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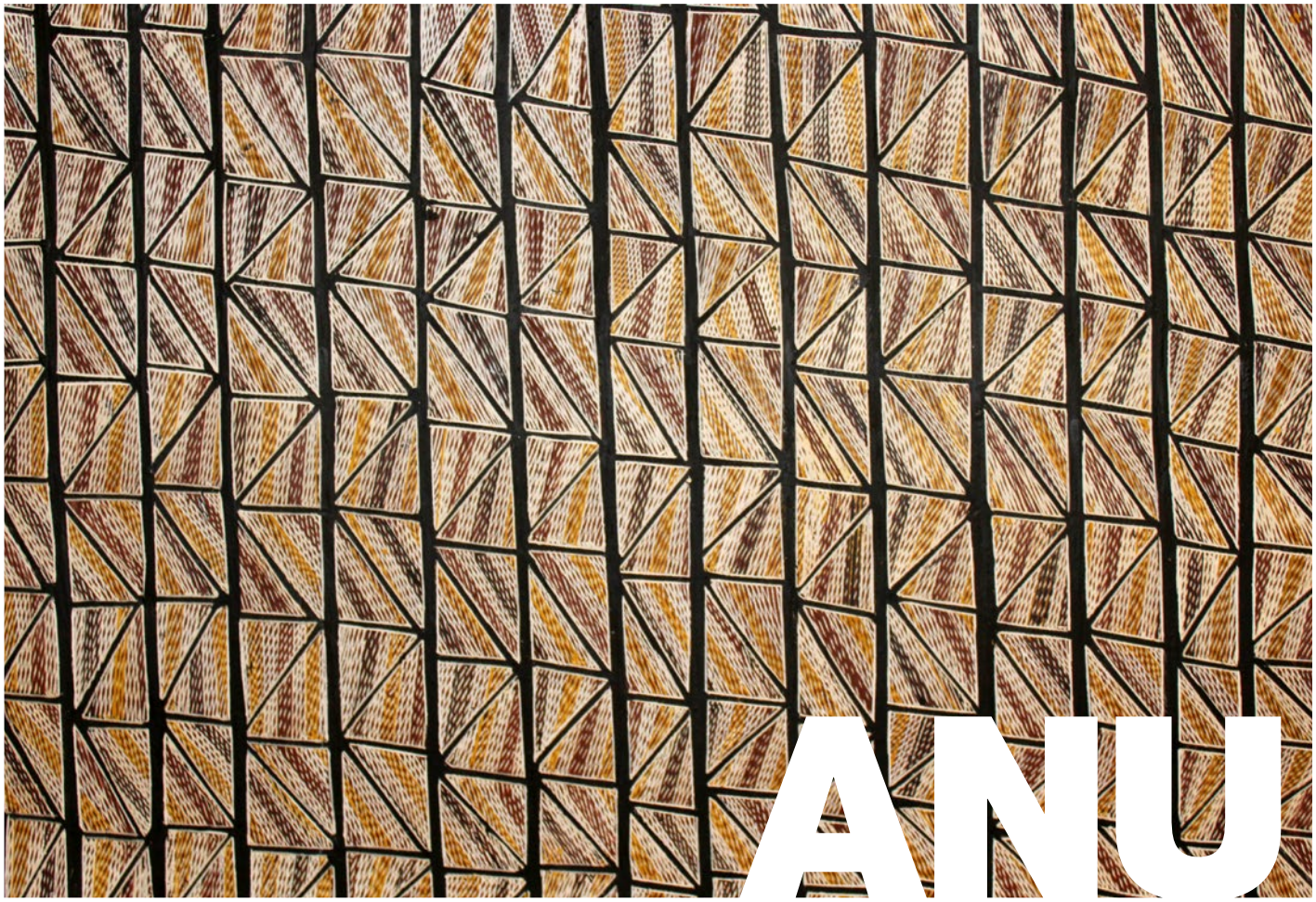

DYNAMICS OF THE DIGITAL DIVIDE

P RADOLL AND B HUNTER

Centre for
Aboriginal Economic
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Dynamics of the digital divide

