (2012) methodology. Results are sensitive to the methodology adopted and productivity measure used. Focussing on labour productivity, Eslake (2011) estimates, for example, that the mining and utilities sectors account for less than 10% of the decline in overall market sector productivity growth over the past decade.

The weakening in productivity has been more pronounced in Australia than in most OECD countries, although it is broadly in line with the experience of some other resource-rich countries (Figure 4 and Table A1.3). Comparisons of the industry productivity patterns across the three resource-endowed countries (Australia, Canada and Norway) for which data are available indicate a strong contribution of the mining sector in each case, suggesting that part of the productivity slump in these specific countries can also be related to the mining-related commodity boom (Figure 5).

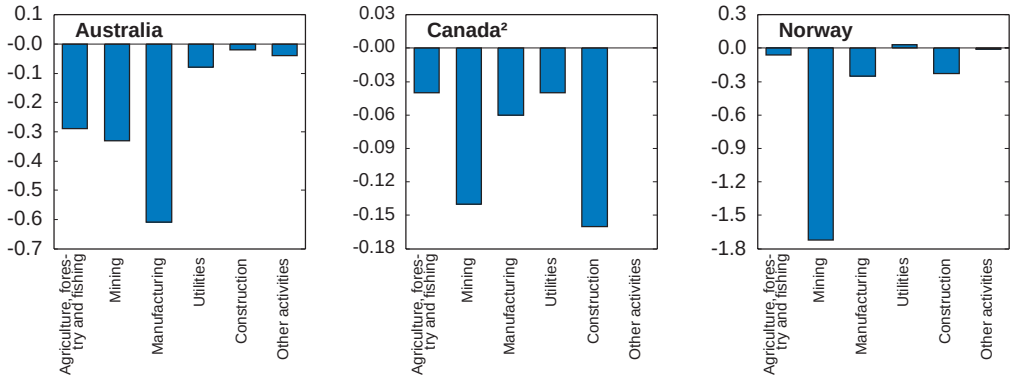
Figure 4. **MFP growth slowdown**
Difference of MFP average growth between the 1990s and the 2000s



1. The OECD aggregate includes only 18 members for which data are available.

Source: OECD, *Productivity database* and The Conference Board, *Total Economy database*, January 2012, http://www.conference-board.org/data/economydatabase/.

Figure 5. **Industry contributions to MFP slump in resource-rich countries**[1]
Percentage points



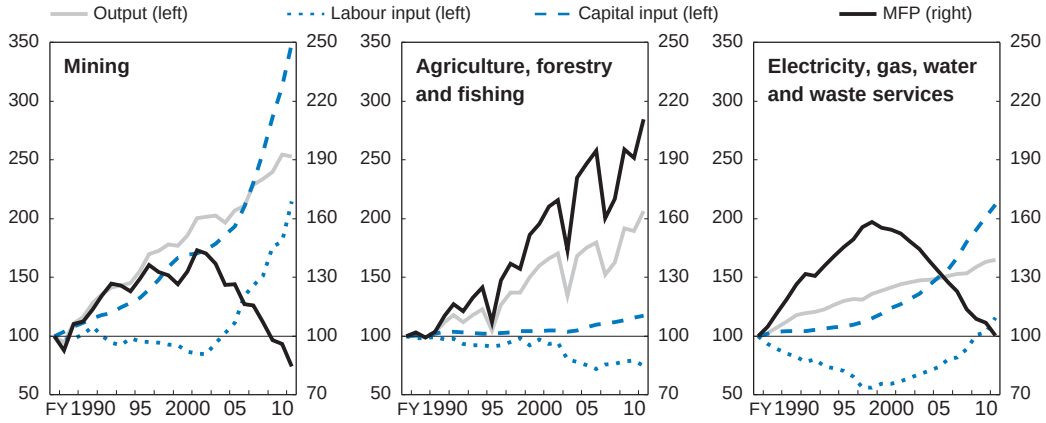
1. The slowdown refers to period 2003-07 compared to period 1999-2003.
2. Data for Other activities not available.

Source: ABS, *Cat. No. 5260.0.55.002* with unpublished data and OECD, *Industry Productivity Database*.

In the Australian mining sector, soaring profits led to a massive injection of capital and labour (PC, 2009) (Figure 6). Yet, due largely to the lags between investment in new capacity and full production, this strong input growth was not matched by output growth, implying a sharp decline in measured mining productivity. Topp *et al.* (2008) estimate the average lag at around three years. Approximately one-third of the decline in mining MFP between FY 2000/01 and FY 2006/07 was attributable to this effect, according to the study, which implies a "pay back" in the years to come, others things being equal (PC, 2009). Another part of the decline was caused by exploitation of more marginal resource deposits as commodity prices rose, requiring the use of more input to produce a given volume of ores and metals. This impact will persist for as long as mineral prices remain high by historical standards (Eslake, 2011).

Productivity in agriculture and utilities has been influenced by drought. Its impact on the agricultural sector was felt particularly strongly in the last complete productivity cycle (FY 2003/04 to FY 2007/08), reflecting a sharp fall in output by more than 15% in FY 2006/07 that was not compensated by adjustments in inputs (PC, 2011a; Parham, 2012) (Figure 6). Both output and productivity have recovered in more recent years.

Figure 6. **MFP decomposition in the three sectors**
Index FY 1986 = 100

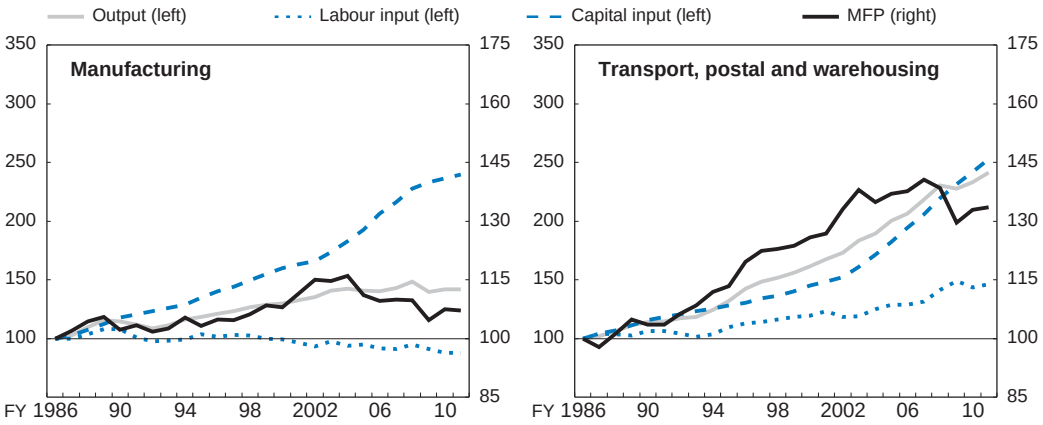


Source: ABS, *Cat. No. 5260.0.55.002*.

In utilities, drought conditions imposed restrictions on water usage, lowering measured output, whilst inducing significant investment in water infrastructure (including the installation of desalination plants) to guarantee water supply (Topp and Kulys, 2012; Parham, 2012) (Figure 6). At the same time, growing demand for energy consumption has induced major programmes of capacity augmentation and renewal, which required new capital investments but have not yet translated into additional output due to lags between installation of new capacity and full utilisation. Technological changes in response to climate-related issues may have also affected adversely productivity in utilities, according to Topp and Kulys (2012), as they represent an increase in input requirements without the same increase in output. Continued shifts away from coal-fired power to higher cost sources are expected to further reduce the level of MFP in the utilities sector, at least until the new technologies become the main sources of supply. Unmeasured quality improvements in output resulting from changes in standards and regulations (for example, higher standards for potable water) also worsened measured MFP since they raise the average cost of production but do not show up as an output increase (PC, 2011a; Topp and Kulys, 2012).

There has also been a broader slowdown in MFP growth, with varying industry contributions, reflecting to a large extent the resource-boom induced adjustment of the economy that goes beyond the mining sector (Figure 2, Figure 3). Manufacturing, in particular, contributed about a third of the MFP slump between the last two complete productivity cycles, following the appreciation of the dollar, which has affected competitiveness. Manufacturing output has remained broadly unchanged since the onset of the mining boom in 2003, while inputs, and specifically productive capital stock, have increased (Figure 7). It is possible that there are different trends within the sector, however, that may reflect mining-related investment in some segments and output declines in others (Parham, 2012).

Figure 7. **MFP decomposition in other sectors**
Index FY 1986 = 100



Source: ABS, *Cat. No. 5260.0.55.002*.

Productivity developments in certain service sectors may also include a mining-related component. It might be the case, for example, that increased input use in the transport sector reflects investment in transport infrastructure (Parham, 2012) (Figure 7). Developments in MFP growth in services might have also been affected by other factors, including the wider indirect effects from the mining boom. For instance, the deceleration in real producer wage growth in services has helped underpin rapid employment growth in the sector (OECD 2012a). Combined with an unusually large decline in the relative price of investment goods, attributable largely to a strong exchange rate, these factors might have slowed MFP growth.

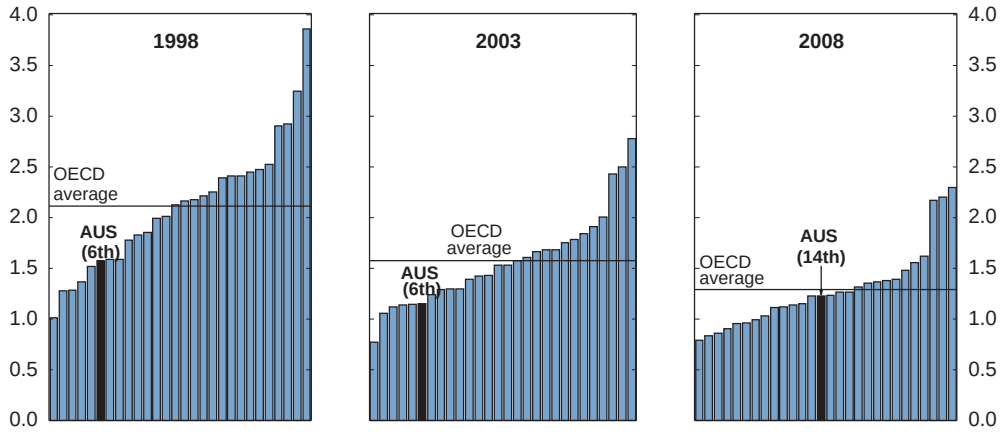
More systemic factors also appear to be at work

The mining boom and concomitant adjustment of the economy undoubtedly provide an important explanation for the MFP growth slump, but some slowdown had commenced before the resource boom, indicating that more systemic factors may also be at work. First, the impetus of past structural reforms to productivity growth may have gradually waned. It is widely accepted that sweeping structural reforms in the 1980s and 1990s have transformed the dynamics of the Australian economy, driving a strong acceleration of productivity in the 1990s (d'Arcy and Gustafsson, 2012). The broad-based MFP slump since the turn of the century, however, raises the possibility that the surge represented a level shift with a catch-up phase, rather than an increase in the long-term growth rate (Dolman, 2009; OECD, 2010a). Recent empirical findings seem to lend support to a "spike" in multifactor productivity growth in the 1990s, rather than a sustained increase, with microeconomic reforms as a determining factor (Mckenzie, 2010).

Second, incentives for productivity-enhancing reforms may have weakened during the economic boom. International comparisons, based on the OECD integrated product market regulation (PMR) indicator, suggest that the reform process has lost momentum in recent years relative to competitor countries, with Australia moving from a "front running" position in 2003 to close to average in 2008 (Australian Government, 2010) (Figure 8). In addition, Eslake and Walsh (2011) argue that some new regulations may have been "productivity-stifling". Broad-based economic prosperity and soaring profits are also likely to have eased the pressures on firms to improve efficiency. The Productivity Commission assesses that, compared to the 1990s, more effort appears to have been devoted on the expansion of production and investment rather than cost cutting (PC, 2008a). The mining sector is a clear example in this regard. Dolman (2009) also concludes a positive link between profitability and lower productivity growth in the 2000s, particularly for some industries serving the domestic market. A recent survey by

Telstra (2012) concludes that the "productivity-improvement deficit" among private sector organisations has widened in 2012 compared to the previous year, despite the increased importance attached to productivity objectives. The deficit is defined as the difference between those organisations who rank productivity as an important business priority and those who actually achieved significant productivity improvement over the past 12 months.

Figure 8. **Product market regulation**
Index scale 0-6, from least to most restrictive



Source: OECD, *Product Market Regulation database*.

Third, Australia also faces capacity constraints following the long expansion of the economy. Skill shortages and infrastructure bottlenecks in key areas may have made it more difficult to raise productivity. Moreover, strong job growth and success in raising participation, as a result of welfare reforms, have drawn relatively low skilled workers into employment and reduced measured productivity, although Dolman (2009) concludes that the productivity effect of unusually low rates of unemployment is not likely to have been large.

The rate of investment in long-term drivers of productivity growth – education and training, innovation and infrastructure spending – has also received attention as a potential explanation to the slowdown in the 2000s. Views diverge, however. Cutler (2008), for example, ascribed much of the productivity slump to a "stalling" innovation effort and "stalled" investment in human capital, citing as main evidence the decline in public spending on research and development (R&D) as a share of GDP and the stabilisation of high school retention rates compared to the 1990s. Other analysts suggest, however, that changes in investment in R&D, information and communication technology (ICT) and education have not been an important drag on productivity growth (Dolman, 2009; PC 2009). Dolman, in particular, found no empirical support in this regard. As for the impact of infrastructure spending on the productivity slowdown, the Productivity Commission (2009) highlights the temporary effect from the rapid rise in mining investment since mid-2000s and new public infrastructure, rather than a slowdown in investment *per se*. There are concerns among analysts, however, about the impact of infrastructure bottlenecks on productivity, though there seems to be little evidence, according to Dolman (2009), that at the aggregate level, a shortfall in infrastructure investment has detracted from productivity.

Lifting productivity is essential to sustain future living standards and promote broader-based growth

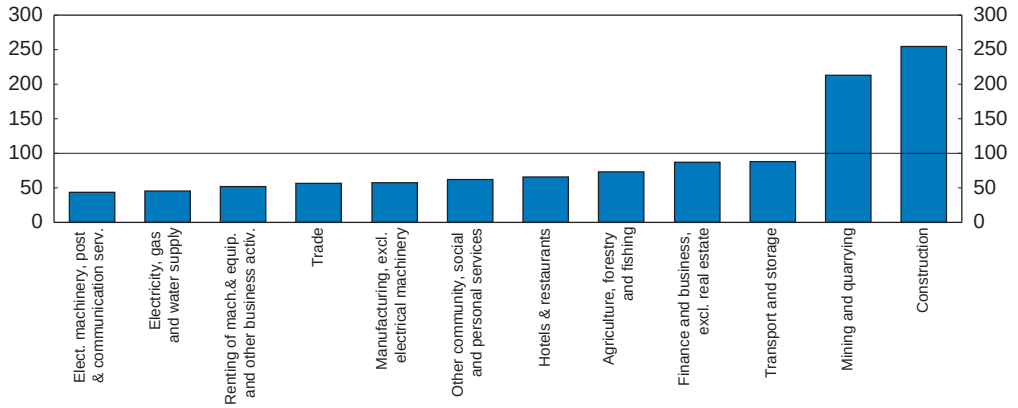
There is a lot of uncertainty about productivity trends in Australia, making it difficult to reach clear conclusions. It seems, however, that part of the slowdown is temporary because investment in key resource projects or other infrastructure investment has not yet come on stream. Estimates by the Reserve Bank of Australia (RBA) suggest, for example, sizeable increases in Australia's iron ore and coal export

capacity over the next few years[2]. In addition, the adjustment effects on productivity from the resource boom and stronger exchange rate may dissipate over time as the structurally challenged industries gradually adjust to the new conditions. Even if part of the slowdown is temporary, efforts are needed to raise productivity above its long-term trend to ensure that living standards continue to grow strongly as in the past two decades, especially if the strong terms of trade decline over time.

International comparisons suggest that there is still scope for Australia to narrow the gap in productivity *vis-a-vis* the United States in several sectors, moving closer to best practice (Figure 9). To a certain extent, productivity differentials between the two countries reflect geographical factors, such as distance to global markets though the importance of such factors is expected to decline in the future as the world is becoming "flatter", with economic gravity shifting towards China and other Asian markets (OECD, 2012a). Management practices at the firm level, affecting the use of resources in production, can be an additional reason explaining such differentials (Dolman and Gruen, 2012). Accordingly, the level of productivity in Australian manufacturing would increase by approximately 8%, if management practices in manufacturing firms were lifted to the average level in the United States. While fully matching the US productivity performance is not considered as a feasible target by Dolman *et al.* (2007), given also the existing differences in industry structure between the two countries, Australia could "go further" and close part of the gap.

Further improvements in the education and training system, enhanced innovation activity and better infrastructure outcomes are critical to enhance Australia's productivity performance, as is the removal of remaining regulatory obstacles to competition. Ultimately, productivity improvements depend on the performance of individual firms. Reforms in these areas, however, along with measures to increase flexibility in responding to the structural adjustment underway (OECD 2012a), could boost such performance and thereby enhancing the productive capacity and capability of the economy. The remainder of the paper discusses these drivers.

Figure 9. **MFP gap relative to the United States**
2007 data, USA = 100



Source: EU KLEMS, *Growth and Productivity Accounts*: November 2009 Release, updated March 2011; Groningen Growth and Development Centre, *GGDC Productivity Level database*; OECD calculations.

