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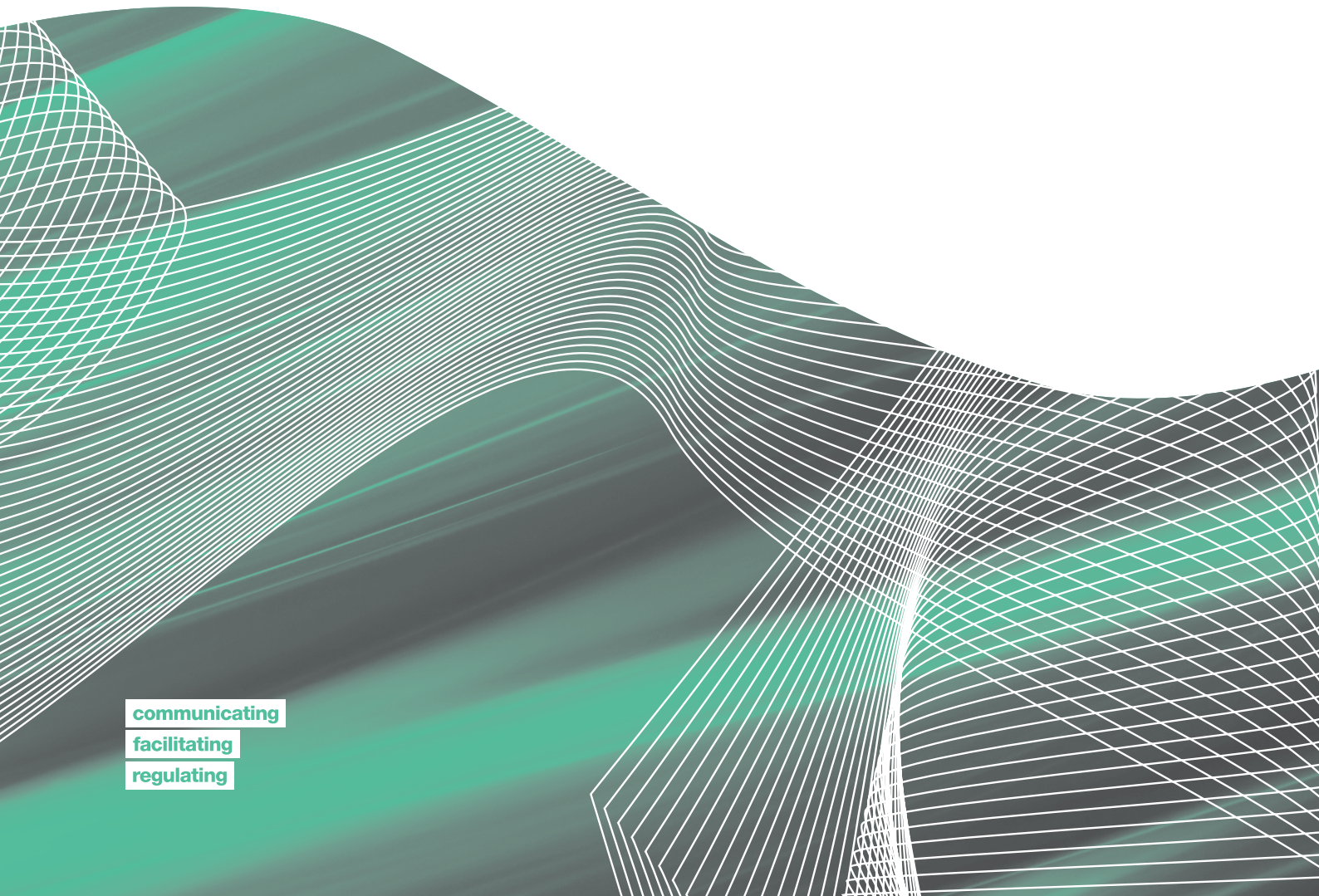
The economic impacts of mobile broadband on the Australian economy, from 2006 to 2013

Research report prepared for the ACMA by The Centre for International Economics

APRIL 2014



communicating
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FINAL REPORT

The economic impacts of mobile broadband on the Australian economy, from 2006 to 2013

Prepared for
The Australian Communications and Media Authority

January 2014

THE CENTRE FOR INTERNATIONAL ECONOMICS
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Executive summary

The Australian Communications and Media Authority (the ACMA) has commissioned the CIE and Analysys Mason to investigate the economic impacts arising from mobile broadband in Australia. **Mobile broadband** means the variety of ways an internet service is delivered via a mobile network, typically comprising mobile wireless internet services provided via a dongle, USB modem or data card service, or mobile phone handset internet services. This report sets out the main economic impacts of mobile broadband from 2006 to 2013. It does not consider the future economic impacts of mobile broadband or how the impacts of mobile broadband would be affected by changes in Government policy.

Mobile communications, of which mobile broadband is a part, is a small component of the Australian economy, accounting for only 0.2 per cent of employment and 0.5 per cent of economic activity. However, its small size belies its impact. Mobile broadband has wrought substantial change across the Australian economy and has been taken up rapidly by Australian households and businesses.

The impacts of mobile broadband are largely **productivity** impacts. Productivity is the amount of inputs, such as labour and capital, required to produce goods and services. In the long term, improving productivity is one of the main ways that we can improve material standards of living. Yet over the last decade, Australia's multi-factor productivity — the amount produced given the amount of hours worked and capital employed in production — has not increased.

There have been various interpretations of Australia's productivity malaise. Partly the lack of productivity growth reflects specific issues with the mining, electricity and water sectors. However, as the Reserve Bank notes:

> "The most widely accepted explanation for the acceleration and subsequent slowing in productivity growth over the past two decades relates to the gradual waning of the impetus to productivity growth initiated by the economic policy reforms of the 1980s and 1990s." [1]

During the mid-1990s, technological innovation in information and communications technology (ICT) coincided with productivity enhancing impacts of economic policy reforms such as trade liberalisation and National Competition Policy. ICT was a small component of Australia's strong productivity performance, contributing around 10 to 20 per cent of the uplift in Australia's productivity growth.

The impacts of mobile broadband have coincided with a very different Australian productivity environment. Mobile broadband has been moving against the tide, unlike the productivity impacts of ICT. The substantial positive impacts of mobile broadband on

---

1 D'Arcy, P. and L. Gustafsson 2012, "Australia's productivity performance and real incomes", Reserve Bank of Australia Bulletin, June.

the Australian economy and productivity have been more than offset by the broader productivity environment. Without mobile broadband, this means that Australia's productivity and economic growth would have been lower still and that the Australian economy would be $33.8 billion smaller in 2013. Further, Australian households would have consumed $652 per person less in goods and services than they actually consumed in the absence of mobile broadband. These very substantial impacts of mobile broadband reflect the productivity growth within the mobile communications sector and the impacts of mobile broadband reported by over 1000 Australian businesses operating across all sectors of the economy.

The overlap between the impacts of technological change and the impacts of government policy are directly relevant to the mobile communications sector. Spectrum, the allocation of which is currently largely at the Australian Government's direction, has been noted by the mobile broadband sector as a critical issue. The allocation of spectrum will be one issue that could potentially constrain or reduce the future economic value of mobile broadband.

Impacts of mobile broadband

The substantial value created by mobile broadband reflects three distinct types of impact.

Higher productivity in the mobile communications sector

From 2006 to 2013, the sector achieved productivity growth of 11.3 per cent per year (table 1). Without mobile broadband, this would have been 6.7 per cent per year. Prices of mobile communications products for households and businesses have fallen by on average 8.4 per cent per year over this period.

1 Productivity growth from 2006 to 2013

Item	2006 to 2013	2006 to 2010	2010 to 2013
	Per cent per year	Per cent per year	Per cent per year
Actual productivity growth	11.3	6.8	17.5
Productivity growth without mobile broadband	6.7	6.4	7.2
Prices	-8.4	-4.6	-13.3

Source: The CIE.

Higher productivity from businesses that use mobile broadband.

Businesses that have taken up mobile broadband have been able to save time and cost, and improve the quality of their goods and services. Over 1000 businesses surveyed reported an average time saved of 2.3 per cent from mobile broadband and an average cost saving of 1.4 per cent (table 2). Two thirds of businesses considered that the impacts of mobile broadband would be larger over the next five years compared to the impacts experienced to 2013. Furthermore:

- businesses that grew more quickly over the past three years noted higher impacts of mobile broadband on their business;
- businesses with a higher level of access to mobile broadband for their employees noted higher impacts of mobile broadband; and
- around a quarter of businesses ranked mobile broadband as one of the three most important issues for their business, a similar amount as noted less government regulation and a more efficient tax system.

2 Impacts of mobile broadband on business performance

Impact area	Share of business activity noting impact	Average impact
	Per cent	Per cent
Reduced costs	25.2	1.4
Saved time for employees with access to mobile broadband	75.2	2.3
Increased sales	20.6	1.1
Improved quality	60.6	
Allowed access to new markets	32.3	
Allowed access to new suppliers	28.9	

Data source: The CIE based on survey undertaken by Woolcott Research.

Greater quality to households

Mobile broadband has likely created greater value to households because of quality changes in the service provided, beyond that allowed for in the output of the sector. This could reflect factors such as greater mobile coverage, higher speed of download and the range of applications and content available. It is difficult to precisely value these quality improvements with available information. Attachment D sets out how these quality changes could be estimated and a range of values based on currently available information. This value is not included in the economy-wide impacts of mobile broadband.

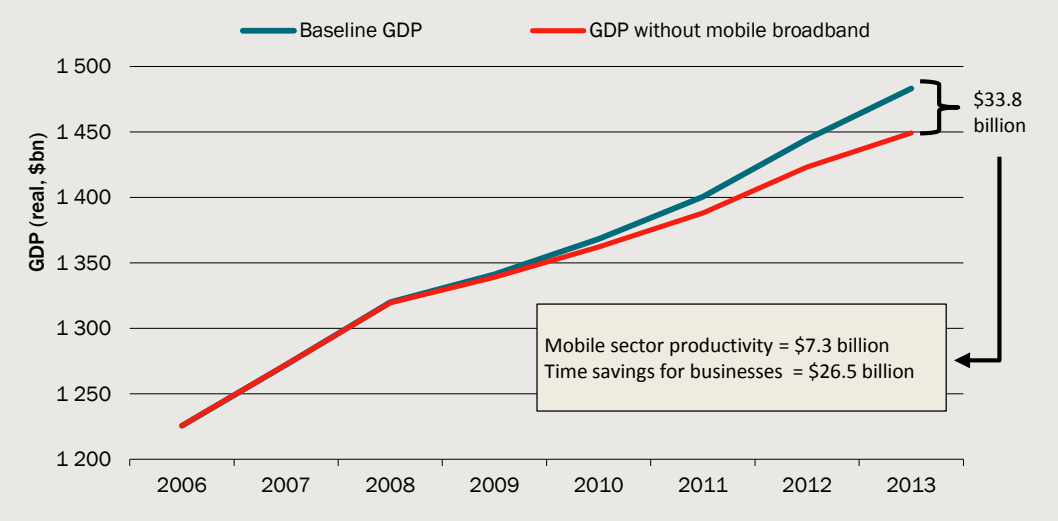
Economy-wide impacts of mobile broadband

The direct economic impacts from mobile broadband have flowed through all aspects of the Australian economy. The most important flow-on impact of the productivity improvements is that this draws additional investment capital into the Australian economy, magnifying the impacts on Australia's economic growth. We use the CIE-REGIONS economic model to show the total impacts on the Australian economy arising from mobile broadband. These impacts are estimated by using the productivity analysis of the mobile broadband sector and the survey of businesses discussed above as inputs into a model of the Australian and state economies.

- We estimate that mobile broadband has increased the growth rate of the Australian economy by 0.28 per cent each year from 2007 to 2013. The actual growth over this period was 2.9 per cent per year, indicating that mobile broadband contributed a substantial part of Australia's economic growth through productivity improvements.

  - Our estimated impacts of mobile broadband are somewhat below the estimated increase in growth from the use of information and communications technologies in Australia in the mid-1990s — this is unsurprising given the scale of these two technological changes.
  - Our estimate is also below the estimated impacts of broadband and mobile technology from a number of international studies but above that of a previous Australian study undertaken for the Australian Mobile Telecommunications Association.
- By 2013, we estimate that mobile broadband has led to an increase in Australia's economic activity of $33.8 billion in 2013 (chart 3), based on the responses from the business survey and our productivity analysis. Of this, $7.3 billion reflects the impact of productivity growth within the mobile communications sector. The majority of this impact ($26.5 billion) reflects the time savings indicated by businesses surveyed.

3 Economic impacts of mobile broadband



Data source: The CIE.

The best indicator of the 'value' of mobile broadband to Australians is how it has changed the amount of goods and services that households are able to purchase — that is, material standards of living. We estimate that by 2013, mobile broadband has increased the amount of goods and services that could be purchased per capita by $652 or $14.8 billion in total (table 4).

4 Household consumption impacts of mobile broadband

Impact item	Australia-wide 2013	Per capita 2013
	$b	$/person
Productivity within mobile communications sector	6.2	274
Higher business productivity	8.6	379
Total	**14.8**	**652**

Source: The CIE.

1 Background and context

The Australian Communications and Media Authority (ACMA) is seeking to better understand how the mobile communications sector impacts on the Australian economy. This project aims to understand the value of mobile broadband technologies to the economy, and therein the potential value of spectrum.

The mobile communications sector

The mobile communications sector covers the provision of voice, data and messaging services via airwaves. The three largest businesses involved in mobile communications are Telstra, Optus and Vodafone Hutchison Australia.

Mobile broadband is one part of the mobile communications sector. The mobile communications sector covers the use of technologies to deliver direct communications via airwaves. Mobile broadband means the variety of ways an internet service is delivered via a mobile network, typically comprising mobile wireless internet services provided via a dongle, USB modem or data card service; or internet services accessed via a mobile phone handset. Devices that can use mobile broadband can also often access fixed networks (such as through a wireless modem). We focus on the use of these devices to access networks of mobile communications businesses only.

The ACMA's role and influence over mobile broadband

The ACMA has an important influence over the mobile communications sector and mobile broadband in particular because of its role in spectrum allocation. The ACMA has recently finalised auctions for spectrum in the 700 MHz band (commonly referred to as the digital dividend) and 2.5 GHz band. Optus, Telstra and TPG Internet purchased spectrum in this auction for a combined price of almost $2 billion.[2]

The ACMA's future spectrum allocation decisions may influence the provision of mobile broadband services. Deloitte (2013) notes that regulation and policy for spectrum allocation and licensing is the most critical issue for the mobile communications sector.[3]

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2 ACMA website, http://www.acma.gov.au/Industry/Spectrum/Digital-Dividend-700MHz-and-25Gz-Auction/Reallocation/digital-dividend-auction-results

3 Deloitte Access Economics 2013, *Mobile Nation: The economic and social impacts of mobile technology,* prepared for the Australian Mobile Telecommunications Association.

This project

This project seeks to understand how mobile communications interacts with the Australian economy. Mobile communications is a general purpose technology. This means that it is used across all sectors of the economy. To understand its impacts we:

- measure the changes within the sector itself;
- measure how businesses use mobile broadband and how this use changes the performance of their business operations; and
- use a computable general equilibrium model to translate these direct changes into overall impacts on the size and structure of the Australian economy.

The impacts of mobile broadband are estimated for the period from 2006 to 2013. These estimates rely on impacts reported by over 1000 Australian businesses operating across all sectors of the Australian economy[4] and productivity calculations based on data from a variety of sources including mobile network operators. To the extent that these sources do not provide an accurate view then the estimated economy-wide impacts will also be inaccurate. Where relevant, we have taken a conservative interpretation of the impacts of mobile broadband, particularly in applying information collected from the survey of businesses.

Acknowledgements

We wish to acknowledge the contribution made to this project by the following groups.

- Analysys Mason and Evans & Peck, who were the CIE's partners in this project
- Woolcott Research, who conducted the survey of businesses
- Telstra, Optus and Vodafone and the Australian Mobile Telecommunications Association for providing data and other input into the study
- The Australian Bureau of Statistics, for providing confirmation of the methods used for mobile sector productivity
- ACMA staff members, for contributing to many aspects of the project

4 Further information on the survey of businesses can be found in Woolcott Research 2013, *Business mobile communications usage and impact survey: Technical report,* prepared for the CIE and ACMA, October. The survey is set out in Attachment E.

PART I

Overview of mobile broadband industry

2 Economic size of mobile communications

The mobile communications industry comprises 0.5 per cent of Australia's economic activity (value added) and 0.2 per cent of Australia's employment in 2012/13, according to IBISWorld (table 2.1).

2.1 Key statistics for mobile communications

Item	Mobile communications industry 2013	Australia	Share of Australian economy
	$b	$b	Per cent
Value added	7.3	1 511.8	0.5
Revenue	19.8	na	na
Employment (000s)	20.9	11 593.3	0.2
Wages and salaries	1.6	734.2	0.2

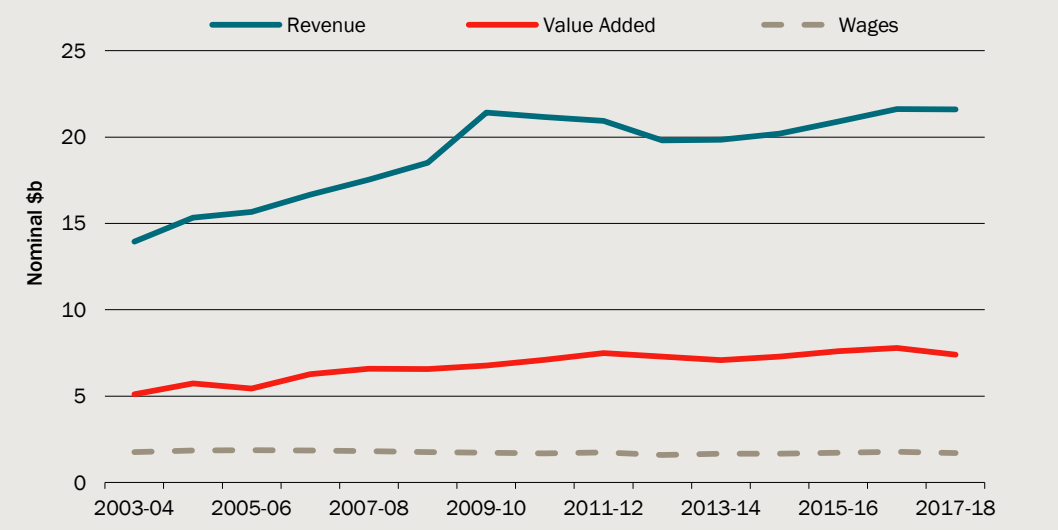
Source: IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May; ABS 2013, Australia's National Accounts, Catalogue No. 5206.0; ABS 2013, Labour Force Australia, Catalogue No. 6202.0.

IBISWorld revenue figures are slightly higher than revenue figures provided by industry and ABS revenue figures for 2008/09. For example, in 2008-09, the ABS estimated revenue for mobile communications at $16.7 billion compared to an IBISWorld figure for the same year of $18.5 billion.[5] This is likely to reflect different definitions as to what is captured within the industry, with the ABS treating some handset sales as outside of the industry.

Revenue, value added and wages in the sector have risen gradually since 2003/04. They are forecast to continue to increase gradually by IBISWorld (chart 2.2).

5 ABS 2012, 5215.055001 Australian National Accounts: Input-Output Tables (Product Details) - 2008-09; IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May.

2.2 Trends in revenues and value added



Data source: IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May

Information on the share of mobile communications output used by households versus businesses is available from a number of sources, suggesting different outcomes. We have used ABS data in the construction of the economic model, as this data involves cross-checking responses of sellers and buyers and also provides the sectoral level of detail. It is likely that industry does not know whether small customers are business or household customers and in this case mobile operators have categorised customers as households and understated the business share. The share of business use in the CIE's modelling declines from 58 per cent in 2005/06 to 28 per cent in 2012/13, as business responds less to the falling prices than do households.[6]

The share of mobile communications output to businesses for 2013 ranges from 25 per cent to 34 per cent, depending on the source (table 2.3).

2.3 Household and business use of mobile communications

Users	CIE 2013	ABS 2008/09	IBISWorld 2013	Industry data 2013
	Per cent	Per cent	Per cent	Per cent
Households	70.0	41.7	66.0	74.7
Businesses	28.0	55.8	34.0	25.0
Other (exports and government)	2.0	2.5	na	0.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: ABS 2012, 5215.055001 Australian National Accounts: Input-Output Tables (Product Details) - 2008-09; IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May; Data from industry; The CIE.

The cost and use structure of mobile communications are set out in Attachment A (A.2).

6 This is an artefact of the economic modelling, as business production functions are less flexible than household demand functions and hence respond less to falling prices for mobile communications.

Rapid growth in mobile data traffic

As shown in chart 2.4, mobile data usage in Australia has been growing steadily since 2011 and is projected by Analysys Mason to increase almost four-fold from 2013 to 2017.[7] We expect total cellular data usage to grow at an annual rate of 38 per cent from an estimated monthly average of 22.2 petabytes in 2013 to 81.1 petabytes in 2017, constituting a 265 per cent increase over this period.[8]

We expect rapid growth in 4G data traffic with an annual growth rate of 76 per cent for 2013-2017, resulting in an 866 percent traffic increase over the period.[9] At the same time, we expect 3G data traffic to level off in 2014 and then decline as users migrate to 4G devices. Hence, we predict a 12 per cent annual decline on average between 2013 and 2017 for 3G data traffic, resulting in a 41 per cent decline over the period.

We do not consider it likely that 2G voicephones[10] will contribute noticeably to aggregate mobile data traffic because of their inherent technological limitations. For 2013 we estimate the average data usage for voicephones to be just 0.06MB per month per phone.[11] Equally, we do not expect machine-to-machine (M2M) connections[12] to generate significant mobile data traffic between 2013 and 2017 despite our projections of a rapid increase in M2M connections for applications such as smart metering, connected alarms and security sensors, commercial vehicle tracking and emergency reporting systems for cars (see M2M penetration in chart 2.6). Excluding the commercialisation of

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7 Source for data traffic forecast: Analysys Mason spectrum demand model for the ACMA based on data provided by operators (2013). Total traffic levels have been validated against the Internet Activity reports prepared by the Australian Bureau of Statistics (ABS Cat No. 8153.0).

8 The latest ABS Internet Activity report for the quarter ending 30 June 2013 records a 3 per cent fall in mobile broadband traffic (excluding handset traffic) compared to the quarter ending 31 December 2012 although handset data traffic increased by 43 per cent. The fall in mobile broadband traffic may be a temporary decline since previous reports have shown a strong upward trend, but if continued the monthly average for 2013 is likely to be lower than we have forecast.

9 3G and 4G devices include smartphones, mid-screen devices and large-screen devices. Mid-screen devices have cellular broadband access independent of netbooks, notebooks, PCs or laptops. The category consists principally of tablets, but also includes eReaders, connected games consoles and cameras. Smartphones are sophisticated cellular phones with PC-characteristics (including high-quality large screens, large memories and fast processors). Lastly, large-screen devices (dongles) are used to access cellular broadband services via netbooks, notebooks, PCs or laptops (including cellular broadband USB modems and integrated PC chipsets).

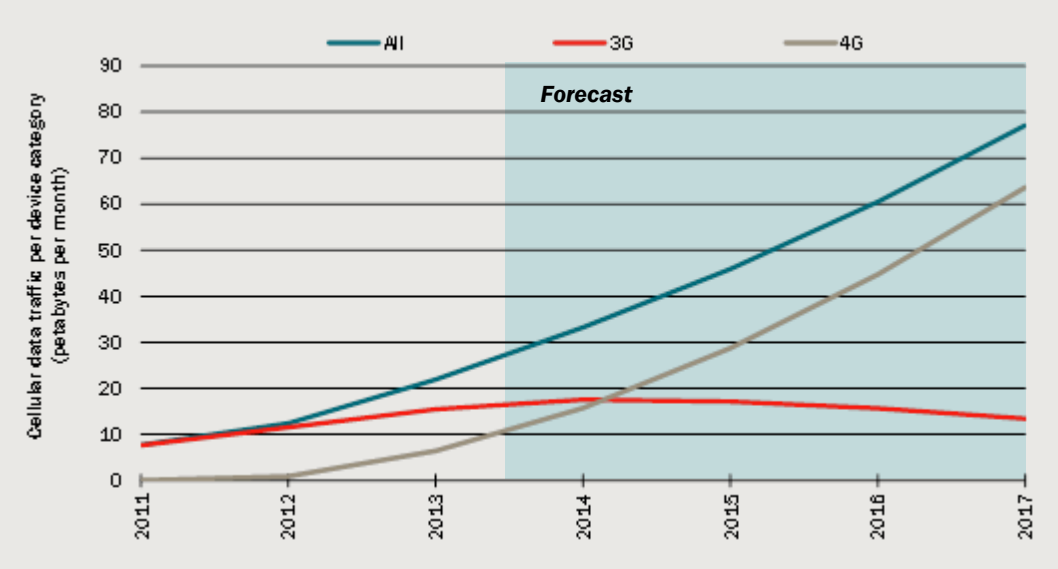
10 Definition of "voicephones" according to Analysys Mason Research: 2G cellular phones capable of supporting voice and basic data services, such as messaging and some, albeit very limited, browsing

11 Preliminary internal update (August 2013) of the following report by Analysys Mason Research: "Wireless network traffic worldwide: forecasts and analysis 2012–2017" (September 2012), available at http://www.analysysmason.com/Research/Content/Reports/wirless-network-forecasts-Sep2012-RDRK0/#06%20September%202012

12 Definition of "M2M devices" according to Analysys Mason Research: Devices that are used to transfer data from one machine to another

radical new device technologies, it is unlikely that M2M connections will account for a significant proportion of total data traffic in the next decade.