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Abstract

The digital divide between Indigenous and other Australians describes the unequal access to information and communications technology (ICT) between these groups. Historically, researchers have focused on acquiring new technology, but we argue that it is important to understand all the dynamics of digital usage, including the loss of access to ICT within a household. For long-lived technology such as internet access, it is particularly important to acknowledge that retention of access to the technology needs to be considered. This paper builds on earlier work by exploring the rates of diffusion of ICT for Indigenous Australians using data from the Australian Census Longitudinal Dataset 2006–2011. This dataset allows a longitudinal analysis of changes in internet usage and apparent flows into and out of internet usage for Indigenous and non-Indigenous Australian households. This paper identifies and analyses the important observation that retention of internet access is almost as difficult as acquiring internet access for many Indigenous households (especially in remote areas). While earlier work analyses the digital divide in terms of 'diffusion' or adoption of ICT, this paper shows that retention of internet access is equally important in driving the digital divide. This observation could reflect 'antidiffusion' processes: factors that drive the loss of access to ICT over time. The dynamics of the digital divide have important and ongoing implications for the digital divide and addressing broader socioeconomic disadvantages experienced by Indigenous Australians. Antidiffusion is largely a phenomenon observed among Indigenous people. By analysing loss of access to ICT among both Indigenous and other Australians, we identify several factors that are associated with diffusion and antidiffusion of technology (e.g. household resources, employment, education, the age composition of households). The paper concludes with a discussion of an agenda for future research and potential implications for current policy settings.

Keywords: information and communications technology, digital divide, diffusion, antidiffusion, internet access

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Acronyms

ACLD	Australian Census Longitudinal Dataset
ANU	The Australian National University
CAEPR	Centre for Aboriginal Economic Policy Research
ICT	information and communications technology

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Introduction

A digital divide is evolving in Australian society, with some groups having better access to information and communications technology (ICT) than others (Davis et al. 2002, Gurstein 2004, Daly 2005). Radoll (2010) identified that the use of ICT is low for Indigenous Australians compared with non-Indigenous Australians. The 2006 Census demonstrated that 43% of Indigenous households had access to the internet, compared with 64% of other households (data accessed using the Australian Bureau of Statistics product TableBuilder). Given the social exclusion of Indigenous Australians, constraints affecting Indigenous adoption of ICT (sometimes called technological diffusion or, more simply, enhanced access to ICT infrastructure) may have important implications for the ongoing gap in socioeconomic outcomes between Indigenous and other Australians. In the modern world, access to services and knowledge of opportunities to enhance wellbeing are dependent on access to ICT, and hence it is crucial to address the digital divide if gaps in socioeconomic outcomes are to be addressed.

While there are existing 'snapshot' studies of the digital divide, we argue that it is important to understand how access to ICT changes over time. ICT is inherently dynamic in that the technology and its use vary substantially over time. Furthermore, these manifold changes are driven by innovations that are not entirely predictable. Rather than attempting to understand these potentially idiosyncratic factors, we focus on the basic infrastructure and overall access to the internet, which is crucial for most forms of ICT. While specific technologies change rapidly, it is possible to conduct a sensible analysis of the dynamics of internet access over a five-year period.

This study provides the first analysis of the dynamics of internet access of Indigenous Australians using a large-scale dataset that combines the responses from the 2006 and 2011 censuses. The release of the Australian Census Longitudinal Dataset (ACLD) provided information on a substantial number of Indigenous people over a five-year period – information from the 2006 Census on 14 802 individuals who identified as being Indigenous in 2006 was linked with 2011 Census records for the same people (identified through probabilistic matching). This paper uses the ACLD, which has recently been made available to users through the 'Data Analyser' software, to provide the first known analysis of the dynamics of internet access for Indigenous and non-Indigenous households.

The remainder of this paper is structured as follows:

- An overview of the current literature on the diffusion of ICT, with a focus on issues for disadvantaged groups, is presented. This builds on the discussion of diffusion by contrasting it with antidiffusion. The concept of antidiffusion can be understood as the loss of technology or access to technology, which is driven by the failure to reinvest in the face of depreciation, technological or social change, or simply changes in the preferences of people for various forms of technology.
- The data and method used in this paper are described.
- A descriptive analysis of the dynamics of internet access by remoteness, income, employment status, educational attainment and household composition status (in terms of age of residence and Indigenous identification) is provided.
- Four factors that may explain these observations are suggested, and potential future research agendas on Indigenous technological use and access (including those based on future releases of the ACLD) are identified.
- A conclusion sums up the implications of the work.

ICT diffusion and its opposite, antidiffusion

A growing body of evidence demonstrates the benefits of ICT adoption to communities, households and individuals. These include access to online services such as government services, educational institutions, electronic health and electronic banking, as well as increased income (Curtin 2001; Arocena & Senker 2003; Allyn & Yun 2005; Daly 2005, 2006). Internet access is important in the context of the digital divide evident between Indigenous and non-Indigenous Australians, because it underpins the ability to adopt and use much of the latest ICT.[1]

Quality, access, coverage and use of ICT are critical for participation in Australian society. ICT forms the basis of much economic activity, and not having access to ICT has a clear detrimental economic and social impact. Along these lines, Radoll (2010) shows that some individuals and households may be excluded from ICT access because of location, education, economic position or culture.

