THE CONTRIBUTION OF BROADBAND TO AUSTRALIA'S ECONOMIC GROWTH: A REVIEW OF THE LITERATURE

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Abstract

In recent years, the connection between economic growth and the take-up and use of broadband has been used to justify significant government intervention and public expenditure in broadband networks. In the United States, stimulus funding has been committed for broadband planning and deployment initiatives. In Australia, the expectation of significant economic benefit has been used to justify government investment in the deployment of a high-speed fibre National Broadband Network (NBN).

The importance of information and communication technologies (ICTs) — which includes broadband networks and infrastructure — to a nation's economic wellbeing is well understood and is documented by a growing body of literature. This paper reviews this growing body of literature and analyses the connection between ICTs, which includes broadband networks and infrastructure, and economic growth. It then focuses on the relevant Australian literature and critically examines the reported connection between the take-up and use of broadband services and Australia's productivity growth and economic development. This paper also highlights some of the strengths and the shortcomings of the literature and explores what these shortcomings may mean for Australian policy makers.

1. Introduction

It is often claimed that widespread access to, and use of, broadband is a driver of productivity gains and economic development. In recent years this claim has been used to justify significant government intervention and public expenditure in broadband networks. In the United States, in the wake of the Global Financial Crisis (GFC), the Obama administration committed US$7.2 billion to expand broadband access and adoption in communities across the country. It is claimed that this funding will:[1]

> increase jobs, spur investments in technology and infrastructure, and provide long-term economic benefits.

The New Zealand Government has argued that access to ultra-fast broadband is part of the essential infrastructure of a productive and growing economy and will be crucial to New Zealand improving its competitive advantage in the global market.[2] Accordingly, NZ$1.5 billion of Government funding has been committed to accelerate the rollout of an ultra-fast broadband network to 75 per cent of New Zealanders.[3]

In Australia, the expectation of significant economic benefit has been used to justify Government funding for the deployment of a high-speed fibre broadband network that will connect 93 per cent of premises across Australia. According to the Australian Government:[4]

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1 Broadband USA, http://broadbandusa.sc.egov.usda.gov/.

2 Minister Hon. Steven Joyce 2009, Ultra-fast broadband investment proposal finalised Media Release 16 September 2009, New Zealand.

3 Ministry of Economic Development 2009, *New Zealand Government Ultra-Fast Broadband Initiative: Overview of Initiative*, New Zealand, p. 1.

4 National Broadband Network, 'Why is broadband essential?', http://www.nbn.gov.au/content/why-broadband-essential.

> The NBN will drive competition, help secure productivity growth and increase Australia's international competitiveness. The NBN will enable teachers to work with a range of online curriculum materials, support the use of interactive content and enhance remote learning opportunities. From Bondi and Balwyn to Broome and Bourke; all Australians will be able to access the best specialist medical care without having to travel long distances; Australian business will become more globally and nationally connected, saving time and money on travel; and families and friends will more easily stay in touch.

In addition to the initiatives of individual countries, the important role of Government in the deployment and use of broadband has received attention from multilateral government organisations such as the United Nation and the OECD. For example, in 2008, member nations of the OECD declared a commitment to:[5]

> Ensure that broadband networks and services are developed to attain the greatest practical national coverage and use.

There is little doubt that broadband has a positive economic effect. Indeed there is a growing body of economic literature documenting how broadband and ICTs in general impact productivity growth and economic development.

Despite the useful contribution that this growing body of literature makes to our understanding of the economic importance of broadband, there is much we still do not know. In particular, as noted by the OECD very few studies have successfully isolated the economic impacts of broadband access from the impacts of complimentary ICTs such as hardware (i.e. computers and communication devices) and software (i.e. applications and software). Additionally, as noted by the Department of Communications Information Technology and the Arts[6] (DCITA), most studies give little or no consideration to the how the economic impacts of increased broadband access compare to the economic impacts from increased access to alternative, albeit inferior, technologies such as dial-up internet access.