2. For a discussion see OECD (2012a).

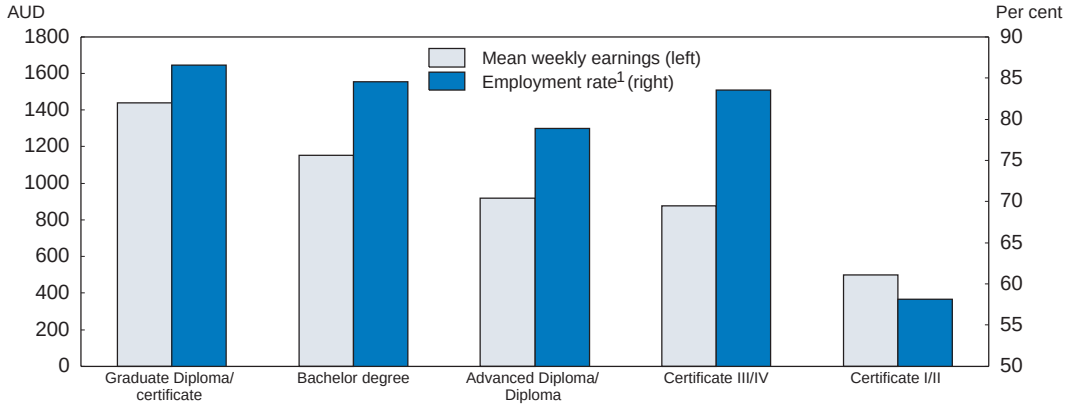
Reforms to boost the long-term drivers of productivity

Enhancing human capital is at the core of productivity growth

Vocational education and training: responding to the skill needs of a rapidly changing economy

Australia has a well developed vocational education and training system (VET), allowing people of all ages to participate (Hoeckel *et al.,* 2008). Recorded skill shortages during the mining boom, however, highlight the need for a more efficient and responsive system. Low completion rates affect the supply of skills, in addition to waste of resources. Only 30% of students who enrolled in a VET course in 2008 are projected to complete a qualification, according to a recent survey (Bednarz, 2012). Even in the case of qualification level III, the first level with a significant impact on earnings and employment according to empirical studies, the projected completion rate is below 50% (Australian Government, 2012a) (Figure 10). While personal reasons and/or optimal training decisions by individuals (in the sense that a student has achieved the intended amount of training) explain a relatively large part of completion patterns, other factors, including training that does not meet student needs, also contribute (NCVER, 2011). Post-study outcomes also remain relatively poor for some occupations, such as machinery operators and drivers (close to 40%), though the level of matching is quite high for technicians and trades (around 70%) (Karmel, 2012). Concerns also arise about the quality of VET delivery. Recent reports by the Productivity Commission concluded that there were shortcomings in the provision of training in areas such as aged care, early childhood education and care (ECEC) and VET workforce (PC, 2012).

Figure 10. **Earnings and employment rate by education attainment**
2009



1. Per cent of the labour force in each category.

Source: ABS, *Cat. No. 6278.0*.

Recent reform initiatives aim at enhancing the quality of the VET system and increasing its responsiveness to changing skill needs (Box 1). As a step forward, a national VET regulator was established in 2011 to ensure adherence to national quality standards. A more effective apprenticeship system continues to be a focal point of the reform process. Harmonisation of apprenticeship regulation across states is underway aiming to reduce barriers to apprentice labour mobility and contain costs for businesses (Australian Government, 2011a). Steps were also taken in the FY 2011/12 budget towards an effective transition from time-based to competency-based completion of apprenticeships and for mentoring, both of which are expected to lift completion rates (standing currently at around 50%) (Australian Government, 2011b). Workplace or employer issues, lack of support and low wages constitute important reasons for the low completion rates for apprenticeships (Expert Panel, 2011). As a further positive step, the FY 2012/13 budget rewards the completion of training (Australian Government, 2012b). Moreover, apprenticeship outcomes are expected to benefit from recent steps towards restructuring and streamlining the training packages (sets of nationally-endorsed standards and qualifications for recognising and assessing skills), making them more flexible and simple.

Box 1. **Recent reform initiatives in the vocational education and training sector**

Improving the capacity and efficiency of the vocational education and training sector is high in the policy agenda. Some recent measures include:

Two important quality assurance bodies were established in 2011, the Australian Skills Quality Authority (ASQA) – a new national VET regulator responsible for registering training organisations and accrediting courses – and the National Skill Standards Council (NSSC) maintaining national standards for the regulation of VET and endorsing training packages. Victoria and Western Australia are the only jurisdictions to retain their state-based VET regulatory systems. Australian Government Ministers have also agreed to strengthen by 2015 the Australian Qualifications Framework (AQF), a unified system of national qualifications in schools, VET and the higher education sector.

Reforms of the Australian Apprenticeship System, in response to the report by the Expert Panel (2011), aim to simplify the system by improving the targeting of support and making competency-based progression a main feature of apprenticeships. The Apprentices Reform Package in the FY 2011/12 budget supports competency-based progression, which allows for skills and competencies to be recognised (including progressing to higher wages), provided that the relevant standards are met, also providing occupation/industry specific information to assist apprentice candidates in choosing the right training path and for targeted mentoring assistance to help successful progressions (Australian Government, 2011b). The budget has also announced the creation of the National Workforce Development Fund (AUD 700 million), supporting employers (under a co-contribution model based on the size of their enterprise) to provide training to new workers and up-skill existing workers. The new industry board led by Australian Workforce and Productivity Agency will make recommendations on targeting funding. Reforms in the Australian Apprenticeships Incentives Programme in the FY 2012/13 budget also reward the completion of training (Australian Government, 2012b).

The Council of Australian Governments (COAG) agreed in April 2012 a new National Partnership Agreement on Skills Reform (NPASR). Reforms aim at a more efficient, transparent, accessible and high quality VET that responds to the needs of the students and the labour market. The target set by COAG is to halve the proportion of Australians without qualifications at Certificate III or above by 2020 and double the number of higher level qualification completions (COAG, 2008). The main elements of the NPASR, as is discussed in COAG (2012a), are:

- Introducing a national training entitlement for a government-subsidised training place to at least the first Certificate III qualification. The entitlement is accessible through any registered public or private provider that meets state-based criteria to deliver publicly-subsidised training. It is available as a minimum to all Australians without a Certificate III or higher qualification, subject to eligibility criteria, though states can offer a higher level as is the case of the Victorian and South Australian schemes (Australian Government, 2012a). It includes foundation skills training (such as language and numeracy training) necessary to complete the Certificate III qualification. Students can enroll to the course or institution of their choice.

- Income-contingent loans for government-subsidised Diploma and Advanced Diploma students, to reduce the upfront costs for students undertaking higher level qualifications.

- Developing and piloting independent validation of training provider assessments and implementing strategies which enable the Institutes of Technical and Further Education (TAFEs) to operate effectively in an environment of greater competition.

- A new *My Skills* website, to improve access for students and employers to information about training options and providers, as well as provider quality to help them make better choices.

- Efficiency and responsiveness of the VET system and equity objectives will be improved through an increase in overall training activity measured by an increase in student completions of qualifications in the order of 375 000 nationally over five years. This includes improved training enrolments and completions in high level skills and among key groups of disadvantaged students, including Indigenous Australians.

A new National Partnership Agreement on Skills Reform (NPASR) was agreed in 2012 by the Council of Australian Governments (COAG) (Box 1). A key element of NPASR is the introduction of a national entitlement for all working-age Australians to access a government-subsidised training place for a

first Certificate III qualification or above (COAG, 2012a). In addition to increasing accessibility to training, this measure promotes a more competitive and client-driven training system by introducing a demand-element to funding with students being able to enrol to the course or institution of their choice. The affordability of training will increase further through a broader coverage of income-contingent loan schemes for Diploma and above courses. Measures also aim at increasing VET transparency and promote equity through additional incentives to improve completion rates, particularly for disadvantaged students.

Some steps were also taken recently at the state level to improve the responsiveness of public training providers (TAFE institutes), as suggested by COAG. In South Australia, for example, TAFE SA – the state's largest training provider – started operating as an independent statutory authority since mid-2012, to be more able to respond to market needs. There is still scope, however, to strengthen TAFEs' ability to compete in the market. Restrictions on the administrative autonomy of TAFE institutes as regards, for instance, their staff management or the courses they provide, still limit flexibility (OECD, 2008). A recent study highlights the importance of appropriate performance indicators for TAFEs in the new more competitive environment to help them coping with the increased organisational accountability (Guthrie and Clayton, 2010).

Strong quality assurance mechanisms that can monitor closely and respond to poor performance are critical for reaping the benefits of a more contestable training market. Increased competition may have some unintended quality (as well as budgetary) consequences, if providers compete only on price (Skills Australia, 2012). Evidence from Victoria, where an entitlement-based system was introduced in 2009, indicates excessive enrolments in some programmes without regard to employment prospects and needs of the economy that made necessary a better targeting of government subsidies to areas with skill shortages (State Government Victoria, 2012; Willox, 2012).

The recently established national VET regulator is an important initiative towards lifting quality and ensuring adherence to nationally-approved standards. It needs to be sufficiently resourced for this task. Quality monitoring would be strengthened further through the deployment of external validations, as planned by COAG (Box 1), in order to assess the qualifications delivered, as is the case for schools and universities (Ross, 2012). Moving towards a national approach of external validation is advisable. The increased emphasis placed by NPASR on raising VET completion rates also goes in the right direction towards enhancing the quality and efficiency of training outcomes. Outcomes-based pay systems, rewarding providers on completions that meet required quality standards, would also increase efficiency (PC, 2012). Skills Australia (now the Australian Workforce and Productivity Agency) (2012) proposes progressive payments at enrolment, midpoint and final payment based on module completion. The new policy frameworks adopted in Victoria and South Australia, for instance, include payments to providers based upon successful completion of competences (PC, 2012).

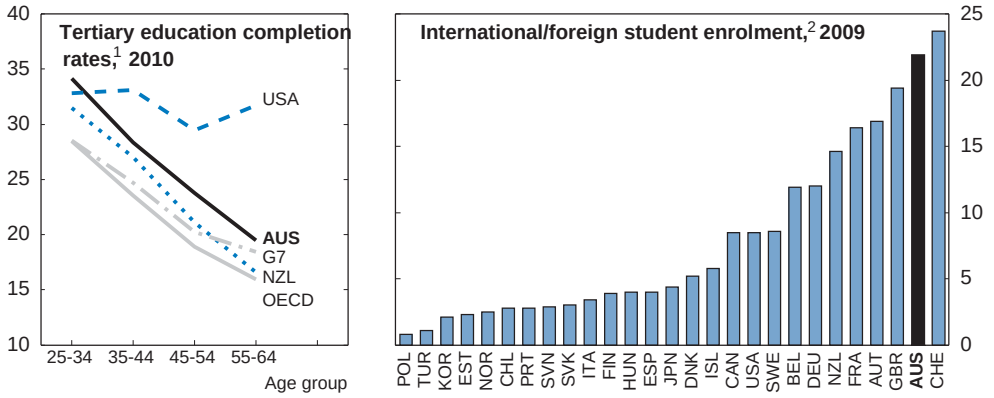
A more systematic approach to disseminate information on VET is another important element for a successful move towards a more client-driven and efficient VET. Easily accessible databases to the prospective students on the quality of providers and course outcomes would facilitate more informed choices and contribute to higher completion rates. At the same time, publishing information on providers' performance would incentivise them to focus on quality (PC, 2012). The implementation of the unique student identifier (USI), which records for each individual who accessed VET all accredited training undertaken and qualification obtained over his/her lifetime, will provide a valuable source of information for the quality of outcomes (The NOUS Consulting Group, 2011). The transparency of the VET system will increase further with the full operation of the *MySkills* website in FY 2015/16 (Box 1). The inclusion in the website of frequently updated information on post-completion employment rates and wages by course and provider, not currently available, would yield important labour market information (PC, 2012).

The agreed reforms go in the right direction towards enhancing the efficiency of the VET system and increase the pool of skilled workers, with estimated future productivity gains (PC, 2012). An additional 5.2 million workers with qualifications at Certificate III or above will be needed by the middle of the next decade to meet industry demand, according to government estimates (Australian Government 2011c). But the re-skilling of mature workers (completions at or below the level of qualifications held) is also expected to increase productivity, as it would help individuals to retain employment or enhance their career prospects. The potential productivity effects, however, would be much lower (on the order of 50%, according to Productivity Commission estimates) compared to the case of higher qualification completion (PC, 2012). Initiatives, such as the Skill Connect service, linking enterprises with a range of skills and workforce development programmes and funding, are welcome steps towards the re-skilling of employees. As a further welcome step, the creation of a National Workforce Development Fund will support employers to provide training (Box 1). There are also benefits from enhancing further foundation skills, and current policy efforts towards this direction are welcome. According to the 2006 Adult Literacy and Life Skills Survey, over 40% of working-age Australians have relatively low language, literacy and numeracy (LLN) skills (ABS, 2008). The development of a National Foundation Skills Strategy for Adults, aiming to create a nationally consistent environment for supportive policies is productivity enhancing (Shomos, 2010). Meeting the strategy's target, that two thirds of the working-age population will have literacy and numeracy skills at Level 3 or above (required to meet the complex demands of everyday life) by 2022, could increase the average level of productivity by around 1 per cent (PC, 2012).

Higher education: ensuring high quality outcomes

The Australian higher education system compares well internationally. Graduation rates have increased steadily over time, closing the gap with the best performing countries (Figure 11). Moreover, the share of international students in tertiary enrolments is among the highest in the OECD. Recent estimates suggest a major productivity premium from higher education qualifications, compared to a Year 12 qualified male, standing at 40% for a bachelor degree and around 60% for higher degrees (KPMG Econtech, 2010).

Figure 11. **Higher education**



1. Population that has completed the level of tertiary type-A and advanced research programmes, percentage by age group.
2. International or foreign students in tertiary type-A and advanced research programmes, as a percentage of all students.

Source: OECD, *Education at a Glance 2011 (respectively 2012): OECD Indicators*, OECD Publishing, Paris.

Important reforms are underway, in response to the Bradley Review (Bradley *et al.*, 2008), aiming to make the higher education sector more responsive to future economic needs and improve further its performance. The target set is that 40% of young adults hold university degrees or above by 2025. To help achieve it, the government uncapped in 2012 the number of Commonwealth supported undergraduate places. This implies a significant change in the funding arrangements for undergraduate places from a capped allocation system, where the funding agreement between the Commonwealth and a public

university specified the number of places and the discipline mix to be supported, to a demand-driven one. Under the new regime, the government provides support for all domestic undergraduate students accepted into an eligible course by a public university. Universities decide on how many undergraduate places to offer and in which discipline (Australian Government, 2009). Growth in higher education participation is underpinned by additional support to universities for student places and increases to the annual indexation of university grants. According to the FY 2012/13 budget, the uncapping of places will drive an estimated AUD 5.2 billion (approximately 0.4% of GDP) increase above previous funding levels to universities between 2010 and 2015, while the additional revenue from indexation over the same period will be around AUD 3 billion (Australian Government, 2012b).

A demand-driven approach to higher education has the potential of increasing competition and efficiency, making the system more diverse and responsive to students and employers needs. Evidence indicates a rapid expansion of university places during 2010 and 2011, when transitional arrangements of the new system were in place, with an increase in student numbers by 22% between 2007 and 2011. In addition, the new system enhances the opportunities for students from disadvantaged backgrounds to access higher education. In 2010, the proportion of undergraduate students from low socioeconomic status (SES) was around 16%, well below the overall level for all students of 25%. The government's target is that 20% of domestic undergraduate students will be from low SES by 2020.

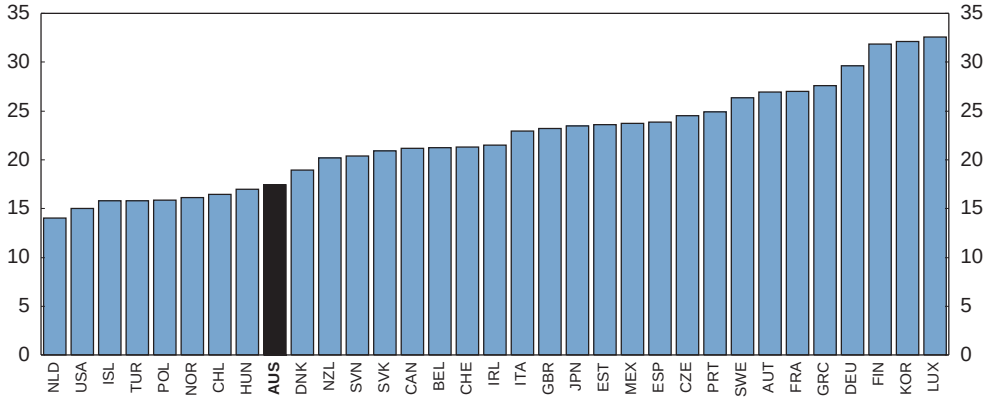
A critical challenge in the new demand-driven system is to maintain high quality outcomes. The establishment of Tertiary Education Quality and Standards Agency (TEQSA), registering and evaluating the performance of higher education providers against national standards, is an important quality assurance mechanism but a close monitoring is still needed. While uncapping undergraduate places increases the entry opportunities to higher education for students who would have been previously excluded, there is a risk that retention and completion levels may decline, raising concerns about the quality of learning outcomes. Existing research found little correlation between entry scores and university performance for low to middle entry scores, though there is evidence that the probability of completion increases with the admission rating score (Murphy *et al*., 2001; Dobson and Skuja, 2005; Marks, 2007). This indicates that additional support may be needed to ensure that less academically prepared students succeed in their studies. In recognition of this, the government provides additional funding to universities for students from low SES backgrounds (who tend to have lower entry scores), through the Higher Education Participation and Partnerships Programme (HEPPP), aiming to improve access to courses and enhance the retention and completion rates of those students. This measure goes in the right direction for improving learning outcomes. Efforts are also aiming to enhance academics' teaching skills, a key element for better student outcomes (OLT, 2011). The focus on quality also includes new performance funding arrangements, making additional financial assistance available to universities both for capacity building and rewards for meeting targets and benchmarks. The performance criteria involve increasing the participation outcomes of low SES background students. Performance funding arrangements were planned to be fully implemented in 2012.

Indispensable for the quality and efficiency of a demand-driven system is to ensure that better information is provided to applicants. The *MyUniversity* website includes key indicators on university performance, including the outcomes of student surveys on teaching quality, thereby improving transparency and informed choice. In addition, it enables universities to benchmark their performance against each other providing incentives for improvements. Transparency and quality would be further enhanced from a swift development of the performance measurement instruments for learning and teaching, a key part of the Advancing Quality in Higher Education initiative announced in the FY 2011/12 budget. These indicators, to be used for performance funding, will be published on the *MyUniversity* website from 2013 onwards.

Providing the right skills required by a rapidly changing economy is another key challenge facing the higher education sector. Funding arrangements that ensure an effective supply of student places are critical in this regard. The demand-driven system gives universities the flexibility to decide about the number of undergraduate places they offer in each discipline. Such decisions however are expected to be heavily influenced by the extent to which discipline funding matches the costs. Over- or underfunding could create a number of inefficient incentives (Lomax-Smith et al., 2011). The expansion of places before the introduction of the demand-driven system showed no signs of unanticipated cuts for the broad field of studies (Norton, 2012). But the system cannot expand indefinitely and significant investments or extra staff may be required to ensure quality outcomes. A more responsive price-setting mechanism based, for example, on more frequent funding reviews or a university-driven increase in tuition fees above their current maximum level set by the government, while monitoring closely participation effects, could be considered (The University of Melbourne, 2011; Norton, 2012). Improved information for students is indispensable for moving towards more deregulated fees. Even in this case, however, such a move should be assessed carefully as it involves a trade-off between participation, in the event that the government does not match the increase in fees with a rise in the income-contingent loans to students, or rising fiscal costs, if the increase in fees is matched. Specifying skill matching as a criterion of funding for universities could be another option, which would require, however, improved information on graduate destinations.