The term 'adoption' is used in the information systems discipline to describe the uptake of ICT. Specifically,

adoption pertains to the 'decision to make full use of an innovation as the best course of action available' (Rogers 1995:21). Another widely used term in the literature is 'diffusion': 'the process by which an innovation is communicated through certain channels over time among the members of a social system' (Rogers 1995:5). More formally, Rogers refers to the diffusion of innovations theory (DOI).

Several other theories may help explain the digital divide between Indigenous and non-Indigenous Australians (Radoll 2010): the theory of reasoned action (TRA; Ajzen & Fishbein 1980), the theory of planned behaviour (TPB; Ajzen 1991), the model of adoption of technology in households (MATH; Venkatesh & Brown 2001), the technology acceptance model (TAM; Davis 1989), and the unified theory of acceptance and use of technology (Venkatesh et al. 2003). Radoll (2010) also argues that the structuration theory of Giddens (1984) has important implications for understanding the digital divide. Theories such as DOI and TAM postulate that perceived ease of use and usefulness are key to adoption, while other theories such as TRA and TPB rely on behaviour and beliefs, which are independent of the 'perceived outcome' of use of the technology (Compeau et al. 1999).

While many factors are found to affect household adoption of ICT in society (Venkatesh & Brown 2001, Venkatesh et al. 2003), research is relatively scarce in explaining the low ICT adoption by Australian Indigenous households. There is also very little research about how such adoption may change over time. The approach adopted in this paper is to take a step back from the specific use of a particular ICT and focus on the more fundamental questions surrounding access to its basic infrastructure. We do not deny the importance of such issues, but the internet has been around for almost 30 years and is no longer in itself a new technology. Rather, access to the internet underpins the ability to adopt new technology that may be developed.

While diffusion theory is broadly relevant to understanding connection to the internet, some socioeconomic issues need to be considered in the context of changing patterns of internet access. The cost of providing internet infrastructure is likely to be higher where the cost of living is higher – for example, in remote areas and nonurban areas that are more distant from the major centres of population. In contrast, the ability to maintain internet infrastructure is likely to be associated with the resources available and the incentives to maintain the infrastructure in the face of technological change, changing community norms about adequate internet access and speed, depreciation, and natural wear and tear. Economists believe that incentives to maintain infrastructure are largely driven by who provides the infrastructure or who owns it (Shilling et al. 1991). The parties who control decisions to maintain the internet are not necessarily the same people who derive benefit from accessing it. If people access the internet at work, the employer and worker costs and benefits of internet use need to be taken into account. If the internet is provided as part of a community resource funded by a local organisation or government agency, overuse, often associated with common property resources, needs to be considered. The key issue here is whether there is private or public ownership of infrastructure, and the incentives of users and providers to maintain the internet services in good working order. Hence, internet access can diminish over time if the original funding agency does not adequately reinvest to maintain the infrastructure in working order or the users do not exercise due care in looking after the equipment provided. Even if a political case is made that internet connectivity should be provided to the Indigenous community at a particular point in time, policy needs to take into account who has the incentive to keep the infrastructure in good working order. The internet infrastructure is, by definition, very technical, so if it breaks down considerable expertise is required; it is probable that suitable expertise is not available locally. Internet provision may be costly, as is maintaining it.

While the argument above is couched in terms of conventional economic incentives, we acknowledge that the incentives to maintain or neglect ICT infrastructure should be viewed through a broader cultural prism, especially in the context of Indigenous Australians. In addition to the role of social norms in driving what people want and aspire to have access to, cultural practices and use of technologies may differ from what the manufacturers and providers originally intended. The analysis in this paper does not attempt to understand all processes that lead to the provision of, or a reduction in, internet access; it merely seeks to describe the extent to which such changes have occurred recently.

Based on a substantial number of interviews, Radoll (2010) builds up a 'grounded theory' that predicts conditions that will support Indigenous ICT diffusion or technological adoption. According to this theory, internet diffusion will be higher:

- in urban areas
- among high-income households
- in dwellings with more workers and/or more highly educated residents
- where children live.

Radoll also argues that the rate of technological adoption is higher in contexts where the 'Indigenous field' is important. This paper analyses this theory by identifying whether recent census data are consistent with these propositions.