This paper consists of four sections. Section 2 provides a brief review of the international literature regarding the economic contribution of ICTs, including broadband. It highlights that over the last decade the overwhelming majority of research suggests a strong positive association between investment in, and use of, ICTs and productivity growth and economic development. Section 3 reviews the Australian literature examining the contribution of broadband to Australia's economic performance. This section highlights that the majority of the current literature finds that the take-up and use of both fixed and mobile broadband has made a positive contribution to Australia's economic growth and employment. Finally, Section 4 makes a number of observations regarding the Australian literature and identifies where further research would benefit our understanding of the economic importance of broadband technology.

2. The contribution of ICTs to productivity growth and economic development: a global perspective

Ever since Robert Solow's quip that 'we see the computer age everywhere but in the productivity statistics'[7] there has been considerable empirical work on the economic impact of computers and other ICTs on growth and productivity. ICTs are generally thought to include: computer technologies such as computer software and hardware, communications technologies such as fixed and mobile telephone devices, telecommunications networks and infrastructure and broadband

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5 OECD 2008, *Broadband and the Economy, Ministerial Background Report* DSTI/ICCP/IE(2007)3/FINAL, Paris, pp. 5–6.

6 The Department of Communications Information Technology and the Arts (DCITA) is now known as the Department of Broadband, Communications and the Digital Economy (BCDE).

7 Solow, R.M (1987), 'We'd Better Watch Out', *New York Times Book Review*, 12 July 1987.

applications; and some broadcasting technologies such as cable television networks. The methodologies that have been used by researchers vary on issues like data availability and different econometric specifications. The broad outcomes of these studies suggest a positive and significant link between investment and use of ICTs and improvements in economic growth and productivity. This section reviews a number of relevant studies over the last decade.

2.1 Computer technologies

A study by Lehr and Lichtenberg[8] uses U.S. firm-level data for non-agricultural firms during the period 1977–93 to estimate the contribution that investment in computer related assets made to improvements in firm level productivity. The principal finding of this study is that computers — especially personal computers — positively contribute to productivity growth. They also find that over the period 1977–93 investments in computers not only contributed to productivity growth, but that they yielded excess returns relative to other types of capital. Based on these findings, the authors conclude that what is traditionally referred to as the 'Computer Productivity Paradox' is largely a measurement problem.

A study by Gera, Gu and Lee[9] uses an empirical model to analyse the effect of IT investments and Research and Development (R&D) spillovers from the IT sector on labour productivity in Canada and the United States. The empirical model consists of a Cobb-Douglas production function that distinguishes between own R&D and R&D spillovers. The findings of this study include: IT investments are an important source of labour productivity growth across industries in both Canada and the United States; that R&D spillovers in Canada are primarily international in scope; that international R&D spillovers from both IT and non-IT sectors contribute significantly to labour productivity growth across Canadian industries; and the international R&D spillovers in Canada from the IT sector are greater than those from the non-IT sector.

A study by Oliner and Sichel[10] investigates the role that ICTs played in the growth of labour productivity in the United Sates in the second half of the 1990's. Using a growth accounting framework, Oliner and Sichel calculate the contribution to output growth from five inputs: computer hardware, computer software, communications equipment other capital and labour hours. They observe that, over the period, stocks of computer hardware and software and network infrastructure swelled boosting their contribution to economic growth. At the same time, producers of computers and semiconductors achieved huge efficiency gains in their operations. The authors find that these developments account for about two-thirds of the acceleration in labour productivity in the United States' nonfarm business sector between the first and second halves of the 1990's.

A study by Oliner, Sichel and Stiroh[11] uses a variety of quantitative modelling techniques including aggregate growth accounting, an assessment of industry-level productivity patterns and Kalman filter and steady-state analysis to examine what contribution ICTs made to the productivity growth experienced by the United Sates over the period 1995–2005. Both the aggregate and industry-level results suggest that ICTs were a key source of productivity growth for the United States over the period 1995–2000 and that after 2000 ICTs made a smaller but still significant contribution to productivity growth.