It is too early to assess the potential impact of the new system on skills. However, some areas of under-supply, especially in science and engineering, raise concerns, given their important role in boosting innovation capacity (Figure 12). Recent budget measures to address the issue, in response to a review, are welcome (Australian Government, 2012b). Initiatives span both schools and tertiary education sectors and aim to stimulate student participation in mathematics and science, through improvements in the quality and supply of teachers delivering such courses, and reward high performing students to encourage them to continue their studies in these areas. Moreover, since 2009, the government provides reductions in income-contingent loan debt repayments for graduates taking up employment in targeted occupations, including mathematics and science. The Higher Education Base Funding Review considers that strategic objectives, such as tackling skill shortages, would be better addressed through labour market measures rather than concessions on income-contingent loans (Lomax-Smith *et al.,* 2011). The Australian Workforce and Productivity Agency, established in 2012 (Box 1), will provide advice on the effectiveness of the higher education system in meeting skill needs. As a positive development, initial applications and offers data for 2012 suggest that students are choosing to follow courses with good employment prospects.

Figure 12. **Science and engineering degrees**
As a percentage of total new degrees, 2010[1]



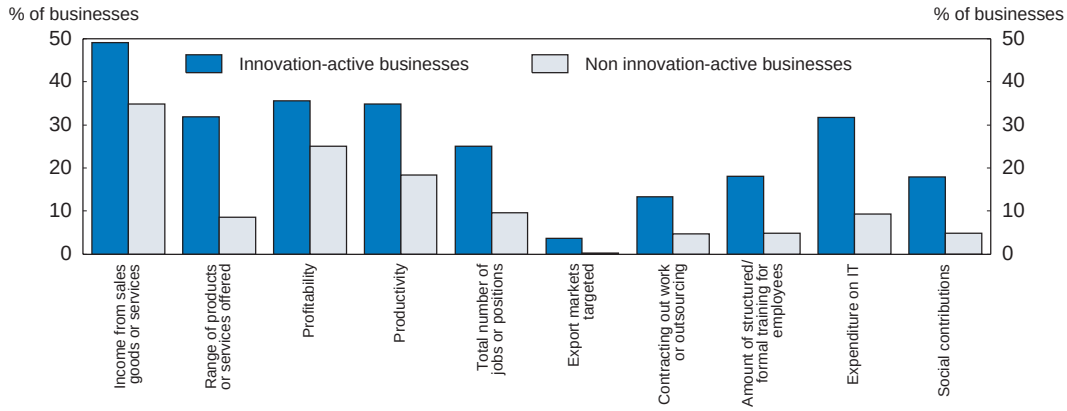
1. Or latest available year.

Source: OECD, *Education database.*

Better innovation performance is key for productivity

Innovation is a major ingredient in productivity growth. Recent empirical evidence suggests that investment in so-called intangible capital (for example skills, R&D, organisational improvements) and their spillover effects accounted for over 60% of Australia's labour productivity growth between FY 1994/95 and FY 2005/06 (Barnes and McClure, 2009; Australian Government, 2011d). Business data by the Australian Bureau of Statistics also provide evidence of a positive link between more innovative production processes and productivity performance (Figure 13). Australia's framework conditions (including the functioning of capital markets and market competition) – a crucial factor for innovation according to OECD research (Jaumotte and Pain, 2005) – rank high internationally (Figure 14, first panel). Moreover, entrepreneurship conditions are favourable, with start-up businesses facing low regulatory barriers. Research capacity and skill base also compare well overall with other OECD countries; this is shown, for example, by the relatively high government-financed expenditure on R&D and high R&D performed in the higher education sector (Figure 14, second panel). Innovation-active businesses accounted for around 40% of all businesses in FY 2010/11, according to ABS (ABS, 2012).

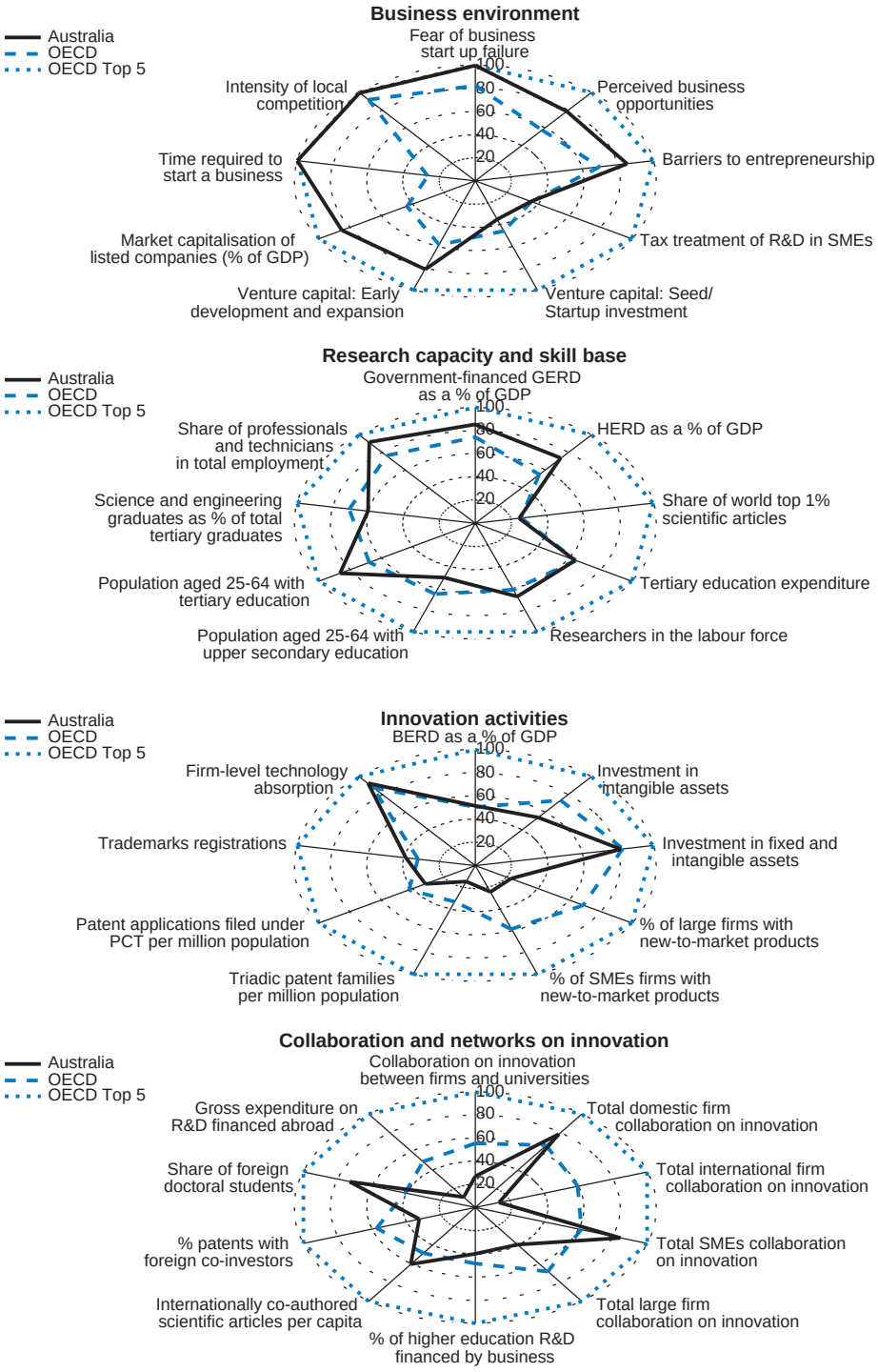
Figure 13. **Business performance improvements by innovation status**[1]
FY 2011



1. Share of businesses whose performance and activities increased compared to previous year.
Source: ABS, *Cat. No. 8167.0*.

Nevertheless, Australia falls short of international best practice on critical dimensions of innovation, such as investment in intangibles and "new to the market innovations" (Figure 14, third panel). Domestic firms are much more likely to adopt or modify already existing innovations than creating new export markets or investing in their own intangible investing capabilities (Australian Government, 2011d). Although the low rates of "creative innovation" can partly be explained by Australia's distance from major markets and the size or structure of the economy, and by a scarcity of seed/start-up venture capital, a critical weakness of the innovation system is the low collaboration among key players that can constrain knowledge exchange (Figure 14, first and fourth panels). Although the direction of causality between low collaboration and "creative innovation" is not easy to establish, research suggests that businesses which engage in collaboration are 70% more likely to achieve products that are new to the world (Australian Government, 2006). Collaboration can also help to enhance the absorptive capacity (that is the ability to identify, absorb, transform and exploit innovations) of firms or other organisations which is especially important for net importers of foreign technologies, such as Australia (Australian Government, 2011d).

Figure 14. **Innovation indicators**
2011 or latest available data



Source: OECD (2012), *Main Science and Technology Indicators*; OECD (2011), *Education at a Glance: OECD Indicators*; OECD (2010), *Measuring Innovation: A New Perspective* and *Science, Technology and Industry Outlook*; OECD (2009 & 2007), *OECD Science, Technology and Industry Scoreboard*; Global Entrepreneurship Monitor, *Adult Population Survey 2011;* World Economic Forum (2011), *The Global Competitiveness Report 2011-12;* WIPO (2011), *World Intellectual Property Indicators;* World Bank, *Financial and Private Sector Indicators database*.

What explains the low level of collaboration on innovation?

There is much scope to enhance the level of business-research collaboration. According to recent survey results, only a third of the firms in 2010 had been involved in collaborative projects with external research providers (AIG, 2010). A particularly noticeable feature is the weak rate of collaboration between firms and higher education institutions (Figure 14, fourth panel). In addition, the collaboration of large Australian firms on innovation falls below the OECD average, although SMEs have a good track record with innovation partners sourced from market-based networks. External collaboration linkages are also weak, with around 3.6% of businesses collaborating internationally.

The low rate of collaboration between firms and higher education institutions may reflect the lack of a collaboration culture in Australian industry, but also shortcomings within universities. The tight links, for example, between promotion opportunities and teaching and publication outcomes can reduce incentives facing researchers at the individual level to engage with industry. The limited focus of university research on industry needs is cited by firms as an important obstacle to successful collaboration between the two sectors (AIG, 2010; Australian Government, 2011e). Deficiencies in the technology transfer offices linked to universities, which tend to be under-resourced and lack clear organisational goals and policies for commercialisation, are seen by the Productivity Commission as another potential barrier to knowledge flows (PC, 2007). There is a general view, however, that commercialisation of university research should not be taken further. Even if such research has practical applications, it is considered that the focus needs to be on the overall community benefits from the dissemination of knowledge and technology (PC, 2007, 2009; Cutler, 2008). The poor collaboration between universities and firms may have also contributed to the low patenting rates in Australia compared to other OECD countries (Figure 14, third panel). This could also reflect the large size of the services sector, making trademarks more important (OECD, 2010b).

The management of intellectual property (IP) by the universities could be another reason. There is a large variety of arrangements for transferring IP to firms, often within the same university, that raises transaction costs, especially for SMEs (PC, 2007). At the aggregate level, Australian universities have lower patent intensities of R&D and lower execution of licenses than in other comparable countries, though activities, such as contracted research and consultancies by research institutions, are also important metrics for the level of collaboration between universities and industries (PC, 2007). In 2010, for example, Australian publicly-funded research organisations (including universities and research agencies) reported gross income of AUD 1.3 billion from engagement activity (contracts and consultancies with end-users) compared to returns of AUD 133 million from invention disclosures (licenses, options and assignments activity) (KCA, 2012). A review to investigate the impact of IP on collaboration between research institutes and private sector stakeholders is underway. The authorities are further reviewing the "innovation patent system", introduced in 2001 to stimulate innovation in SMEs by protecting inventions that do not meet the inventive threshold required for standard patent protection. The system has been criticised, however, on the grounds of being too generous, while concerns also arise in case larger companies are able to use such innovation patents to increase their competitive position at the expense of SMEs (ACIP, 2011; OECD, 2011a).

Enhancing knowledge exchange in the innovation system

The government has set a target to double the level of collaboration between researchers and business over the next decade. This is supported by a number of policy initiatives (Australian Government, 20011d). A focal point of the strategy is to boost the demand-side capacity of the SMEs cohort to apply and commercialise more research. Only 3% of SMEs collaborate on innovation with higher education institutions, compared to 10% of large firms (OECD, 2009a). Collaboration between SMEs and government research centers is equally weak. Unlike larger firms, SMEs face impediments to build

capability because of limited resources and a lack of absorptive capacity. Enterprise Connect, one of Australia's key business support programmes, aims to increase businesses' awareness of the benefits of innovation and collaboration, as well as to assist firms to identify and connect to potential collaborators and build up their capacity to conduct future relationships independently. The programme provides free reviews on business potential to eligible firms requesting them and tailored advisory service and grants to implement the review recommendations, including funding for the placement of researchers directly into firms to assist them in developing business-focused intellectual property. A referral service linking businesses to experts in relevant technological fields is also available. The programme covers firms in a wide range of industries, including clean technology and manufacturing, with over 80% of the clients being satisfied with the outcomes of the programme for their business (Australian Government, 2012c).

The comprehensive approach to boosting collaboration adopted by the government is welcome and should continue. Work is also underway to encourage Australian research to respond more to industry demand. To be effective, collaboration-enhancing programmes need to be simple and flexible, with their outcomes being frequently monitored. A review of the Cooperative Research Centers (CRC) programme, aiming to build long-term partnerships between researchers and businesses, highlighted, for example, the delays in the negotiation and formalisation of agreements for collaborative research arising from the lack of flexibility in governance and management, complexity and high bidding and transaction costs (Commonwealth of Australia, 2008).

Public finances allowing, the authorities could consider further options to boost collaboration, such as providing innovation vouchers to SMEs for use in academic contracting. This could complement current initiatives, such as the Enterprise Connect programme, and strengthen further existing engagement and support mechanisms. If properly designed, voucher schemes can be effective as the fiscal spending is controllable and technology transfer is stimulated, while firms have full autonomy in defining projects (OECD, 2012b). Existing evaluation evidence suggests that such a scheme does stimulate new activity, in that most of the projects would not have been undertaken in its absence (OECD, 2010c). To be successful, innovation vouchers need to be simple and straightforward, effectively advertised and promoted and have efficient brokering which is best performed by a public agency (OECD, 2010c). Any voucher should recognise the local context in which it is implemented to ensure that it is well designed. Effective voucher outcomes are conditional on effective connections and outcomes. A voucher approach has already been adopted by New South Wales and Queensland, and is also used in many European countries in the form of regional or national schemes (Australian Government, 2011d; European Commission, 2009).

Employee-driven innovation could also be further explored. This is embedded in workers' human capital, on-the-job training and other up-to-date information acquired by employees. It can provide valuable inputs in informal internal networks in the form of information flow to the firm, exchange of practical knowledge and know-how in activities (Hoyrup, 2010). More co-operative approaches to industrial relations in firms would favour employee-driven innovation with positive effects on firms' productivity and competitiveness (OECD, 2012a). Support and recognition of employees' ideas, and the translation of such ideas into concrete initiatives, are also considered as important factors for promoting employee-driven innovation (Hoyrup, 2010; LO, 2007). Advances in internet and broadband technology are expected to increasingly enable collaboration. The National Broadband Network (NBN) is intended to deliver high speed fibre broadband to 93% of the Australian population by the end of the decade with important estimated potential productivity and output benefits (Deloitte Access Economics, 2011).

Stimulating and facilitating innovation activity

Governments face the question of which policy tools are best suited to stimulate innovation. They can provide direct support *via* grants or use fiscal incentives (OECD, 2011b). R&D tax incentives are granted to all (potential) R&D performers and are therefore industry, region and firm neutral, even though,

in some countries such schemes may entail preferential treatment to specific groups of firms or investment types. They can involve, however, deadweight losses, which need to be addressed when designed, as they might encourage innovation that would occur in the absence of support. R&D can also be difficult to define, and targeting incentives to input instead of results may not always be effective. Grants, on the other hand, can be directed to specific projects that have high social returns, but they are subject to the discretion of government agencies awarding them, although direct support programmes in many countries are highly competitive. The optimal mix of direct and indirect R&D support varies across countries, as the two instruments address different market failures and are thus complementary (OECD, 2011b).

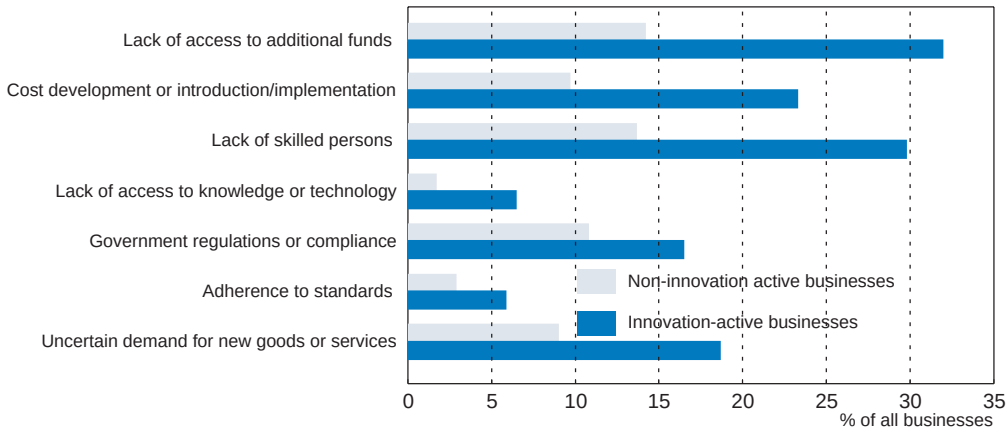
A large part of government support to business investment in innovation comes *via* the tax system in Australia. The longstanding R&D tax concession scheme accounted for 75% of budgetary assistance to business innovation in FY 2010/11, compared to 40% in FY 2001/02, according to Productivity Commission estimates (Banks, 2011). Such schemes avoid problems, such as "picking winners", as investment decisions are made by businesses themselves and incentives applied to a wide range of industries and innovation types. On the other hand, they can be complex and it can be difficult to design a scheme that is very effective in stimulating additional R&D (Banks, 2011).

As an important step forward, in 2011 the government changed the nature of the R&D regime from tax deductions to a tax credit. The tax incentive provides much higher base rates of assistance than the previous scheme, especially for smaller firms, which are eligible for a 45% refundable tax offset (compared to a non-refundable 40% for larger firms). The new scheme also expands access of the R&D tax benefit to foreign companies permanently established in Australia, reduces complexity and has the potential to encourage innovation that would not otherwise occur (additionally) by introducing new eligibility criteria to better target the program, and re-orient support towards R&D activities that create new knowledge. A clear administrative interpretation of the new eligibility criteria and frequent evaluation of the achieved outcomes will be crucial for a successful implementation (PKF International, 2011). The first review of the R&D tax incentive is scheduled to occur after two years of operation (2014), and will be informed by an independent advisory group report to government, ahead of the review.