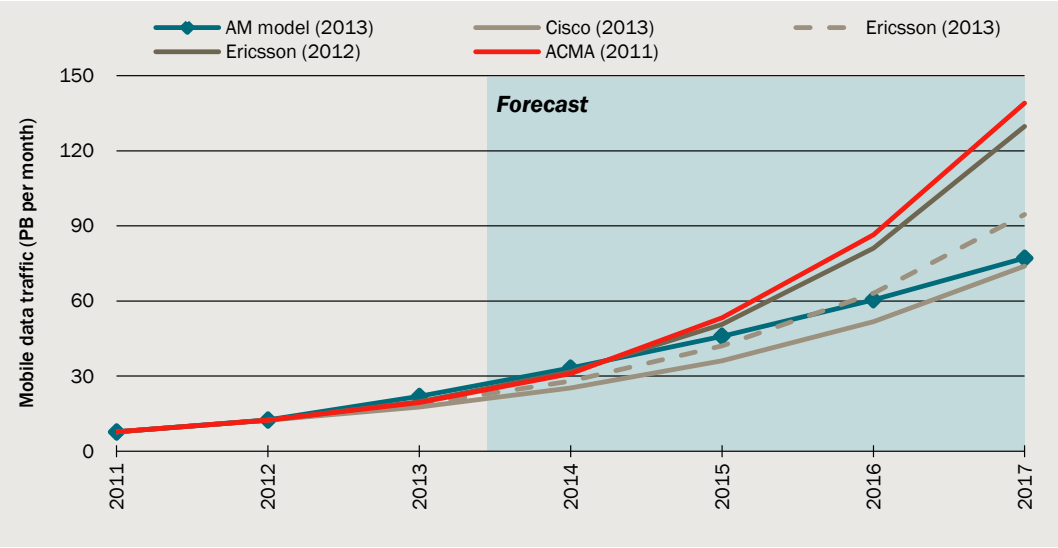
2.4 Total monthly cellular data traffic by device type



Data source: Analysys Mason, 2013

Chart 2.5 shows that our mobile data growth estimate is broadly in line with other recent forecasts – in particular the 2013 "VNI Mobile Forecast" from Cisco and Ericsson's 2013 "Mobility Report, although somewhat lower than forecasts from 2011 and 2012.

2.5 Overview of mobile data growth scenarios



Data source: Analysys Mason, Cisco, Australian Secretariat of the Parliamentary Joint Committee on Law Enforcement, 2013; Ericsson, 2012; ACMA, 2011

Penetration of mobile broadband devices

The numbers of smartphones and tablets (connected mid-screen devices, i.e. those containing a SIM card) in Australia are forecast to increase substantially over the next five years, constituting a major driver of mobile data traffic growth.[13]

The overall population penetration of mobile phone devices (i.e. the total penetration of 3G and 4G smartphones plus 2G voicephones) has remained relatively stable at just above 100 per cent since 2011 and we predict this to remain the case until 2017 (see chart 2.6).[14] However, we predict the proportion of smartphones will increase from an average of 78 per cent in 2013 to a saturation level of around 91 per cent in 2017. At the same time, we estimate voicephone penetration to fall from an annual average of 24 per cent in 2013 and level off at around 11 per cent in 2017.[15]

We expect the penetration of mobile broadband (MBB) devices to stabilise at approximately 35 per cent in 2017 (see chart 2.6). This is due to an increase in the penetration of tablets from 6 per cent in 2013 to 19 per cent in 2017. The penetration of large-screen devices with dongles or in-built MBB modems is expected to remain stable at 16 per cent.

We believe that the number of large-screen MBB connections has been static since 2012 and is unlikely to increase in the future due to a combination of increasing Wi-Fi coverage, the growing acceptance of smartphone tethering as an alternative to using a dongle or Mi-Fi router and improvements in fixed broadband speeds resulting from the roll out of the National Broadband Network (NBN).[16]

Lastly, penetration of machine-to-machine (M2M) devices is expected to increase very strongly from 7.4 per cent in 2013 to 18.1 per cent in 2017. This constitutes the greatest change in any of the device penetration rates. However, as discussed above, current M2M mobile data traffic per connection is negligible and we do not expect M2M devices to have much impact on overall traffic volumes in the near future.[17]

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13 Source for all Australian mobile device penetration forecasts unless otherwise specified: Analysys Mason spectrum demand model for the ACMA based on data provided by operators (2013)

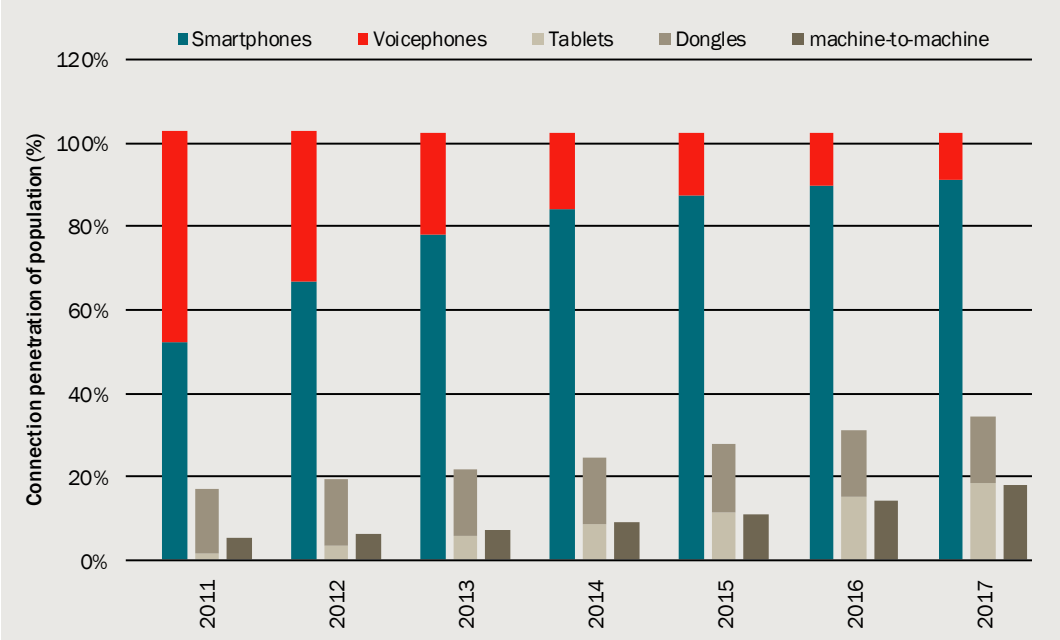
14 Penetration has been relatively stable over the past 3 years, suggesting a plateau has been reached in terms of handset penetration.

15 For the avoidance of doubt, penetration is defined as connections divided by population unless otherwise specified.

16 Information on fixed-mobile substitution and the National Broadband Network: Data published by the Australian Department of Broadband, Communications and Digital Economy (2013), available at http://www.nbn.gov.au/

17 Source for M2M penetration forecasts: Analysys Mason Research, "Wireless network traffic worldwide: forecasts and analysis 2012–2017" (September 2012), available on the Analysys Mason Knowledge Centre

2.6 Average annual population penetration of connections by device type



Data source: Analysys Mason, 2013

2.7 Annual average connections by device type

	Unit	2011	2012	2013	2014	2015	2016	2017
All phones	Millions	23.0	23.4	23.6	24.0	24.3	24.7	25.1
Voicephones	Millions	11.3	8.2	5.6	4.2	3.5	3.0	2.7
Smartphones	Millions	11.7	15.1	18.0	19.7	20.8	21.7	22.3
All MBB devices	Millions	3.8	4.5	5.0	5.7	6.6	7.5	8.5
Mid–screen devices	Millions	0.4	0.8	1.3	2.0	2.8	3.7	4.6
Large–screen devices	Millions	3.5	3.7	3.7	3.8	3.8	3.9	3.9
Machine–to–machine	Millions	1.2	1.4	1.7	2.1	2.7	3.4	4.4

Source: Analysys Mason, 2013

Mobile data usage per device is also rising

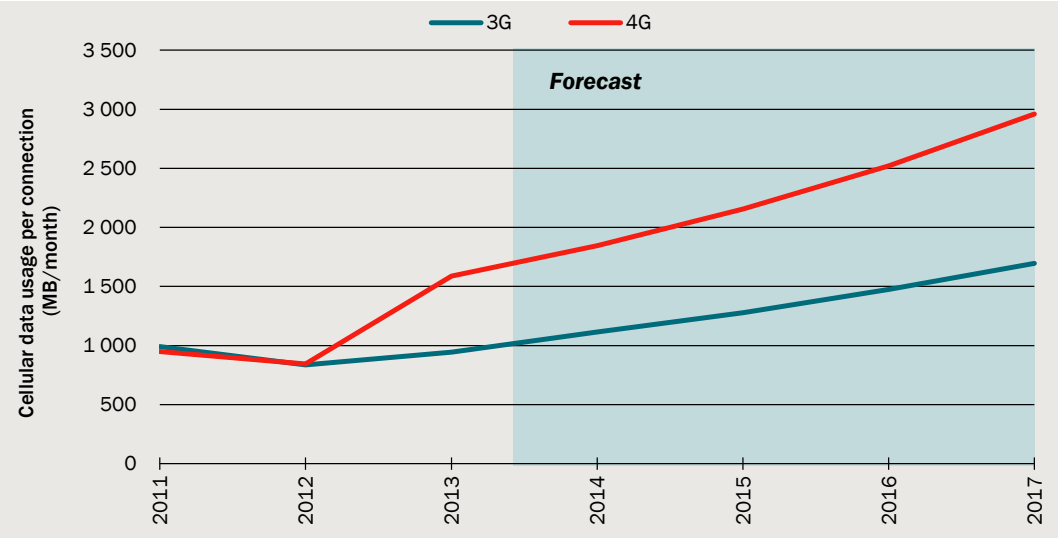
Chart 2.8 shows trends and forecasts for cellular data usage per connection.[18] It indicates that mobile data usage for 3G and 4G devices is set to increase markedly over the next five years, contributing to overall mobile data traffic growth.

We believe that the average usage per device for 4G devices is considerably higher than for 3G devices (see chart 2.8) but note figures for 2011 and 2012 are distorted by the fact that 4G coverage and the penetration of 4G devices were both very low prior to 2013. We estimate that 4G devices will use an average of 1.7GB per month in 2013 and we

18 Source for usage levels per device: Analysys Mason spectrum demand model for the ACMA based on data provided by operators (2013)

expect this to grow at an annual rate of 15 per cent, reaching 3GB per connection per month in 2017 (an increase of 78 per cent over the period). 3G data usage per device is expected to grow at an annual rate of 15 per cent between 2013 and 2017. As a result, we forecast that the average monthly mobile data usage of 3G devices will increase from an estimated 1GB per connection per month in 2013 to 1.7GB in 2017 (an increase of 73 per cent over the period).

2.8 Cellular data traffic per connection per month



Data source: Analysys Mason, 2012

Business use of mobile data

Cisco estimates the share of mobile data usage attributable to business was 28 per cent in 2012. It sees this share falling to 26 per cent by 2017.[19] Such a low share of mobile data traffic is plausible given that business users tend not to consume a lot of data-intensive video content and there is very little substitution by businesses from fixed broadband to mobile broadband.

Chart 2.9 uses these point estimates by Cisco for 2012 and 2017 in combination with the mobile data forecast by Analysys Mason to illustrate the growth of business and private mobile data traffic until 2017.[20] To generate a complete time series, chart 2.9 applies the same share of mobile data traffic attributable to business customers in 2011 as in 2012 and assumes that this share decreases in a linear fashion between 2012 and 2017.

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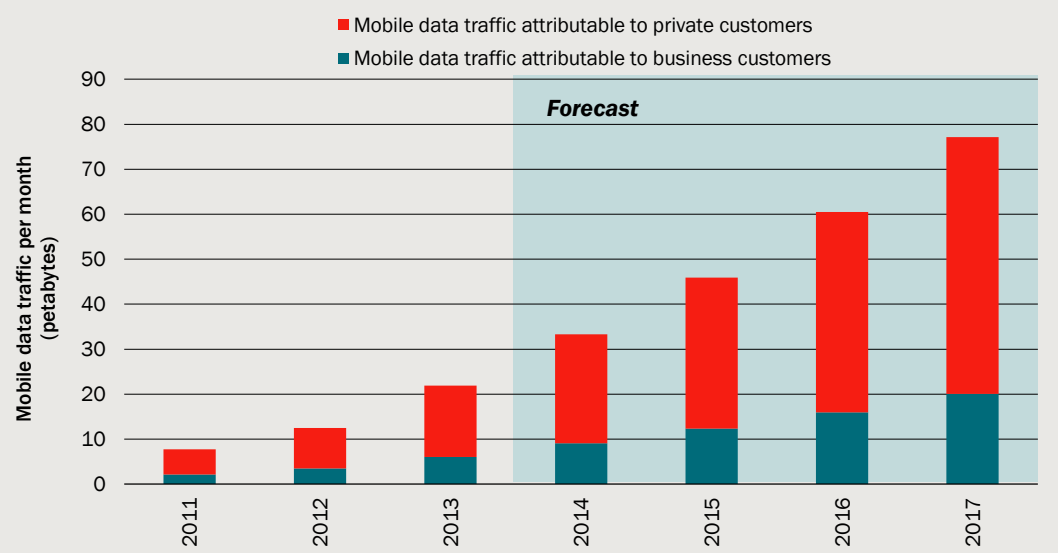
19 Cisco Systems, "Visual Networking Index (VNI) Mobile Forecast Highlights, 2012-2017" (27.08.2013), available at: http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html#~Country

20 Source for traffic forecast: Analysys Mason spectrum demand model for the ACMA based on data provided by operators (2013)

Total mobile traffic attributable to business customers can be expected to increase to about 20 petabytes per month in 2017. This constitutes a 231 per cent increase from its estimated 2013 value of 6.1 petabytes. By contrast, private mobile data traffic is likely to increase to 57 petabytes per month in 2017, which represents a 260 per cent increase from its 2013 value of 16 petabytes.

2.9 Mobile data traffic attributable to business and private customers respectively



Data source: Analysys Mason based on Cisco data, 2013

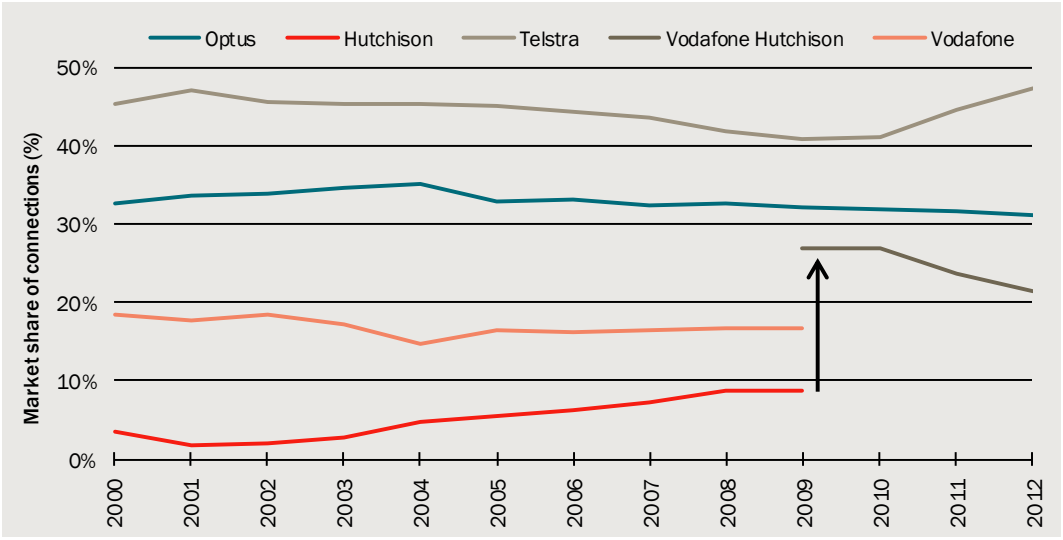
3 Market structure

Market shares

The Australian mobile market currently contains three facilities-based mobile network operators: Optus (SingTel), Telstra and Vodafone Hutchinson Australia (VHA).[21] Of these, Telstra is the largest player and has further expanded its market share since 2009, gaining nearly 10 percentage points largely at the expense of Vodafone Hutchison (see chart 3.1). This appears to have mainly been driven by past network quality issues for VHA. The second largest operator, Optus, has seen its market share erode gradually over the last 10 years. Following the merger of Hutchison 3G Australia (H3G) and Vodafone Australia in June 2009, the 50/50 joint venture VHA has lost market share over the last three years.[22]

The merger of Hutchison and Vodafone in 2009 created three players of similar size (see chart 3.1). However, since 2010 the stratification of the market has increased again with Telstra gaining nearly 7 percentage points and Optus and – in particular – VHA losing ground.[23]

3.1 Market shares in Australia measured as an operator's share of total connections, which are defined as unique SIM cards



Data source: Analysys Mason, based on GSMA Intelligence, 2013

21 Market shares in chart 3.1 are calculated as an operator's total connections over the sum of all operators' total connections. A connection is defined as a unique SIM card (or phone number, where SIM cards are not used) that has been registered on an operator's mobile network at the end of a given period.

22 Source for market share information: GSMA Intelligence (2013)

23 Source for market share information: GSMA Intelligence (2013)

Overview of spectrum holdings

In Australia some mobile spectrum bands have been awarded on a national basis while others have been awarded on a regional basis. Moreover, there are two different licensing regimes in operation: "spectrum licensing" and "apparatus licensing". There are important technical differences between these two types of licence but both enable mobile operators to provide services to their customers so we make no distinction between them here.

The operators' current spectrum holdings are summarised in table 3.2.

3.2 Summary of mobile operators' spectrum holdings

Band	Optus	Telstra	VHA	Notes
700MHz	2x10MHz national	2x20MHz national	-	Available from 2015
850MHz	-	2x10MHz national + additional 2x5MHz outside largest 5 cities	2x5MHz national + additional 2x5MHz in largest 5 cities	
900MHz	2x8.4MHz national	2x8.4MHz national	2x8.2MHz national	
1800MHz	2x15MHz in largest 5 cities + small number of regional licences	2x20MHz in Adelaide, Brisbane and Perth, 2x15MHz in Melbourne and Sydney, 2x10MHz in Cairns, Canberra and Hobart, 2x12.5MHz to 2x15MHz in regional areas	2x30MHz in Melbourne and Sydney, 2x25MHz in Adelaide, Brisbane and Perth, 2x5MHz in Canberra, Darwin and Hobart	
1900MHz	5MHz in metro areas	10MHz in metro areas	5MHz in main capital cities	Not currently used (no equipment ecosystem)
2GHz	2x20MHz in metro areas, 2x15MHz in regional areas and 2x10MHz in remote areas	2x15MHz in metro areas, 2x20MHz in regional areas and 2x10MHz in remote areas	2x25MHz in Melbourne and Sydney, 2x20MHz in Adelaide, Brisbane and Perth, 2x10MHz in Canberra, Darwin and Hobart, 2x5MHz in regional areas	
2.3GHz	98MHz in Adelaide, Brisbane and Perth, 91MHz in Melbourne and Sydney, 70MHz in Canberra	-	-	
2.5GHz	2x20MHz national	2x40MHz national	-	

Source: Analysys Mason, 2013.

4 Technology

Technology roll-out

Telstra, Optus and VHA have built a widespread network of 2G and 3G enabled base stations (see map 4.4 and map 4.5). 4G (LTE) technology, by contrast, is still in the process of being rolled out. The first half of 2013 has seen a substantial expansion of 4G networks to cover a significant proportion of Australia's larger towns and cities (see map 4.6).

4G take-up has grown steadily since February 2011 (see chart 4.1), when Telstra first introduced commercial 4G. Telstra has since then rapidly expanded coverage and by the end of 2013 it is aiming to cover 85 per cent of the Australian population. At the same time, Telstra is aiming to expand its LTE services from the 1800MHz to the 900MHz band to improve coverage in rural areas.[24]

Optus similarly launched trial 4G services in April 2012 in Greater Newcastle, Maitland, Port Stephens and areas in the Hunter Valley. In July 2012 Optus then announced it was launching "commercial LTE services for SME and government customers in Sydney and Perth". As of March 2013, Optus was offering commercial 4G services to residential customers in "Sydney, Perth, Newcastle as well as Melbourne, Brisbane, the Gold Coast and Adelaide". Optus has since rapidly expanded its 4G coverage, most recently reaching Wollongong in July 2013. It plans to provide 4G services in "Shellharbour, Kiama, Figtree, Woonona, Maddens Plains, Calderwood, Fern Hill, Unanderra, Port Kembla, West Dapto, Warilla, Shell Cove and Blackbutt" by the end of the 2013.[25] Optus has also launched what it calls 4G plus service (technically TD-LTE using Optus' spectrum allocation in the 2.3GHz band) in Adelaide, Brisbane, Canberra, Melbourne and Sydney.[26]

VHA experimented with 4G technology in 2010; further, in response to the launch of LTE services by Optus and Telstra, it introduced trial 4G services in Sydney in 2012 for existing customers with 4G-compatible devices. In July 2013, VHA then started offering commercial 4G services in "Sydney, Perth, Melbourne, Adelaide, Brisbane, Newcastle and

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24 Source for 4G development in Australia: Telegeography (2013); see in particular Telegeography (2 May 2013), available at http://www.telegeography.com/products/commsupdate/articles/2013/05/02/telstra-4g-subs-hit-2-1mn-as-network-rollout-continues-apace/

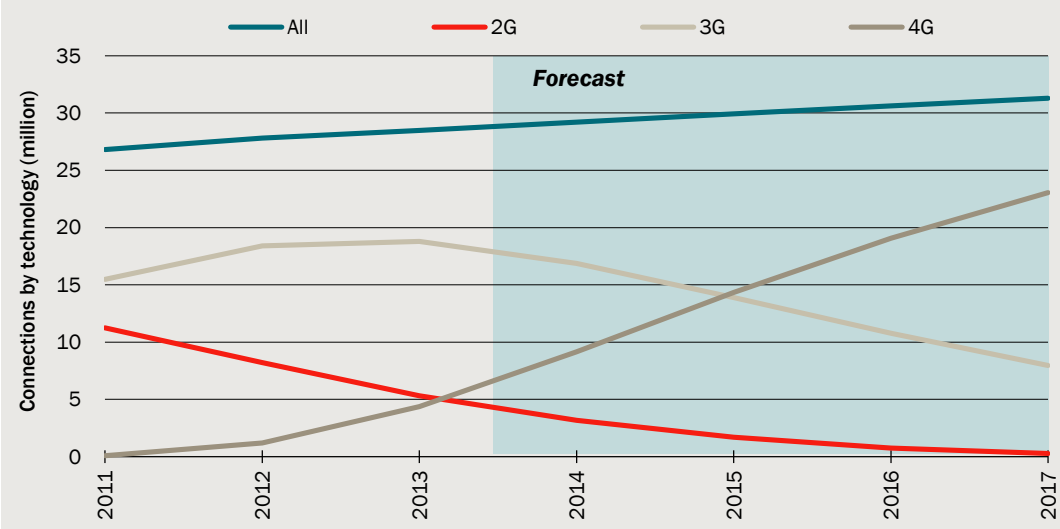
25 Source for 4G development in Australia: Telegeography (2013); see in particular Telegeography (10 July 2013), available at http://www.telegeography.com/products/commsupdate/articles/2013/07/10/optus-launches-4g-in-wollongong/

26 Source: Optus press release, available at http://www.optus.com.au/aboutoptus/About+Optus/Media+Centre/Media+Releases/2013/What%27s+better+than+one+fast+4G+network-two+fast+4G+networks

Wollongong". VHA has claimed that its LTE speeds are superior to those of Telstra and Optus because it owns "2×20MHz of contiguous spectrum in the 1800MHz band".[27]

All three operators now offer 4G services and continue to expand their coverage. This indicates that 4G connections are likely to grow strongly over the coming years, though they are currently still at a low base in comparison to 3G (see chart 4.1).[28]

4.1 Evolution of connections by 2G, 3G and 4G technology (excluding M2M)



Data source: Analysys Mason, 2013

The difference in the current number of connections by technology evident in chart 4.1 is also reflected in the number of physical base stations using 2G, 3G and 4G. As shown in table 4.2, 3G enabled base stations (83 per cent of all base stations) exceed 2G base stations (only 60 per cent of total base stations). Only 16 per cent of base stations have 4G technology, underscoring the scope for the future expansion in the 4G network. These differences are also evident in map 4.4, map 4.5 and map 4.6, which demonstrate the geographic range of 2G, 3G and 4G base stations as of August 2013.