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8 Lehr. W. and Lichtenberg. F. 1999, 'Information Technology and its impact on Productivity: Firm-level Evidence from Government and Private Data Sources 1977-1993', *Canadian Journal of Economics,* 32(2) (April), pp. 335–62.

9 Gera. S., Gu. W. and Lee. F.C. 1999, 'Information technology and labour productivity growth: and empirical analysis for Canada and the United States', *The Canadian Journal of Economics,* 32 (2) (April), pp. 384–407.

10 Oliner. S.D. and Sichel. D.E. 2000, The Resurgence of Growth in the Late 1990s: 'Is Information Technology the Story', *Journal of Economic Perspectives,* 14(4), pp. 3–22.

11 Oliner. SD. Sichel. D.E. and Stiroh. K.J. 2006, Explaining a productive decade, *Journal of Policy Modeling,* 30, pp. 633–73.

A study by Australia's Productivity Commission[12] analysed firm level effects of using ICTs and concluded that increased use of ICTs during the 1990s raised the rate of growth in Australia's labour productivity and multi-factor productivity. These findings were consistent with those made by the Australian National Office of the Internet Economy (NOIE)[13] after undertaking a series of firm level case studies and found that ICTs contributed up to 1.26 per cent growth in Australia's labour productivity.

NOIE also undertook a study that explored the impact of ICT use on Australia's manufacturing sector.[14] This study concluded that an increase in capital deepening accounted for around 20 per cent of the growth in labour productivity and that during the period 1984–85 to 2000–01 between 65 and 85 per cent of multi-factor productivity growth in manufacturing was due to technological factors. A study by DCITA[15] of Australia's service industry found that, over the same period, between 59 to 78 per cent of total productivity growth could be attributed to the adoption and use of ICTs.

2.2 Communications technologies

Madden and Savage[16] developed a supplyside growth model that relies on teledensity and the share of telecommunications investment in national income as proxy measures for telecommunications use and the stock of telecommunications capital respectively. The results suggest a significant positive cross-country relationship between telecommunications capital and economic growth.

A widely cited study by Roller and Waverman[17] jointly estimates a microeconomic model for telecommunications investment with a macroeconomic production function for the OECD group of nations for the period 1970–90. The authors find a strong causal relationship between telecommunications infrastructure and economic growth. They also find evidence of a critical mass phenomenon, which implies that there are increasing returns on growth at levels approaching universal service. This suggests that increases in telecommunications infrastructure could create higher growth effects in OECD countries than in the less-developed non-OECD countries.

A study by Koutroumpis[18] employs a macroeconomic production function with a microeconomic model for broadband investment to estimate how investment in broadband infrastructure impacted economic growth in 22 OECD countries over the period 2002–07. The results suggest that there is a strong causal link between broadband and economic growth. They also suggest that there are increasing returns to investments in broadband infrastructure and that countries with broadband penetration rates of more than 30 per cent enjoy higher returns from broadband investments relative to those countries with lower broadband penetration rates.

An econometric study by Crandall, Lehr and Litan[19] estimates the effects of broadband penetration on economic output and employment, in aggregate and by industry sector. The study uses data from the Federal Communications Commission (FCC) on broadband penetration for 48 States of the United States over the period 2003–05. The study finds that non-farm employment in several industries is positively associated with broadband use. More specifically, for every one per cent

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12 Productivity Commission 2004*, ICT Use and Productivity: A Synthesis from Studies of Australian Firms*, Canberra.
13 NOIE 2003, *Productivity and Organisational Transformation: Optimising Investment in ICT*, Canberra.
14 NOIE 2004, *Productivity growth in Australian manufacturing, NOIE occasional economic paper*, Canberra.
15 DCITA 2005, *Productivity Growth in Service Industries: Occasional Economic Paper*, Canberra.
16 Madden. G. and Savage. S. 2000, 'Telecommunications and Economic Growth', *International Journal of Social Economics*, 27(7), pp. 893–906.
17 Roller. L.H. and Waverman. L. 2001, 'Telecommunications infrastructure and economic developed: A simultaneous approach', *The American Economic Review,* 91(4), pp. 909–23.
18 Koutroumpis. P. 2009, 'The economic impact of broadband on growth: A simultaneous approach', *Telecommunications Policy*, 33, pp. 471–85.
19 Crandall. R., Lehr. W. and Litan. R. 2007, 'The Effects of Broadband Deployment on Output and Employment, A Cross-sectional Analysis of U.S. Data', *Issues in Economic Policy,* (6), The Brookings Institute, Washington D.C.