The adoption in 2011 of the Clean Energy Futures Plan, aiming to boost green innovation, is another welcome initiative towards new commercialisation activity. The Clean Energy Finance Corporation will invest AUD 10 billion in the deployment of renewable energy, energy efficiency and clean technologies, with additional funds for businesses under the Clean Technology Innovation Program to support R&D in renewable energy and other low-pollution measures.

The Australian government has also been supporting the development of a venture capital sector *via* an equity-based co-investment mechanism since 1997 which is appropriate given the need to address market failure. Firms regard lack of access to funds, however, as a very important barrier to innovation (Figure 15). Australia has a less mature venture capital market compared to some other advanced countries and there are obstacles to its further development, including the limited scale of the existing venture capital industry, the small cohort of fund managers focused on venture capital and the lack of strong record in attracting international venture capital (PC, 2007). Nevertheless, even within the venture capital segment of the private equity market, a large share of funds goes to early development and expansion of firms rather than start ups (Figure 14, first panel). Ongoing assessment of current support programmes is welcome.

Figure 15. **Barriers to innovation**
Per cent of all businesses, FY 2011



Source: ABS, *Cat. No. 8167.0*.

However, cross-country evidence suggests that there are limits to venture capital in addressing the problem of financing innovation, as it tends to focus on a few sectors at a time, with the size of the minimum investment too big for some start-ups (Hall and Lerner, 2009). Another source of financing for start-up firms could be the employee share scheme (ESS), which can be used by firms as a means to attract and compensate its employees at the first stages of their operation, when they are not yet profitable. The current take-up rates for ESS are low and further work could be done to examine the reasons and what, if any, actions should be taken to remove constraints on start-ups growing within Australia.

Achieving better outcomes in infrastructure will help productivity

Infrastructure investment is of key importance for productivity, given both its direct impact on the volume of capital stock and its indirect effects on efficiency (PC, 2009). Based on cross-country evidence, OECD (2009b) concludes that infrastructure investment can boost output in the longer term more than other types of investment. However, Australia's infrastructure falls short of current demand, while the "deficit" may get worse in the years to come in view of the strong demand generated by the mining boom and expected population growth (OECD, 2010d). Major infrastructure needs have been identified in key areas including the transport sector and water supply. Infrastructure Australia cites estimates that infrastructure bottlenecks cost approximately AUD 6 billion per annum (around 0.5% of GDP) (IA, 2008). Well-targeted and efficiently-financed infrastructure projects, combined with an efficient maintenance and use of the existing infrastructure stock, are of critical importance to meet growing demand and boost productivity. While capacity-building reforms in recent years, discussed in the previous *Economic Survey of Australia*, have filled some policy gaps, scope remains to enhance the efficiency of infrastructure development and use.

Co-ordination and selection of public infrastructure provision can be improved further

Managing the infrastructure sector entails particular difficulties as the delivery of these services depends on natural monopolies. Moreover, the development of infrastructure often involves externalities (positive or negative), which may not be recognised during planning, leading to socially sub-optimal levels of investment (McInerney *et al.,* 2007; OECD, 2010d). The capacity problems encountered by Australia in recent years, however, also reflect the consequences of complex and fragmented governance of the infrastructure sector, including a weak inter-governmental co-ordination and, especially at the national level, poorly co-ordinated planning (IA, 2008).

The government has taken steps to address these inefficiencies, especially through the establishment of Infrastructure Australia (IA) – tasked to advise governments on nationally significant infrastructure priorities and reforms on the basis of rigorous cost-benefit analysis. IA has completed its first audit and compiled a list of priority infrastructure, which is updated on a yearly basis. It has also released a national ports strategy, signed off by the Council of Australian Governments (COAG) in April 2012 (IA, 2010a; IA, 2011). Furthermore, the Australian Government released its national freight strategy that aims to boost co-ordination of investment choices between the various modes of transport (IA, 2012a).

The FY 2011/12 budget allocated AUD 36 million over the next four years (an increase in funding by nearly 40%) to strengthen and expand the mandate of IA in an effort to improve infrastructure governance. To enhance transparency, IA will publish cost-benefit analyses while projects funded by the federal government will be evaluated after completion to ensure value for money (Australian Government, 2011b). Steps were also taken at the state level to improve infrastructure networks with the creation, in 2011, of Infrastructure New South Wales (INSW) and the Tasmanian Infrastructure Advisory Body (TIAB), aiming to identify and prioritise critical sub-national or regional infrastructure projects (IA, 2012b). INSW, in particular, released its first ever long-term infrastructure strategy for the state covering a 20-year period (INSW, 2012).

These measures shall improve the quality of infrastructure assessment and infrastructure governance. However, the co-ordination, planning and provision of infrastructure projects remain complex because of the large number of inter-governmental bodies involved: the federal government, eight state governments and 560 local councils (IA, 2011). Further initiatives at the state level to improve infrastructure frameworks, along the lines of INSW and the TIAB, would be welcome. Improvements in the effectiveness of infrastructure provision also hinge on a more effective planning and selection processes. Too much emphasis is placed at present on specific investment projects rather than on systemic issues and strategy development (IA, 2011). The prioritisation of proposed projects requires further attention, according to the latest report of Infrastructure Australia (IA, 2012b). Future audits for infrastructure needs should pay more attention on demand assessments, and evaluating imbalances relative to supply of infrastructure services using regularly updated indicators (OECD, 2010d). Such an approach would support a more effective provision of infrastructure to meet actual needs, though the difficulties in measuring infrastructure demand and supply cannot be underestimated. IA has developed a comprehensive database, with plans for further improvements. Recent measures to enhance transparency in the selection process are welcome.

Financing options for infrastructure need to be developed further

Financing future infrastructure remains a critical issue. In view of the public good aspect of many infrastructure projects, the government has historically played a key role in their funding (IFWG, 2011). The need for fiscal consolidation in the coming years, however, will constrain growth of public infrastructure investment, making it indispensable to maximise the pool of potential financing sources.

The Infrastructure Finance Working Group (IFWG) was established in 2011 to identify potential obstacles to infrastructure finance and develop reform options, especially to encourage greater private sector investment. In a recent report, IFWG calls for a comprehensive approach to address the issue of infrastructure financing through an overhaul of funding, better planning to provide a deep pipeline of infrastructure projects (through the preparation of 20-year infrastructure strategies, with a common framework and timeframe across jurisdictions) to boost industry certainty, and more flexible and efficient markets that attract private investment (IFWG, 2012). The sale of selected public assets (identified through a review of existing holdings) to fund new infrastructure is seen as one option for increasing investment capacity, given the preference of potential investors for existing projects that are less risky than completely new projects. However, certain conditions for privatisation, in particular appropriate regulation, need to be in place to ensure efficiency. User charging (discussed below) can be a key step towards increasing investment funding, according to the IFWG report. Besides providing funding for new

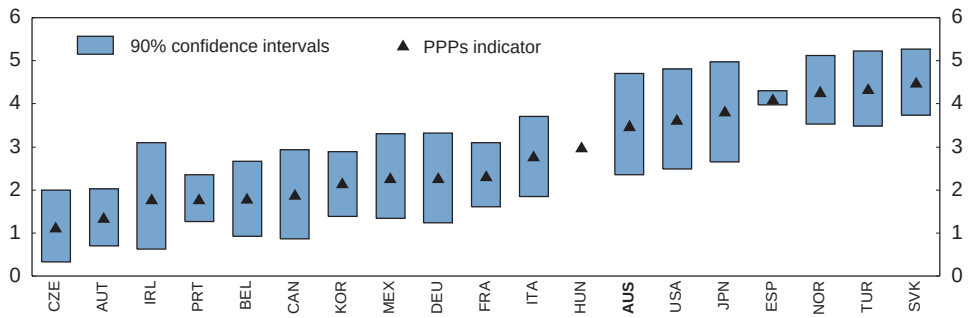
projects, user charges provide incentives for a more efficient use of infrastructure (IA, 2012b). Additional funding approaches recommended by IFWG include a reform of government balance sheets, through a combination of sales of existing state infrastructure assets and user charging/efficient pricing models across existing assets, to create capacity to invest in new infrastructure assets, and a greater use of alternative funding models. A suggested option, for example, is to augment the traditional grant-based approach to infrastructure funding with co-funding between the federal, states and private sector on major Public Private Partnership (PPP) projects, so as to bring these projects to market more quickly. The IFWG further highlighted the need for changes in planning and procuring infrastructure projects, as well as for reforms to attract private investment, including superannuation funds. Attracting such funds to invest on infrastructure would require removing a number of impediments, including uncertainty associated with the number and size of upcoming national infrastructure projects, high bid costs and a perceived mismatch between the need of superannuation funds for liquidity and the long-term nature of infrastructure investment (IFWG, 2011).

There is also scope for expanding the use of Public Private Partnerships (PPPs) to finance public infrastructure. For example, PPPs finance around 5% of public investment in infrastructure in Australia compared to between 10% and 20% in Canada (KPMG, 2010). If designed appropriately, PPPs may yield important benefits, including better risk management and increased synergy between the construction, operation and maintenance of infrastructure, enhancing efficiency over a project's lifetime (Chan *et al.,* 2009). A benchmarking study of Melbourne University concludes that PPP contracts are more likely to deliver projects on time compared to traditional procurement contracts (Duffield *et al.,* 2008). Chan *et al.* (2009) claims that doubling or tripling of the PPP share in public investment infrastructure could generate savings of around 0.5% of GDP over the next decade, compared to traditional procurement, arising largely from the increased efficiency in the delivery of projects.

PPP policy settings could be improved further (Figure 16). High bidding costs, reflecting to a large extent excessive information and documentation requirements and other inefficiencies in the procurement process, may act as a barrier to new entrants to PPPs and reduce competition among existing players. Bid costs in Australia are estimated to be, on average, around 25% to 45% higher than in Canada, which is considered to be a comparable overseas market (IFWG, 2012). Inaccuracy in demand forecasting appears to be another major obstacle to private sector investment in infrastructure projects, especially in the case of roads (IFWG, 2011). A number of recent high profile PPP failures were partly due to over-optimistic demand projections.

Figure 16. **Indicator values of PPP policy settings**[1]

Indicator scale index of 0-6 from most to least conductive to efficient investment



1. The indicator is calculated for the 19 countries that provided a sufficient number of answers on PPPs in an *ad hoc* OECD questionnaire on infrastructure investment. The figure gives the average indicator value and 90% confidence intervals, which are calculated using random weights.

Source: Ad hoc OECD Questionnaire on infrastructure investment, cited in OECD (2010), *Economic Policy Reforms: Going for Growth*, OECD Publishing, Paris.

A number of measures were introduced in recent years to promote private sector investment in infrastructure. The FY 2011/12 budget announced changes in the tax treatment of losses for designated infrastructure projects to generate greater certainty for private investors (Minister of Infrastructure and Transport, 2011). In particular, access to better tax treatment for losses for designated infrastructure projects will be unaffected by changes in ownership or business structure and the value of losses is maintained over time by indexing them at the government bond rate (Australian Government, 2011b). Reform initiatives also include a National Infrastructure Construction Schedule, providing potential investors with detailed information on upcoming infrastructure projects across all government levels. But further reform efforts are needed. Superannuation funds could give consideration to the establishment of experienced teams of investment professionals to assess opportunities for smaller funds. Finding ways to break down large and illiquid infrastructure projects into more manageable investments could also help (IFWG, 2011).

Building investor capability by raising the bar of governance among institutions is also important to generate the right incentives for asset managers to better look after the long-term interest, according to OECD analysis (Della Croce *et al.,* 2011). One option to create institutions of sufficient scale that can implement a long-term investment strategy is through the collaboration among superannuation funds. The government's Stronger Super reforms are aimed at driving competition and consolidation in the superannuation sector.[3] With greater consolidation, funds will have increased scale which will provide greater opportunities to invest in a range of asset classes such as infrastructure assets. The government is also providing temporary income tax relief to superannuation funds wishing to merge which remove barriers to funds achieving greater scale. Providing information on the returns of the smaller- and large-size funds could help the small funds assess the relative benefits.

Reforms underway aim to enhance the effectiveness of PPP processes (including through a standardisation of contractual requirements) and improve approaches to managing forecasting and demand risk of infrastructure projects (National PPP Working Group, 2010; IFWG, 2011). A recent report by the Infrastructure Australia identifies a suite of best practice benchmarks to promote efficiency in procurement of major infrastructure projects (IA, 2012c). A review was further undertaken by the government on forecasting performance for toll roads where demand forecasts have proven over-optimistic in recent years (BITRE 2011, 2012).[4] These reforms go in the right direction in boosting investors' confidence in PPP projects and should continue. Consistent approaches across states to the selection and approval of the PPP projects are also essential and initiatives to this end are welcome. As an additional option to attract private investment in completely new projects, IFWG (2012) recommends a more flexible approach to the allocation of risk between public and private sectors. The government could be involved, for example, in the initial development of the project and then transfers it to the private sector. However, it needs to make sure that such an approach is balanced and does not simply result in all project risks being ultimately transferred to taxpayers. Augmenting the traditional grant-based approach to infrastructure funding with co-funding between the federal, states and private sector on major PPPs projects, as recommended by IFWG (2012), would help to bring these projects more quickly to the market, boosting investor confidence. Finally, the government initiative to review the national access regime to infrastructure is welcome, given the limitations of the current regulatory framework for private investment identified in the previous *Survey*.

3. In particular, superannuation funds will have a duty to undertake an annual assessment of scale and where it is determined that the assets or member numbers are insufficient, the fund will need to take appropriate action to rectify the insufficiency so they continue to meet their general obligation to promote the financial interests of beneficiaries.

4. Moreover, the government currently examines the best international practices for disincentivising overbidding for toll road concessions (Australian Government, 2012d).

Ensuring efficient pricing mechanisms for infrastructure services

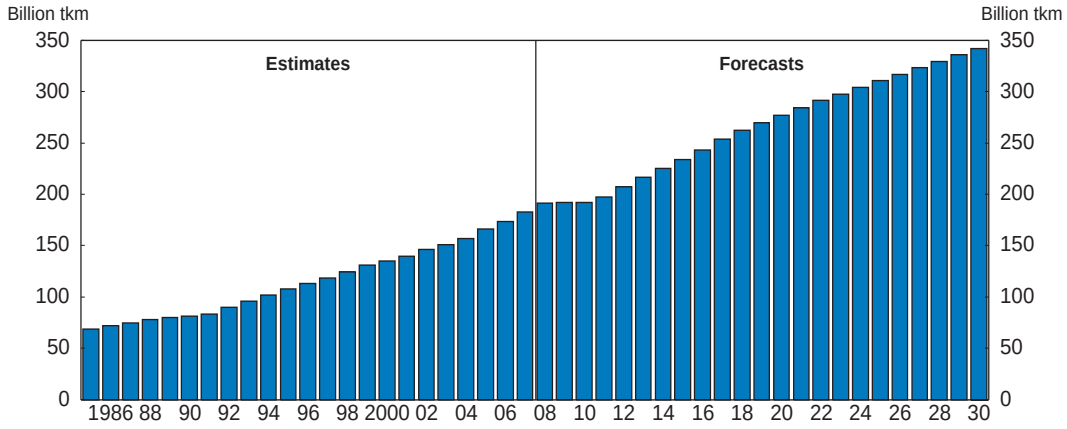
Efficient pricing facilitates the operation of competitive markets and encourages new investment in infrastructure, as well as a better use of existing stock, by providing the signals that guide decisions regarding the demand and supply of infrastructure (PC, 2011b). The challenge of a pricing reform is most pressing in the transport sector, in view of the rapidly growing freight demand and high and rising congestion costs despite significant expansion of capacity over the past decade. Important pricing issues also arise in the water and energy sectors.

The scope of user charges in the transport sector should be broadened

The road freight task – the freight expected to be carried on Australia's roads – is projected to nearly double between 2008 and 2030, without a charging system that ensures that heavy vehicles (which account for the bulk of road maintenance costs) pay for their specific marginal road-wear costs (CRRP, 2011a) (Figure 17). The current charging framework for heavy vehicles, which combines registration fees and fuel-based charges for road use, does not provide credible signals about the costs of using particular roads, or about the demand for different roads. Such charges do not always depict accurately the actual road wear arising from the mass, distance travelled or types of roads used by a vehicle (CRRP, 2011b), resulting in significant cross-subsidies between various types of vehicles and infrastructures. Evidence from European countries with national charging systems for heavy vehicles shows efficiency improvements from pricing reforms (Gustafsson *et al*., 2007).

Figure 17. **Road freight developments**

Total Australia



Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE, 2010). "Road Freight Estimates and Forecasts in Australia: Interstate, Capital Cities and Rest of State", *Report 121*, Canberra.

A feasibility study for introducing more direct pricing for heavy vehicles and on the future funding arrangements for roads was completed at end-2011 and considered by COAG. A number of pricing options, involving alternative combinations of mass, distance and location charging parameters, have been developed and evaluated by the COAG Road Reform Plan (CRRP) team. The findings appear to support a staged move to charging heavy vehicles for road use, with the initial focus on biggest vehicles (CRRP, 2011c).

Current efforts towards road infrastructure pricing reforms are welcome and should continue. These measures should be accompanied by overhauling the framework of managing and financing road infrastructure, given that the two reforms could reinforce each other (OECD, 2010d; CRRP, 2011b). Given the complexities that reforms in the pricing and funding mechanisms involve, a staged approach, could be

considered by the authorities. Broadening the scope of pricing reform to light vehicles at a later stage, which constitute the majority of the Australian vehicle fleet, would enhance the efficiency of the Australian land transport sector (Stanley and Hensher, 2011).

Congestion charges would improve the use of road infrastructure and ensure better environmental outcomes. Official estimates, cited by BCA (2009), suggest that congestion costs are increasing. In the absence of road pricing, the "avoidable" urban congestion costs (in constant prices) would more than double between 2005 and 2020, rising to AUD 20.4 billion (around 1.4% of GDP) by 2020. Under current road charging arrangements users have no incentive to consider the costs of using the urban network at peak times.

Although congestion is recognised as a major economic cost in Australia, no systematic approach to better pricing congested urban roads has been pursued so far. The introduction of location-specific and time-varying congestion charges for road infrastructure in large cities, recommended by the Henry Tax Review, is still pending (AFTS, 2010). International evidence, including the experiences from London and Stockholm, strengthens the case for using charges to ensure low levels of congestion (OECD 2010d; Stanley and Hensher, 2011). In Australia too, the introduction of time-of-day tolling in the Sydney Harbour Bridge and Tunnel in early 2009, appears to have reduced crossings during the increased tolling period (BCA, 2009). Infrastructure Australia suggests that small shifts in traffic levels of around 6-7% could have an appreciable impact on congestion levels (IA, 2011).