27 Source for 4G development in Australia: Telegeography; see in particular Telegeography (10 July 2013), available at http://www.telegeography.com/products/commsupdate/articles/2013/07/10/vodafone-australia-removes-restriction-on-4g-sign-ups/

28 Source for connections forecast: Analysys Mason spectrum demand model for the ACMA based on data provided by operators (2013)

4.2 Number of physical base stations per technology generation as of August 2013

Technology generation	Number of base stations with equipment	Percentage of the total number of base stations
		Per cent
2G	9 304	60
3G	13 003	83
4G	2 427	16

Source: Analysys Mason based on ACMA data and technology allocation rules, 2013 [29]

The numbers displayed in table 4.2 are not directly available from the ACMA's database. Instead, we used a set of assumptions – approved by the ACMA – to infer what equipment (2G, 3G, 4G or any combination thereof) is most likely installed at each base station, as follows.

As a first step, the type of equipment present at any given site was deduced from the spectrum bands used at that site following the ACMA information in table 4.3. This is unambiguous for the 800MHz and 2000MHz bands, as these have been identified by the ACMA as being used exclusively for 3G at the present time by the three major mobile communications operators.

4.3 Spread of technology generations across spectrum bands

Spectrum band	2G technology	3G technology	4G technology
800MHz	-	Yes	-
900MHz	Yes	Yes	-[30]
1800MHz	Yes	-	Yes
2000MHz	-	Yes	-

Source: Analysys Mason based on ACMA guidelines, 2013 [31]

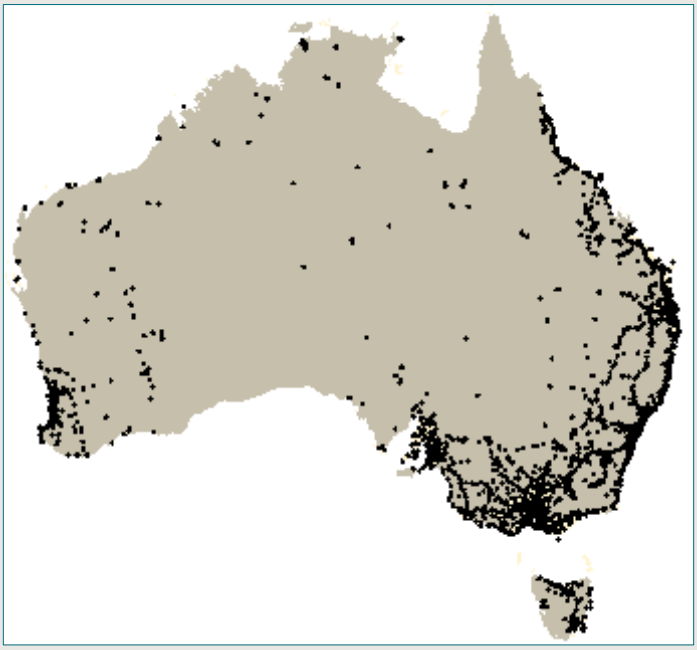
For equipment in the 1800MHz and 900MHz bands, we then use the "emission designators" associated with each site to discriminate between 4G equipment, which uses several unique codes, and 2G or 3G equipment. Lastly, we use the spectrum bandwidth assigned to each site using the 900MHz band to determine whether it hosts 3G (from 3.84MHz to 5MHz of bandwidth, both boundaries included) or 2G equipment (all other bandwidth allocation).

29 Note that a physical base station can serve several technology generations by housing different types of equipment. Hence, the percentages that show the share of base stations servicing each technology exceed 100 per cent.

30 Small scale trials of 4G in the 900MHz and 2GHz bands were not taken into consideration

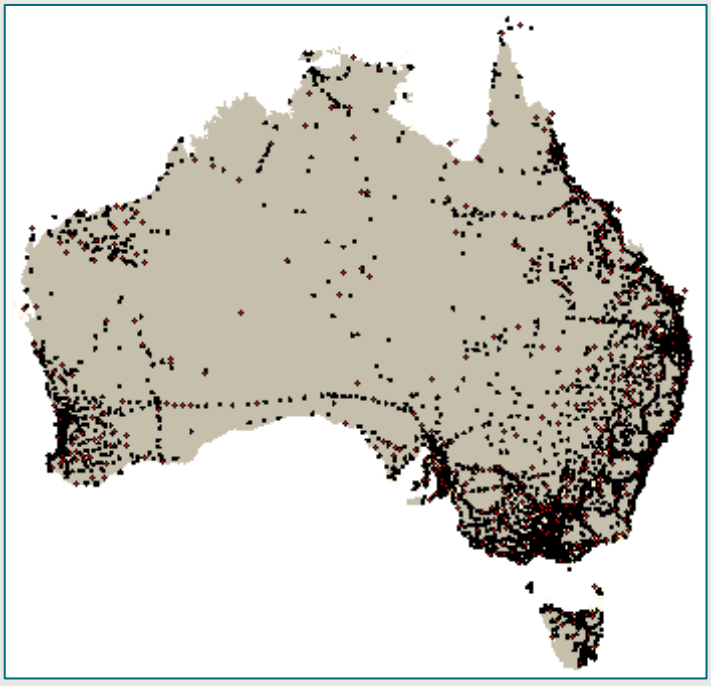
31 As suggested by the ACMA, we use the terms "800MHz band" and "2000MHz band" throughout this document to refer to what are more commonly known as the "850MHz band" and the "2100 MHz band".

4.4 2G base station for all operators across Australia as of August 2013



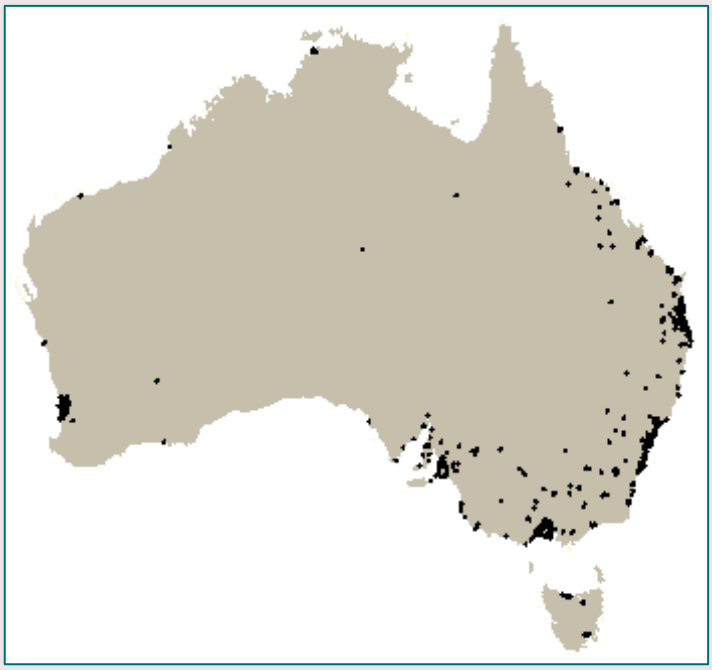
Data source: Analysys Mason, based on ACMA data, 2013

4.5 3G base station for all operators across Australia as of August 2013



Data source: Analysys Mason, based on ACMA data, 2013

4.6 4G base stations for all operators across Australia as of August 2013



Data source: Analysys Mason, based on ACMA data, 2013

PART 2

Economic impacts of mobile broadband

5 Approach

The rapid uptake of mobile broadband by households and businesses is an indication that households and businesses place significant value on it. This value can be measured through the economic changes that mobile broadband causes. These economic changes can be segmented into three categories.

1 The economic value as the mobile sector becomes more productive. That is, as the mobile sector produces more outputs for each input, this leads to either additional value to producers (profit or producer surplus) or additional value to households and businesses (consumer surplus).

2 The economic value created as use of mobile services enables businesses to become more productive. Similar to other general purpose technologies such as ICT and broadband, mobile broadband enables businesses to do things in different ways that can reduce costs and increase output. This allows them to create additional economic value or to free up resources to be used to produce other goods and services.

3 The economic value created for households as use of a given amount of mobile broadband becomes more valuable, such as because there is a greater variety of content or applications that can be used. This is additional 'consumer surplus' that is not reflected in measures of economic activity. Because of the uncertainty around this estimate, we do not include it in aggregated estimated impacts. Attachment D sets out an approach and a range of estimates for this additional value from higher quality.

Our approach seeks to measure each of these aspects of mobile broadband. This involves first understanding the direct impacts in each of these categories. These are the types of impacts that would typically be considered in benefit cost analysis.[32] We take this one step further and consider how these immediate changes flow around the Australian economy. This allows for us to measure aggregate and sectoral economic impacts arising from the changes wrought by the mobile broadband sector.

In each chapter below we set out in detail the approach to measuring the economic impacts of the mobile broadband sector for the first two categories of impact and the resulting economy-wide impacts.

32 Note that benefit cost analysis would be undertaken generally for a particular government policy. In this case the impacts of the policy would be traced through these channels.

6 *Productivity impacts within the mobile telecommunications sector*

The mobile telecommunications sector has achieved dramatic productivity growth in recent years. From 2006 to 2013, it has increased its outputs by 12.9 per cent each year while requiring an increase in inputs of only 1.5 per cent per year. In the later part of this period, this has particularly reflected the impact of mobile broadband.

Approach

We measure the productivity of the mobile telecommunications sector as the ratio of the outputs of the sector to the inputs of the sector. The outputs and inputs used in this analysis are set out in table 6.1. We have accounted for changes in the amount of voice minutes and data used on mobile devices. Our productivity estimates are likely to be conservative as we have not accounted for changes in the quality of networks or quality of handsets.[33]

6.1 Outputs and inputs of the mobile sector

Output	Source
Number of connections	GSM Association
Voice minutes originating on mobile network	Analysys Mason estimates for 2007 to 2012, industry data for 2006 and 2013
Data usage on mobile network	Analysys Mason for 2011 to 2013. Industry data for 2006 to 2010

Input	Source
Number of people employed	IBISWorld
Volume of intermediate inputs	IBISWorld intermediate inputs in nominal dollars divided by the ABS Producer Price Index for intermediate inputs (domestic and imported)
Volume of capital [a]	IBISWorld value added share for capital in nominal dollars divided by the ABS capital index for telecommunications

[a] We have information only on the capital share of value added rather than the stock of capital. We therefore use the value added share of capital as a proxy for the stock of capital, which implies a constant depreciation rate and return on capital over time for the industry, as discussed further below.

Source: As noted in table; The CIE.

33 Note that improvements in handset quality are largely a productivity improvement outside of Australia, as Australia does not manufacture mobile handsets.

Estimating input and output weights

To construct an index of outputs and an index of inputs requires weights to be used to aggregate the inputs and output in table 6.1. To construct input weights we use cost shares for 2013. Constructing output weights is more complex. We:

- estimate how different characteristics of products offered by Telstra, Optus and Vodafone change the prices of the products offered;
- apply weights to connections, voice minutes and data downloaded based on this analysis;[34] and
- develop output shares by multiplying the factors by the amount of each output.

Estimating value of characteristics of mobile communications products

Mobile communications products are typically sold as a bundle. This bundle can include:

- a handset, which have different attributes (such as camera and software);
- a connection to a network through a SIM card;
- an amount of voice minutes that can be used before additional charges apply; and
- an amount of data that can be used before additional charges apply.

Hedonic pricing seeks to disentangle a price attributable to each of these characteristics from a bundled price.[35] Once we have a derived price for each attribute we can then construct a measure of the revenue shares for each output. Hedonic pricing is used by some statistical agencies for estimating price indices where data is available.[36] For example, the ABS uses a hedonic pricing regression model for desktop computers.[37]

To disentangle the prices of the attributes of mobile communications, we use data collected by Analysys Mason on the prices and attributes of 19 mobile communication plans on offer from Telstra, Vodafone and Optus (see Attachment B). We undertake ordinary least squares regression of the price of these offers against:

- the maximum voice minutes included in the bundle;
- the maximum data usage included in the bundle;
- whether or not a handset is included; and
- dummy variables for each company offering products, which takes a value of one for the company and zero for other companies.

The results of this regression are set out in table 6.2. This indicates that:

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34 Note that this is equivalent to dividing revenue by a price index constructed for mobile outputs.

35 For a discussion of hedonic pricing see Rosen, S 1974, "Hedonic prices and implicit markets: Product differentiation in pure competition", *The Journal of Political Economy,* Vol. 82, Issue 1, pp 34-55.

36 ABS 2011, *Consumer price index: concepts, sources and methods*, Catalogue Number 6461.0, p. 32 contains a discussion of alternative methods to account for quality change.

37 For a discussion of the use of regression to generate hedonic pricing see ABS 2008, *Reviewing the ABS's hedonic regression model for desktop computers,* Catalogue No., 1352,0, Research Paper.

- a product from Vodafone has a fixed cost of $5.8 per month, Optus $11.9 ($5.8 + $6.1) and Telstra $15.7 ($5.8 + $9.9) — the different prices presumably reflect consumer perceptions of network quality and coverage available;
- a handset costs an additional $18.2 per month;
- each 100 minutes of free monthly voice minutes costs $4.8; and
- each 1000MB of free monthly data costs $5.4.

6.2 Analysis of product offers

	Coefficient	Standard Error
Connection with Vodafone	5.8	4.0
Additional for Telstra	9.9	3.4
Additional for Optus	6.1	3.1
Handset	18.3	3.3
Voice minute (per 100 mins free monthly)	4.8	0.4
Per monthly data allowance (1000MB)	5.4	1.0

Note: Adjusted R2 is 87 per cent. There are 19 observations in the sample.
Source: The CIE.

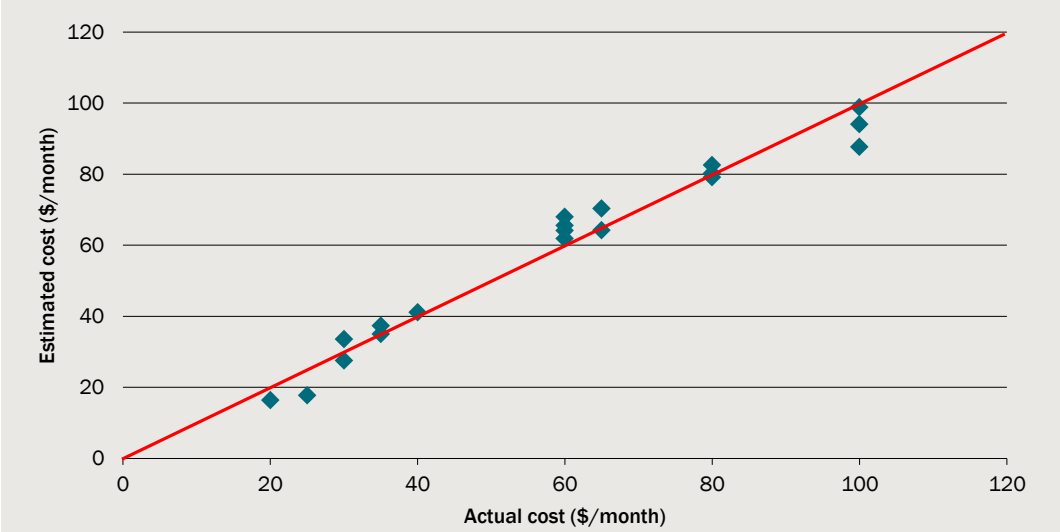
The standard errors around estimates are relatively small, particularly given the small sample size (table 6.2). For example, the standard error for the price per 1000MB of monthly data allowance is 1.0. This means that we can be 95 per cent confident that the estimate lies between $3.2 and $7.6.[38] In chart 6.3 we also show the fit between actual monthly prices and estimated prices. Our simple model does a good job of fitting the price data.

The calculated prices associated with each product are limited in that they rely on 19 pricing plans of the three telecommunications carriers (Telstra, Optus and VHA) from a single point in time. The estimated output growth is robust to considering removing one observation, that could be considered to be an outlier.[39] The estimates could change if further observations are added, such as from resellers, or if this is analysed over multiple periods of time. For instance, it is possible that unit costs of providing each of the different outputs have changed over time and that weights could also then be changing through time.

38 For our sample size, the lower bound and upper bound of a 95 per cent confidence interval are equal to the coefficient ± 2.16 multiplied by the standard error.

39 This reduces the coefficient for Telstra to a level similar to Optus and makes both coefficients statistically significant at the 95 per cent confidence level.

6.3 Comparison of actual and estimated costs



Data source: The CIE.

Calculating output shares

To calculate output shares, we convert the prices per unit into revenue shares for 2013. This involves:

- calculating a unit cost per connection, which reflects:
  - multiplying the unit prices for Telstra, Optus and Vodafone connections by their relevant market shares for 2013;
  - multiplying the handset unit price by the share of connections that include a handset. This is estimated at 73 per cent of connections using Analysys Mason datasets;
- calculating a unit cost per 100 voice minute used — the price we have obtained is per voice minute allowed. Because many users do not use their full allowance the price is higher per 100 voice minutes used; and
- calculating a unit cost per 1000MB of data used — the price we have obtained is per 1000MB of data allowed. Because many users do not use their full allowance the price is higher per 1000MB of data used.

To make the adjustment from voice/data allowed to voice/data used we calibrate the unit costs so that total revenue from output unit prices matches total revenue indicated by IBISWorld for 2013 of $19.8 billion. This indicates that users are on average using only about 35 per cent of their voice and data allowed and hence the price per actual minute/MB use is around three times that per allowed minute/MB.

We then apply these unit costs to 2013 numbers of connections, voice minutes and data use to generate revenue shares (table 6.4). The output weights developed through our approach give the most weight to the connection (47.4 per cent), second-most to voice minutes (34.0 per cent) and lowest weight to data used (18.5 per cent).

6.4 Calculating output shares

Item	Connections	Voice minutes per month	Data per month
Amount of output 2013	30.7 million	4 146 million minutes per month	19 786 million MB per month
Unit revenues for each output ($/connection/month)	25.5	13.5	15.4
Total revenue ($m 2013 per month)	783	562	306
Revenue share (per cent)	47.4	34.0	18.5
IBISWorld product share	13.0	44.5	42.5

Note: Unit revenues are from the statistical analysis. The voice minutes and data are actual usage and the statistical analysis is allowed maximum usage. To align these we used a factor of people using 35 per cent of allowed, which generates monthly revenue equivalent to that reported by IBISWorld for 2013 for mobile telecommunications.
Source: The CIE; IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May.

One comparator to the weights that we have used is IBISWorld product category weights (also shown in table 6.4). IBISWorld product categories show larger weights for voice and data than our method. Because voice and data have grown more quickly than the number of connections, this means that the estimated increase in outputs would be larger using IBISWorld weights compared to our constructed weights.

The data underlying the IBISWorld product segments is not known to us. For this reason, and because our approach provides a more conservative view of productivity growth, we use the output weights obtained from the hedonic regression above.

Input and output weights used

The resulting input and output weights are set out in table 6.5. These weights are for 2013. Hence we apply these weights to indices for each output and input that are equal to 100 in 2013.[40]

6.5 Output and input weights

Output	Weight
Number of connections	47.4
Voice minutes originating on mobile network	34.0
Data usage on mobile network	18.5
Total	**100.0**

Input	Weight
Number of people employed	7.8
Volume of intermediate inputs	65.7
Volume of capital	26.4
Total	**100.0**

Note: Numbers may not add due to rounding.
Source: The CIE.

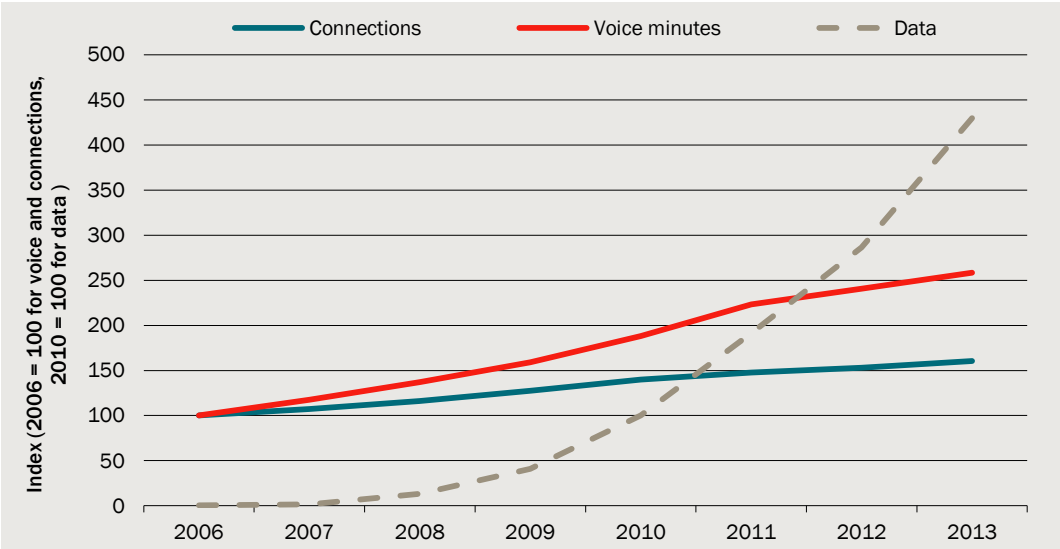
40 The input and output indices are constructed as $I^t_{All} = \sum_j I^t_j . w_j$ where t is each year, I is the index (for all and for each component j) and w are the weights.

Changes in outputs of the mobile sector

Data on outputs of the mobile sector has been provided to us by Telstra, Optus and Vodafone. We have also sourced data from collections from trade associations such as the GSMA.

Outputs of the mobile sector have risen rapidly from 2006 to 2013 (chart 6.6). Connections have risen by more than 50 per cent, voice minutes have risen by more than 150 per cent and data has risen by almost 1000-fold (from almost nothing in 2006).[41]

6.6 Outputs of the mobile sector 2006 to 2013

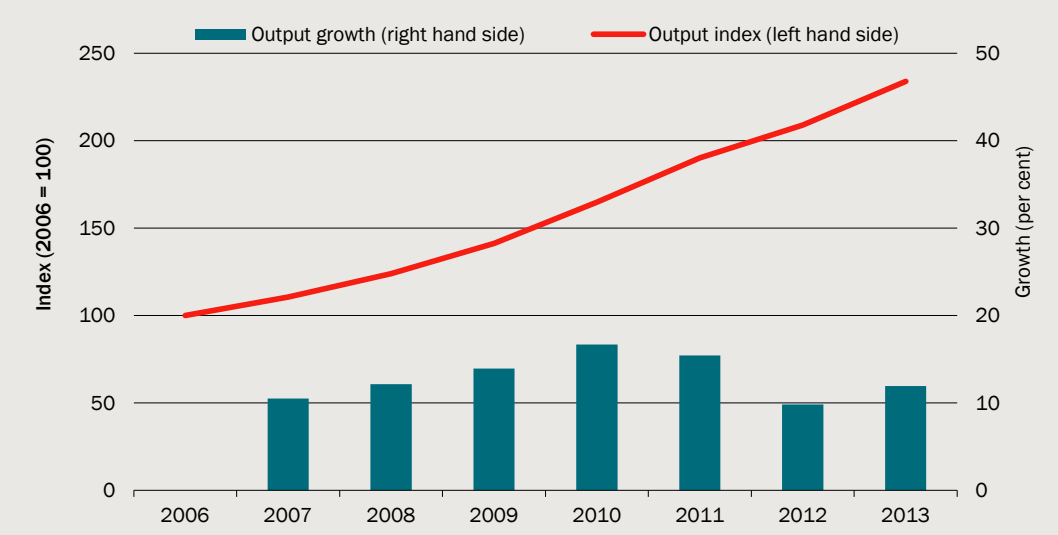


Data source: Analysys Mason; The CIE.

The weighted average outputs of the mobile sector are shown in chart 6.7. Output growth has averaged 12.9 per cent per year from 2006 to 2013 and outputs have more than doubled from 2006 to 2013.

41 Data is reported with an index based on 2010 = 100 in the chart so it is visible.

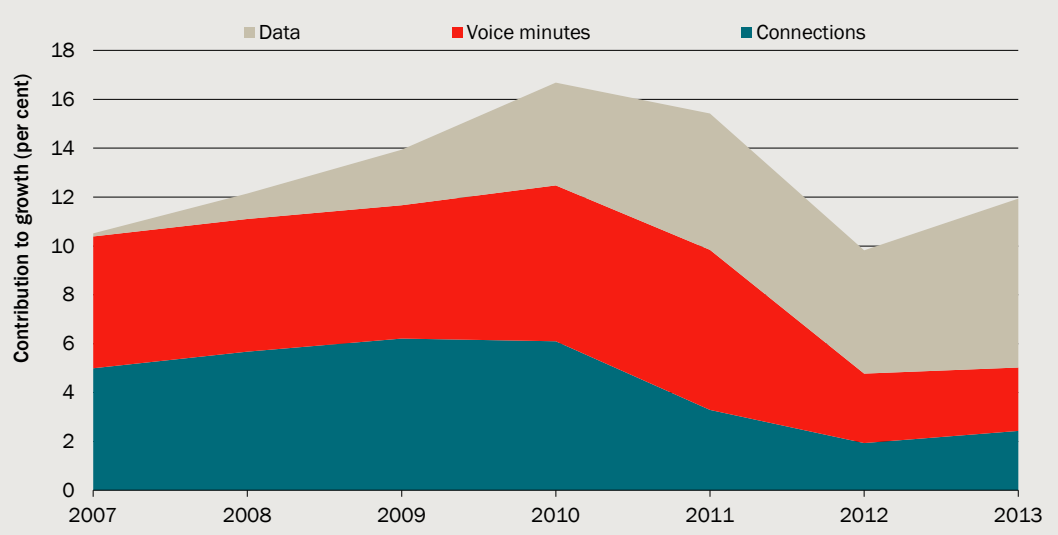
6.7 Aggregate outputs and growth in the mobile communications sector



Data source: The CIE.