increase in broadband penetration in a State, employment is increased by 0.2 to 0.3 per cent per year. At a more disaggregated level the study finds that employment in both manufacturing and service industries (especially finance, education and health care) is positively related to broadband penetration. The study also concludes that State output of goods and services is also positively associated with broadband use.

A number of recent international studies have suggested that mobile broadband services are an important and growing source of productivity gains. Ovum[20] estimated that in 2005, mobile broadband services produced productivity gains of $28 billion for the US economy. Ovum also found that in 2005 the total productivity gain from all mobile wireless services was $185 billion and that by 2016 this could grow to around $427 billion — this represents a 130 per cent increase over an eleven year period.

In India a study by Kathuria et al.,[21] which employed a top-down econometric analysis using state level economic indicators, found that a ten per cent increase in India's mobile penetration delivers, on average, a 1.2 per cent increase in annual output. This study concluded that differences in the diffusion of mobile telephony appear to explain some of the differences in economic growth rates between India's 28 States. This conclusion is consistent with that of a study by Waverman et al.[22] that was prepared on behalf of Vodafone. This study, which attempted to measure the impact of mobile telephony in poorer developing countries, concluded that difference in the penetration and diffusion of mobile telephony appears to explain some of the differences in growth rates between developing countries.

While the recent international literature clearly suggests that there is strong positive relationship between investments in ICTs and productivity growth and economic development, what is less clear is will this contribution continue, and if so what will be the nature and magnitude of any future impacts. For example, Crandall et al. notes that investments in ICTs may be easily replicated and that competitive advantage premised on differences in ICT use may be short-lived.[23] They argue however that this does not mean that ICTs will cease to be productive but rather that the excess productivity will be captured by consumers who benefit from competitive forces that erode excess profits. Additionally, Stiroh[24] notes that it is possible that future investments in ICTs will improve the productivity of complementary non-ICT capital as businesses take advantage of ICT-enabled processes to improve all aspects of firm operations.

3. The contribution of broadband to Australia's productivity growth and economic development

The impact of broadband on the Australian economy has been the subject of much research over the last decade. A common theme throughout much of this research is that broadband is an enabling technology that, when combined with ICTs, impact economic activity through many channels both directly and indirectly. Direct impacts arise from investments in the infrastructure itself and associated ICTs. Indirect impacts come from all aspects of economic activity affected by broadband and which drive economic growth. Many studies also highlight that broadband enables the

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[20] OVUM 2005, *The Impact of the US Wireless Telecom Industry on the US Economy: A study for CTIA-The Wireless Association,* Boston.

[21] Kathuria. R., Uppal. M. and Mamta., (2009), 'An Econometric analysis of the impact of mobile', *Vodafone Public Policy Series*, Number 9, January 2009, United Kingdom.

[22] Waverman. L., Meschi. M. and Fuss. M., (2005), 'The impact of telecoms on economic growth in developing countries', *Vodafone Public Policy Series*, Number 2, March 2005, United Kingdom.

[23] Crandall. R., Lehr. W. and Litan. R. 2007, 'The Effects of Broadband Deployment on Output and Employment, A Cross-sectional Analysis of U.S. Data', *Issues in Economic Policy,* (6), The Brookings Institute, Washington D.C.

[24] Stiroh. K. 2006, 'The Industry Origins of the Second Surge of U.S. Productivity Growth', draft mimeo, Federal Reserve Bank of New York, February 2006, http://web.gc.cuny.edu/Economics/SeminarPapers/spring_2006/stiroh_second_020606_0307.pdf.

emergence of new business models, processes and innovation which in turn improves firm efficiency, reduces costs, and increases productivity, competitiveness and flexibility in the economy.