Critical for the successful implementation of congestion charges is public acceptance of the policy. Survey evidence suggests that acceptability evolves over time, rising to its highest level as the scheme becomes operational and benefits may exceed the expectations of users (OECD, 2010e; Stanley and Hensher, 2011). A transparent and understandable congestion charging system, based on clear rules for access and a credible compliance regime, are important factors for acceptance, according to the *OECD International Transport Forum* (OECD, 2010e). Developing public support that provides alternative options for travelling is also of high importance. While the purpose of charging variable congestion fees is to correct market failures, rather than increase tax revenue, the resources collected can be used to support public transport which appears to play a less significant role in land transport in Australia compared to other OECD countries (Figure 3.6, OECD, 2010d).

More cost-reflective water pricing would improve efficiency and environmental outcomes

Well functioning pricing mechanisms would result in more efficient use of water resources. The National Water Initiative (NWI), which underpins current reform initiatives, includes objectives for water market development, so trade in water rights can enable the allocation of water to its highest value use, including for environmental purposes. NWI planning principles have been agreed by all Australian governments to facilitate cost recovery for water delivery services. The National Water Commission (NWC) highlights the improvements under the NWI in terms of governance and quality of planning, as well as the beneficial effects of pricing reforms on water trading and in encouraging a more efficient use and investment in the water sector (NWC, 2011a).

Nevertheless, important issues remain. Despite improvements in the way water-rights markets work in rural areas, over-allocation of water resources is still an issue in several areas that needs to be addressed. Over-allocation leads to an under-pricing of water, in addition to having serious environmental consequences which are likely to be exacerbated by climate change (OECD, 2010d). The lack of consistent definitions and methods for assessing over-allocation of water resources and remaining barriers to water trading, especially the 4% upper annual limit on out-of-area trade of water entitlements in Victoria, are important obstacles in resolving the problem (NWC, 2009; PC, 2010). Moreover, while notable progress was made overtime towards full cost recovery for water services, many rural water systems have not yet

achieved it. In particular, minimal progress was made, so far, in implementing cost recovery of water planning and management activities, which should be reflected in water prices (NWC, 2011b). Government subsidies for irrigation infrastructure in rural areas also have the potential to distort efficient investment decisions and pricing, though they may be required for transitional purposes.

Improvements in urban water pricing could be further implemented. Most water businesses have attempted to set the volumetric component of the tariff with reference to the long-term marginal cost (LRMC) of supply. NWC concludes, however, that in practice many utility companies use inclining block tariffs (IBTs) which impose higher prices for successive blocks of water (NWC, 2011b). This is a mechanism to discourage wasteful water use by households (Crase *et al.,* 2007). Another objective for an IBT pricing system is to address affordability issues by setting a low price for what some consider to be "essential" water (PC, 2008b, 2011b). However, IBTs raise concerns on both efficiency and equity grounds, as in many cases it is not clear whether such tariffs reflect long-run marginal cost, and such pricing structure, by not being adjusted for household size, can disadvantage larger households that have higher essential water needs (NWC, 2011b; PC, 2011b). The drought has also made the case for more flexible pricing schemes to better manage water variability (NWC, 2011b). Pricing at LRMC is static and smoothes prices over time, but does not reflect short-term changes in the marginal cost caused by changes in water availability (PC, 2008b; NWC, 2011b). It is thereby unlikely to provide efficient signals to consumers and suppliers in cases of highly variable dam inflows. During the recent extended drought, there was a strong reliance on water restrictions which is an inefficient approach to demand management in the longer term (PC, 2008b). Restrictions on the choice of supply-side options, including regulatory obstacles to rural–urban water trading and use of water recycling for potable reuse, which represent lower cost sources of water supply (although the cost of water recycling initiatives may vary depending on the transportation distances), also hamper the efficient allocation of water resources, and hence productivity, in urban areas (OECD, 2008; IA, 2010b).

The government is addressing reforms in the water sector. In the rural sector, ongoing reform efforts, under the NWI, aim to tackle the over-allocation of water in the Murray-Darling Basin, Australia's most important agriculture region through the Murray-Darling Basin Plan and the Restoring the Balance in the Murray-Darling Basin Program. Initiatives include an AUD 3.1 billion buyback of water entitlements to increase environmental flows, investment in water saving infrastructure and improvements in water planning and information about water availability and use. The government has recently committed to provide additional funding for water recovery projects of AUD 1.8 billion over ten years starting in 2014 (Gillard, 2012). Close co-ordination among Murray-Darling Basin jurisdictions is essential for the success of the water recovery programme (NWC, 2011a). Dismantling barriers to trade is also vital for achieving a better balance between consumptive use of water and water for the environment. Quantitative restrictions on trade will be prohibited under the proposed Murray-Darling Basin Plan, and Victoria has made commitments to remove the 4% annual limit on the trade of water entitlements out of irrigation districts by 2014**.** A faster than scheduled removal of such limits is advisable. Moreover, to reduce over-allocation, water pricing should ensure full cost recovery, including environmental costs, though the challenges in identifying and valuing water-related environmental externalities need to be recognised (OECD, 2010f). Government subsidies to irrigation infrastructure need to be removed, using the savings, instead, to repurchase water user rights or for making budgetary room (OECD, 2012a).

Further pricing reform is also needed in the urban water sector for better cost recovery (PC, 2011b). Currently basic prices reflect affordability concerns for lower income consumers, while prices for larger consumption are higher. Prices need to reflect the cost of supply. This would also reduce the need for state subsidies to water companies, even if the support is of short term and intermittent. Social objectives would be better pursued through the tax-transfer system. More flexible pricing schemes, which are responsive to changes in water availability in urban supply (scarcity-based pricing), could be considered, but to be successful such schemes need to be accompanied with improvements in metering and

a higher frequency billing to ensure that price signals are effectively transmitted to water users (PC, 2008b; NWC, 2011b). The introduction of smart meters, as in the case with the electricity sector (see below), would be welcome, though their costs and benefits would need to be assessed.

Achieving urban water security at the lowest cost would require the exploitation of all supply-side options, including rural-urban trade and water recycling for potable reuse, which are currently restricted by state regulations. This would reduce reliance on water restrictions and costly investment projects, such as the construction of numerous desalination plants in recent years to avoid the consequences of drought (OECD, 2010d; PC, 2011b). According to Productivity Commission, the expected gains to consumers and the community from implementing reform in the urban water sector can only be moderate in the short term, but are expected to increase over time as water needs rise (PC, 2011b). Achieving rural and urban water reform outcomes depends on implementing the National Water Initiative as a whole.

Enhancing the efficiency of the energy market

A number of energy market reforms are currently on the agenda of the national and sub-national governments aiming among others to increase competition in retail markets and improve regulation of transmission networks.[5] The Council of Australian Governments (COAG) assessed at its end-2012 meeting the progress made in energy reforms and possible additional policy responses.

Price cap regulation for small customers continues to apply in most jurisdictions. Prices are set, in particular, by state regulators so that electricity retailers can recover what the regulator considers to be the costs an "efficient" retailer expected to incur in the period for which the cap applies (RBA, 2010). State governments have agreed to phase out retail price regulation for energy where competition is effective. So far, only Victoria has removed regulation (CRC, 2011). Electricity tariff caps reduce supply-side signals for investment. They further inhibit efficient price signals to consumers, increasing the risk of overconsumption (McInerney *et al*., 2007). The effectiveness of any carbon price is conditional on price signals reaching consumers, and therefore on retail price deregulation (Hepworth, 2010). Faster progress towards installing advanced metering infrastructure ("smart meters") is also critical for energy-efficient consumption choices, as it would facilitate better demand management strategies (CRC, 2011). A greater responsiveness of electricity consumption to pricing would reduce the need for the construction of costly production capacity to meet peak demand. Smart meters are being rolled out in Victoria, with the installation process expected to be completed by 2013. Trials for smart metering are also being conducted in most other states and the timelines for the introduction were planned to be reviewed in 2012. A national framework to support the use of smart meters and related services is under development. Consumer "education and engagement" about smart metering is an important factor for the success of the measure, according to the Draft Energy White Paper (Commonwealth of Australia, 2011). Based on public consultation, the Australian Energy Market Commission (AEMC) will report to national and sub-national energy ministers on measures to encourage demand-side participation, at the household and industrial scales, in the National Electricity Market (AEMC, 2012).

A key regulatory issue in the energy sector regards the development of an electricity transmission network that can handle increases in renewable energy. Reliance on new energy sources is expected to increase further in the future, especially under Australia's Renewables Target (RET) and the recently adopted clean energy package (OECD, 2012a). Entry of renewable generation is likely to be clustered in certain geographic areas, most of which are expected to be distant from the shared network (AEMC, 2009). Investment is needed to enlarge transition networks to connect clusters of new generation.

5. Other objectives include further competition reforms in the wholesale energy markets, strengthening the governance of energy market regulatory bodies and empowering consumers to engage in energy markets.

According to AEMC (2009), the existing regulatory framework is not well-structured to deal with clustered generation. This is due to the lack of commercial incentives for network service providers to bear the risk associated with constructing scale efficient networks extensions (SENE). Without a high degree of certainty that generators will connect *via* SENE, or rules ensuring cost recovery, network service providers are unlikely to invest in such costly infrastructure to accommodate expected future connections, even if this could lower the costs for the system as a whole (Wright, 2012). In addition, according to the AEMC (2009) report, the existing framework can make the co-ordination of numerous generators difficult for network service, as it is based on bilateral negotiation, thereby increasing the risk for inefficient duplication of infrastructure and delays in connections, with possibly large knock-on effects on end-users. In view of these shortcomings, AEMC made the case for framework change.

The National Electricity Rules were amended in June 2011 to facilitate the enlargement of transmission networks. Transmission grid owners are now required to undertake and publish, on request, studies into the potential for efficiency gains from the co-ordinated connection of expected new generators in a particular area (AEMC, 2011a). The AEMC's rule does not compel anyone to bear the risk and cost of stranded assets. Rather, it provides a mechanism under which opportunities to capture scale efficiencies can be made transparent, the purpose of which is to help potential investors to make informed decisions. Some analysts, however, have expressed doubts as to whether the new provisions address the shortcomings of the current framework, as they continue to allocate the risk and cost of network extensions to project developers, rather than to consumers as was originally envisaged (Wright, 2012). AEMC (2010) proposed, in particular, that generators connecting to the network would have to pay for the proportion of scale efficient network extension cost equal to capacity they use. The cost of the surplus capacity built in anticipation of future projects would be met by consumers until such projects were built (Wood, *et al.*, 2012). There was, however, a change compared to original proposal. While recognising the environmental benefits associated with having consumers pay, the AEMC made its determination on the basis of whether it would contribute to the long-term interests of consumers. In addition, consumers are not well placed to manage risks associated with asset stranding, and therefore, are not in a position to provide hedges against renewable investment. Project developers are best able to assess and manage that risk (AEMC, 2011a). It is still too early to evaluate the impact of the new rules on improving efficient network connection.

Swift implementation of regulatory reforms is required

Overlapping and inconsistent regulations across jurisdictions can impede efficiency and productivity. COAG agreed in 2008 a wide-ranging regulatory reform to deliver a seamless national economy. The agenda entails business regulation and competition reforms, complemented by reforms to improve regulatory processes. Implementation has moved forward, with three quarters of the entailed reforms being "on track" as of end-2011, according to the COAG Reform Council (CRC) performance report (CRC, 2011). As a significant step in the area of competition reforms, single national regulators are set to be in place by 2013 for heavy vehicles, rail and maritime safety, reducing the number of regulators across Australia from 23 to three. Official estimates suggest that the reform could boost national income by up to AUD 30 billion (approximately 2% of 2011 GDP) over the next 20 years.

In the energy sector, derogations allow for jurisdictional variations in the national rules, and are planned to be phased out to allow for transition to the national regime. A review of energy market derogations is set to take place in June 2014 (COAG, 2012b). However, the lack of a seamless national approach to developing and paying for transmission networks hinders interconnections among states and reduces effective competition (IA 2011; Wood *et al.,* 2012). The AEMC is currently consulting on a change to the National Electricity Rules to allow for inter-regional transmission charges to be used. This would ensure that network service providers contribute to the costs of beneficial investments undertaken in other jurisdictions participating in the national electricity market (AEMC, 2011b). The AEMC expects to finalise this rule change by February 2013.

Implementation also varies with business regulation reforms. Much scope for harmonisation remains, for instance, in legal profession and in establishing a national occupational licensing system. Despite some progress, the regulation for the legal professions remains complex, with differences across states in areas such as admission and practising certificates, which prevents legal practitioners from operating in multiple jurisdictions (CRC, 2011). COAG agreed in 2009 on further reforms to ensure consistent national regulation of the legal profession. New South Wales, Victoria and the Northern Territory have committed to taking this reform forward, with Queensland still considering the proposed reform. The national regulation scheme is expected to commence operating in 2013, with scope for non-participating jurisdictions to also implement the law at a later date.

It is also important to address overlaps and inconsistencies in occupational licensing procedures across the states. COAG agreed in 2009 on a national occupational licensing system for specified occupations.[6] In recognition of the complexity of these reforms, COAG decided in April 2012 that implementation of the first range of occupations would occur during 2013. Additional occupations may be introduced over time. However, CRC expressed concerns as to whether a national trade licensing system can be fully achieved in practice, given the uncertainty about some jurisdictions' participation in the national system and due to legislative variations to the national law in some states (CRC, 2011).

The implementation of the COAG reform agenda on business regulation could result in significant reductions in the cost of red tape. In assessing the direct impact of 17 of the seamless national economy reforms, the Productivity Commission concluded that, if fully implemented such reforms could lower business costs by around AUD 4 billion per year and, after an adjustment period, national output could be increased by around 0.4% (or AUD 6 billion per year) (PC, 2012). The decision of COAG to bring forward (to end-2012) the completion date of the first wave of seamless national economy reforms, and to consider options for a further wave of reforms, is therefore welcome (CRC, 2011). In April 2012, COAG announced its priorities for a new regulatory and competition reform agenda, to be supported by a "national productivity compact" between governments and businesses. The aims include, streamlining state and federal environmental approval processes, as well as major development approvals and further energy market reform. Swift endorsement and implementation of the agreed plan for taking the reform priorities forward would be desirable. Moving ahead, consideration could also be given to removing existing barriers to entry in the taxi industry – an area of reform identified by OECD *Regulatory Review* for Australia (OECD, 2010a). For example, Abelson (2010) finds "few efficiency or social reasons" for entry regulations to the Sydney taxi industry, with the net benefits from their removal estimated at AUD 265 million per annum. Further improvements to regulatory harmonisation, mutual recognition and institutional co-operation between Australia and New Zealand, under the Closer Economic Relations agreement and the Single Economic Market agenda, could yield additional economic gains (OECD, 2011c). A joint study to be conducted by the Productivity Commissions of the two countries will identify options for further reforms which could boost efficiency, increase competitiveness and strengthen further economic integration.

6. These include initially the occupational areas of plumbing and gas fitting, electrical, property and refrigeration and air conditioning and then secondly building occupations, valuers and conveyancers.

Box 2. **Recommendations on boosting productivity**

Ensuring a high quality education and training system

- Implement competency-based apprenticeships in line with the skills strategy. Proceed with efforts towards developing strong quality assurance mechanisms for training.
- Harmonise apprenticeship regulation across states. Ensure simple and flexible training packages.
- Move towards a national approach of external validation to assess the qualifications delivered. Provide public VET providers with more flexible administrative arrangements.
- Ensure improved information for prospective tertiary students on course quality and outcomes. Monitor completion rates and learning outcomes in higher education following the uncapping of places in universities. The funding arrangements in the new system should ensure an effective supply of student places.
- Promote the responsiveness of the higher education system in meeting skill needs. A more responsive price setting mechanism should be considered.

Enhancing innovation performance

- Programmes to support collaboration and networking between universities and businesses should be simple and flexible to reinforce their impact on innovation.
- Consideration should be given, fiscal savings allowing, to further measures to increase collaboration between researchers and business, such as the provision of well-designed innovation vouchers for contracting academic research as a complement to government's comprehensive approach to facilitate effective connections and outcomes.
- Ensure a clear administrative interpretation of the eligibility criteria entailed in the recently introduced R&D tax incentive scheme. Evaluate outcomes in terms of projects that would not have been undertaken in the absence of the scheme.

Improving infrastructure outcomes

- Improve infrastructure outcomes by reducing the complexity of governance and provision of infrastructure investment and ensuring a more effective planning. Remove barriers to private participation in financing investment infrastructure. Continue efforts to increase the effectiveness of public-private partnership processes and improve approaches to managing risks of such projects. To achieve these objectives:
    - Streamline the number of inter-governmental bodies involved to reduce the complexity of governance and provision of infrastructure projects. Extent initiatives at the state level to improve infrastructure frameworks, along the lines of Infrastructure New South Wales and the Tasmanian Infrastructure Advisory Body.
    - Shift the emphasis from specific projects to more systemic issues and strategy development, paying more attention to demand assessments relative to supply to enhance the effectiveness of infrastructure planning process.
    - Remove barriers to private participation in financing investment infrastructure, including superannuation funds, through suitable projects, in terms of size and liquidity, for smaller investors and a deep pipeline of upcoming projects.
    - Further streamline procurement bidding processes to improve the effectiveness of public-private partnerships. Build on the current initiatives to improve mechanisms to manage forecasting and patronage risks of such projects.

Ensuring efficient pricing mechanism for infrastructure services is essential

- Broaden the use of road user charges. Introduce location-specific and time-varying congestion charges for road infrastructure in large cities. Move towards more cost reflective prices in the water sector. Install advanced metering infrastructure ("smart meters") for electricity to promote energy-efficient consumption choice.

- Develop the public transport system to increase the attractiveness of substitutes to private transport. Proceed with pricing reforms for heavy vehicle sector and overhaul the framework of managing and financing road infrastructure.
- Water pricing should ensure full cost recovery, including environmental costs. Social objectives would be better pursued through the tax-transfer system. Government subsidies to irrigation infrastructure should be removed and remaining barriers to water trade should be dismantled.

Swift implementation of regulatory reforms is required

- Implement fully the agreed reforms under the COAG agenda for a seamless national economy. Move towards a national approach to developing and paying for transmission networks. Harmonise regulation for legal and other professions and occupational licensing. Intensifying the trans-Tasman relationship would reduce spatial transaction costs and facilitate carrying out increasingly complex regulatory functions through greater economies of scale.
- The recently agreed productivity pact between business and governments is a welcome step and should be endorsed and implemented swiftly.

BIBLIOGRAPHY

Abelson, P. (2010), "The High Cost of Taxi Regulation, with Special Reference to Sydney", Agenda Vol. 17, No. 2., ANU College of Business & Economics, Canberra, pp. 41-72.