Connections, voice minutes and data usage have contributed a similar amount to output growth between 2006 to 2013. However, within this period the contribution has been changing with data contributing over half the output growth in recent periods (chart 6.8)

6.8 Composition of output growth in mobile communications



Data source: The CIE.

Changes in inputs of the mobile communications sector

The inputs of an industry are typically broken into labour inputs, capital inputs and intermediate inputs (such as other goods used in production). We source all input data from IBISWorld. The methods used for each input are as follows.

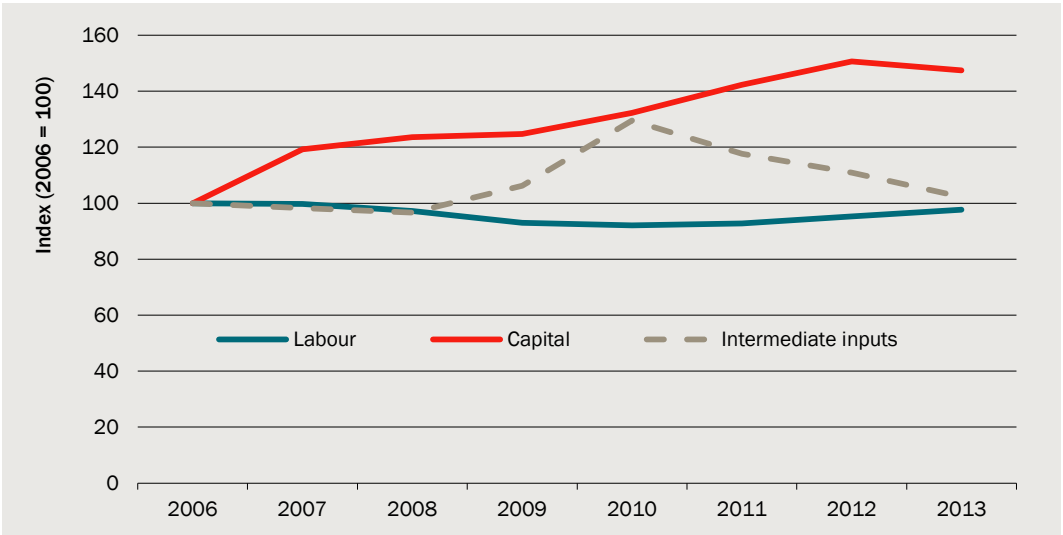
- Labour is measured as the number of people employment in wireless telecommunications from IBISWorld. We do not have data on hours worked (or

quality adjusted hours worked) so use total employment as the best available indicator.

- Intermediate inputs is measured as nominal intermediate inputs (from IBISWorld) purchased by the sector divided by the ABS Producer Price Index for Intermediate Inputs (domestic and imported).
- We do not have a good measure of capital employed in the mobile telecommunications sector. We use the value added attributable to capital for the sector as a proxy for the level of capital employed in the sector. This is calculated as value added of the sector less wages and salaries, both from IBISWorld. The nominal value added is then converted to a real value using the ABS Information, media and telecommunications capital services price index.
  - Our measure of capital is a good proxy if the depreciation rate of the sector's capital and the return on capital have been relatively constant over time — in this case the value added share of capital will remain a constant proportion of the capital stock. And vice versa, the capital measure used will relate less closely to actual capital employed if returns on capital are changing over time or depreciation rates on capital are changing over time.
  - Our measure of capital increases by 60 per cent from 2006 to 2013 in nominal terms. We have information from some businesses on their measured capital stock for mobile communications. This indicates capital increases of 50 per cent over the same period. If this was the same for all businesses, our approach may slightly overstate the growth in the level of capital and hence understate the level of productivity growth.

The growth in inputs into the sector is shown in chart 6.9. Employment and intermediate inputs are similar in 2013 as in 2006. Capital, as measured by our proxy for capital share of value added, has gradually increased over the period in real terms.

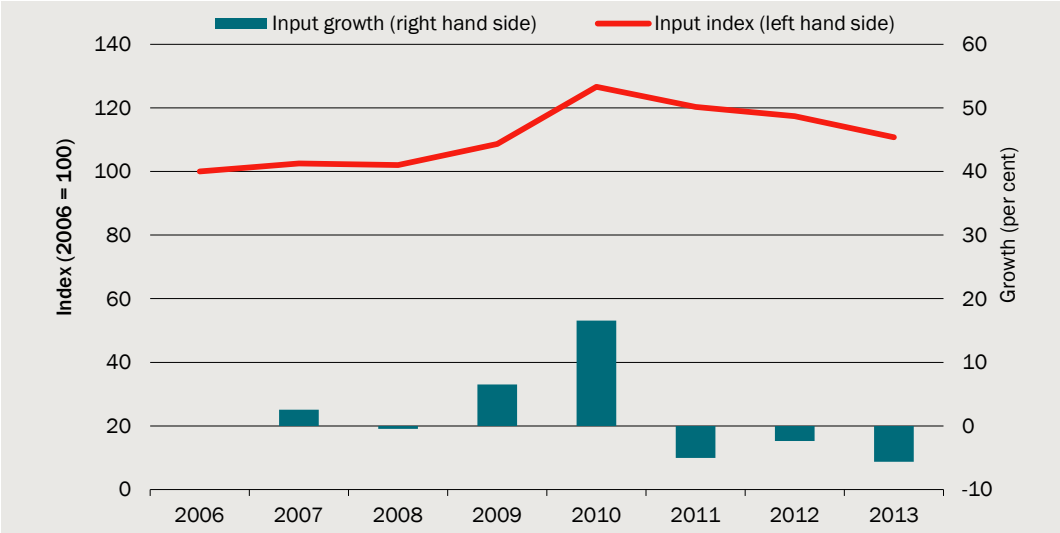
6.9 Inputs of the mobile communications sector 2006 to 2013



Data source: The CIE.

In aggregate, inputs have grown by 10 per cent from 2006 to 2013 (chart 6.10).

6.10 Aggregate inputs and input growth of the mobile communications sector 2006 to 2013



Data source: The CIE.

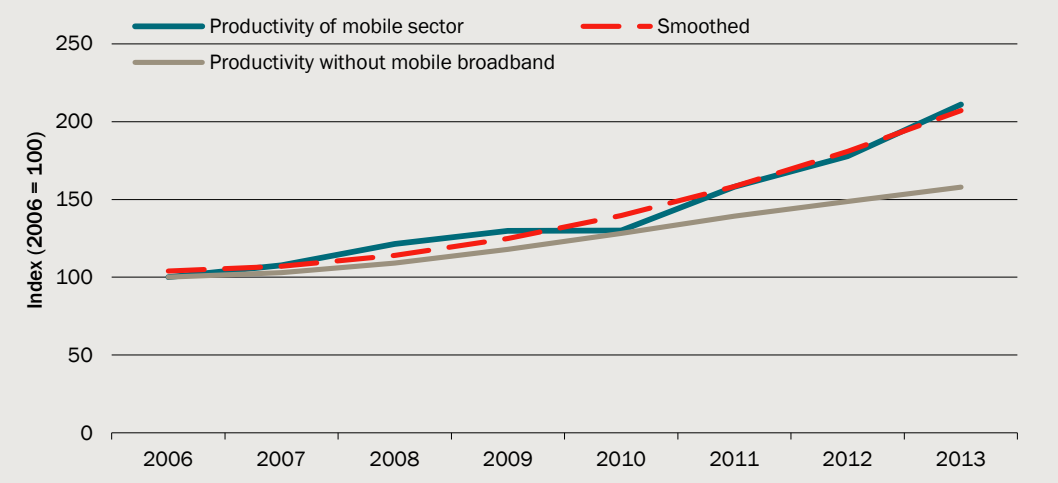
Productivity of the mobile communications sector

Productivity is defined as outputs divided by inputs.[42] Outputs of the mobile communications sector have increased rapidly, while inputs have increased gradually from 2006 to 2013. As a result, we estimate that there has been substantial productivity growth in the sector (chart 6.11).

- Productivity has increased by over 100 per cent for the mobile sector from 2006 to 2013.
- Not all of this increase is due to mobile broadband. We have no way of knowing how inputs to the sector would have changed in the absence of mobile broadband. However, if we split productivity growth based on output growth (see chart 6.8), then mobile broadband is responsible for just under half of this productivity improvement.

42 Productivity can be measured using only capital and labour (gross value added) in the denominator or using all inputs (gross output). We measure productivity using all inputs as we are not able to determine whether there have been changes in outsourcing arrangements that change how intermediate inputs are treated.

6.11 Productivity of the mobile communications sector 2006 to 2013



Note: The smoothed productivity is based on fitting a second order polynomial.
Data source: The CIE.

A summary of the changes in inputs and outputs over the period is shown in table 6.12. Productivity has grown by 11.3 per cent on average each year from 2006 to 2013. This has accelerated more recently (2010 to 2013). This is a very high level of productivity growth. To put it in context, the Australian economy at its peak can achieve around 3 per cent multi-factor productivity growth per year and generally achieves growth well below this.[43]

6.12 Productivity growth from 2006 to 2013

Item	2006 to 2013	2006 to 2010	2010 to 2013
	Per cent per year	Per cent per year	Per cent per year
Productivity growth	11.3	6.8	17.5
Smoothed productivity growth	10.3	7.7	14.0
Without mobile broadband	6.7	6.4	7.2
Outputs	12.9	13.3	12.4
Inputs	1.5	6.1	-4.4

Source: The CIE.

Price changes for mobile services

The rapid productivity growth in mobile telecommunications has meant rapid decreases in prices for households and businesses (table 6.13).[44]

- The average revenue per connection has fallen by 21 per cent from 2006 to 2013 or 3.3 per cent each year on average.

43 Note that it would not be expected that the Australian economy would achieve productivity growth of the same level as an emerging technology.

44 Changes in price may also partly reflect changes in the level of competition. Greater concentration could impact directly on productivity. It could also reduce prices through reducing returns to capital. Because we have measured capital as the capital share of value added, all competition impacts are implicitly captured as productivity changes.

  - We also have average revenue per unit figures obtained from the GSM Association for 2007 to 2012. This shows a slightly more moderate decline of 1.7 per cent per year, compared to 2.5 per cent per year over the same period based on IBISWorld revenue data divided by the number of connections.
- The average price per bundled output has almost halved since 2006, with an annual reduction of 8.4 per cent each year
- This compares to the consumer price index which has increased by an average annual rate of 2.8 per cent each year from 2006 to 2013.

6.13 Prices of mobile communications 2006 to 2013

Financial year	Average revenue per connection	Average revenue per bundled output	CPI [a]
	$/year	Index	Index
2006	780	100	84
2007	774	96	87
2008	750	90	90
2009	723	84	93
2010	762	83	95
2011	713	71	98
2012	681	64	100
2013	615	54	102
Change 2006 to 2013 (per cent)	**-21.2**	**-45.9**	**21.1**
Annual change 2006 to 2013 (per cent)	**-3.3**	**-8.4**	**2.8**

[a] The CPI is average of four quarters for the financial year.

Source: The CIE; ABS Consumer Price Index (All Groups, Australia) to June 2013, Catalogue Number 6401.0.

Key points

Productivity within the mobile communications sector has been rapid from 2006 to 2013.

- Inputs into the sector have experienced only moderate growth
- Outputs of the sector have grown rapidly
- Productivity of the sector has therefore increased, by an average of more than 10 per cent per year from 2006 to 2013
- This has been passed on to households and businesses through lower prices

7 *Productivity from the use of mobile broadband by business*

Mobile broadband has enabled businesses to change the way they operate, save them time and save them money. Businesses report that the uptake of mobile broadband has reduced business costs by 1.4 per cent and saved 2.3 per cent of employees' time, as well as improving the quality of their products and services and increasing their revenue.

This chapter sets out the impacts of mobile broadband on Australian businesses based on a survey undertaken by Woolcott Research.[45]

Approach

Mobile broadband is a general purpose technology. This means that it can affect the entire economy, as it is used as a tool for changing the way that business is undertaken. Other technologies classed as general purpose technologies include computing and the internet. Or, looking further back in history, the steam engine and the railroad.

Measuring the impacts of general purpose technologies can be difficult. This is because their impacts are widespread (rather than specific) and it can be difficult to establish causal linkages between the technology and outcomes. For example, the dramatic changes wrought by the ICT revolution have not been easy to identify in economic statistics, leading to Robert Solow, a Nobel prize winning economist to suggest that "You can see the computer age everywhere but in the productivity statistics"[46]. In Australia, productivity impacts from ICT have eventually shown up in statistics (box 7.1).

45 Further information on the survey of businesses can be found in Woolcott Research 2013, *Business mobile communications usage and impact survey: Technical report,* prepared for the CIE and ACMA, October. The survey is set out in Attachment E.

46 Robert Solow 1987, "We'd better watch out", New York Times Book Review, Jul 12, p. 36.

7.1 Productivity impacts of ICT

Australia's Productivity Commission has led a large body of work looking at the productivity impacts from the use of ICT in Australia.[47] The consensus from a range of studies is that:

- ICT led to an acceleration in multi-factor productivity growth of around 2 tenths of a percentage point in the mid-1990s. If this lasted for five years this implies around a 1 per cent cumulative increase in multi-factor productivity. If this lasted for ten years this implies around a 2.0 per cent increase in multi-factor productivity. The studies generally look at a period covering around five years;
- In addition, capital deepening from ICT led to an increase in output growth and labour productivity growth of 2 to 3 tenths of a percentage point. Over a period of five years this implies a cumulative increase in output of 1 to 1.5 per cent, or 2 to 3 per cent over ten years; and
- Taken together, these impacts suggest an aggregate impact on Australia's economy of about 0.5 per cent per year from ICT. Over a period of five years, this amounts to a 2.5 per cent impact or a 5 per cent impact over ten years.

There are a number of ways of seeking to understand the productivity impacts of mobile broadband. In this study we ask businesses directly whether they use mobile broadband, what they use it for and what impacts they think it has had. We surveyed 1002 businesses of different sizes and across different sectors of the economy. As a cross-check, we also asked businesses how they viewed mobile broadband relative to other factors that could be important to their business.

The advantages of this approach are that it:

- collects primary data from businesses;
- provides for a view on how impacts have differed across sectors of the economy; and
- allows for an understanding of how the identified impacts are being generated from the use of mobile broadband.

Details of the survey are set out in Woolcott 2013, *Business mobile communications usage and impact survey*, Technical report.

Alternative methods for considering the impact of mobile broadband on the economy could include:

- analysis of growth patterns and technology uptake across countries — cross-country analysis;
- analysis of the timing of technology uptake/capital investment and aggregate growth or productivity — time series analysis;
- analysis of business outcomes and technology uptake for a set of businesses — firm level analysis; and
- case studies.

47 Productivity Commission 2004, *ICT use and productivity: a synthesis*, Research Paper.

We discuss findings from using these approaches from other international studies.

The Productivity Commission work on ICT captures the various approaches that can be used to understand the impacts of a general purpose technology.[48] As this work makes clear, conclusions are most robust when drawn from multiple techniques and studies.

Survey of businesses

To provide an understanding of the impacts of mobile broadband, Woolcott Research was commissioned to undertake a survey of Australian businesses. This involved:

- a 10 minute questionnaire seeking information on the characteristics of the business, how they used mobile broadband, how it changed the business and what quantifiable impacts mobile broadband had on the business
- telephone interviews for small and medium businesses; and
- face-to-face interviews for larger business.

The survey covered 1002 responding businesses across all sectors of the Australian economy (or 0.05 per cent of all Australian businesses). The survey was stratified according to sector and size, with a higher share of large businesses surveyed given their greater economic importance.

Within each business, the respondent was defined as the senior person within the business who could provide an idea of expenditure on telecommunications and on mobile communications, as well as estimates of how the use of mobile communications and mobile internet by staff has impacted on the business. For small and medium businesses, the respondent was generally the owner or the general manager, whereas for the larger businesses, the respondent was the Chief Operating Officer, Chief Financial Officer, Telecommunications or IT Director, or other decision maker who could provide the level of information required.

Of the 3282 contacts made that were in scope, 31 per cent responded to the survey.[49] The number of businesses that responded and shares of businesses covered are set out in table 7.2.

The survey questionnaire is shown in Attachment E. Further information is available in Woolcott 2013, *Business mobile communications usage and impact survey*, Technical report.

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48 Productivity Commission 2004, *ICT use and productivity: a synthesis*, Research Paper.

49 There were 13 988 calls made in total. Businesses were out of scope where quotas for business size had already been achieved.

7.2 Sample of businesses surveyed

Sector	Number surveyed	Share of Australian businesses surveyed
Accommodation and food services	72	0.09
Administrative and support services	44	0.05
Agriculture, forestry and fishing	69	0.04
Arts and recreation services	11	0.04
Construction	146	0.04
Education and training	16	0.06
Electricity, gas, water and waste services	4	0.07
Financial and insurance services	43	0.03
Health care and social assistance	60	0.06
Information media & telecommunications	10	0.05
Manufacturing	62	0.07
Mining	8	0.09
Other services	76	0.09
Public administration and safety	5	0.06
Rental, hiring and real estate services	41	0.02
Retail trade	100	0.07
Transport, postal and warehousing	50	0.04
Unknown	3	na
Wholesale trade	51	0.07
Total	**1 002**	**0.05**

Business size	Number surveyed	Share of Australian businesses surveyed
1-4	534	0.03
5-19	326	0.14
20-199	100	0.12
Over 200	42	0.65
Total	**1002**	**0.05**

Source: The CIE based on Woolcott Research.

To provide aggregate figures, the survey responses are weighted. We have two sets of weights.

1 Weights based on the number of businesses across Australia — for example, 60 per cent of Australian businesses use mobile broadband

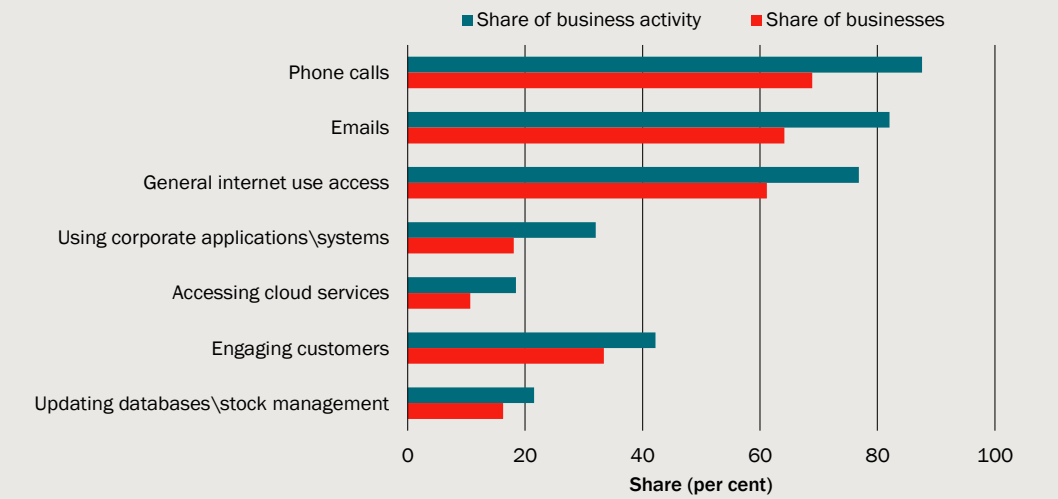
2 Weights based on the share of economic activity across Australia — for example, 60 per cent of Australia's economic activity is undertaken by businesses that use mobile broadband. This accounts for differences in responses across businesses of different sizes within the survey.

For most areas we report results using the second set of weights, as our main concern is the economic importance of mobile broadband.

Business use of mobile communications

The main uses of mobile communications by businesses were for phone calls, emails and general internet access/use (chart 7.3). However, there was a substantial amount of business activity also using mobile communications for more sophisticated functions, such as accessing cloud services, using corporate applications, engaging customers and updating databases/stock management.

7.3 Business use of mobile communications



Data source: The CIE based on survey conducted by Woolcott Research.

Most businesses had some level of employee access to company paid mobile broadband devices. For about 21 per cent of business activity, over three quarters of employees had access to such devices (table 7.4).

7.4 Business access to mobile broadband

Share of employees with access to company paid mobile broadband device	Share of businesses	Share of business activity
	Per cent	Per cent
0 per cent	29	12
1-20 per cent	18	33
21-50 per cent	14	24
51-75 per cent	7	11
76-100 per cent	31	20

Source: The CIE based on survey undertaken by Woolcott Research.

Mobile communications was a small proportion of telecommunications spend (less than 20 per cent) for a majority of businesses and business activity (table 7.5). This indicates that very few businesses view mobile devices as their entire telecommunications solution.

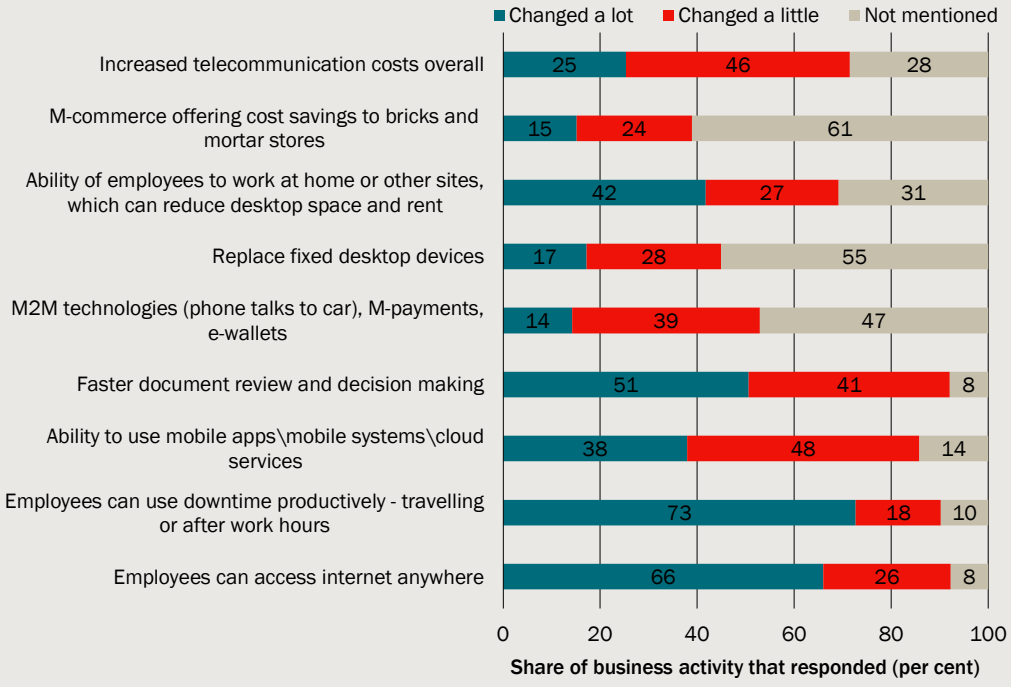
7.5 Mobile share of telecommunications expenditure

Mobile share of telecommunications expenditure	Share of businesses	Share of business activity
	Per cent	Per cent
0 per cent	28	17
1-20 per cent	33	47
21-40 per cent	14	13
41-60 per cent	20	18
61-80 per cent	5	4
81-100 per cent	1	1

Note: Numbers may not add to 100 due to rounding.
Source: The CIE based on survey undertaken by Woolcott Research.

Businesses identified the main pathways for mobile broadband to impact their business as employees accessing the internet anywhere, using downtime more productively and faster document review and decision-making (chart 7.6). For each pathway offered to businesses, more than a third of those that responded noted that pathway, indicating that there are many different ways that businesses are using mobile broadband within their business operations. The majority of businesses that responded also noted that mobile communications increased their telecommunications costs.

7.6 Pathways of change from mobile communications



Note: Numbers may not add to 100 due to rounding. A significant number of businesses did not answer this segment because they answered that mobile communications had not impacted on their business operations. This appears to reflect a misinterpretation of business operations as these businesses noted time savings from mobile broadband. Reflecting this, we report numbers as a share of those that responded to this section.

Data source: The CIE based on survey undertaken by Woolcott Research.

Impacts of mobile broadband

Businesses were asked to quantify whether and, if so, how much mobile broadband had impacted on their business across a range of key economic performance measures. Over half of business activity covered by the survey indicated that mobile broadband had saved time for employees and improved quality (table 7.7). Around a quarter of businesses (by activity) surveyed indicated that mobile broadband had reduced costs, increased sales and allowed access to new markets and new suppliers.