Broadly speaking, the Australian literature that examines how broadband has impacted the Australian economy can be classified as follows:

- **Studies that report the impact of broadband at the firm level.** The majority of these studies report the findings of surveys or interviews with business users. Usually business users of broadband services and applications are asked to report the cost savings that they have experienced as a consequence of taking up or using broadband services. Several studies also ask respondents to report the increased revenues that have resulted from broadband use over a given period.
- **Studies that report the macroeconomic impacts** arising from the deployment, take-up and use of broadband services and applications. Most of these studies rely on computable general equilibrium (CGE) models or input-output (I-O) analysis.

3.1 Firm level analysis

A study for Cisco Systems undertaken by The Allen Consulting Group[25] reports findings from a survey of businesses on the cost savings derived from using broadband Internet. The survey results indicate that businesses experienced cost savings of around 6.3 per cent from broadband Internet compared to 1.5 per cent for dial up. The study claims that the reported average cost savings would result in a productivity gain of around 0.32 per cent for business. A more recent survey by the Australian Industry Group[26] reported that over 93 per cent of the firms surveyed indicated that broadband had a positive impact on their productivity and efficiency.

A report by Econtech[27] sets out the findings of a telephone survey of 26 Australian companies across 15 industry sectors in relation to the productivity gains obtained by businesses from the use of a third generation (3G) mobile broadband network. On average, business users reported a 9.3 per cent productivity gain from using 3G mobile services. The drivers of the productivity gains included savings in travel time, reduced travel expenses, and increased worker productivity while travelling or working offsite. Importantly, the survey results showed that the highest gains in productivity were experienced by business users in rural and remote areas.

3.2 Macroeconomic impacts

A study undertaken by The Allen Consulting Group[28] using a computable general equilibrium (CGE) model of the Australian economy estimated that the deployment and use of a next generation broadband network in South East Queensland would generate significant economic benefits, including increased output, employment and wages at the local, state and national levels. This study also found that additional economic output would result if the network was open access. This finding was largely a result of model inputs assuming that, relative to a network which was owned and operated by a vertically integrated incumbent, an open access network would increase competition in the retail provision of broadband services leading to lower prices and increased take-up and use of broadband services.

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[25] Allen Consulting Group and Cisco Systems 2002, *Built for Business II: Beyond Basic Connectivity, The Internet and Australian Business in 2002*, Sydney.

[26] Australian Industry Group 2008, *National CEO Survey – High Speed to Broadband: Measuring industry demand for a world class service*, Australia.

[27] Econtech 2007, *Productivity Gains of Next G™ Results on the Customer Survey*, Australia, www.econtech.com.au/information/Industry/Telstra%20Survey%20Results_report_4%20Dec.pdf.

[28] Allen Consulting Group 2003, True Broadband: Exploring the Economic Impacts, Sydney.

The following table summarises the regional and state level economic impacts arising from the deployment of a high-speed fibre broadband network in South East Queensland as estimated by the Allen Consulting Group.

Table 1: Macroeconomic impacts of a fibre broadband network in South East Queensland[29]

Macroeconomic indicator	South East Queensland		Queensland	
	Vertically integrated	Open Access	Vertically integrated	Open Access
Output ($ Million)	2,640	3,160	4,180	4,900
Aggregate Consumption ($ Million)	N/A	N/A	2,835	4,680
Employment (Jobs)	1,030	1,005	1,630	1,583

A study by the Centre of International Economics[30] using the Monash Multi-Regional Forecasting (MMRF) model showed that the deployment and use of a genuine broadband network to 98 per cent of the Australian population would increase Australia's GDP, reduce real prices and improve Australia's international competitiveness and export performance. According to the CIE:

> The MMRF simulation results show that genuine broadband offers gains over most economic indicators. GDP would rise. An increase of around 1.4 per cent is projected after about 5–6 years. This is equivalent to $15 billion in terms of GDP in 2007–08. Prices would fall — by around half a per cent. The Australian economy would be more competitive and export more and investment would grow.
>
> The industry results point to a structural change in the economy. Retail and wholesale activities will be smaller than otherwise, reflecting direct sales and supply chain consolidation. Other activities grow as they offer greater value to customers (such as health, education and recreation). Residential building grows by a lot reflecting Australia's penchant for real estate and the family home.