ABS (Australian Bureau of Statistics) (2008), *Adult Literacy and Life Skills Survey, Summary Results*, Cat. No. 4228.0, January.

ABS (2012), *Innovation in Australia Business 2010-11*, Cat. No. 8158, August.

ACIP (Advisory Council on Intellectual Property) (2011), "Review of the Innovation Patent System", *Issues Paper*, Australian Government, August.

AEMC (Australian Energy Market Commission) (2009), *Review of Energy Market Frameworks in light of Climate Change Policies: Final Report,* September 2009, Sydney.

AEMC (2010), *Consultation Paper: National Electricity Amendment (Scale Efficient Network Extensions) Rule 2010*, Australian Energy Market Commission, April.

AEMC (2011a), *Scale Efficient Network Extensions: Final Rule Determination 2010,* Australian Energy Market Commission, June.

AEMC (2011b), "National Electricity Amendment (Inter-Regional Transmission Charging) Rule 2011", *Discussion Paper*, Australian Energy Market Commission, August.

AEMC (2012), "Power of Choice – Giving Conumers Options in the Way the Use Electricity", *Draft Report*, Australian Energy Market Commission, September.

AFTS (Australia's Future Tax System) (2010), Report to the Treasurer, Part 1 and 2, December, www.taxreview.treasury.gov.au/Content/Content.aspx?doc=html/home.htm.

AIG (Australian Industry Group) (2010), "Innovation: New Thinking- New Directions", A Report to the Australian Industry Group by the Innovation Review Steering Committee, October.

Australian Government (2006), *Collaboration and Other Factors Influencing Innovation Novelty in Australian Business: An Econometric Analysis*, Commonwealth of Australia, Canberra.

Australian Government (2009), *Transforming Australia's Higher Education System*, Commonwealth of Australia, Canberra.

Australian Government (2010), *Budget 2010-11*, Commonwealth of Australia, Canberra.

Australian Government (2011a), *Australian Apprenticeship Reform*, Commonwealth of Australia, Canberra.

Australian Government (2011b), *Budget 2011-12*, Commonwealth of Australia, Canberra.

Australian Government (2011c), *Building Australia's Future Workforce: Reform of the National Training System*, Commonwealth of Australia, Canberra.

Australian Government (2011d), *Australian Innovation System Report 2011*, Commonwealth of Australia, Canberra.

Australian Government (2011e), "Focusing Australia's Publicly Funded Research Review", *Final Report*, October.

Australian Government (2012a), *Skills for All Australians: National Reforms to Skill More Australians and Achieve a More Competitive, Dynamic Economy,* Commonwealth of Australia, Canberra.

Australian Government (2012b), *Budget 2012-13*, Commonwealth of Australia, Canberra.

Australian Government (2012c), "Enterprise Connect", http://www.enterpriseconnect.gov.au.

Australian Government (2012d), "Disincentivising Overbidding for Toll Road Concessions, Commonwealth of Australia, September.

Banks, G. (2011), "Industry Assistance in a patchwork Economy", ACCI Annual Dinner, Canberra, November.

Barnes, P. and A. Mc Clure (2009), "Investments in Intangible Assets and Australia's Productivity Growth", Productivity Commission, *Staff Working Paper*, Canberra.

BCA (Business Council of Australia) (2009), "How We Can Achieve a Long-Term Growth Ambition? Ground Work for Growth: Building the Infrastructure that Australia Needs", *Report to BCA* by Rod Sims.

Bednarz, A. (2012), "Lifting the Lid on Completion Rates in the VET sector: How Are They Defined and Delivered?", *Occasional Paper*, NCVER.

BITRE (Bureau of Infrastructure, Transport and Regional Economics) (2011), "Review of Traffic Forecasting Performance", Commonwealth of Australia, Canberra.

BITRE (2012), "Addressing Issues in Patronage Forecasting for PPP/Toll Roads", *Consultation Paper*, Commonwealth of Australia, Canberra, February.

Bradley, D., *et al*. (2008), *Review of Australian Higher Education*, Final Report, Commonwealth of Australia, December.

Chan, C. *et al*. (2009), "Public Infrastructure Financing —An International Perspective", *Productivity Commission Staff Working Paper*, March.

COAG (Council of Australian Governments) (2008), *National Agreement for Skills and Workforce Development*, Canberra.

COAG (2012a), *Council of Australian Governments Meeting,* 13 April, Communique, Canberra.

COAG (2012b), "Response to the COAG Reform Council National Partnerhsip Agreement to Deliver a Seamless National Economy: Report On Performance, 2010-2012", Canberra.

Commonwealth of Australia (2008), "Collaborating to a Purpose, Review of the Cooperative Research Centers Programme", Commonwealth of Australia, July.

Commonwealth of Australia (2011), *Draft Energy White Paper 2011: Strengthening the Foundations for Australia's Energy Future*, December.

Crase, L., S. O'Keefe, and J. Burston (2007), "Inclining Block Tariffs for Urban Water", Agenda, Vol. 14, No. 1, pp. 69-80.

CRC (COAG Reform Council) (2011), *Seamless National Economy: Report on Performance*, December, Sydney.

CRRP (COAG Road Reform Plan) (2011a), "Preliminary Findings Consultation Paper", June, Sydney.

CRRP (2011b), "Evaluation of Options", October, Sydney.

CRRP (2011c), "CRRP Feasibility Study: Final Report to COAG", November.

Cunningham, M. B. and D. Harb (2012), "Multifactor Productivity at the Sub-national Level in Australia", Australian Conference of Economists, August.

Cutler, T. (2008), *Venturous Australia: Building Strength in Innovation*, Melbourne.

d'Arcy, P. and L. Gustafsson (2012), "Australia's Productivity Performance and Real Incomes", *Reserve Bank of Australia Bulletin,* June Quarter, Sydney.

Della Croce, R., F. Stewart and J. Yermo (2011), "Promoting Longer-Term Investment by Institutional Investors: Selected Issues and Policies", *OECD Journal: Financial Market Trends*, Vol. 2011, Issue 1, OECD, Paris.

Deloitte Access Economics (2011), "The Connected Continent: How the Internet is Transforming the Australian Economy", *Report* commissioned by Google Australia Pty Ltd, August.

Dobson, I. and E. Skuja (2005), "Secondary Schooling, Tertiary Entry Ranks and University Performance", *People and Place*, Vol. 13, No. 1, pp. 53-62.

Dolman, B., Parham, D. and S. Zheng (2007), "Can Australia Match US Productivity Performance", *Productivity Commission Staff Working Paper*, Canberra, March.

Dolman, B. (2009), "What Happened to Australia's Productivity Surge?", *The Australian Economic Review*, Vol. 42, No. 3, pp. 243-63.

Dolman, B., and D. Gruen (2012), "Productivity and Structural Change", 41st Australian Conference of Economists, July.

Duffield, C., P. Raisbeck, and Ming Xu (2008), "National PPP Forum – Benchmarking Study, Phase II Report on the Performance of PPP Projects in Australia when Compared with a Representative Sample of Traditionally Procured Infrastructure Projects", 17 December.

Eslake, S. (2011), "Productivity: The Lost Decade", Paper presented to the Reserve Bank of Australia Conference, "The Australian Economy in the 2000s", Sydney, August.

Eslake, S. and M. Walsh (2011), "Australia's Productivity Challenge", *Report*, No. 2011-1, Grattan Institute, Melbourne.

European Commission (2009), "Availability and Focus on Innovation Voucher Schemes in European Regions", Brussels, November.

Expert Panel (2011), "A Shared Responsibility: Apprenticeships for the 21st Century", *Final Report* of the Expert Panel, January.

Gillard, J. (2012), "Returning the Murray-Darling Basing to Health", Prime Minister's Press Release, October.

Gustafsson, I., P.W. Cardebring and R. Fiedler (2007), "Road User Charging for Heavy Goods Vehicles - Overview of Regional Impact", East West Transport Corridor, January, Hamburg.

Guthrie, H. and B. Clayton (2010), "Building Capability in Vocational Education and Training Providers: The TAFE Cut", *Occasional Paper*, NCVER, Commonwealth Australia.

Hall, B. and J. Lerner (2009), "Financing R&D and Innovation", *NBER Working Paper Series*, No. 15325, August.

Hepworth, A. (2010), "Power Price Caps to be Axed under COAG Deal", *The Australian,* 21 September.

Hoeckel, K. *et al*. (2008), *Learning for Jobs: OECD Review of Vocational Education and Training – Australia*, OECD Publishing, Paris.

Hoyrup, S. (2010), "Employee-driven Innovation and Workplace Learning: Basic Concepts, Approaches and Themes", *Transfer: European Review of Labour and Research,* Vol. 16(2), pp. 143-154.

IA (Infrastructure Australia) (2008), *A Report to the Council of Australian Governments*, Australian Government, December.

IA (2010a), "Getting the Fundamentals Right for Australia's Infrastructure Priorities", *An Infrastructure Australia Report to the Council of Australian Governments*, Australian Government, June.

IA (2010b), *Review of Urban Water Security Strategies*, Price Waterhouse Coopers, June.

IA (2011), "Communicating the Imperative of Action", *A Report to the Council of Australian Governments*, Australian Government, June.

IA (2012a), *National Land Freight Strategy Update,* Australian Government, June.

IA (2012b), "Australian Infrastructure Progress and Action", *A Report to the Council of Australian Governments*, Australian Government, June.

IA (2012c), "Efficiencies in Major Project Procurement: Benchmarks for Efficient Procurement of Major Infrastructure", Australian Government, June.

IFWG (Infrastructure Finance Working Group) (2011), "Infrastructure Finance Reform", *Issues Paper*, Infrastructure Australia, Australian Government, July.

IFWG (2012), "Infrastructure Finance and Funding Reform", IFWG, April.

INSW (Infrastructure New South Wales) (2012), *First Things First: The State Infrastructure Strategy 2012-2032*, INSW, October.

Jaumotte, F. and N. Pain (2005), "From Innovation Development to Implementation: Evidence from the Community Innovation Survey", *OECD Economics Department Working Papers*, No. 458, OECD Publishing, Paris.

Karmel, T. (2012), "VET Research for Industry", presented at the AVETRA Conference, Canberra, NCVER, April.

KCA (Knowledge Commercialisation Australasia (2012), "Commercialisation Metrics Survey Report 2012", KCA Inc, February.

KPMG (2010), "PPP Procurement", *Review of Barriers to Competition and Efficiency in the Procurement of Infrastructure Projects*, KPMG Corporate Finance (Aust) Pty Ltd, May.

KPMG Econtech (2010), "Economic Modeling of Improved Funding and Reform Arrangements for Universities", Report for Universities Australia, April.

LO (2007), Employee-Driven Innovation – A Trade Union Priority for growth and Job Creation in Globalised Economy", published by LO, the Danish Confederation of Trade Unions.

Lomax-Smith, J. *et al.* (2011), "Higher Education Base Funding Review", *Final Report*, October.

Marks, G. (2007), "Completing University: Characteristics and Outcomes of Completing and Von Completing Students", *LSAY Research Reports,* Longitudinal Surveys of Australian Youth Research Report, No. 51.

McInerney, L., C. Nadarajah, and F. Perkins (2007), "Australia's Infrastructure Policy and the COAG National Reform Agenda", *Economic Round-Up*, Issue Summer, the Australian Treasury.

McKenzie, M. (2010), "Microeconomic Reform and Productivity in Australia – Boom or Blip?", *School Working Paper,* 2010-15, Deakin University, Australia.

Minister of Infrastructure and Transport (2011), "Infrastructure Finance Reform - Meeting the Challenge", Speech, 8 November.

Murphy, M. *et al*. (2001), "Entrance Score and Performance: A Three Year Study of Success", *Journal of Institutional Research*, Vol. 10, No. 2, pp. 32-49.

National PPP Working Group (2010), "National PPP Working Group Statement of Response to the Infrastructure Australia & KMPG Report", August.

NCVER (2011), "Australian Vocational Education and Training Statistics: Student Outcomes 2011", NCVER, Commonwealth of Australia.

Norton, A. (2012), *Mapping Australian Higher Education*, Grattan Institute, Melbourne.

NWC (National Water Commission) (2009), *Annual-Report 2009-10*, Australian Government, Canberra.

NWC (2011a), *Annual-Report 2010-11*, Australian Government, Canberra, April.

NWC (2011b), *Review of Pricing reform in the Australian Water Sector*, Australian Government, Canberra.

OECD (2008), *OECD Economic Surveys: Australia,* OECD Publishing, Paris.

OECD (2009a), *OECD Science, Technology and Industry Scoreboard*, OECD Publishing, Paris.

OECD (2009b), *Economic Policy Reforms: Going for Growth*, OECD Publishing, Paris.

OECD (2010a), "Towards a Seamless National Economy", *OECD Reviews of Regulatory Reform: Australia*, OECD Publishing, Paris.

OECD (2010b), *Measuring Innovation: A New Perspective*, OECD Publishing, Paris.

OECD (2010c), "Innovation Vouchers", *OECD Innovation Policy Platform*, www.oecd.org/innovation/policytranform.

OECD (2010d), *OECD Economic Surveys: Australia,* OECD Publishing, Paris.

OECD (2010e), *Implementing Congestion Charges*, International Transport Forum, Round Table 147, Transport Research Centre, OECD Publishing, Paris.

OECD (2010f), *Sustainable Management of Water Resources in Agriculture,* OECD Publishing, Paris.

OECD (2011a), *OECD Review on Intellectual Assets and Innovation for SMEs*, OECD Publishing, Paris.

OECD (2011b), "Tax Reform Options: Incentives for Innovation", Testimony by the OECD to the United States Senate Committee on Finance Tuesday, September 20.

OECD (2011c), *OECD Economic Surveys: New Zealand,* OECD Publishing, Paris.

OECD (2012a), *OECD Economic Surveys: Australia,* OECD publishing, Paris.

OECD (2012b), *OECD Economic Surveys: Canada,* OECD publishing, Paris.

OLT (Office for Learning and Teaching) (2011), "Promotion of Excellence in Learning and Teaching in Higher Education", Australian Government.

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

PC (Productivity Commission) (2007), "Public Support for Science and Innovation", *Research Report*, Canberra.

PC (2008a), "Annual Report 2007-08", *Annual Report Series*, Productivity Commission, Canberra.

PC (2008b), "Towards Urban Water Reform: A Discussion Paper", *Productivity Commission Research Paper*, Melbourne, March.

PC (2009), "Australia's Productivity Performance", Submission to the House of Representatives, Standing Commitees on Economics, Commonwealth of Australia.

PC (2010), "Market Mechanism for Recovering Water in the Muarray-Darling Basin", *Final Report*, March.

PC (2011a), "Annual Report 2010-11", *Annual Report Series*, Productivity Commission, Canberra.

PC (2011b), "Australia's Urban Water Sector"*, Report* No. 55, Final Inquiry Report, Canberra.

PC (2012), "Impacts of COAG Reforms: Business Regulation and VET", *Research Report*, Vol. 3-VET, Canberra.

PKF International (2011), "Tax Reliefs and Credits for Research and Development", *Special Report*, Henley Media Group.

RBA (Reserve Bank of Australia) (2010), "How are Electricity Prices Set in Australia? http://www.rba.gov.au/foi/disclosure-log/pdf/101115.pdf

Ross, J. (2012), "External Validation Gets Thumbs Up", *The Australian*, 21 March.

Shomos, A. (2010), "Links Between Literacy and Numeracy Skills and Labour Market Outcomes", *Productivity Commission Staff Working Paper*, Melbourne, August.

Skills Australia (2012), *Impacts of COAG Reforms*: *Business Regulation and VET*, Skills Australia's Response to the Productivity Commission's Discussion Draft, February.

Stanley, J. and D. Hensher (2011), "Environmental and Social Taxes: Reforming Road Pricing in Australia", *Working Paper*, ITLS-WP-11-17, Institute of Transport and Logistics Studies, University of Sydney, September.

State Government Victoria (2012), "Refocusing Vocational Education System in Victoria", April, Melbourne.

Telstra (2012), *The Telstra Productivity Indicator 2012, www.relstra.com.au*.

The NOUS Consulting Group (2011), "Introduction of a Unique Student Identifier for the VET Sector", *Discussion Paper*, NCVER, July.

The University of Melbourne (2011), "Higher Education Base Funding Review", University of Melbourne Submission, March.

Topp, V. *et al*. (2008), "Productivity in the Mining Industry: Measurement and Interpretation", *Productivity Commission Staff Working Paper*, December.

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

VCEC (Victorian Competition and Efficiency Commission) (2011), "Securing Victoria's Future Prosperity: A Reform Agenda", *Productivity Information Paper*, November.

Willox, I. (2012), "Make the Training System Work", *The Australian Financial Review*, 3 July.

Wood, T. *et al.* (2012), "No Easy Choices: Which Way to Australia's Energy Future? Technology Analysis", Grattan Institute, February.

Wright, G. (2012), "Facilitating Efficient Augmentation of Transmission Network to Connect renewable Energy Generation: The Australian Experience", *Energy policy*, *Consultation Paper: National Electricity Amendment (Scale Efficient Network Extensions) Rule 2010,* Vol. 44, pp. 79-91.

ANNEX A1

MEASURING AND INTERPRETING PRODUCTIVITY

The first part of this annex discusses the main issues surrounding productivity measurement and estimation, along with the methods applied in the current analysis to overcome some of the underlying statistical problems and obtain a more accurate assessment of Australia's productivity slowdown. The second part outlines the methodology used to estimate industry contributions to MFP growth in Australia and other resource-rich countries and presents the empirical findings for these countries.

Statistical issues in productivity measurement

What measure for productivity?

Productivity measures the degree of efficiency at which an economy operates. It is defined as the ratio of output to the inputs necessary to produce it (OECD, 2008a). Two commonly used measures of productivity are labour productivity (LP), computed as output divided by labour input, and multifactor productivity (MFP), measuring the amount of output produced from a combined unit of capital and labour (PC, 2010). "Partial" (single-input) productivity measures need to be interpreted carefully: labour productivity, in particular, does not capture solely workers' efficiency, but it is also affected by changes in capital intensity or other non-labour factors that influence output (Parham and Zheng, 2006; PC, 2010). MFP is a more comprehensive productivity measure accounting fully for both labour and capital input changes. It is considered, in principle, as a better indicator of efficiency, though in some cases robust measures of capital input can be difficult to find (PC, 2009; 2010). MFP growth can reflect various sources of production efficiency such as the diffusion of new technologies, changes in industry composition or economies of scale (Parham and Zheng, 2006).