The magnitude of impacts noted by many businesses was substantial. Businesses reported that, on average, mobile broadband reduced their costs by 1.4 per cent, saved 2.3 per cent of employee time and increased sales by 1.1 per cent.[50] To put these figures in perspective, a time saving of 2.3 per cent is equivalent to saving $15 billion in 2013.[51]

7.7 Impacts of mobile broadband on business performance

Impact area	Share of business activity noting impact	Average impact
	Per cent	Per cent
Reduced costs	25.2	1.4
Saved time for employees with access to mobile broadband	75.2	2.3
Increased sales	20.6	1.1
Improved quality	60.6	
Allowed access to new markets	32.3	
Allowed access to new suppliers	28.9	

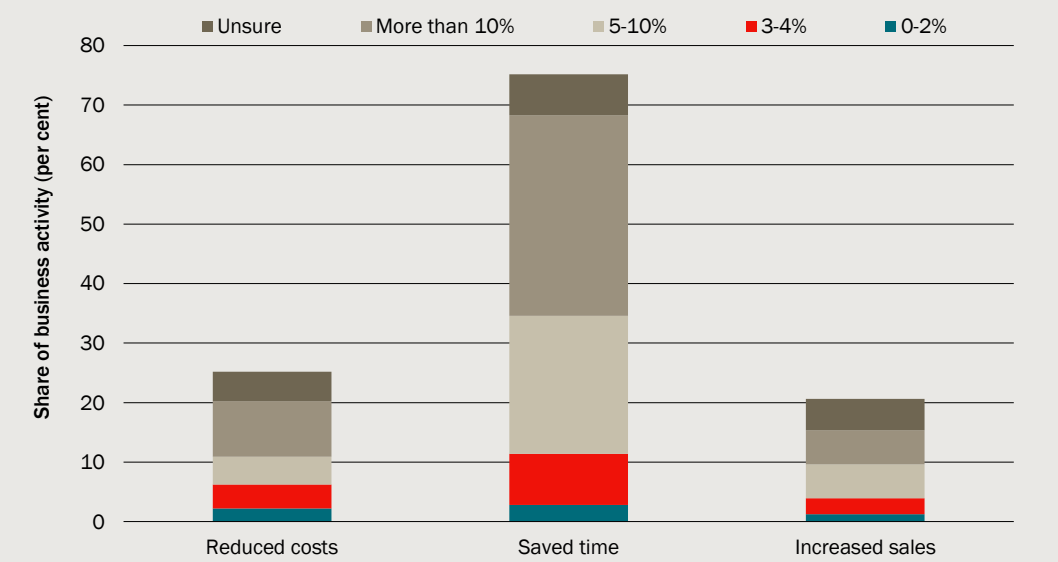
Note: All businesses than answered "Yes" are included in the share of businesses noting impact. If these businesses answered "Unsure" for the size of the impact then this is allocated as zero.
Data source: The CIE based on survey undertaken by Woolcott Research.

Businesses that indicated that they had been impacted often suggested substantial impacts. Over a third of businesses that indicated they had been impacted reported time savings of more than 10 per cent (for those employees with access) and cost savings of more than 10 per cent (chart 7.8).

50 The magnitude of impact is based on the mid-point of the range and the lower bound of the range for the highest range.

51 The value of time saving is calculated by applying this percentage to the wages and salaries for Australia.

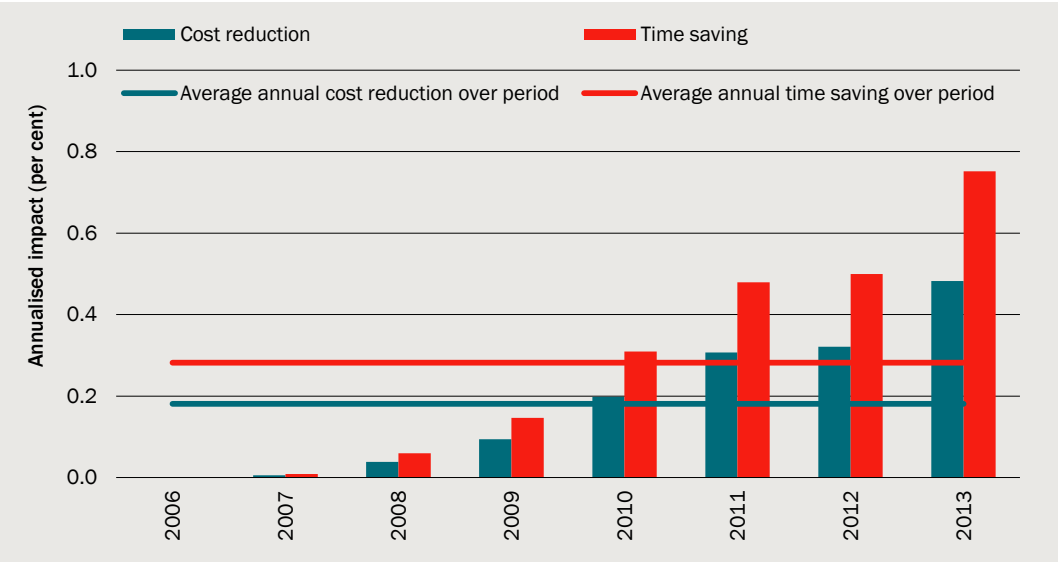
7.8 Size of impacts indicated by business



Data source: The CIE based on survey undertaken by Woolcott Research.

The survey asked for the impact of mobile broadband on businesses in total. These impacts cumulate over a number of years. For example, if mobile broadband has generated a 10 per cent cost saving in 2013 relative to not having mobile broadband then this might mean a 2.5 per cent reduction in costs over four years compared to constant costs without mobile broadband. For the economic modelling, we allocate annual cost reductions based on the pattern of mobile data use, as shown in chart 7.9. The average annual impact from 2006 to 2013 is slightly less than a 0.2 per cent cost reduction per year and slightly less than a 0.3 per cent time saving per year.

7.9 Pattern of impacts through time



Note: Impacts noted by businesses are spread across years based on the amount of data used on mobile networks.

Data source: The CIE based on survey undertaken by Woolcott Research; industry information on mobile data usage.

We also asked businesses to identify how they expected the impacts from mobile broadband in the next five years to compare to impacts experienced to date. The majority

of businesses by number and activity considered that the impacts would be larger than experienced to date (table 7.10).

7.10 Future impacts of mobile broadband

Impacts in next five years compared to impacts to date	Share of businesses	Share of business activity
	Per cent	Per cent
Smaller	3.6	3.8
The same	36.7	27.2
Larger	53.5	66.6
Don't know	6.3	2.4

Data source: The CIE based on survey undertaken by Woolcott Research.

The findings of the business survey conducted for this study echo findings from previous industry surveys that have been conducted.

- The *Optus Future of Business Report 2013: Thriving in a customer-driven economy*[52] *found that o*rganisations are embracing the multi-channel world, with strong growth in digital channels. Of the organisations surveyed, 47 per cent expect 4G to increase productivity while 45 per cent of respondents said increased productivity and the ability to better service customers would be the greatest benefit of NBN infrastructure.
- The *Optus Future of Business Report 2011*[53] found that human resource departments believe flexible working arrangements enabled by mobile applications and cloud computing will help attract and retain skilled staff. IT departments believe these arrangements will improve productivity.
- *The Telstra productivity indicator: A report on business attitudes towards improving productivity in Australia, 2009* was a survey conducted in October 2008 of a statistically representative cross-section of Australian organisations with more than 200 employees. It found that ICT investment is seen as having contributed substantially more to improving productivity in Australia's largest organisations than non-ICT investment. 61 per cent of organisations identified that investments in ICT, including mobile and fixed broadband data networks had improved productivity 'a lot'.

52 Surveyed 2177 consumers regarding current and future expectations of interacting with organisations via traditional and digital channel; and 550 customer experience, marketing and IT decision makers from organisations with more than 100 employees in 10 industries and government (plus 10 qualitative interviews).

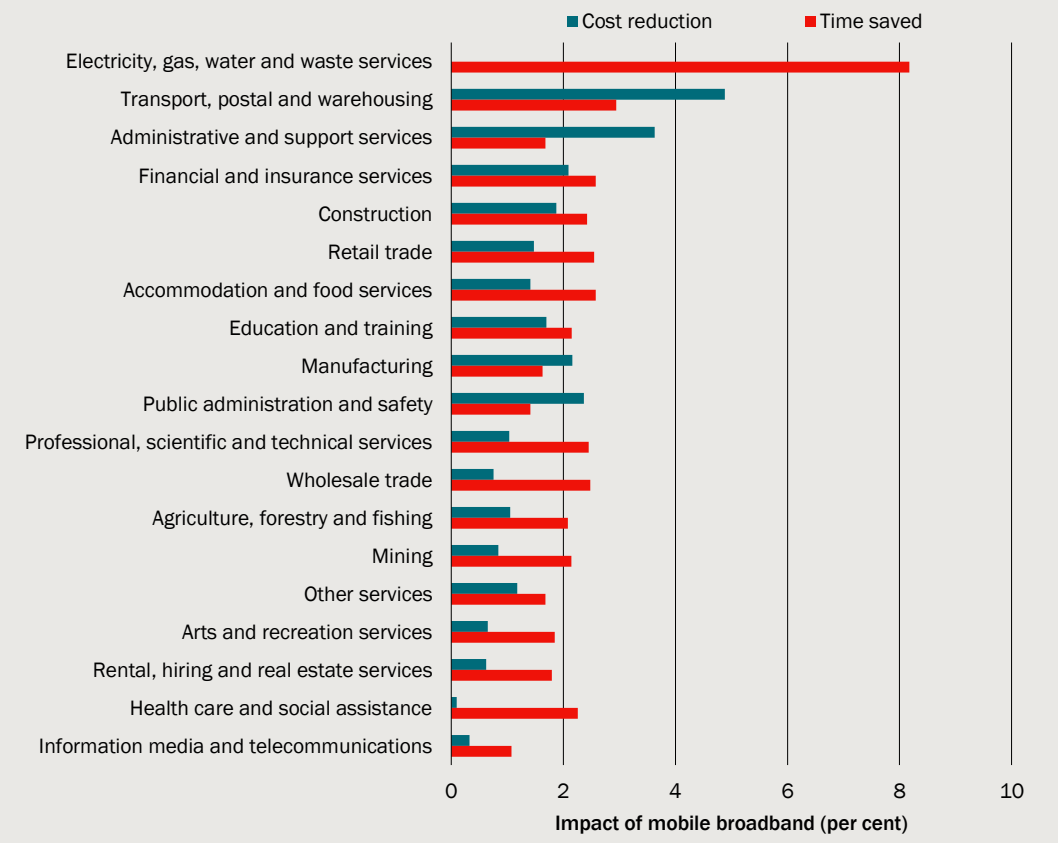
53 Online survey of IT and HR decision makers across medium-sized to large businesses and government organisations. In-depth qualitative interviews were also conducted across multiple industries

Pattern of impacts across business types

There were different impacts of mobile broadband reported depending on the sector within which a business operated, its size, its growth and the level of access provided to mobile broadband.

The sectors citing the largest impacts from mobile broadband were Electricity, gas, water and waste services; Transport postal and warehousing; Administrative and support services; and Financial and insurance services (chart 7.11). The smallest impacts were noted by businesses in the healthcare sectors and information media and telecommunications sectors. The information media and telecommunications result is understated as a large business in this category indicated that there were impacts but was unsure of the size of the impacts. To ensure results are conservative this has been set as a zero impact for calculations.

7.11 Impacts of mobile broadband by sector



Data source: The CIE based on survey undertaken by Woolcott Research.

The impacts cited by businesses of different sizes were fairly consistent (table 7.12) — mobile broadband is having substantial impacts across businesses of all sizes.

7.12 Mobile broadband impacts by business size

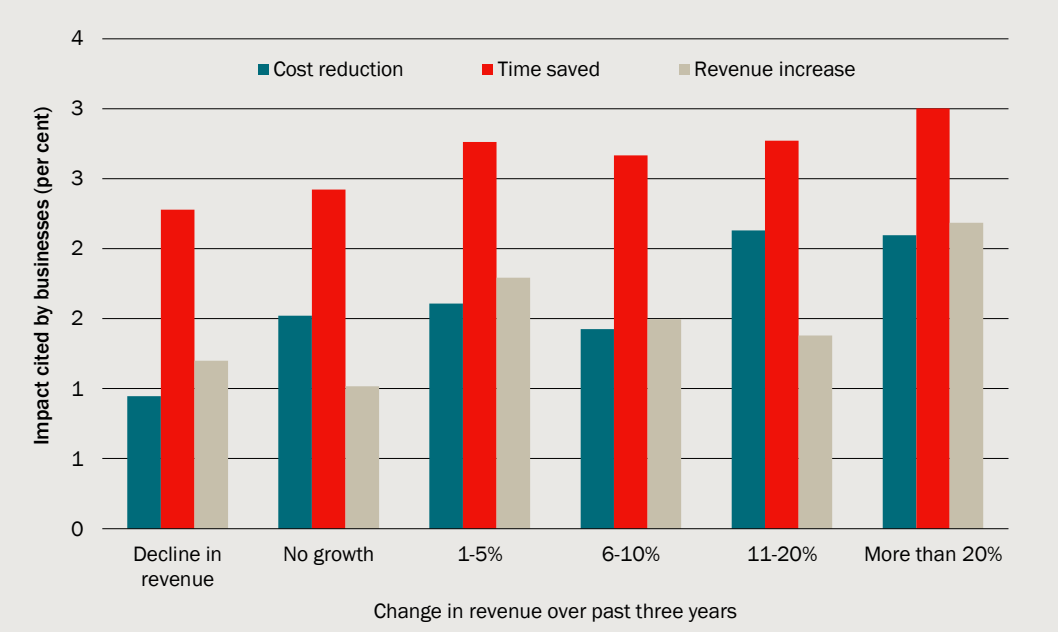
Number of people employed	Cost reduction	Time saved
	Per cent	Per cent
1-4	2.2	2.3
5-19	0.8	1.5
20-199	1.4	2.6
Over 200	1.3	2.5
All	**1.4**	**2.3**

Data source: The CIE based on survey undertaken by Woolcott Research.

We also asked businesses for information that could assist in verifying the responses provided. We found that:

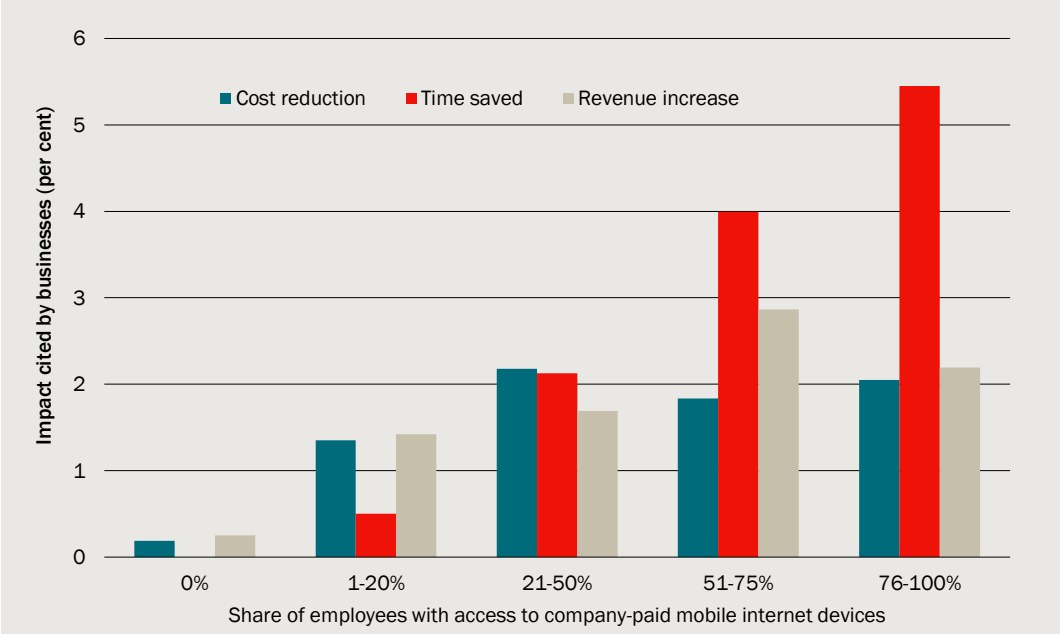
- businesses that grew more quickly over the past three years were more likely to note impacts from mobile broadband — this suggests that the responses provided by business about mobile broadband also align with the broader experience of the businesses (chart 7.13); and
- businesses that had provided a higher level of access to mobile broadband for employees were more likely to indicate higher levels of impact from mobile broadband — this suggests that business behaviour is consistent between their actions and their perceived impacts from mobile broadband (chart 7.14).

7.13 Mobile broadband impacts by revenue growth of businesses



Data source: The CIE based on survey undertaken by Woolcott Research.

7.14 Mobile broadband impacts by employee access to mobile broadband devices



Note: Businesses provided a time saved per employee with access to mobile internet devices. This means there is a stronger relationship between overall impacts for time saved as this is equivalent to the time saved per employee multiplied by the level of access.
Data source: The CIE based on survey undertaken by Woolcott Research.

Importance of mobile broadband for businesses

Mobile broadband is only one issue relevant to running a successful and competitive business. We asked businesses to place mobile broadband within the context of a range of other issues that are important from a business operations perspective and that are important from a Government perspective.

A surprisingly large number of businesses (around one quarter) noted investment in mobile broadband as a highly ranked issue for them (table 7.15). This is surprising because of the sometimes passive nature of mobile broadband activity, where it is driven by individual employees rather than company strategy. The results reported by business may be biased somewhat because they are answering this question within a survey about mobile broadband use. But they do provide some confirmation that the large impacts noted by businesses are within a plausible range.

Mobile broadband ranked as an issue of similar importance to a more efficient tax system and less government regulation. These issues have received substantial public policy attention from the Australian Government and state governments.

The highest ranking issue for businesses surveyed was the skill development of employees.

7.15 Importance of selected issues for businesses

Item	Number mentioned	Share of business activity	Share of business numbers
	No.	Per cent	Per cent
Skill development of employees	716	81	72
More efficient tax system	357	24	38
Less government regulation	408	28	41
Investing in IT systems	346	39	33
Improving internal systems and processes	505	62	50
Investing in mobile broadband	209	26	20
Investing in machinery, other capital equipment	374	34	38

Note: Businesses were asked to choose three of the above issues or to mention other additional issues.

Data source: The CIE based on survey undertaken by Woolcott Research.

Key points

Mobile broadband has delivered substantial productivity gains to Australian businesses of all sizes and across all sectors.

- In aggregate, businesses indicated that mobile broadband has reduced business costs by 1.4 per cent and saved 2.3 per cent of employee time to 2013.
- Businesses that grew more quickly over the past three years noted higher impacts of mobile broadband on their business.
- Businesses with a higher level of access to mobile broadband for their employees noted higher impacts of mobile broadband on their business.
- Around a quarter of businesses ranked mobile broadband as one of the three most important issues for their business.
- Two thirds of businesses considered that the impacts of mobile broadband would be larger over the next five years compared to the impacts experienced to 2013.

8 Economy-wide impacts from mobile broadband

The immediate impacts of mobile broadband on businesses do not capture the full range of economic impacts from uptake of mobile broadband. The key behavioural changes in response to direct changes from mobile broadband include:

- greater use of mobile broadband — as productivity within the sector drives lower prices;
- increased output (GDP) — as business costs fall they respond by increasing production;
- higher wages and employment — competition for labour from expanding sectors drive up wage costs across the Australian economy. This is in large part offset because greater efficiency of the use of labour from mobile broadband means that businesses need less labour to produce the same amount;
- higher levels of investment — higher returns to capital (because of higher productivity) lead to additional investment;
- lower prices — competition means part of the productivity gains to businesses are passed on to consumers through lower prices, both in mobile communications and in other sectors. This occurs particularly in non-traded sectors (such as construction), while in traded sectors (such as mining) businesses respond with a larger increase in output rather than lower prices; and
- higher household consumption — lower prices and rising incomes allow Australian households to purchase a higher amount of goods and services.

To consider the full impacts, we use the productivity changes of the mobile communications sector and the impacts from the survey of Australian businesses as inputs into an economic model of the Australian and state and territory economies.

Developing the baseline

The baseline is constructed by rolling forward the model with the newly constructed database from 2005-06 to 2012-13. It runs a series of year-on-year simulations of the model with macro and industry specific targets and shocks. These targets and shocks include:

- annual historical growth of gross state product;
- annual historical growth of regional population;
- annual historical growth of national employment, investment, household consumption, and exports; and
- annual historical growth of the mobile broadband industry activity (volume) and productivity improvement

The details of these targets and shocks are given in tables A.4 through A.10 in Attachment A.

In a normal simulation, most of these targets are generally endogenous, that is, determined by the model run. In the rolling forward or projection simulations, these targets are achieved through adjusting some usually exogenous variables. For example, we allow for changes in household preferences to achieve the mobile communications industry output target.

Table 8.1 summarises the mobile communications industry in terms of output value, cost structure and use structure. The industry value combines the change of industrial volume (set as a target in the simulation) and the change in price. Due to the productivity improvement in the mobile broadband industry driving prices downwards, the growth in industry value is less than the volume growth target. This is consistent with independent data on the size of the industry. The share of the industry value being used by other sectors (industrial use) declines over the model period. This reflects the more limited adjustment allowed in the model for business response to lower prices relative to households.

The share of the mobile communications industry in Australia's total industry output has decreased from 0.74 per cent in 2005-06 to 0.66 per cent in 2012-13.

Industrial value added for mobile communications in total cost has fallen from 34.6 per cent in 2005-06 to 30.5 per cent in 2012-13. This is due to the productivity improvements applied to all factors driving greater responsiveness in the use of labour and capital.

Mobile broadband is one part of the mobile communications industry and we do not separately identify it as a sector.

8.1 Mobile communications industry in the baseline

Year	Mobile communications industry revenue	Share of value of Australian total industry output	Value added share	Industrial use share
	$m	Per cent	Per cent	Per cent
2005-06	14 647	0.74	34.6	58.0
2006-07	16 324	0.78	35.5	54.9
2007-08	18 166	0.81	37.3	51.0
2008-09	19 121	0.84	37.4	44.7
2009-10	21 353	0.89	39.9	38.8
2010-11	21 677	0.86	38.4	33.8
2011-12	19 627	0.72	32.9	31.3
2012-13	18 657	0.66	30.5	28.0

Note: Total industry output is the sum of revenue for each industry. It is larger than the size of the economy because a particular activity could be included firstly within the industry in which it is conducted and secondly within an industry that uses the outputs of the first industry.
Source: CIE-REGIONS model simulations

Developing CGE model shocks

An economic model allows for an understanding of the impacts from particular changes or 'shocks' to the economy. We derive the shocks to the economy **if mobile broadband had not been available** from the previous two chapters.

Impacts on mobile communications sector

Without mobile broadband, the mobile communications sector would have achieved a lower level of productivity growth. As set out in chapter 6, we estimated that annual productivity growth in the mobile communications sector would have been 6.7 per cent without mobile broadband compared to 11.3 per cent with mobile broadband from 2006 to 2013.

Impacts on other sectors

Without mobile broadband, businesses that have achieved productivity gains from the use of mobile broadband would not have done so. The best evidence that we have as to the productivity impacts for businesses is from the survey of businesses. We could use survey information in a number of different ways. To ensure that results are conservative and because businesses are likely to have responded more accurately to questions about time savings, we focus on the time savings indicated by businesses.

Hence to consider how the economy would have evolved without mobile broadband we increase the amount of labour businesses would have required to achieve the same outputs based on survey responses. A different time saving is applied for each sector. For example, if the electricity sector indicated that it saved 2 per cent of time for employees from mobile broadband, then the 'shock' applied is that the business would require 2 per cent more labour for a given level of output by 2013 than in the baseline. We apply changes annually based on the pattern of use of mobile broadband from 2006 to 2013. For example, the cumulative time saving of 2 per cent above is apportioned between 2007 and 2013 based on the amount of data use of mobile broadband over this period.

The 'shocks' included as above are likely to be conservative. Businesses indicate larger reductions in total costs in dollar terms ($38 billion per year if the average impact is applied across all expenditure) compared to the reductions in time savings ($15 billion). Additional cost impacts aside from labour savings would include *additional* expenditure on mobile communications and *reduced costs* such as requiring office space, fuel and fleet (for transport) and inventory. Businesses also noted that mobile broadband had allowed them to increase quality and to increase revenue.

As a sensitivity to the use of only the time savings indicated by the survey, we also show the magnitude of estimated impacts from allowing an additional cost saving in non-labour costs. This is calculated as the part of the reduction in total cost indicated by businesses not accounted for by the time saving. For example, suppose the survey indicated that the electricity sector saved 2 per cent of time and 1 per cent of total costs, and that labour costs comprised one quarter of operating costs. Then we calculate the residual impact on non-labour operating costs as:

(Total cost saving – time saving * labour share)/(1-labour share)

In this case this would indicate that mobile broadband saved 0.67 per cent of non-labour operating costs.