A report prepared by Network Insights on behalf of the Australian Mobile Telecommunications Association (AMTA)[31] found that over the period 2013 to 2020 productivity benefits to the Australian economy would be around AU$143 billion. This equates to around 12 per cent of Australia's current GDP.

A 2009 study by Concept Economics[32] concluded that the roll-out of a very high speed, third-generation digital mobile network to 99 per cent of the Australian population resulted in productivity improvements for some Australian businesses in the order of $7,000 per year per worker. This study highlighted that for businesses mobile broadband services increased productivity through increased staff mobility and accessibility, a reduction in paperwork and double-handling, a reduction in downtime for the mobile workforce, the ability for workers to access operations in real time and the scope for remote monitoring. Using the estimated per worker benefits as reported by a 2005 OVUM study, Concept Economics also forecast that the introduction of mobile broadband in Australia would increase real GDP by 0.94 per cent. Of this increase, 60 per cent would be attributable to productivity gains, with the remainder coming from capital adjustments and taxes. This study also concluded that the introduction of mobile broadband in Australia would increase real wages by around one per cent.

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[29] All figures are expressed in net present value terms assuming a seven per cent real discount rate. Figures are expressed in 2003–04 dollars.

[30] Centre for International Economics 2008, Impact of genuine broadband for Australia, Sydney.

[31] Network Insights 2010, *The future deployment of mobile broadband services*, Australia.

[32] Concept Economics 2009, *Next G Productivity Impacts Study*, Sydney.

4. Some observations of the Australian literature

The growing body of academic research and consultancy reports clearly highlight that the deployment and use of broadband networks and infrastructure has had a positive impact on Australia's productivity growth and economic development. Moreover, the available literature strongly suggests that future investments in broadband will yield additional benefits. Accordingly, the existing literature provides a valuable contribution to our knowledge and understanding of the importance of broadband to Australia's economic wellbeing.

That said however, there exists a number of important questions that are not answered by the existing literature. First, much of the Australian research considers the economic impact of ICTs more broadly but does not isolate broadband specific impacts. This was noted by DCITA in a paper that undertakes an extensive review of the available Australian literature:[33]

> There have not been any studies undertaken in Australia which estimate the contribution of broadband to productivity across the economy. There have, however been studies focused on the effect of ICTs, of which broadband is one component, on productivity growth.

Second, studies which report survey data are, at best, upper limit estimates of the benefits of broadband. This is because respondents are likely to have reported costs savings arising from the use of broadband dependant services as opposed to the specific incremental benefits that arise from the availability of greater bandwidth.

Third, there has not been any ex-post analysis of what effect broadband has had on economic output, employment or wages. While there have been several forward looking studies which use computable general equilibrium models these are problematic given that both the base case and counterfactual scenarios are hypothetical constructs. Moreover, the general equilibrium modelling conducted to date involves the input of an estimated forward looking productivity shock which, as previously discussed, is likely to reflect the use of ICTs more generally.

Fourth, in relation to mobile broadband, many of the Australian studies have estimated the macroeconomic benefits with reference to estimates from a 2005 OVUM study which looks at the economic impact of wireless communications, on a per worker basis, in the United States. Consequently, it is not clear whether the Australian studies have truly isolated the economic impacts arising from mobile broadband services only. It is also unclear, given cross-country differences in industry structures, price levels and cultural factors, whether the use of mobile broadband by Australian businesses will deliver the same level of productivity gains per worker as those experienced in the United States.

Given that these important questions are still to be answered there is strong merit in further research to identify and measure the specific contribution that broadband has made to Australia's recent productivity growth and economic development. This further research will no doubt go some way to informing our understanding of how future investment in broadband will likely impact Australia's future economic performance.

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[33] DCITA 2007, *The economic effects of the broadband: and Australian perspective,* Canberra, p. 10.