Productivity estimates are subject to measurement error arising from data limitations

Productivity estimations are subject to errors in the measurement of inputs and outputs. Capturing changes in the quality of inputs used for the production process, and of units produced, is a key issue. To address the input-quality problem, the Australian Bureau of Statistics (ABS) has began, for example, to provide estimates of adjusted labour input, taking into account changes in the skills (educational attainment and work experience) of the workforce (Reilly *et al.*, 2005). Another distortion in input measurement could arise from the exclusion of some intangibles assets, such as R&D or organisational improvements, from capital estimates (Barnes and McClure, 2009).

Productivity estimates based on disaggregated data are even more prone to measurement errors. For example, industry measures of productivity are generally less reliable than those of the market sector as they are based on smaller sample (Parham and Zheng, 2006). Moreover, it can be difficult to allocate some output or input to specific segments. The increasingly blurred boundaries between the manufacturing and services sector is a clear example in this regard (Parham and Zheng, 2006).

Additional issues arise when conducting international comparisons of MFP. The methodology of measuring industry outputs and inputs can differ across countries or depend, for instance, on how average hours worked are estimated (Young *et al*., 2008). Different business cycles or country-specific temporary shocks (see below) have to be taken into account in the analysis, together with different industry structure across countries. Productivity level comparisons would further require common international price units and deflators (Young *et al*., 2008).

Productivity growth is affected by cyclical factors

Productivity can exhibit high volatility in the short term influenced largely by business cycles. This increases the risk that, in the short term, MFP growth does not reflect the underlying trend (Parham and Zheng, 2006). Cyclicality can further result in estimates that are extremely sensitive to the start and end points of the growth periods compared. During periods of downturn, for example, employers tend to hoard labour and this can reduce productivity. Lags between investment in new capacity and full production provides for another example.

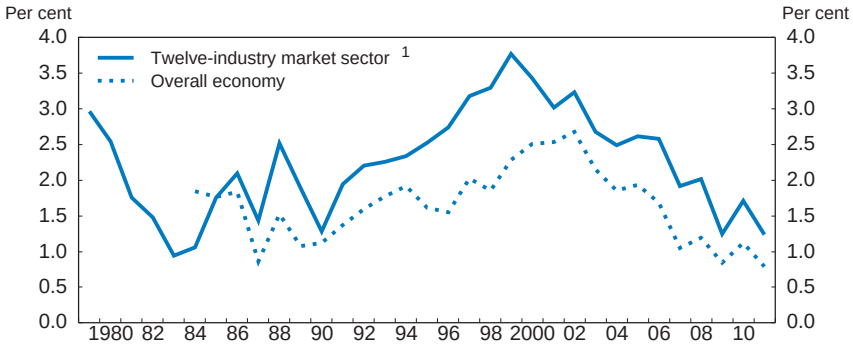
To abstract from short term volatility, ABS identifies for the market sector "MFP growth cycles", which are often defined by productivity peaks (ABS, 2008; PC, 2011). The peaks are determined by comparing the annual MFP growth estimates with their corresponding long-term trend estimates, with the methodology involving advanced filtering techniques. More general economic conditions at the time are also taken into account (ABS, 2008). The "MFP growth cycles" provide a more consistent base for productivity comparison over time, although the rate of growth over the cycles still requires careful interpretation as it can be affected by unmeasured quality changes or other factors.

Individual industries may exhibit patterns of MFP growth that do not always coincide with the market sector productivity cycles defined by ABS due to specific shocks that a sector experienced. For example, utilities (electricity, gas, water and waste services), and especially, agriculture, are affected by droughts. A recent study by the Productivity Commission identified several industry-specific cycles (Barnes, 2011).

Overcoming some of the statistical problems

To overcome some of the measurement and volatility problems, discussed above, the current analysis of productivity trends in Australia proceeded as follows. First, the analysis was concentrated on the market sector, comprising 12 industries, for which productivity is well measured. This permits to exclude industries, such as health or education, for which there are no market transactions for output, making it difficult to measure output – and hence productivity – independently of inputs (d'Arcy and Gustafsson, 2012). The 12 industries account for two thirds of the Australian economy and together they represent sufficiently well its labour productivity pattern (Figure A1.1). ABS data appear to support a similar conclusion in the case of multifactor productivity (ABS 2008, 2011).

Figure A1.1. **Labour productivity growth**
Five-year moving average

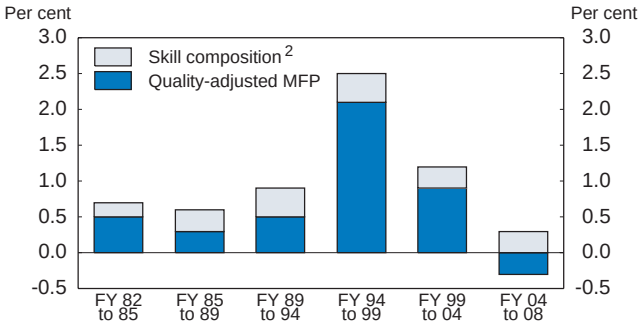


1. Twelve-industry market sector: agriculture forestry and fishing; mining; manufacturing; utilities (electricity, gas, water and water services); construction; wholesale trade; retail trade; accommodation and food services; transport, postal and warehousing; information and technology (communications); finance and insurance; art and recreational services.

Source: ABS, *Cat. Nos. 5260.0.55.002 and 5204.0.*

To examine the impact of unmeasured changes in the quality of labour input on MFP growth the analysis used the ABS measure of "quality-adjusted hours worked", which takes into account changes in the skill composition (measured in terms of educational attainment and work experience) of the workforce. The quality-adjusted MFP recognises the heterogeneity among workers in terms of productivity and provides a measure of labour input which is adjusted by weighting hours with the wage rate of each type of worker (Reilly *et al.*, 2005; ABS, 2010). The growth of skill composition component (calculated as the difference between the standard MFP growth and quality adjusted MFP growth) has slowed down somewhat during the last two complete cycles, but it was not the main driver of the productivity slowdown (Figure A1.2). Rather, the slump appears to be attributable to a decline in the growth of the quality-adjusted MFP component.

Figure A1.2. **MFP growth over productivity cycles in the market sector**[1]
Compound annual growth rates



1. Twelve-industry market sector: agriculture forestry and fishing; mining; manufacturing; utilities (electricity, gas, water and waste services); construction; wholesale trade; retail trade; accommodation and food services; transport, postal and warehousing; information and technology (communications); finance and insurance; art and recreational services.
2. The skill composition component was computed as the difference between standard MFP growth and quality-adjusted MFP growth.

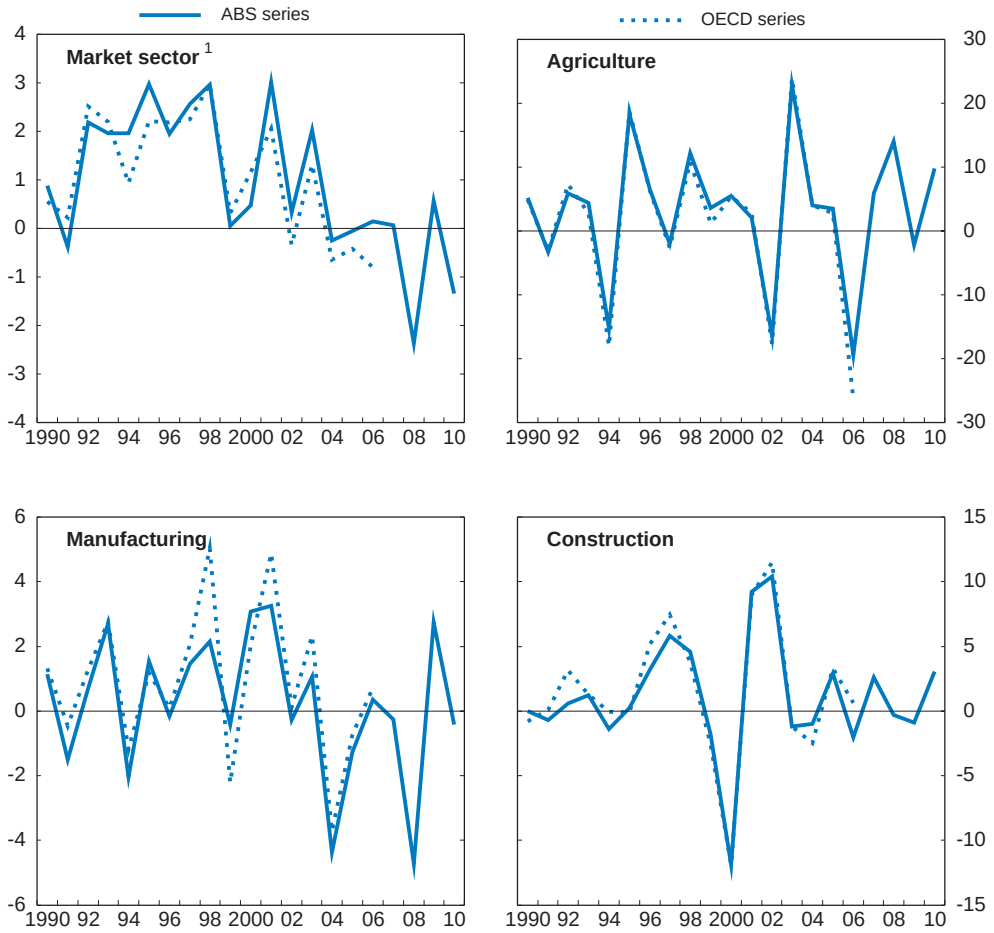
Source: ABS, *Cat. No. 5260.0.55.002.*

As far as addressing the issue of short term volatility is concerned, the analysis focuses solely on comparisons of average MFP growth rates over the complete ABS productivity cycles, both for the market sector and, for simplicity and comparability, at the industry-level although, as discussed earlier, industry cycles may not coincide with market sector cycles (Barnes, 2011).

Regarding international comparisons, the analysis was mostly focused on assessing MFP growth rates across selected industries and their contribution to market MFP growth to minimise data comparability problems. In addition, the countries considered – Australia, Canada and Norway – have all been subject to commodity price booms. Data constraints, however, did not allow the use of a common international database for the three resource-rich countries under examination, as would be desirable. In particular, the MFP data for Canada and Norway were derived from the OECD industry productivity database (iPDB), while those for Australia from the National Accounts due to missing information for compiling the labour cost share for some Australian industries in the OECD database.

The use of different data sources raises some issues that need to be considered when interpreting the results of cross-country analysis. First, national data are based on more detailed sources than the international ones. Second, there are differences across sources in the definitions of industry. As a result, the current analysis was focused solely on five sectors – agriculture, mining, utilities, manufacturing and construction – which were comparable across the different databases, while all the other industries were treated as a single sector ("other activities"). Third, ABS uses capital services as a measure of capital input, while iPDB uses capital stock (Benoit *et al.,* 2011). Capital services take into account the relative productivity of different kinds of assets and are usually a preferred measure of capital input. However, data constraints at the international level do not always allow computing capital services. As a consequence, using the net capital stock as a substitute for capital services could lead to an underestimation of input growth, and hence an overestimation of MFP. To check the compatibility of the two different databases, the few industry-level estimates available in the OECD productivity database for Australia were plotted against the ones provided by ABS. As long as only *growth rates* of industry MFP are taken into account, the estimates are not considerably different between the OECD and ABS data (Figure A1.3).

Figure A1.3. **Australia's MFP growth according to different databases**
Annual growth in log changes

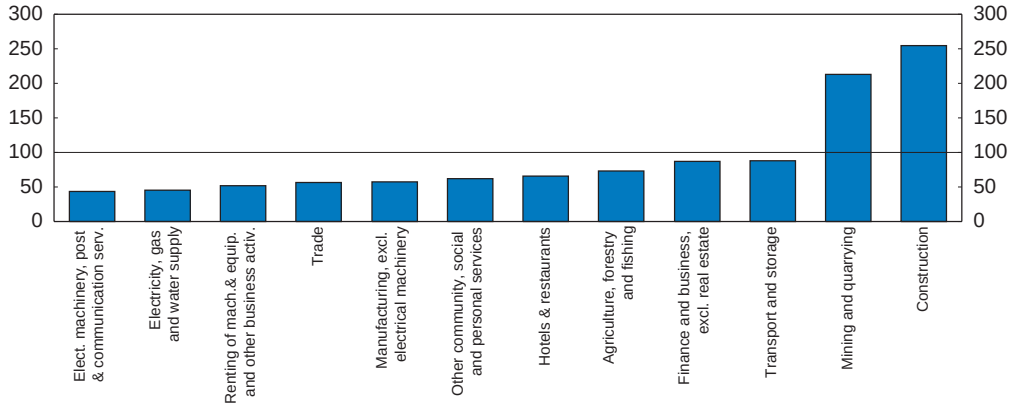


1. The ABS series refers to the twelve-industry market sector (for definition, see Figures 1 and 2) while the OECD series refers to ISIC Rev.3 definition including agriculture, forestry and fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale and retail trade; restaurant and hotels; transport, storage and communications; finance, industry and business services; community, social and personal services.

Source: ABS, *Cat. No. 5260.0.55.002;* OECD, *Industry Productivity database.*

In the current analysis, comparisons of MFP levels by industry in Australia relative to those of the United States are based on extrapolations from Inklaar and Timmer's (2008) estimates for 1997 (Figure A1.4). This basically involves adjusting the 1997 benchmark for the relative MPF growth rates of the two countries between 1997 and 2007, using data from EU-KLEMS database (constructed at the Groningen Growth and Development Centre). A limitation of such an approach is that it assumes that the structures of industry prices and quantities are constant between countries and over time. Typically, the biases due to this assumption are more pronounced the further one moves from the benchmark year. This "extrapolation" methodology, however, is widely used, as noted by Inklaar and Timmer (2008), due to the heavy data requirements of the alternative approach – that is to derive a benchmark estimates for another year than 1997.

Figure A1.4. **MFP gap relative to the United States**
2007 data, USA = 100



Source: EU KLEMS, *Growth and Productivity Accounts*: November 2009 Release, updated March 2011; Groningen Growth and Development Centre, *GGDC Productivity Level database*; OECD calculations.

Computation of industry contributions to MFP

Theoretical Framework

According to the standard framework, productivity reflects the shift in technological change that affects how the inputs, through the production function, are transformed in output (Solow, 1975; Zeng 2005; OECD, 2008b). Hence:

$$y_t = F(k, l, t) = a_t * f(k_t, l_t) \tag{1}$$

Where y_t is the output volume, k_t and l_t are the volumes of capital and labour inputs of the production process and a_t is the technological parameter of interest.

By exploiting the growth accounting framework we can rewrite (1) as:

$$\dot{y}_t = \dot{a}_t + \vartheta_t^k \, \dot{k}_t + \vartheta_t^l \, \dot{l} \tag{2}$$

Where the growth in output is decomposed to the sum of the contribution of productivity growth $\dot{a}_t$ and the inputs growth $\dot{k}_t$ and $\dot{l}_t$. By definition ϑ_t^k and ϑ_t^l are the elasticities of output with respect to capital and labour inputs. Although not observable, by assuming constant returns to scale and competitive equilibrium in both output and input markets, the output elasticities can be considered equal to the factor shares. By defining then w_t^k and w_t^l as the shares of capital and labour income in total factor income, the following identities hold: $\vartheta_t^k = w_t^k$ and $\vartheta_t^l = w_t^l$, resulting in:

$$\dot{mfp}_t = \dot{a}_t = \dot{y}_t - w_t^k \, \dot{k}_t - w_t^l \, \dot{l}_t \tag{3}$$

It is evident from (3) how the growth accounting approach evaluates multifactor productivity growth ($\dot{mfp}_t$) residually, only by using the rate of change of output and inputs (OECD, 2008b). This equation can also be used in the case of disaggregated productivity growth. For instance, ABS constructs industry MFP estimates in the image of (3) taking as a references indexes of value added volumes, hours worked and

capital services for selected industries in the market sector (ABS, 2007). Industry income shares of capital and labour are used to weight capital services and hours worked rates of growth.

Industry contributions to MFP growth

Industry MFP growth provides valuable information for the dynamics of a specific industry but it is not sufficient for investigating MFP developments in the total economy. A large decrease in industry productivity growth, in particular, does not always result in an equally large decrease in aggregate productivity. Estimating industry contributions to overall MFP growth requires an evaluation of the extent to which an industry accounted for the MFP growth by weighting its importance in the overall economy. In other words, it is necessary to know how large an industry is in terms of produced outputs and used inputs relatively to the total resources of the economy (Dolman 2009; Parham, 2012).

Since MFP is calculated as the difference between output growth and combined input growth, each industry's contribution to MFP can be defined as its contribution to total output minus its contribution to total input. Industries' contributions to output and inputs can be obtained by weighting their respective share in total output and input volumes. Hence it is possible to capture both the importance of a sector in the total MFP growth rate and the changes in industries' shares of value added, capital or labour inputs. Such an approach was adopted by the current analysis for all three resource-endowed countries considered (that is, Australia, Canada, Norway), although it has been adapted eventually, according to the data source used (Dolman 2009; Parham, 2012, Benoit et al. 2011). The differences in computation of labour and capital input shares for each of these countries provide an example in this regard.

By taking equation (3) as a reference for the calculation of the residual MFP of the total economy, the contribution of industry *i* to the total MFP growth at time *t* would then be:

$$\dot{cont}_{it} = w_{it}^{y}\,\dot{y}_{it} - w_{it}^{k}\,\dot{k}_{it} - w_{it}^{l}\dot{l}_{it} \tag{4}$$

Where w_{it}^{y} is the output share of industry *i* in the total economy; and w_{it}^{k} and w_{it}^{l} are industry *i* shares of capital and labour income in the total factor income generated in the economy. It needs to be noted that, w_{it}^{k} (and w_{it}^{l}**)** can be considered as the product of two different shares. The first is the fraction of capital (or labour) income of industry *i,* relative to the total. The second share represents how the total factor income in the economy is distributed between either capital or labour and it is necessary to produce a measure of *combined* total input growth.

Discrepancy issues

By definition, all industries contributions must sum up to the aggregate MFP growth:

$$\sum_{i} \dot{cont}_{it} = \dot{mfp}_{t} \tag{5}$$

However, MFP estimates of the market sector are not usually computed directly from industry-level MFP estimates. In the case of Australia, in particular, the ABS constructs separate output and input indexes to compute aggregate MFP since industry-level data are more subject to measurement error (Parham and Zheng, 2006; Parham, 2012). Moreover, ABS uses different methodologies to derive aggregate output and input indexes (Parham, 2012). Changes in industry-weights over time introduce additional approximation errors. Hence, it is not possible to reproduce precisely the market sector MFP estimates from a direct aggregation of the industry MFP contributions (Parham, 2012). Similar consistency problems are present for both Canada and Norway. The different methodologies of aggregation of the various data sources affect

the way in which the shares w_{it}^{y} , w_{it}^{k} and w_{it}^{l} of equation (4) are built. In this context, the paragraph below will explain the methodology of computation of industry contributions to MFP growth separately for each of the examined countries. In each case, the empirical analysis focuses on the market sector, which is better measured, rather than the economy as a whole which was the basis of the theoretical discussion above.