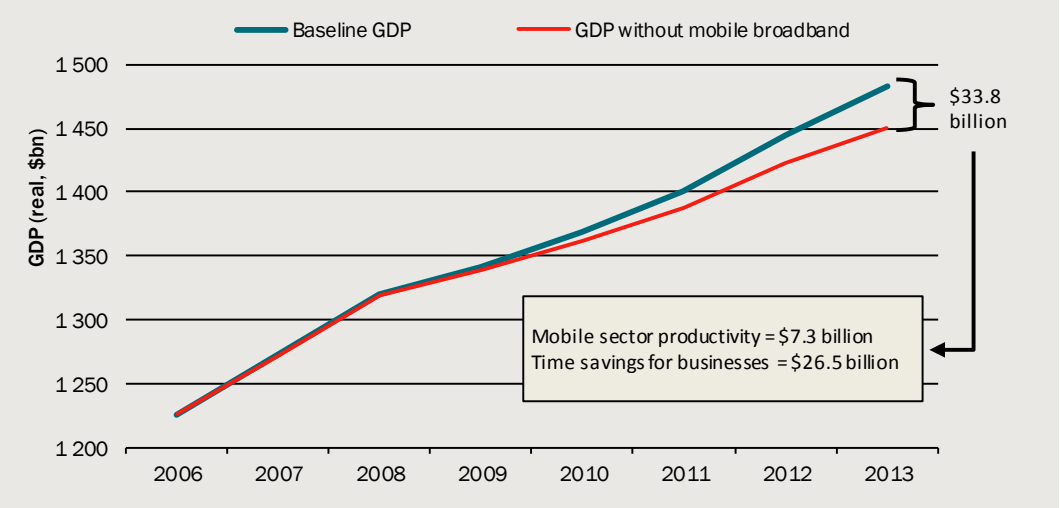
The level of shocks input into the economic model is set out in detail in Attachment A.

Economic impacts

The economic impacts from the mobile broadband sector, based on the results of the business survey and productivity analysis, are substantial. The baseline path of the Australian economy and the anticipated path if mobile broadband had not been available are shown in chart 8.2.

- The Australian economy would have been $7.3 billion smaller without productivity growth within the mobile sector by 2013.[54]
- Without the time savings indicated by businesses from mobile broadband, the Australian economy would have been an additional $26.5 billion smaller in 2013.
- In total, the Australian economy would have been $33.8 billion smaller without mobile broadband, equivalent to 2.28 per cent of Australia's GDP.

8.2 The Australian economy with and without mobile broadband



Data source: The CIE.

Average growth impacts for key economic indicators are set out in table 8.3. Mobile broadband is estimated to have increased the growth rate of the Australian economy by 0.28 per cent each year from 2007 to 2013. About a quarter of this impact is from the productivity improvement within the mobile communications sector and three quarters from productivity impacts of sectors using mobile broadband. The growth impact for consumption is slightly lower at 0.21 per cent per year. This reflects that part of the

54 Note that the official GDP baseline for Australia probably does not capture this productivity growth, due to the way that prices are constructed for mobile services. The ABS is likely to have understated the degree of price reductions in mobile communications. Because volume of outputs is equal to the value of output divided by prices, this means that the volume of output is understated.

additional GDP growth reflects additional capital. This has to be paid for and hence consumption does not grow as rapidly.

In table 8.3 we also show the impacts of taking a less conservative view of the survey responses from businesses. This would also allow for reductions in intermediate input use for businesses. The economic impact of this would almost double the estimated impacts of mobile broadband on the Australian economy, with the additional reduction in costs resulting in an additional 0.29 per cent increase in GDP growth per year from 2007 to 2013, compared to there being no mobile broadband.

8.3 Average impacts on growth of the Australian economy 2007 to 2013

Indicator	Mobile sector productivity	Time saved by businesses	Total	Additional impacts allowing for other cost reductions
	Per cent	Per cent	Per cent	Per cent
GNP	0.06	0.19	0.26	0.29
GDP	0.06	0.22	0.28	0.29
Household consumption	0.09	0.12	0.21	0.23
Wages	0.12	0.00	0.13	0.35
Exports	-0.02	0.30	0.28	0.03
Employment	0.00	0.00	0.00	0.00

Note: Employment is constrained to be the same for the baseline and simulation. We report impacts as impact from mobile broadband rather than without mobile broadband.
Source: The CIE.

The average dollar impacts on aspects of the Australian economy over the period 2007 to 2013 are shown in table 8.4. Household consumption is the indicator that best reflects the value of mobile broadband to Australians. Household consumption captures the amount of goods and services that households can purchase, given changes in the income they receive from wages and salaries and returns to capital and prices of goods and services. We estimate that household consumption was on average $4.2 billion higher per year, or $184 higher per person each year, because of mobile broadband over the period 2007 to 2013. Part of this additional consumption value reflects greater levels of consumption of mobile broadband itself, but part also reflects higher consumption of other goods and services.

8.4 Average impacts on the Australian economy 2007 to 2013 ($b)

Indicator	Mobile sector productivity	Time saved by businesses	Total	Additional impacts allowing for other cost reductions
	$b	$b	$b	$b
GNP	2.3	7.0	9.3	10.9
GDP	2.2	7.7	9.9	10.6
Household consumption	1.8	2.4	4.2	4.8
Wages	2.2	-0.3	2.0	6.5
Exports	-0.1	2.4	2.3	0.2

Note: Nominal dollars.
Source: The CIE.

The cumulative impact of mobile broadband in 2013 is shown in tables 8.5 and 8.6. By 2013, it is estimated that GDP would have been 2.28 per cent lower without mobile broadband, equivalent to $33.8 billion.

8.5 Impacts on the Australian economy 2013 (per cent)

Indicator	Mobile sector productivity	Time saved by businesses	Total	Additional impacts allowing for other cost reductions
	Per cent	Per cent	Per cent	Per cent
GNP	0.53	1.70	2.23	2.53
GDP	0.49	1.79	2.28	2.33
Household consumption	0.74	1.03	1.77	1.91
Wages	1.06	0.03	1.08	3.00
Exports	-0.19	2.59	2.39	0.21

Source: The CIE.

8.6 Impacts on the Australian economy 2013 ($b)

Indicator	Mobile sector productivity	Time saved by businesses	Total	Additional impacts allowing for other cost reductions
	$b	$b	$b	$b
GNP	7.6	24.3	31.9	36.1
GDP	7.3	26.5	33.8	34.6
Household consumption	6.2	8.6	14.8	16.0
Wages	7.8	0.2	8.0	22.0
Exports	-0.6	7.8	7.2	0.6

Note: Nominal dollars.
Source: The CIE.

The results set out in the above tables did not adjust employment in response to economic changes. An alternative assumption is to allow for changes in employment levels, but to maintain real wage levels. Employment responses work in different directions from the impacts of mobile broadband. Because labour is more productive, less labour is required to produce a given amount of output. However, expansion of output because of lower prices leads to greater demand for labour. If we allow for adjustment in employment, then this does not make much difference to results for the time savings but roughly doubles the economic impacts of improved productivity within the mobile communications sector.

Impact on household consumption

The best indicator of the 'value' of mobile broadband to Australians is how it has changed the amount of goods and services that households are able to purchase — that is, material standards of living. This is measured by household consumption.

We estimate that by 2013, mobile broadband has increased the amount of goods and services that could be purchased per capita by $652 or $14.8 billion in total (table 8.7).

Households have increased consumption of mobile broadband, as well as consumption of other goods and services, with a total increase valued at $652 per person.

The impact on household consumption is more moderate than the impacts on GDP. This is because the higher labour productivity draws additional capital into the Australian economy, increasing the amount of economic activity. (This is similar to the capital deepening impact measured from ICT improvements in the mid-1990s.) The extra capital has to be paid for, so the effect on household consumption is therefore smaller than the impact on GDP.

8.7 Household consumption impacts of mobile broadband

Impact item	Australia-wide 2013	Per capita 2013
	$b	$/person
Productivity within mobile communications sector	6.2	274
Higher business productivity	8.6	379
Total	**14.8**	**652**

Source: The CIE.

Sectoral impacts of mobile broadband

The sector most impacted by mobile broadband is the mobile communications sector. In the absence of mobile broadband, this sector's output would have been almost 40 per cent lower by 2013 than it actually is.

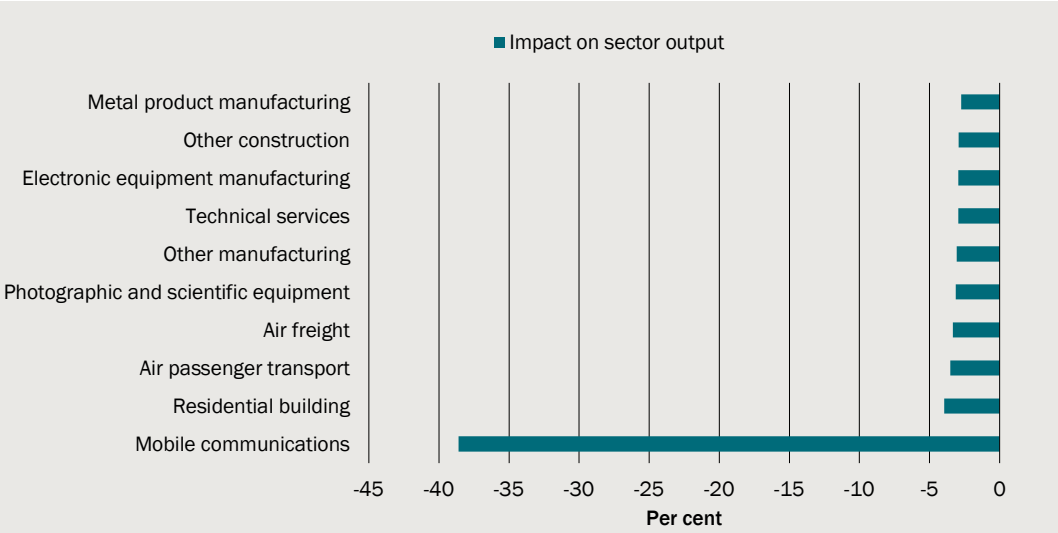
Other sectors are impacted by mobile broadband in a number of ways.

- Mobile communications is an input into other sectors — a more productive mobile communications sector lowers the price of inputs for other sectors
- Other sectors are inputs into mobile communications — expansion in the mobile communications sector requires additional inputs, although this is largely offset by productivity gains from the use of inputs in the mobile communications sector
- Sectors would not have achieved the productivity impacts identified from the survey in the absence of mobile broadband. This would have meant that they required more labour to produce the same output
- Increases in household income increases demand for the output of sectors of the economy
- The changes in demand feed through to the various supply relationships that operate between sectors

We find that the largest impacts in 2013 occur in sectors that produce capital, such as construction sectors. This is because the change in household income leads to a higher demand for dwelling services — satisfying this demand requires a significant increase in construction activity in the short term. This increase in construction activity will be largely temporary. Construction sectors also cited a relatively large productivity impact from their use of mobile broadband.

The sectors that would be most impacted by the absence of mobile broadband are shown in chart 8.8. Outside of mobile communications, the most impacted sectors — as shown in chart 8.8 — would have output 3-4 per cent smaller in the absence of mobile broadband. All sectors of the economy are estimated to be smaller without mobile broadband. The sectors least impacted are agricultural production and oil and gas production, where the impacts on output are less than 1 per cent.

8.8 Main sectors impacted by the absence of mobile broadband 2013



Data source: The CIE.

Comparative studies on the economic impact of broadband

A growing body of literature has found a positive relationship between broadband penetration (including mobile broadband) and economic development. Few studies focus specifically on mobile broadband.

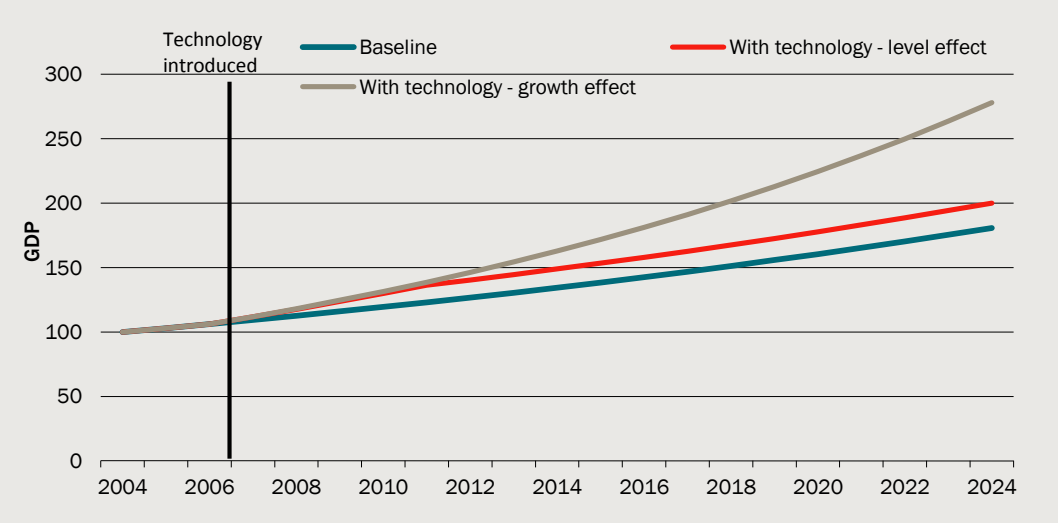
The literature identifies broadband or mobile broadband impacts in two ways.

1 Growth impacts — this identifies that technology changes the growth rate of a country or region.

2 Level impacts — this identifies that technology changes the level of economic activity.

These two measures are related. For example, a level impact of a 1 per cent increase in GDP is equivalent to a growth impact of 0.2 per cent for a period of five years. Because of the way that studies are undertaken, growth impacts that are measured do not have an end point, implying a higher permanent increase in growth. We consider this unlikely and that at some point growth would revert to a trend rate following a technology change. The difference between a growth impact and a level impact is shown in chart 8.9.

8.9 Growth and level impacts



Data source: The CIE.

The review of research indicates that there are several methods to estimate the economic impact of broadband, including econometric techniques, input-output analysis and qualitative case studies. Variations in estimates may be due to the differences in the definition of 'broadband', the statistical methodology used, datasets underpinning the analysis and model specifications/shortfalls. Attachment C sets out the findings of these studies.

Growth studies that focus on explaining economic output have found the following.

- Koutroumpis (2009) estimates that a 10 per cent increase in broadband penetration yields a 0.25 per cent increase in GDP growth.
- Czernich et al (2009) finds that a 10 percentage-point increase in broadband penetration raises annual per capita growth by 0.9-1.5 percentage points.
- Deloitte (2012) find that for a given level of total mobile penetration, a 10 per cent substitution from 2G to 3G penetration increases GDP per capita growth by 0.15 percentage points.
- Qiang and Rossotto (2009) suggest that a 10 per cent increase in broadband penetration yields an additional 1.21 percentage points of GDP growth.
- Rohman and Bohlin (2012) estimate that doubling the broadband speed for an economy will contribute 0.3 per cent growth compared with the growth rate of the base year.

Thompson and Garbacz (2008) focus on levels rather than growth rates. They estimate that a 10 per cent increase in broadband penetration yields a 3.6 per cent increase in economic output[55].

The findings of these studies suggests a wide range of impacts from relatively small changes in broadband penetration. While it is not clear over what period growth changes may occur, these estimates tend to be higher than our estimates in this study. For

55 Assuming that a 1 per cent increase in productivity results in 1 per cent increase in GDP. This study found no statistically significant **direct effects** associated with broadband services.

example, if we consider the Deloitte (2012) study, Australia has experienced an increase in 3G penetration of about 50 percentage points from 2007 to 2012. This would then suggest an increase in per capita GDP growth of 0.75 per cent from 2007 to 2012. This is about three times the growth impact that we have found in this study.

Against these generally higher findings from overseas evidence related to broadband and mobile technologies, Australian evidence for ICT suggests lower impacts (see Box 7.1 for Productivity Commission findings). The overall GDP growth impacts from ICT have been estimated at about 0.5 per cent and multi-factor productivity growth impacts of 0.2 per cent. Our estimates of GDP growth impacts of 0.2 per cent per year are lower than the estimated ICT impacts, which would be expected. A larger amount of the growth impact is from productivity gains rather than capital deepening, which again is consistent with the relatively inexpensive nature of mobile broadband compared to the significant costs of ICT investment.

Our estimated impacts are substantially higher than the figures presented in Deloitte (2013) for the Australian Mobile Telecommunications Association.[56] The Deloitte (2013) study estimated an increase in GDP from mobile broadband of $495 million per year in 2011, rising to $1.8 billion per year in 2025. Our estimates are higher for a number of reasons. Firstly, we account for productivity within the sector. Secondly, we had access to a survey of Australian businesses to directly seek information on how they viewed mobile broadband had impacted their business.[57]

Australia's productivity growth performance

The substantial impacts noted by business fit within the context of Australia's historical productivity performance. Productivity growth is traditionally measured using labour productivity, which is equal to output/labour inputs, or multi-factor productivity, which is equal to output/labour and capital inputs. We focus on the latter as it appropriately accounts for changes in the amount of capital invested in production.

- In the mid-1990s, Australia experienced a marked multi-factor productivity acceleration. About 10 per cent of this acceleration has been attributed to the impact of ICT and the rest to microeconomic reforms such as reducing trade barriers and National Competition Policy.
- In the last ten years, Australia has had no appreciable measured multi-factor productivity growth.

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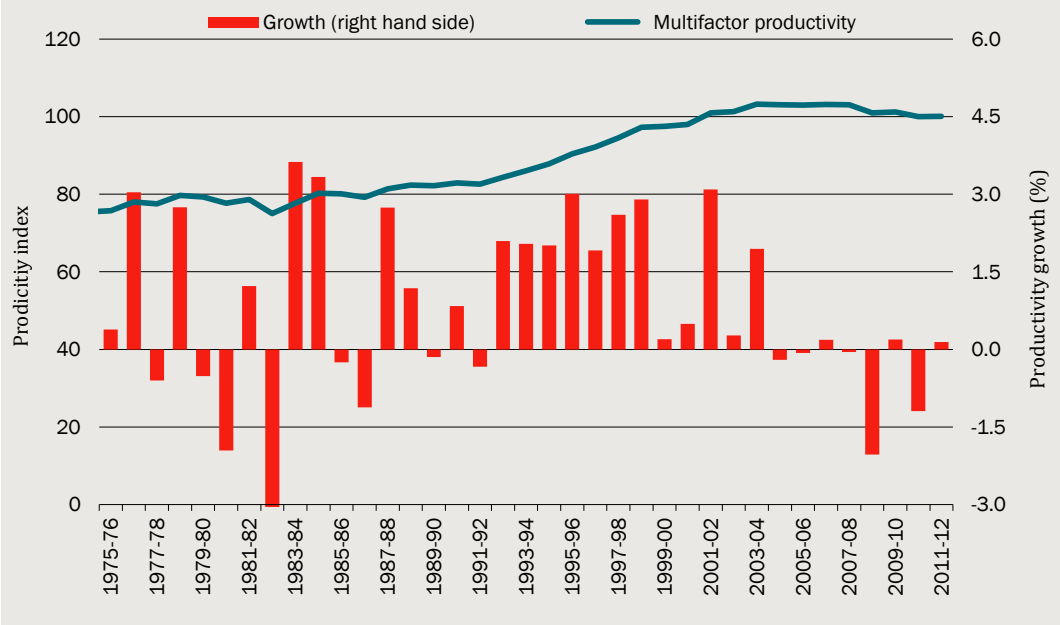
56 Deloitte Access Economics 2013, *Mobile Nation: The economic and social impacts of mobile technology,* prepared for the Australian Mobile Telecommunications Association.

57 Deloitte used a benchmark of the impacts of ICT on economic growth against which to consider the impacts of mobile broadband. It appears that this growth benchmark has been applied as a level impact, which would understate the impacts of the technology over time.

8.10 Australia's multi-factor productivity performance



Data source: ABS 2012, Estimates of industry multifactor productivity, Australia, Catalogue No. 5260.0.

The reasons for the lack of productivity growth in the past ten years have been explored in depth by the Reserve Bank of Australia.[58] They have noted that this is partly explained by investment in utilities (electricity and water) to improve reliability and security of supply and which appears to be a productivity reduction. The productivity deceleration is also partly explained by increases in prices for commodities (particularly mining), which has (1) led to additional capital investment that will generate outputs over many years but which appears as a short term productivity loss, and (2) led to production of higher cost deposits, which also is accounted for as a productivity loss. However, after accounting for these factors there has still been a broad-based productivity deceleration.

The reasons behind the remaining unexplained productivity deceleration are not easy to untangle. Partly, it reflects the high productivity growth of the 1990s and a return to more normal levels. As the Reserve Bank notes:

> "The most widely accepted explanation for the acceleration and subsequent slowing in productivity growth over the past two decades relates to the gradual waning of the impetus to productivity growth initiated by the economic policy reforms of the 1980s and 1990s." [59]

How does the substantial productivity growth both within the mobile broadband sector and noted by businesses using mobile broadband fit within this?

Firstly, it is likely that the productivity within the mobile broadband sector has not been accurately factored into Australia's historical productivity performance. Consumer prices measured by the ABS for mobile services have not fully accounted for the higher usage (and quality) of mobile services. This has then meant that production volumes for mobile

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58 D'Arcy, P. and L. Gustafsson 2012, "Australia's productivity performance and real incomes", Reserve Bank of Australia Bulletin, June.

59 D'Arcy, P. and L. Gustafsson 2012, "Australia's productivity performance and real incomes", Reserve Bank of Australia Bulletin, June.

services are under-counted and productivity growth is understated. The ABS has indicated that it is currently investigating methods to more accurately account for price changes in mobile telecommunications.[60] This would lead to a downward revision to telecommunications prices and an upward revision to output and productivity.

Secondly, if businesses have achieved the level of productivity growth from using mobile broadband suggested by the survey responses, then the level of productivity growth in Australia would have been even lower without mobile broadband. This would then imply a potentially greater drag on productivity from the waning of the economic reforms discussed by the Reserve Bank of Australia above and others.[61] That is, mobile broadband is allowing our businesses to be more productive but this has not been sufficient to outweigh negative productivity impacts from a range of other factors. We have not sought to investigate what these factors are, but note that regulation has been cited as one probable reason for declining productivity growth.[62]

An alternative view is that business responses to the survey are optimistic, given the difficulties with being able to measure impacts from mobile broadband within their business. Or businesses may include impacts related to broadband as well as mobile broadband. The estimates suggested by businesses are within the range of impacts found by other studies. The estimates used in the modelling have also taken a very conservative approach to interpreting the responses of businesses. Given this, we think it is fair to consider that productivity growth as measured by the ABS would have been even lower had mobile broadband not been available to Australian businesses.

Key points

Mobile broadband has been a major driver of Australia's recent economic growth.

- The time savings from mobile broadband indicated by business have led to the Australian economy being $26.5 billion larger than would otherwise have been the case.
- Productivity within the mobile sector means the economy is $7.3 billion larger in 2013 than would have been the case in the absence of mobile broadband[63].

These changes are equivalent to mobile broadband having increased Australia's rate of economic growth by 0.28 per cent per year from 2007 to 2013. This is (unsurprisingly) slightly lower than the measured impacts of the use of information and communications

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60 ABS (2013), personal correspondence, 9 October.

61 Dolman B (2009), 'What Happened to Australia's Productivity Surge?', *Australian Economic Review*, 42(3), pp 243–263.; Eslake S (2011), 'Productivity: The Lost Decade', in H Gerard and J Kearns (eds), The Australian Economy in the 2000s, Proceedings of a Conference, Reserve Bank of Australia, Sydney, pp 223–254.

62 Eslake S (2011), 'Productivity: The Lost Decade', in H Gerard and J Kearns (eds), The Australian Economy in the 2000s, Proceedings of a Conference, Reserve Bank of Australia, Sydney, pp 223–254

63 Although this is probably not well captured in Australia's National Accounts.

technologies on the Australian economy in the mid-1990s. It is also somewhat below the findings of international studies of the impacts of broadband and mobile technologies.

Most importantly, mobile broadband is estimated to have led to higher levels of household consumption, which is the most appropriate measure of the value to Australian households. On average, it has led to an additional $184 per year per person of household consumption from 2007 to 2013. In 2013, we estimate that it has led to additional household consumption of $652 per person.

PART IV

Attachments

A CGE model and assumptions

Adaptations to economic model

The model used for this analysis, CIE-REGIONS, is a 53-sector, 8-region, computable general equilibrium (CGE) model of the Australian economy. The model was developed based on the MMRF-NRA model of the Productivity Commission[64]. It has a base year of 2005/06 and does not separately identify the mobile communications industry which is included in the telecommunications sector. Therefore adaptations must be made to the model to:

- split out the mobile communications sector from the telecommunications sector and
- roll forward the model from 2005-06 to 2012-13.

Splitting out the mobile communications sector

Splitting the mobile communications sector out of the telecommunications sector involves the following tasks:

- identifying the size of the industry;
- estimating the cost structure of the industry;
- estimating the uses of the mobile communications products; and
- integrating the sector into the rest of the economy

The size of the mobile communications industry

The database of the CIE-REGIONS model was originally compiled from the 2005-06 input-output tables published by the ABS in which the mobile broadband industry was not separately identified. Since the release of 2006-07 IO tables, production and uses information of mobile and other telecommunication network services including wireless and satellite (IOPC 58020010) have been reported in the product details tables (ABS Cat.No.5215.0.55.001), and the latest release of IO product details tables are for 2008-09.