Computation of Australia's industry contributions to market sector MFP growth

The methodology used in the paper to compute the components of equation (6) follows that of Parham (2012). In practice, the equivalent of equation (4) for the contribution of industry *i* to the MFP growth at time *t* is:

$$\dot{cont}_{it} = s_{it-1}^{y}\,\dot{y}_{it} - \bar{s}_{it}^{k}\,\dot{k}_{it} - \bar{s}_{it}^{l}\,\dot{l}_{it} \tag{6}$$

The different notation compared to equation (4) regarding the industries' shares in output, capital and labour reflect the fact that these variables are not theoretical anymore. Rather, they have been computed following the essence of the methodology used by ABS to aggregate output and input indexes, while also taking into account data constraints. More specifically:

- $\dot{y}_{it}$ $\dot{k}_{it}$ and $\dot{l}_{it}$ are the log-differences between year *t* and *t-1* respectively of the indexes of GVA volumes, capital services and hours worked that can be found in ABS Cat. No. 5260.0.55.002.

- s_{it-1}^{y} is industry's *i* share in current price GVA of industry *i* at the time *t-1*. Current price measures of output make it possible to overcome the non-additivity property of chained volume indexes (that is they ensure that $\sum_i s_{it}^{y} = 1$). Moreover, to replicate the ABS chained Laspeyres index aggregation method, it was necessary to refer to year t-1 as the base year. Current price GVA is available in ABS Cat. No. 5204.0.

- $\bar{s}_{it}^{k}$ is industry's *i* capital income as a share of market sector total factor income. This share is the result of two different weightings, as discussed above. The first weighting exploits the unpublished industries' shares of capital income, provided by the ABS. Since ABS aggregates industries' capital services as a Tornqvist index based on weighted change in capital income weights, the shares are averaged over time *t* and *t-1*. These shares are then weighted for the average share of capital in total factor income of the market sector, available in ABS Cat. No. 5260.0.55.002.

- $\bar{s}_{it}^{l}$ is industry's *i* labour income as a share of market sector total factor income. The computation of this share parallels the one of $\bar{s}_{it}^{k}$, and it is also the result of two different weightings. The first weighting exploits the industries' shares of hours worked available from the Labour Force Survey (LFS). These shares, averaged over time *t* and *t-1,* are weighted additionally for the relative average share of labour in total factor income of the market sector, available in ABS Cat. No. 5260.0.55.002.

After computing all the year-on-year industry contributions following the methodology above, the productivity-cycle contributions are calculated as an average of all the single years' contributions for the specific period. For example:

$$\dot{cont}_{i2004-2008} = \frac{\dot{cont}_{i2005} + \dot{cont}_{i2006} + \dot{cont}_{i2007} + \dot{cont}_{i2008}}{4} \tag{7}$$

Empirical findings for Australia

The following two tables present, respectively, MFP industry growth over the ABS productivity cycles and the results of the disaggregation of market-sector MFP growth into industry contributions for Australia. Table A1.2, in particular, shows industry contributions to MFP growth over cycles and contributions to MFP slowdown (changes in industry contributions). Since the last MFP-cycle is not complete yet, the results for the last three years are presented on a year-on-year basis.

Table A1.1. **MFP industry growth: Australia**
Annual Average growth, log-change

	1988-89 to 1993-94	1993-94 to 1998-99	1998-99 to 2003-04	2003-04 to 2007-08	2008-09	2009-10	2010-11
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Agriculture	4.0	3.9	3.5	-1.5	13.9	-2.3	9.8
Mining	2.7	0.6	0.0	-4.1	-9.1	-1.7	-13.0
Manufacturing	0.0	0.6	1.3	-1.4	-4.7	2.7	-0.4
Utilities	3.4	1.9	-2.3	-4.9	-4.6	-1.6	-6.6
Construction	-0.5	2.5	0.9	0.6	-0.3	-0.9	3.0
Wholesale Trade	-2.3	5.2	1.3	0.0	-1.5	-1.2	-0.2
Retail Trade	1.7	2.1	1.4	0.3	1.1	4.0	-1.8
Accommodation and Food	-0.7	1.7	0.8	0.4	-3.1	-4.8	-1.4
Transport, Postal and Warehousing	1.3	2.0	1.7	0.7	-6.7	2.5	0.5
Telecommunications	5.6	2.8	-1.0	0.1	-0.6	1.6	-1.1
Finance	3.9	2.8	2.3	4.3	-1.2	0.1	0.6
Arts and Recreation Services	-1.7	-1.9	1.0	-1.9	3.1	2.2	-2.1
Market sector[1]	**0.9**	**2.5**	**1.2**	**0.0**	**-2.4**	**0.6**	**-1.3**

1. 12-industry market sector.

Source: ABS and OECD calculations.

Table A1.2. **Industry contributions to MFP growth within and between cycles: Australia**

In percentage points

	Industry contributions to MFP growth							Change in industry contributions to MFP				
	1988-89 to 1993-94 [1]	193-94 to 1998-99 [2]	1998-99 to 2003-04 [3]	2003-04 to 2007-08 [4]	2008-09 [5]	2009-10 [6]	2010-11 [7]	[2]-[1]	[3]-[2]	[4]-[3]	[6]-[5]	[7]-[6]
Agriculture	0.3	0.2	0.2	-0.1	0.5	-0.1	0.5	-0.1	0.0	-0.2	-0.6	0.6
Mining	0.2	0.0	0.0	-0.4	-1.2	-0.1	-1.7	-0.2	0.0	-0.4	1.1	-1.5
Manufacturing	0.0	0.1	0.3	-0.3	-0.8	0.4	-0.1	0.1	0.1	-0.5	1.2	-0.5
Utilities	0.2	0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.1	0.1	-0.2
Construction	-0.1	0.3	0.0	0.1	0.0	-0.1	0.4	0.4	-0.2	0.0	-0.1	0.5
Wholesale Trade	-0.2	0.4	0.1	0.0	-0.1	0.0	0.0	0.6	-0.3	-0.1	0.1	0.0
Retail Trade	0.1	0.1	0.1	-0.1	0.2	0.4	-0.2	0.0	-0.1	-0.1	0.2	-0.6
Accommodation and Food	-0.1	0.0	0.0	0.0	-0.1	-0.2	-0.1	0.1	0.0	0.0	-0.1	0.1
Transport, Postal and Warehousing	0.1	0.2	0.1	0.1	-0.6	0.2	0.0	0.1	0.0	-0.1	0.8	-0.2
Telecommunications	0.3	0.2	-0.1	0.0	0.0	0.1	-0.1	-0.1	-0.2	0.1	0.1	-0.1
Finance	0.4	0.4	0.4	0.8	-0.2	0.0	0.1	0.0	0.0	0.4	0.3	0.1
Arts and Recreation Services	0.0	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.1	-0.1	0.0	-0.1
Sum of contributions	**1.3**	**2.0**	**1.0**	**-0.1**	**-2.5**	**0.5**	**-1.4**	**0.7**	**-1.0**	**-1.1**	**3.0**	**-1.9**
Market sector[1, 2]	**0.9**	**2.5**	**1.2**	**0.0**	**-2.4**	**0.6**	**-1.3**	**1.6**	**-1.3**	**-1.2**	**2.9**	**-1.9**

1. 12-industry market sector.
2. For a discussion of the factors explaining the discrepancy between the sums of industry contributions and aggregate MFP growth see the section on “Discrepancy Issues”. The discrepancy is particularly evident during the cycles 1988-89 to 1993-94 and 1993-94 to 1998-99 because of a change in the aggregation method of output by the ABS that allowed to achieve a better consistency of results only after 1995-96.

Source: ABS, and OECD calculations.

Computation of industry contributions for Canada and Norway

Equation (6) has also been used to calculate contributions of industry *i* for the year *t* for Canada and Norway. However, the variables and methodology regarding the input components of the equation reflect the data provided by the OECD industry productivity database (iPDB), used as a source for these two countries (Benoit *et al.*, 2011). More specifically:

$$\dot{cont}_{it} = s^{y}_{it-1}\,\dot{y}_{it} - \bar{s}^{k}_{it}\,\dot{k}_{it} - \bar{s}^{l}_{it}\,\dot{l}_{it} \tag{6}$$

- $\dot{y}_{it}$, $\dot{k}_{it}$, $\dot{l}_{it}$ are the log average growth of GVA, net capital stock and hours worked indexes available in the industry productivity database iPDB.
- s^{y}_{it-1} is the GVA share of industry *i* in current prices relative to time *t-1*.
- $\bar{s}^{k}_{it}$ is the share of industry *i* in net capital stock volumes at time *t-1*, weighted also for the average between time t and t-1 of the share of capital cost in the total factor costs of the market sector.
- $\bar{s}^{l}_{it}$is the share of industry *i* in hours worked at time *t-1*, weighted also for the average between time t and t-1 of the share of labour cost in the total factor costs of the market sector.

In the case of Canada**,** due to the fact that net capital stock volumes are not available in OECD iPDB, gross capital stock volumes were used to weight the capital stock growth.

International comparison of industry contributions to productivity slowdown in resource-rich countries

Comparisons of the industry productivity patterns across Australia, Canada and Norway indicate a strong contribution of the mining sector in each case, suggesting that part of the productivity slump in these specific countries can also be related to mining-related commodity boom (Table A1.3). A distinguished feature of Australia is the much larger relative contributions of the manufacturing and agriculture sectors in the market MFP slowdown. Detailed findings are shown only for those industries that have a similar definition across the three countries and for which it has been verified that different data sources and methodologies lead to the same growth estimates (Figure A1.3). Those industries not directly considered are mostly services and their contributions have been aggregated under “other activities”, though particular caution is needed when comparing the results across countries due to differences in definitions between the ABS and OECD productivity databases.

Table A1.3. **Industry contributions to MFP growth and change over time: resource-rich countries**

Australia			
	Industry contributions to MFP growth		Changes in industry contributions
	1999-2003 [1]	2003-2007 [2]	[2]-[1]
Agriculture, Forestry and Fishing	0.23	-0.06	-0.29
Mining	-0.09	-0.42	-0.33
Manufacturing	0.35	-0.26	-0.61
Utilities	-0.09	-0.18	-0.08
Construction	0.09	0.07	-0.02
Other activities	0.80	0.77	-0.04
Market sector[1]	**1.46**	**-0.02**	**-1.48**
Canada			
	Industry contributions to MFP growth		Changes in industry contributions
	1999-2003 [1]	2003-2007 [2]	[2]-[1]
Agriculture, Forestry and Fishing	0.11	0.07	-0.04
Mining	-0.07	-0.21	-0.14
Manufacturing	0.28	0.22	-0.06
Utilities	-0.04	-0.08	-0.04
Construction	0.14	-0.02	-0.16
Other activities	0.50	n.a.	n.a.
Market sector[1]	**0.79**	**n.a.**	**n.a.**
Norway			
	Industry contributions to MFP growth		Changes in industry contributions
	1999-2003 [1]	2003-2007 [2]	[2]-[1]
Agriculture, Forestry and Fishing	0.23	0.16	-0.06
Mining	0.50	-1.22	-1.72
Manufacturing	0.40	0.15	-0.25
Utilities	0.08	0.11	0.03
Construction	-0.09	-0.31	-0.23
Other activities	0.50	0.27	-0.01
Market sector[1]	**2.46**	**-0.35**	**-2.81**

1. The ABS series refers to the twelve-industry market sector (for definition, see Figures 1 and 2) while the OECD series refers to ISIC Rev.3 definition including agriculture, forestry and fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale and retail trade; restaurant and hotels; transport, storage and communications; finance, industry and business services; community, social and personal services.

Source: ABS, OECD Industry Productivity database (iPDB) and OECD calculations.

BIBLIOGRAPHY

ABS (Australian Bureau of Statistics) (2007), *Experimental Estimates of Industry Multifactor Productivity*, Cat. No. 5260.0.55.00, Canberra.

ABS (2008), *Australian System of National Accounts, 2007-08*, Cat.. No. 5204.0, Canberra.

ABS (2010), *Measures of Australia's Progress*, Cat. No. 1370.0, Canberra.

ABS (2011), *Australian System of National Accounts, 2010-11*, Cat.. No. 5204.0, Canberra.

Barnes, P., and A. McClure (2009), "Investments in Intangible Assets and Australia's Productivity Growth", *Productivity Commission Staff Working Paper*, Canberra.

Barnes, P. (2011), "Multifactor Productivity Growth Cycles at the Industry Level, *Productivity Commission Staff Working Paper*, Canberra.

Benoit, A., *et al.* (2011), "Measuring Multi-factor Productivity by Industry: Methodology and First Results From the OECD Productivity Databse," *The Statistics Newsletter*, Issue No. 54, December, OECD publishing, Paris.

d'Arcy, P. and L. Gustafsson (2012), "Australia's Productivity Performance and Real Incomes", *Reserve Bank of Australia Bulletin*, June Quarter, Sydney.

Dolman, B. (2009), "What Happened to Australia's Productivity Surge? *The Australian Economic Review*, Vol. 42, No.3, pp. 243-63.

Inklaar, R., and M.P. Timmer (2008), "GGDC Productivity Level Database: International Comparisons of Output, Inputs and Productivity at the Industry Level", Research Memorandum GD-104, University of Groningen.

OECD (2008a), *OECD Compendium of Productivity Indicators*, OECD publishing, Paris.

OECD (2008b), *Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth*, OECD publishing, Paris.

Parham, D., and S. Zheng (2006), "Aggregate and Industry Productivity Estimates for Australia", *The Australian Economic Review* , Vol. 39, No. 2, pp. 216-26.

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

PC (Productivity Commission) (2009), "Productivity Primer", Productivity Commission, http://www.pc.gov.au/research/productivity/primer/measures.

PC (2010), "Annual Report 2009-10", *Annual Report Series*, Productivity Commission, Canberra.

PC (2011), "Annual Report 2010-11", *Annual Report Series*, Productivity Commission, Canberra.

Reilly, R., Milne, W., and S. Zhao (2005), "Quality-adjusted Labour Inputs", ABS, Canberra.

Solow, R.M. (1957), "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics* , Vol. 39, No.3, pp. 312-320.

Young, A. *et al*. (2008), "International Comparison of Industry Productivity", *Economic Roundup*, Issue 3, Commonwealth of Australia, Canberra.

Zheng, S. (2005), "Estimating Industry-Level Multifactor Productivity for the Market-Sector Industries in Australia: Methods and Experimental Results", Research Paper, ABS, Cat. No. 1351.055.004.

WORKING PAPERS

The full series of Economics Department Working Papers can be consulted at www.oecd.org/eco/workingpapers/

1024. *Housing, financial and capital taxation policies to ensure robust growth in Sweden* (January 2013), by Müge Adalet McGowan

1023. *Labour market and social policies to foster more inclusive growth in Sweden* (January 2013) by Stéphanie Jamet, Thomas Chalaux and Vincent Koen

1022. *Educational attainment and labour market outcomes in South Africa*, 1994-2010 (January 2013) by Nicola Branson and Murray Leibbrandt

1021. *Education quality and labour market outcomes in South Africa* (January 2013) by Nicola Branson and Murray Leibbrandt

1020. *Do policies that reduce unemployment raise its volatility? Evidence from OECD countries (January 2013) by Alain de Serres and Fabrice Murtin*

1019. *Slovakia: A catching up euro area member in and out of the crisis* (January 2013) by Jarko Fidrmuc, Caroline Klein, Robert Price and Andreas Wörgötter

1018. *Improving the fiscal framework to enhance growth in an era of fiscal consolidation in Slovakia* (January 2013) by Caroline Klein, Robert Price and Andreas Wörgötter

1017. *Investing efficiently in education and active labour market policies in Slovakia* (January 2013) by Caroline Klein

1016. *The performance of road transport infrastructure and its links to policies* (January 2013) by Henrik Braconier, Mauro Pisu and Debra Bloch

1015. *The US labour market recovery following the great recession* (January 2013) by Wendy Dunn

1014. *Why do Russian firms use fixed-term and agency work contracts?* (December 2012) by Larisa Smirnykh and Andreas Wörgötter

1013. *The Equity implications of fiscal consolidation* (December 2012) by Lukasz Rawdanowicz, Eckhard Wurzel and Ane Kathrine Christensen

1012. *The Dutch labour market: preparing for the future* (December 2012) by Mathijs Gerritsen and Jens Høj

1011. *Reforming policies for the business sector to harvest the benefits of globalisation in the Netherlands* (December 2012) by Mathijs Gerritsen and Jens Høj

1010. *Health care reform and long-term care in the Netherlands* (December 2012) by Erik Schut, Stéphane Sorbe and Jens Høj

1009. *Enhancing the inclusiveness of the labour market in Belgium*
(December 2012) by Jens Høj

1008. *Reducing poverty in Estonia through activation and better targeting*
(December 2012) by Sarah Flèche and Artur Radziwill

1007. *Matching skills and jobs in Estonia*
(December 2012) by Lilas Demmou

1006. *Debt and macroeconomic stability: An overview of the literature and some empirics*
(December 2012) by Douglas Sutherland and Peter Hoeller

1005. *Debt and macroeconomic stability: Debt and the business cycle*
(December 2012) by Volker Ziemann

1004. *Debt and macroeconomic stability: Case studies*
(December 2012) by Rossana Merola

1003. *Debt and macroeconomic stability*
(December 2012) by Douglas Sutherland, Peter Hoeller, Rossana Merola and Volker Ziemann

1002. *Reducing greenhouse gas emissions in a cost effective way in Switzerland.*
(December 2012) by Anita Wölfl and Patrizio Sicari

1001. *Strengthening innovation in the United States*
(November 2012) by David Carey, Christopher Hill and Brian Kahin

1000. *Long-term growth scenarios*
(January 2013) by Åsa Johansson, Yvan Guillemette, Fabrice Murtin, David Turner, Giuseppe Nicoletti, Christine de la Maisonneuve, Philip Bagnoli, Guillaume Bousquet and Francesca Spinelli

999. *Selected aspects of household savings in Germany – evidence from micro-data*
(November 2012) by Christina Kolerus, Isabell Koske and Felix Hüfner

998. *Improving the tax system in Indonesia*
(November 2012) by Jens Arnold

997. *Unleashing business innovation in Canada*
(November 2012) by Alexandra Bibbee

996. *Public policy and resource allocation: evidence from firms in OECD countries*
(October 2012) by Dan Andrews and Federico Cingano

995. *Promoting SME development in Indonesia*
(October 2012) by Annabelle Mourougane

994. *Portugal: Rebalancing the economy and returning to growth through job creation and better capital allocation.*
(October 2012) by Álvaro Pina and Ildeberta Abreu