IBISWorld estimates the wireless telecommunications industry revenues in its industry report J5802 from 2003-04 to 2012-13 and provides projections up to 2017-18.

64 Productivity Commission 2006, *Potential Benefits of the National Reform Agenda*, report to the Council of Australian Governments, Canberra.

A.1 Production value of Australian mobile communications industry

	ABS	IBISWorld	ABS to IBISWorld
	$m	$m	Per cent
2005-06		15 666	
2006-07	15 109	16 670	90.6
2007-08	18 846	17 528	107.5
2008-09	15 501	18 510	83.7
2009-10		21 415	
2010-11		21 151	
2011-12		20 936	
2012-13		19 801	

Source: ABS, Australian National Accounts: Input-Output Tables (Product Details) - Electronic Publication, various years, Cat.No.5215.0.55.001; IBISWorld, 2013, Wireless Telecommunications Carriers in Australia, IBISWorld Industry Report J5802,

Table A.1 compares the data from these two sources. In two of the three years with comparable data, the IBISWorld estimates are higher than the ABS values. It is likely that the difference comes from the coverage of the industry. For example, 13 per cent of the industry revenue in 2012-13 was from handsets and equipment sales in the IBISWorld report. If applying this share to the 2005-06 industry revenue, the sales of handsets and equipment would be a little over $2 billion, being equivalent to the electronic equipment inputs into the whole telecommunications sector for that year.

This suggests that part of the handsets and equipment sales are not treated as the output of the mobile broadband industry. We therefore deduct half of the handset and equipment sales from the IBISWorld industry revenue, that is, the industry output would be 6.5 per cent less than the IBISWorld value. It is estimated that the size of the mobile communications industry was $14 647.3 million for the year 2005-06.

Cost structure

IBISWorld provides estimates of mobile communications industry value added and wages together with industry revenue. In 2005-06 the value added and wage accounted for about 35 per cent and 12 per cent, respectively, of the revenue. These shares are applied to the estimated $14.6 billion industry output to estimate the industry value added, labour cost, and total intermediate input costs for the model.

The sectoral composition of intermediate inputs for the whole communications sector is then used to estimate the specific inputs for each sector into the mobile communications sector. Similarly the shares of other value added components for the whole sector are used to estimate the costs of other factors into the mobile communications sector.

The left half of table A.2 summarises the cost structure of the mobile communications sector in 2005-06. Intermediate inputs account for 65.4 per cent of the total cost, with the

top 10 input sectors accounting for 52.6 per cent. Labour and capital costs account for 11.9 per cent and 21.3 per cent, respectively.

A.2 The cost and use structures of mobile communications 2005-06

Costs	$m	Per cent	Uses	$m	Per cent
Intermediate inputs	***9574.7***	***65.4***	***Total industrial use***	***8493.3***	***58.0***
Top 10 sectors	*7698.3*	*52.6*	*Top 10 sectors*	*6539.9*	*44.6*
Business Services	2917.9	19.9	Trade	1593.4	10.9
Electronic Equipment	1391.4	9.5	Business Services	1438.7	9.8
Construction Services	899.9	6.1	Technical Services	928.0	6.3
Technical Services	593.7	4.1	Public Services	760.6	5.2
Trade	496.6	3.4	Transport Services	523.5	3.6
Financial Services	321.7	2.2	Education	309.3	2.1
Chemicals	317.6	2.2	Other Services	287.9	2.0
Transport Services	287.0	2.0	Other Construction	242.5	1.7
Printing and Publishing	267.3	1.8	Financial Services	238.9	1.6
Metal Products	205.3	1.4	Accom. & Hotels	216.9	1.5
Total value added	***5072.6***	***34.6***	***Total final use***	***6154.0***	***42.0***
Labour	1744.7	11.9	Household	5796.1	39.6
Capital	3120.9	21.3	Government	40.3	0.3
Land	0.0	0.0	Exports	317.6	2.2
Other	207.0	1.4	Other	0.0	0.0
Total cost of production	**14647.3**	**100.0**	**Total use**	**14647.3**	**100.0**

Source: CIE estimates

Use structure

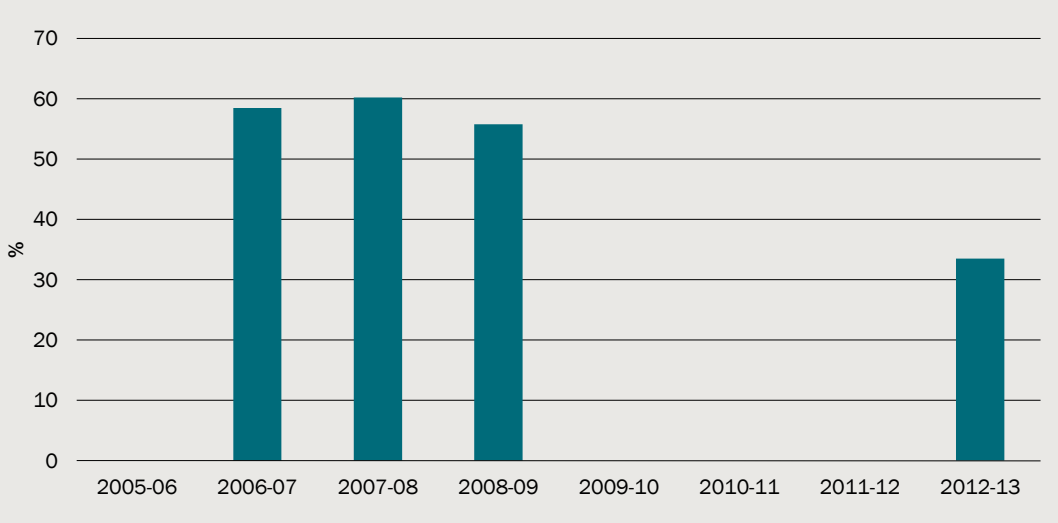
The right half of table A.2 reports the detailed use structure of mobile communications for 2005-06 and indicates 58 per cent of use is by other sectors for the year 2005-06. The top 10 industrial sectors account for 44.6 per cent of the services, and private households just under 40 per cent.

This compares to:

- ABS estimates that the share of industrial use of the mobile communications services was 58.5 per cent for 2006-07, 60.2 per cent for 2007-08 and 55.8 per cent for 2008-09; and
- IBISWorld estimates that the share was 33.5 per cent for 2012-13 (chart A.3).

These differences may reflect measurement differences and changes in use through time. The economic model shows a decline in industrial use through time and is therefore consistent with both sources.

A.3 Industrial use share of mobile broadband



Data source: 2006-07 through to 2008-09 from ABS, 2012-13 from IBISWorld

Rolling forward the model

The next step of the modelling is to roll forward the model with the newly constructed database from 2005-06 to 2012-13 using a modelling program called RunDynam. It runs a series of year-on-year simulations of the model with macro and industry specific targets and shocks. These targets and shocks include:

- Annual growth of gross state product (table A.4);
- Annual growth of regional population (table A.5);
- Annual growth of national employment, investment, household consumption, and exports (table A.6); and
- Annual growth of the mobile broadband industry activity (volume) and productivity improvement (table A.7)

In a normal simulation, most of these targets are generally endogenous, that is, determined by the model run. In the rolling forward or projection simulations, these targets are achieved through adjusting some usually exogenous variables.

A.4 Annual growth rate of gross state product

	NSW	VIC	OLD	SA	WA	TAS	NT	ACT
2006-07	2.1	3.8	5.7	2.0	6.2	2.7	5.7	4.4
2007-08	2.9	3.5	4.8	5.8	3.9	2.9	7.0	3.1
2008-09	1.0	1.1	1.0	1.9	4.3	2.4	4.8	4.1
2009-10	2.0	1.9	1.4	1.0	4.3	0.1	1.2	3.1
2010-11	2.6	2.7	1.0	2.3	4.0	0.2	1.2	3.2
2011-12	2.4	2.3	4.0	2.1	6.7	0.5	4.4	3.5
2012-13	2.0	2.0	3.8	1.8	6.0	2.3	3.9	2.0

Source: CIE compilation based on ABS Cat.No.5220.0; 2012-13 forecast based on State Treasury projections.

A.5 Annual growth of regional population

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
2006-07	1.4	1.8	2.6	1.2	2.7	0.8	2.2	2.2
2007-08	1.6	2.0	2.6	1.1	3.1	1.1	2.9	1.7
2008-09	1.6	2.2	2.6	1.3	3.2	1.2	2.8	1.8
2009-10	1.3	1.7	1.8	1.1	2.3	0.9	1.7	2.0
2010-11	1.0	1.4	1.6	0.8	2.7	0.5	0.7	1.7
2011-12	1.1	1.6	2.0	1.0	3.4	0.2	1.7	1.9
2012-13	1.1	1.4	2.1	1.0	2.0	0.7	1.5	1.2

Source: CIE compilation based on ABS Cat.No.3218,0; ABS projections for 2012/13 series B.

A.6 Annual growth of national macroeconomic variables

	Investment	Household consumption	Exports	Federal government spending	State government spending	Employment
2006-07	8.7	5.5	3.3	6.9	0.5	2.8
2007-08	9.5	2.8	4.1	4.7	4.2	3.1
2008-09	-4.6	0.2	0.7	1.5	2.3	1.0
2009-10	5.8	2.8	7.1	4.7	3.1	0.1
2010-11	5.7	3.4	-2.3	2.3	2.2	2.7
2011-12	10.0	3.3	5.9	6.7	2.1	1.4
2012-13	-1.3	1.9	6.5	0.4	0.7	0.5

Source: CIE compilation based on ABS Cat.No.5206,0

A.7 Annual growth of mobile broadband industry

	Volume	Productivity
2006-07	10.5	3.0
2007-08	12.1	6.5
2008-09	13.9	9.5
2009-10	16.7	11.8
2010-11	15.4	13.3
2011-12	9.8	14.2
2012-13	11.9	14.6

Source: CIE estimates

Shocks used in the economic model

The shocks applied to the economic model to represent the without mobile broadband scenario are shown in table A.10 (productivity of the mobile sector), table A.11 (productivity from reported time saved) and table A.12 (additional productivity from cost reduction from lower inputs).

The process for generating these shocks is as follows.

For the shocks to the mobile communications sector, these are generated directly from the productivity analysis discussed in chapter 6.

For the shocks from the use of mobile communications by business, the following approach is adopted.

- The cumulative shock in 2013 for time savings is based directly on the survey responses for time savings for each sector. For example, if the weighted average impact for the sector is a 3 per cent time saving, then this represents the cumulative time saved by mobile broadband to 2013.
- The cumulative time saving between a 'with' and 'without' mobile broadband scenario builds over time to its 2013 level. We match the pattern of annual impacts to the pattern of data usage for Australia. This pattern is set out in table A.8.
- The time savings from mobile broadband (or additional time without mobile broadband) is applied as an increase in the amount of labour required to produce a given output, with the use of other factors held constant.

Only using time savings is a conservative approach to taking the survey responses to the economic modelling. The cost savings indicated by businesses are substantially higher than can be captured by time savings alone. As a sensitivity, we model an additional shock to the use of intermediate inputs into production, as follows.

- We assume that the total cost savings indicated by businesses apply to labour costs and intermediate inputs only.
- For each sector, we estimate the gap between the total cost savings and the time savings indicated by businesses as:
  - Gap = Total cost saving – time saving*labour share of operating costs
- We apply this gap to the intermediate input share of operating costs as:
  - Intermediate input cost saving = gap/intermediate input share of operating costs
- This is set out in table A.9.
- We apportion this to annual changes based on the pattern of data usage set out in table A.8.
- The annual shocks are then applied to all intermediate inputs used by each sector.

Note that for all sectoral shocks the shocks are calculated for 19 aggregate sectors and applied based on concordances between these sectors to 53 sectors in the economic model.

A.8 Time pattern of shocks

Year	Annual impact	Cumulative impact
	Per cent	Per cent
2006	0.0	0.0
2007	0.4	0.4
2008	2.7	3.1
2009	6.5	9.6

Year	Annual impact	Cumulative impact
	Per cent	Per cent
2010	13.7	23.3
2011	21.2	44.5
2012	22.2	66.7
2013	33.3	100.0

Source: The CIE.

A.9 Calculating additional cost shock

Sector	Total cost	Time	Labour share of operating costs	Intermediate input share of operating costs	Shock applied to intermediate inputs
	Per cent	Per cent	Per cent	Per cent	Per cent
Accommodation and food services	1.41	2.58	29.4	70.6	0.93
Administrative and support services	3.63	1.68	26.3	73.7	4.33
Agriculture, forestry and fishing	1.05	2.08	15.1	84.9	0.87
Arts and recreation services	0.65	1.85	20.2	79.8	0.35
Construction	1.88	2.43	19.5	80.5	1.74
Education and training	1.70	2.15	68.2	31.8	0.73
Electricity, gas, water and waste services	0.00	8.18	22.0	78.0	-2.30
Financial and insurance services	2.09	2.58	47.8	52.2	1.64
Health care and social assistance	0.09	2.26	75.6	24.4	-6.59
Information media and telecommunications	0.33	1.07	22.5	77.5	0.11
Manufacturing	2.16	1.63	16.3	83.7	2.27
Mining	0.84	2.14	30.2	69.8	0.28
Other services	1.17	1.68	47.9	52.1	0.71
Professional, scientific and technical services	1.04	2.45	39.0	61.0	0.13
Public administration and safety	2.37	1.41	44.3	55.7	3.13
Rental, hiring and real estate services	0.62	1.79	0.3	99.7	0.62
Retail trade	1.47	2.55	33.3	66.7	0.94
Transport, postal and warehousing	4.88	2.94	26.0	74.0	5.56
Wholesale trade	0.75	2.48	33.3	66.7	-0.11

Source: The CIE.

A.10 Annual productivity growth of mobile communications sector

Sector	2006	2007	2008	2009	2010	2011	2012	2013
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
With mobile broadband	0.0	3.0	6.5	9.5	11.8	13.3	14.2	14.6
Without mobile broadband	0.0	3.0	6.0	8.0	8.8	8.5	6.9	6.1
Difference	**0.0**	**0.0**	**-0.6**	**-1.6**	**-3.0**	**-4.8**	**-7.3**	**-8.4**

Source: The CIE.

A.11 Cumulative productivity loss without mobile broadband — time saved

Sector	2006	2007	2008	2009	2010	2011	2012	2013
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Accommodation and food services	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.7	-2.6
Administrative and support services	0.0	0.0	-0.1	-0.2	-0.4	-0.7	-1.1	-1.7
Agriculture, forestry and fishing	0.0	0.0	-0.1	-0.2	-0.5	-0.9	-1.4	-2.1
Arts and recreation services	0.0	0.0	-0.1	-0.2	-0.4	-0.8	-1.2	-1.8
Construction	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.6	-2.4
Education and training	0.0	0.0	-0.1	-0.2	-0.5	-1.0	-1.4	-2.1
Electricity, gas, water and waste services	0.0	0.0	-0.2	-0.8	-1.9	-3.6	-5.5	-8.2
Financial and insurance services	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.7	-2.6
Health care and social assistance	0.0	0.0	-0.1	-0.2	-0.5	-1.0	-1.5	-2.3
Information media and telecommunications	0.0	0.0	0.0	-0.1	-0.2	-0.5	-0.7	-1.1
Manufacturing	0.0	0.0	0.0	-0.2	-0.4	-0.7	-1.1	-1.6
Mining	0.0	0.0	-0.1	-0.2	-0.5	-1.0	-1.4	-2.1
Other services	0.0	0.0	-0.1	-0.2	-0.4	-0.7	-1.1	-1.7
Professional, scientific and technical services	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.6	-2.5
Public administration and safety	0.0	0.0	0.0	-0.1	-0.3	-0.6	-0.9	-1.4
Rental, hiring and real estate services	0.0	0.0	-0.1	-0.2	-0.4	-0.8	-1.2	-1.8
Retail trade	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.7	-2.6
Transport, postal and warehousing	0.0	0.0	-0.1	-0.3	-0.7	-1.3	-2.0	-2.9
Wholesale trade	0.0	0.0	-0.1	-0.2	-0.6	-1.1	-1.7	-2.5

Note: Applied to labour input.
Source: The CIE.

A.12 Cumulative productivity loss without mobile broadband — additional cost reduction

Sector	2006	2007	2008	2009	2010	2011	2012	2013
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Accommodation and food services	0.0	0.0	0.0	-0.1	-0.2	-0.4	-0.6	-0.9
Administrative and support services	0.0	0.0	-0.1	-0.4	-1.0	-1.9	-2.9	-4.3
Agriculture, forestry and fishing	0.0	0.0	0.0	-0.1	-0.2	-0.4	-0.6	-0.9
Arts and recreation services	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.2	-0.3
Construction	0.0	0.0	-0.1	-0.2	-0.4	-0.8	-1.2	-1.7
Education and training	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.7
Electricity, gas, water and waste services	0.0	0.0	0.1	0.2	0.5	1.0	1.5	2.3
Financial and insurance services	0.0	0.0	-0.1	-0.2	-0.4	-0.7	-1.1	-1.6
Health care and social assistance	0.0	0.0	0.2	0.6	1.5	2.9	4.4	6.6
Information media and telecommunications	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
Manufacturing	0.0	0.0	-0.1	-0.2	-0.5	-1.0	-1.5	-2.3
Mining	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3
Other services	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.5	-0.7
Professional, scientific and technical services	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1
Public administration and safety	0.0	0.0	-0.1	-0.3	-0.7	-1.4	-2.1	-3.1
Rental, hiring and real estate services	0.0	0.0	0.0	-0.1	-0.1	-0.3	-0.4	-0.6
Retail trade	0.0	0.0	0.0	-0.1	-0.2	-0.4	-0.6	-0.9
Transport, postal and warehousing	0.0	0.0	-0.2	-0.5	-1.3	-2.5	-3.7	-5.6
Wholesale trade	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1

Note: Applied to intermediate inputs for each sector.
Source: The CIE.

B Pricing plans for mobile services

The output weights for connections, voice minutes and data usage were derived from 2013 pricing plans for Telstra, Optus and Vodafone. This Attachment sets out the pricing plans used.

B.1 Retail pricing strategies by operator for contracts including both a SIM and mobile phone

SIM + phone plans	Telstra	Optus	VHA
AUD 60 SIM + phone plans			
Monthly cost (AUD)	60	60	60
Monthly value (AUD)	600	0	700
Free Minutes	0	600	0
Free SMS	Unlimited	Unlimited	Unlimited
Free data (Mbytes)	1000	1000	1500
Free on-net	Texts	Texts	Calls, Texts
AUD 80 SIM + phone plans			
Monthly cost (AUD)	80	80	80
Monthly value (AUD)	800	0	80
Free Minutes	Unlimited night calls	800	Unlimited
Free SMS	Unlimited	Unlimited	Unlimited
Free data (Mbytes)	1500	2000	2000
Free on-net	Texts	Texts	Calls, texts
AUD 100 SIM + phone plans			
Monthly cost (AUD)	100	100	100
Monthly value (AUD)	900	0	100
Free Minutes	Unlimited night and weekend calls	Unlimited	Unlimited
Free SMS	Unlimited	Unlimited	Unlimited
Free data (Mbytes)	2000	3000	5000
Free on-net	Texts	Calls, texts	Calls, texts

Source: Operator websites, 2013

B.2 Retail pricing strategies by operator for contracts including only a SIM-card

SIM-only plans	Telstra	Optus	VHA
AUD 20-30 AUD SIM-only plans			
Monthly cost (AUD)	-	25	20
Monthly value (AUD)	-	0	200
Free Minutes	-	100	0
Free SMS	-	Unlimited	0
Free data (Mbytes)	-	200	200
Free on-net	-	Texts	n/a
AUD 30-40 AUD SIM-only plans			
Monthly cost (AUD)	-	40	35
Monthly value (AUD)	-	0	500
Free Minutes	-	500	0
Free SMS	-	Unlimited	Unlimited if not free on-net calls chosen
Free data (Mbytes)	-	1000	1000
Free on-net	-	Texts	Calls, if not unlimited texts chosen
AUD 60-70 AUD SIM-only plans			
Monthly cost (AUD)	60	65[65]	65
Monthly value (AUD)	800	0	80
Free Minutes	Unlimited night calls	Unlimited	Unlimited
Free SMS	Unlimited	Unlimited	Unlimited
Free data (Mbytes)	1500	2000	2000
Free on-net	Texts	Calls, texts	Calls, texts

Source: Operator websites

B.3 Retail pricing strategies by operator for prepaid plans

Prepaid + MBB plans	Telstra	Optus	VHA
Prepaid 30 AUD			
Monthly cost (AUD)	30[66]	30[67]	30
Monthly value (AUD)	250 or 30	30	450
Free Minutes	Free nights or 250	250	0
Free SMS	Free nights or 250	Unlimited	Unlimited
Free data (Mbytes)	400 or 200	500	500

65 12 month "My Sim Plan"

66 This shows the options when choosing either the "Telstra Pre-Paid Beyond Talk" or the "Telstra Pre-Paid Cap Encore" plans; the "Telstra Pre-Paid Simplicity" plan and the "Telstra Pre-Paid Long Life" cannot meaningfully be compared in the context of this comparison

67 "Optus Prepaid Social" plan; the other options of Optus cannot meaningfully be compared in the context of this table

Free on-net	n/a	Calls	n/a
Prepaid 50 AUD			
Monthly cost (AUD)	50	50	50
Monthly value (AUD)	50 or 1000	50	1000
Free Minutes	500 or unlimited night calls	450	0
Free SMS	Unlimited or unlimited night texts	Unlimited	Unlimited
Free data (Mbytes)	400 or 800	2500	1000
Free on-net	n/a or 1cent texts to Telstra mobiles	Calls, texts	n/a

Source: Operator websites, 2013

B.4 Retail pricing strategies by operator for MBB plans

Mobile broadband	Telstra	Optus	VHA
Monthly cost (AUD)	35	30	30
Monthly device cost (AUD)	0	2.5[68]	0[69]
Free data (Mbytes)	4000	4000	4000

68 Assumes the cheapest device available, the "USB Classic Modem"

69 Assumes the cheapest device available, the "USB Classic Modem"

C Summary of past studies on technology impacts

C.1 Research on the relationship between broadband and economic development

Author	Title	Year	Technology	Methodology/data	Impact
Ericsson in conjunction with Arthur D. Little and Chalmers University of Technology	Economic effects of broadband access speed on households	2013	Broadband	Statistical regression analysis based on 2010 survey data from Ericsson ConsumerLab (22 000 respondents from 14 OECD and BRIC countries).	The average increase in household income for a broadband speed upgrade from 4 to 8 Mbps was estimated at US$120 per month in OECD countries.
Phillipa Marks, David Lewin, Yi Shen Chan and Sarongrat Wongsaroj	The economic benefits from deploying 1.4GHz spectrum for a mobile broadband supplemental downlink in the MENA region	2012	Use of 1452-1492 MHz for a supplemental downlink for mobile broadband services	Multi-country analysis with estimated benefits based on: ▪ costs avoided by upgrading existing base stations rather than building new ones; ▪ the benefits of better quality of service in terms of (primarily) in-building coverage.	NPV of the benefits estimated to US$26 billion. Results vary greatly by country. Net present values calculated over a 10-year period from 2015 using a 10 per cent pa discount rate.
Shane Greenstein and Ryan McDevitt	Measuring the broadband bonus in thirty OECD countries	2012	Broadband	Historical cross-country comparison of the consumer surplus and the net gain in producer revenue of transition to broadband internet in each OECD country (between 2005 and 2010).	The economic value created in 30 OECD countries correlates roughly with the overall size of their broadband economies. The aggregate broadband bonus (consumer surplus and the net gain in producer revenue) is US$156.7 billion (or US$548.3billion when adjusted for quality improvements).
Ibrahim Kholilul Rohman and Erik Bohlin	Does broadband speed really matter as a driver of economic growth? Investigating OECD countries	2012	Broadband	Adapted econometrics model derived from Lehr et al (2005), which employs cross-sectional panel data set of communities (by zip code) across the US matched against data from the FCC on broadband availability.	Quantifies the isolated impact of speed, showing that doubling the broadband speed for an economy will contribute 0.3 per cent growth compared with the growth rate of the base year.
Deloitte	What is the impact of	2012	3G and mobile data	Impact of mobile data on GDP growth — dynamic	For a given level of total mobile penetration, a 10

Author	Title	Year	Technology	Methodology/data	Impact
	mobile telephony on economic growth?			panel data estimation method. The dataset employed consists of 14 countries for which data from Cisco Systems is available. Impact of 3G penetration — Econometric approach follows previous work by Andrianaivo and Kpodar (2011) and Lee, Levendis and Gutierrex (2009). A panel of 96 countries is used.	per cent substitution from 2G to 3G penetration increases GDP per capita growth by 0.15 percentage points. A doubling of mobile data use leads to an increase in GDP per capita growth rate of 0.5 percentage points.
Shane Greenstein, Ryan McDevitt	The broadband bonus: accounting for broadband internet's impact on US GDP	2009	Broadband	Numerical estimates based on historical data from 1999 to 2006. No measurement of indirect benefits.	The direct, net impact of broadband's deployment was approximately $8.3 to $10.6 billion of new GDP in 2006. An additional $4.8-6.7 billion in new consumer surplus was created by broadband (net of what would have accrued with dial-up service). This study does not consider indirect benefits and nets out the benefits from replaced technology.
Pantelis Koutroumpis	The economic impact of broadband on growth: A simultaneous approach	2009	Broadband	A macroeconomic production function with a micro-model for broadband investment is used. The scope of this research is 22 OECD countries based on data collected for the period 2002-2007.	An increase in broadband penetration of 10 per cent yields 0.25 per cent increase in GDP growth.
Christine Zhen-Wei Qiang and Carlo M. Rossotto (World Bank)	Economic impacts of broadband	2009	Broadband	Cross-country empirical model using 1980-2002 data from 66 developed countries.	A 10 per cent increase in broadband penetration yields an additional 1.21 percentage points of GDP growth.
Nina Czernich, Oliver Falck, Tobias Kretschmer, Ludger Woessmann	Broadband Infrastructure and Economic Growth	2009	Broadband	Measures the effect of broadband on economic growth in the panel of OECD countries in 1996-2007 using an instrumental-variable model, which derives its non-linear first stage from a logistic diffusion model where pre-existing voice-telephony and cable-TV networks predict maximum broadband penetration.	A 10 percentage-point increase in broadband penetration raises annual per-capita growth by 0.9-1.5 percentage points.
Herbert Thompson and Christopher Garbacz	Broadband impacts on State GDP: direct and	2008	Broadband	US direct effects estimated by regressing broadband penetration rates on state GDP per	No statistically significant direct effects associated with broadband services.

Author	Title	Year	Technology	Methodology/data	Impact
	indirect impacts			capita. Indirect effects based on model developed in (Thompson and Garbacz, 2007) which employs a stochastic-frontier production functions approach where broadband penetration is modelled as an inefficiency reducing factor.	A 10 per cent increase in broadband penetration associated with 3.6 per cent increase in efficiency (indirect effect).
Robert Atkinson, Daniel Castro and Stephen Ezell	The digital road to recovery: A stimulus plan to create jobs, boost productivity and revitalize America	2009	Broadband networks, health IT and the smart power grid	Direct employment created estimated using industry-specific data on employee compensation provided by the Bureau of Labour Statistics. Indirect and induced jobs created estimated using industry-level employment multipliers from the Bureau of Economic Analysis. A network effect multiplier of 1.17 was added to estimate additional job growth based on the expected immediate network effect.	Additional investment of $30 billion in America's IT network infrastructure in 2009 would create around 949 000 US jobs. Approximately 525 000 of these jobs are estimated to be in small businesses.
Robert Crandall, William Lehr, and Robert Litan	The effects of broadband deployment on output and employment: A cross-sectional analysis of US data	2007		Input-output matrix and cross sectional analysis using FCC data on broadband penetration for the lower 48 States of US for the period 2003-2005	Not statistically significant results for broadband impact on GDP growth. For every 1 per cent point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 per cent per year 'assuming the economy is not already at full employment'.
Deloitte Access Economics	Mobile nation: The economic and social impacts of mobile technology	2013	Measures growth in MFP across all industries from ICT	Based on an assessment of the ICT impact on MFP (based on PC data) and multiplying by the share of business use of mobile/ business use of ICT (ABS data and IBIS world). This results in ranges for the impact of mobile technology on MFP from 0.03 — 0.1 per cent. These productivity values were imputed into the Deloitte Access Economics' CGE Model (DAE-GEM).	MFP benefit to the Australian economy of $11.8 billion from 2011–2025. Productivity benefits expected to grow over time — to $1.8 billion in 2025. The peak contribution to FTE employment (in 2013) is estimated at 3 600. Cumulative benefits are in NPV terms out to 2025 in 2012 dollars using a discount rate of 7 per cent.

Source: The CIE.

D Household demand impacts from mobile broadband

An economic model does not capture all the benefits that arise from mobile broadband. In particular, an economic model (and measures such as GDP) does not capture all changes in the value of mobile broadband to households from quality change. For example because of higher speeds, greater network coverage and a greater variety of applications and content accessible through mobile broadband. Some part of this value has been included through defining mobile outputs to include voice minutes and data usage. However, there are likely to be remaining changes in the quality of services that are not reflected in the economic model.

We do not include this benefit from higher quality not already captured in the economic model due to the greater uncertainty around the estimate of its magnitude.

Household benefits from mobile broadband

Households are a major user of mobile broadband services. They benefit from the productivity impacts of mobile broadband through lower prices, as discussed in chapter 7. But there may be an additional benefit to households as the value they place on the outputs of mobile communications increases. This benefit to households is not captured within the economic modelling presented in chapter 8 or in measures of Gross Domestic Product[70].

Household consumption of outputs from the mobile communications sector has increased rapidly over time, as discussed in chapter 6. This increase over time may reflect:

- lower prices for mobile services and hence a response from households to increase demand because mobile communications is cheaper — this is represented by a movement along the demand curve (A to B in chart D.1); and/or
- higher value for the same quantity of output from mobile services — this is an outward shift in the demand curve for mobile services (such as a movement from A on demand curve D to C on demand curve D' in chart D.1).

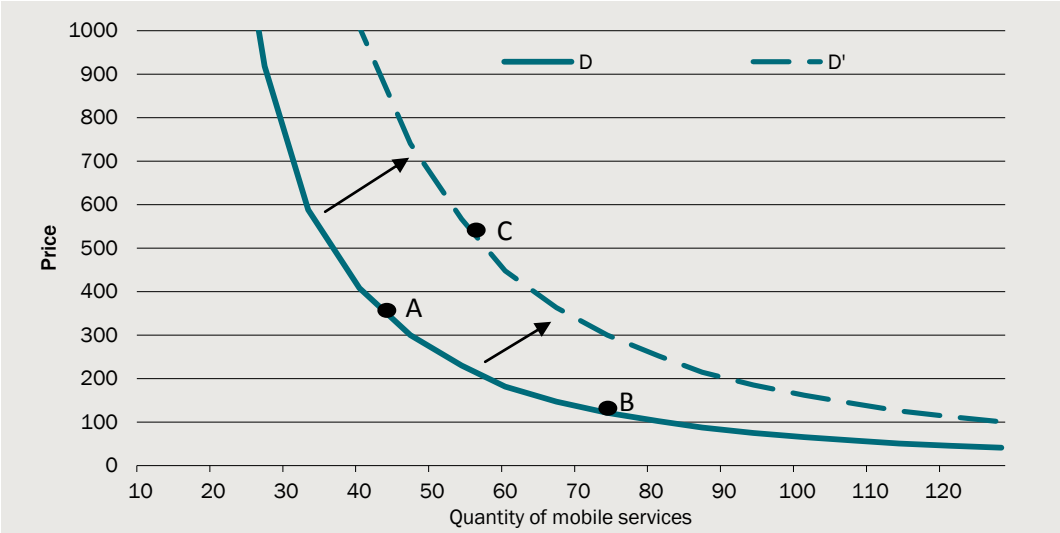
The benefits to consumers are higher in the second case, because people are placing a greater value on the mobile communications outputs that they purchase.

Our analysis suggests that the changes observed in the market likely reflect both of these impacts. That is, the quantity of mobile communications consumed is increasing both

70 A similar point has been made by Greenstein, S. and R. McDevitt (2011), "The broadband bonus: estimating broadband internet's economic value", *Telecommunications policy,* Vol. 35, No. 7, pp 617-632.

because of falling prices and because of greater value from consuming it. Changes that could increase consumer value for a given level of consumption of mobile services could include a wider range of applications and content available, greater network coverage and improved network speed. A part of these changes are covered because consumers respond by increasing their data and voice use, but there is an additional level of value not reflected in the economic modelling.

D.1 Changing demand for mobile communications through time



Source: The CIE.

If the demand curve is moving outward because of quality change, then the economic modelling results might understate the full value of this technology.[71] The higher value of consumption is the vertical distance between the original demand curve (D) and the new demand curve (D').

In order to measure the magnitude of the additional consumer benefits from mobile broadband, we consider what combination of consumer response to lower price and consumer response from greater value would have led to the outcomes observed in Australia for mobile communications. The first part will reflect the change in prices and the amount that consumers respond to prices — known as the price elasticity of demand. The second part reflects the difference between observed market outcomes and what could be driven by price responsiveness alone.

Price elasticity estimates for mobile services

A number of studies discuss the price elasticity of demand for mobile services. Plum Consulting considered the studies presented in table D.1 in its report on the use of the

71 Potentially, this impact could be included through adjusting outputs to account for quality/consumer value from a given amount of output.

1.4GHz band in the MENA region[72]. These are generally measured for mobile services rather than mobile broadband. (Our data on prices and outputs is for mobile services.) The average range for these studies is -0.56 to -0.92. The average minimum is calculated using the minimum from each study or point estimate if no minimum is provided. The average maximum is calculated using the maximum from each study or point estimate if no range is provided.

D.1 Price elasticity impacts for mobile communications

Authors	Countries	Price elasticity of demand for mobile services
Srinuan et al (2012)	Sweden	-0.479 to -3.623 (mobile broadband) (1)
Hazlett and Munoz (2009)	US	-1.12 (mobile services)
Dewenter and Haucap (2008)	Austria	-0.74 (mobile services for business customers) -0.36 (mobile services for consumers)
Cadman and Dineen (2008)	28 OECD countries (mainly high income)	-0.43 (broadband, not specifically mobile) (2)
Hausman and Sidak (2007)	Ireland	-0.84 (mobile services)
Europe Economics (2006)	UK (based on review of secondary sources)	-0.3 to -0.47 (mobile services)
Garbacz and Thompson Jr (2005)	Developed countries	-0.5 (mobile services)
Ida and Kuroda (2005)	Japan	-0.564 to -0.783 (3G mobile services) -0.231 to -0.303 (2G mobile services)
Average		**-0.56 to -0.92**

Note: Notes: (1) Price elasticity for mobile broadband higher in areas where 3 or 4 alternatives broadband options (e.g. DSL, cable, fibre) are available. Price elasticity for mobile broadband lower in rural areas where broadband infrastructures are underdeveloped. Mobile broadband considered a significant substitute for DSL in rural areas. (2) Long run elasticity.

Source: Plum Consulting, *The economic benefits from deploying 1.4 GHz spectrum for a mobile broadband supplemental downlink in the MENA region,* A report for Ericsson and Qualcomm, 12 October 2012 — the studies quoted in the table are sourced to their original authors in Figure C-9 of the Plum report.

The Swedish study[73] quoted in the report from Plum makes a distinction between areas where two, three or four broadband technologies are available, as presented in table D.2. It concludes that the price elasticity increases in line with the number of broadband technologies available to a given (potential) subscriber, reflecting the fact that a subscriber has a higher willingness to pay when offered only a limited range of options (as there is only limited substitutable services).

72 Plum Consulting, *The economic benefits from deploying 1.4 GHz spectrum for a mobile broadband supplemental downlink in the MENA region,* A report for Ericsson and Qualcomm, 12 October 2012.

73 Pratompong Srinuan, Chalita Srinuan and Erik Bohlin (2012). "Fixed and mobile broadband substitution in Sweden", *Telecommunications Policy*, 36, 237-251.

D.2 Own-price elasticity in Sweden in areas with four, three or two broadband technologies available

	Area 1 (four technologies available)	Area 2 (three technologies available)	Area 3 (two technologies available)
DSL	– 2.727	– 2.085	– 0.275
Cable	– 1.342	Not available	Not available
LAN/fibre	– 1.439	– 1.553	Not available
Mobile broadband	– 3.623	– 2.667	– 0.479

Source: Pratompong Srinuan, Chalita Srinuan and Erik Bohlin (2012). Fixed and mobile broadband substitution in Sweden. *Telecommunications Policy*, 36, 237-251.

The studies present a wide range of own-price elasticity figures, although the majority suggest that quantity responds less than a given change in price (i.e the elasticity is between 0 and -1.0). That is a 1 per cent increase in price corresponds to somewhat less than a 1 per cent reduction in demand.

How much of the change in demand is from price responsiveness?

In order to estimate how much of the change in quantity of mobile communications demanded in Australia reflects the reduction in price versus an increase in demand, we develop a simple model for the sector.

- The demand for the sector is specified as a constant price elasticity of demand function and calibrated to match 2006 outputs and prices.[74]
- The output under 2013 prices is estimated for this demand function.
- The 2013 actual prices and demand are adjusted so that prices are adjusted for CPI and demand is adjusted for population growth. Specifically, prices are adjusted by the change in the CPI from 2006 to 2013 and output is adjusted by the change in population from 2006 to 2013.
- The outward shift in the demand function is estimated to calibrate to 2013 adjusted prices and outputs.

We test results of this analysis under various assumptions about the price elasticity of demand.

If consumers are not very responsive to prices then this would indicate that the observed changes largely reflect an increase in value (i.e. upward shift). If consumers respond more to price then the observed changes in output would largely reflect a price impact.

In table D.1 we show the results. Under the mid-point price elasticity estimated from other studies of -0.75, value per unit of output consumed of mobile communications has increased by an estimated 22 per cent. There is substantial variation in the estimated increase in value under different elasticities.

74 A constant price elasticity function is $Q = A.P^{\varepsilon}$ where Q is quantity, P is price, A is a constant and ε is the own-price elasticity.

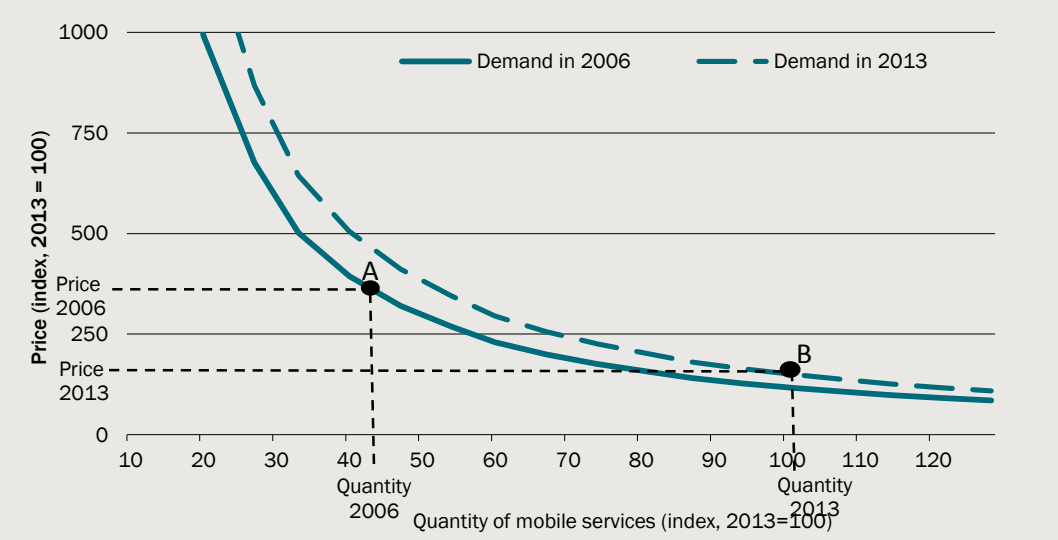
D.1 Increase in value (upward shift) under alternative assumptions

Demand elasticity	Implied additional value per unit of output
	Per cent
-0.25	793
-0.50	101
-0.75	22
-1.00	-5
-1.25	-16

Source: The CIE.

The explained market movements are shown in chart D.2. We know from our market analysis that mobile services quantity and prices has moved from A to B. Part of this movement reflects the consumer response to lower prices and part reflects a shift upwards in the demand curve.

D.2 Explaining market outcomes



Data source: The CIE.

The uplift in demand can be attributed a value to Australian households. This reflects the gap between the demand curve from 2006 and the population adjusted demand curve from 2013.[75] For example, a 22 per cent uplift in 2013 in the demand curve would equate to $111 per connection, given that revenue per connection in 2013 is $615. Applied across all household connections, the additional consumer gains are then estimated at $2.4 billion in 2013. The estimated range is wide at $0.2 to $5.5 billion, using the range of elasticities from past studies set out in table D.1.

75 That is, the additional consumer surplus is equal to $\int_{Q=0}^{Q2013}[D_{2013}(Q) - D_{2006}(Q)]dQ$, where D is the demand function and Q is quantity. To be conservative we apply the distance at the current level of consumption (Q_{2013}) across all consumption levels, meaning the additional consumer surplus is $Q_{2013}.[D_{2013}(Q_{2013}) - D_{2006}(Q_{2013})]$. Note we apply this on a per capita basis because of the adjustment for population.

This mid-point estimate of additional value is equivalent to giving households an additional $105 per person.

D.3 Additional consumer value from consumption of mobile broadband

	Unit	Mid-point	Max	Min
Elasticity	No.	-0.75	-0.56	-0.92
Revenue per connection 2013	$	615	615	615
Increase in demand curve	Per cent	22	71	2
Additional value per connection 2013	$	111.3	255.4	9.8
Connections	Million	32.2	32.2	32.2
Household share [a]	Per cent	67	67	67
Additional household value in 2013 [b]	$b	2.4	5.5	0.2
Additional household value per person	$/person	105	241	9

[a] The household share is based on IBISWorld 2013, Industry report, Wireless telecommunications carriers in Australia, May.
[b] Additional household value is calculated as the value per connection multiplied by the number of connections multiplied by the household share.
Source: The CIE.

There is considerable uncertainty about these estimates of consumer value that is additional to value already modelled. This reflects:

- uncertainty around the shape and responsiveness of demand for mobile communications to prices — as shown above the results are sensitive to this assumption;
- uncertainty about how value has changed along the demand curve — observed changes can only provide information about changes in value at the margin; and
- the presence of other factors that could impact on demand but are not quality factors and have not been accounted for. For example higher incomes, changes in substitute or complementary products or slow diffusion might also explain demand changes.

For these reasons, the estimates of value from additional quality set out above have not been included in the main impacts of mobile broadband presented in this report.

Key points

Households have rapidly expanded their consumption of mobile communications. This reflects both a price effect from a reduction in prices and a quality effect, as using mobile communications provides more value to households than it used to. This latter effect is difficult to value precisely. Our estimates put this at between $0.2 to $5.5 billion in 2013, equivalent to $9 to $241 per person.

E Survey questionnaire

E.1 Survey questions

Segment	Questions
Business Particulars	1 How many employees do you have currently in Australia? (FTE) [use bands if won't answer] ☐ 1–4 ☐ 20–199 ☐ 5–19 ☐ >200 2 What is the main industry in which your business/organisation operates ☐ Agriculture, forestry and fishing ☐ Mining ☐ Manufacturing ☐ Electricity, gas, water and waste services ☐ Construction ☐ Retail trade ☐ Accommodation and food services ☐ Transport, postal and warehousing ☐ Information media and telecommunications ☐ Financial and insurance services ☐ Rental hiring and real estate services ☐ Professional, scientific and technical services ☐ Administrative and support services ☐ Public administration and safety ☐ Education and training ☐ Health care and social assistance ☐ Arts and recreational services ☐ Other services ☐ Unknown
Mobile broadband use and productivity	3 What percentage of your employees has access to a mobile broadband enabled device that is paid for either fully or partly by your company? ☐ 0% ☐ 51–75% ☐ 1–20% ☐ 76–100% ☐ 21–50% *If 0% go to 3a, otherwise proceed to question 4.* a. Is mobile broadband used at all in the business? ☐ Yes (continue) ☐ No (go to question XX)
	4 What are the mobile devices used for in your business? ☐ Phone calls ☐ Accessing cloud services ☐ Emails ☐ Engaging customers ☐ Internet searching/general internet use access ☐ Updating databases/stock inventory management ☐ Using corporate applications/systems ☐ Other _____
	5 Do you believe using mobile broadband has had any of the following effects? a. Has it reduced costs to your business? ☐ Yes (go to 5b) ☐ DK/NA (go to 5c) ☐ No (go to 5c) b. By approximately what percentage has mobile broadband reduced total costs including wages of your business ☐ 0–2% ☐ 5–10% ☐ 3–4% ☐ More than 10%

Segment	Questions
Mobile broadband use and productivity (continued)	c. Has it saved time for employees ☐ Yes (go to 5d) ☐ DK/NA (go to 5e) ☐ No (go to 5e) d. By approximately what percentage has mobile broadband saved time for your employees who use it? ☐ 0–2% ☐ 5–10% ☐ 3–4% ☐ More than 10% e. Has it increased sales ☐ Yes (go to 5f) ☐ DK/NA (go to 5g) ☐ No (go to 5g) f. By approximately what percentage has mobile broadband increased sales? ☐ 0–2% ☐ 5–10% ☐ 3–4% ☐ More than 10% g. Has it improved the quality of your service/product delivery? ☐ Yes ☐ DK/NA ☐ No h. Has it allowed you access to new markets ☐ Yes ☐ DK/NA ☐ No i. Has it allowed you access to new suppliers ☐ Yes ☐ DK/NA ☐ No

6 Has mobile broadband impacted on your business operations in any way?

☐ Yes ☐ No

If yes, can you indicate whether changes have been in the following areas.

	Changed a lot	*Changed a little*	*No Change*
Employees can access internet anywhere			
Employees use downtime productively (travelling or after hours work)			
Ability to use mobile apps/mobile systems/ cloud services, which assists organisational processes			
Faster document review and decision making			
M2M technologies (phone talks to car) M-payments, e-wallets			
Replace fixed desktop devices			
Ability of employees to work at home or other sites, which can reduce desktop spaces and rent			
M-commerce offering cost savings to bricks and mortar stores (mobile point of sale, iPad type cash registers, e-wallets)			
Increased telecommunication overall			

Other than those mentioned above, can you think of any ways that mobile broadband has changed the way your business operates?

Segment	Questions
Mobile broadband use and productivity (continued)	7 How do you think the impacts of mobile broadband on your business over the next 5 years will differ to those experienced to date? Will the impact be: ☐ Smaller ☐ Larger ☐ The same ☐ DK *Why do you say that* _____
Mobile broadband in relation to other productivity factors	8 What are the top three factors that are the most important for your company to improve productivity? (*note: no more than three choices*) ☐ Skill development of employees ☐ Improving internal systems and processes ☐ More efficient tax system ☐ Investing in mobile broadband ☐ Less government regulation ☐ Investing in machinery, other capital equipment ☐ Investing in IT systems ☐ Other _____
Mobile broadband spend	9 What is your total annual expenditure on telecommunications, such as phones, internet and mobile internet?

0-4 employees	*5-19 employees*	*20-199 employees*	*200+ employees*
☐ Less than $1k	☐ Less than $5k	☐ Less than $50k	☐ Less than $200k
☐ $1.1k–$2k	☐ $5.1k - $10k	☐ $50.1k - $100k	☐ $200.1k - $1m
☐ $2.1k–$5k	☐ $10.1k - $25k	☐ $100.1k - $200k	☐ $1.1m - $5m
☐ $5.1k–$10k	☐ $25.1k - $50k	☐ $200.1k - $500k	☐ $5.1m - $20m
☐ Over $10k	☐ Over $50k	☐ Over $500k	☐ Over $20m
Amount _____	Amount_____	Amount _____	Amount _____

10 What is your total expenditure on telecommunications, such as phones, internet and mobile internet

☐ 0% (go to question 11) ☐ 41–60%
☐ 1–20% ☐ 61–80%
☐ 21–40% ☐ 81–100%

10a. Has your expenditure on mobile broadband enabled devices changed over the past three years?
☐ Yes (go to question 10b)
☐ No (go to question 11)

10b. By approximately what percentage has it changed?
☐ Decrease of more than 20% ☐ Increase of 21–30%
☐ Decrease of 1–20% ☐ Increase of 31–50%
☐ Increase of 0–10% ☐ Increase of 51–100%
☐ Increase of 11–20% ☐ Increase of over 100% _____

Revenue

11 What is the annual revenue of your business?

0-4 employees	*5-19 employees*	*20-199 employees*	*200+ employees*
☐ $0–$100k	☐ 0–500k	☐ $0–$5m	☐ $0-$20m
☐ $101k–$200k	☐ $501k–$1m	☐ $5.1m–$10m	☐ $20.1m - $100m
☐ $201k– $500k	☐ $1.1m–$2.5m	☐ $10.1m–$20m	☐ $100.1m–$500m
☐ $501k– $1m	☐ $2.6m–$5m	☐ $20.1m–$50m	☐ $501m–$2b
☐ Over $1m	☐ Over $5m	☐ Over $50m	☐ Over $2b
Amount _____	Amount_____	Amount _____	Amount _____

Segment	Questions
Revenue (continued)	12 What has been your level of revenue growth in percentage terms over the past three years? ☐ Decline in revenue ☐ 6–10% ☐ No growth ☐ 11–20% ☐ 1–5% ☐ More than 20%
	13 What is your expected level of revenue growth in percentage terms over the next three years? ☐ Decline in revenue ☐ 6–10% ☐ No growth ☐ 11–20% ☐ 1–5% ☐ More than 20%

Source: The CIE and Woolcott Research

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