The ICT diffusion literature, and information systems literature more generally, tend to focus on the adoption phase of technology. This is understandable because they are attempting to analyse and explain the take-up of innovations that are, by definition, new. However, once innovations are adopted, they need to receive ongoing investment to maintain their usefulness. Hence, diffusion is only one part of the story; in terms of the dynamics of the digital divide, we need to understand the outcomes and processes associated with antidiffusion, where households who had access to the internet lose their access to it over time. The next section outlines the data and method used to analyse the dynamics of internet access, and hence the processes of diffusion and antidiffusion for Indigenous and non-Indigenous Australians.

Data and method

Census questions are usually asked at a point in time and reported only as cross-sectional data. The ACLD is an important new development by the Australian Bureau of Statistics. A 5% random sample of the 2006 Census was linked with the 2011 Census using data linkage techniques to create the ACLD. The ACLD includes linked 2006 and 2011 Census data for 800 759 individuals, of whom 14 802 identified as being Indigenous in 2006. This number represents substantially less than 5% of the Indigenous population, but nonetheless forms the largest longitudinal dataset of Indigenous Australia (ABS 2013). Unfortunately, because 2016 Census data will not be integrated into the ACLD until 2018, the analysis of the dynamics of internet access of Indigenous households necessarily focuses on the 2006 and 2011 censuses. However, the penultimate section of this paper does provide some analysis of the general data from the 2016 Census.

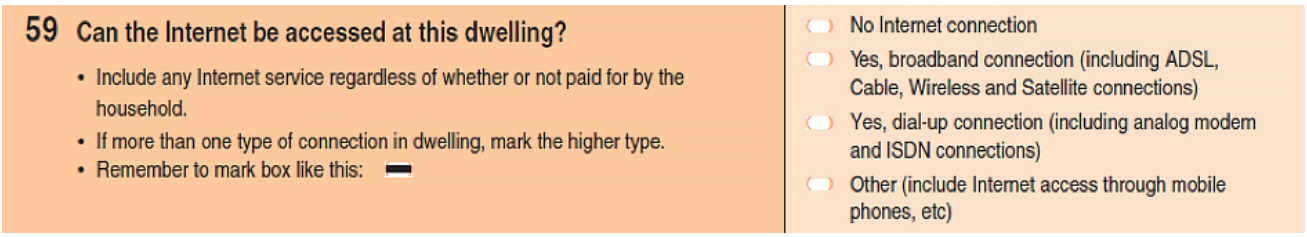
The census household form is designed to be completed by one person on behalf of everyone in their household. Census questions from 2006 and 2011 about internet access are identical and are shown in Fig. 1. Respondents are instructed to mark the category that is highest in the list, if there is more than one type of connection in the dwelling.[2]

Many researchers have pointed out the overall trend of increasing identification of Indigenous people in recent statistical collections (Taylor 2009). However, at an individual level, it is possible that many people choose not to identify in a particular statistical collection. Considering that, of those who were identified as being Indigenous in 2006 within the ACLD, 9.2% were identified as being non-Indigenous in 2011 and 1.1% had 'not stated' Indigenous status in 2011. The instability in the identification of Indigenous status presents a challenge for analysis in this field, and such challenges are particularly pronounced for the interpretation of the longitudinal data. In this paper, we have defined Indigenous status as measured by the 2006 Census.

The analysis in this paper focuses on household-level data because this is the level at which internet access is measured in the censuses. For the purposes of this analysis, the measure of diffusion is the percentage of households who did not have internet access in 2006 but acquired it by the time of the 2011 Census. Antidiffusion is measured as the percentage of households who had internet access in 2006 but for one reason or another lost that access by 2011.

We explore the main factors identified by Radoll (2010) as being associated with ICT diffusion, but we also measure these factors at the household level. For example, employment is measured as the number of hours worked by all members in the household. Education is measured as the highest educational level attained by a member of the household. Remoteness, household composition and income are also measured at the household level, and hence there is a consistency throughout the analysis.

FIG. 1. Census question about internet access from the 2006 and 2011 censuses



Source: ABS (2011a)

Household income is equivalised using the modified Organisation for Economic Co-operation and Development OECD equivalence scale, to capture a measure of household resources available after household composition and structure are taken into account (de Vos & Zaidi 1997). Equivalising is a means of standardising household incomes in terms of household size and composition so that the relative material wellbeing of households of different sizes and compositions can be analysed.

In practical terms, equivalisation reflects that a larger household needs more income than a smaller household for the two households to have similar standards of living (all else being equal). It also means that there are economies of scale as household size increases so that, as the size of a household increases, the cost per person decreases. The modified OECD scale assigns the first adult a cost value of 1.0, the second and subsequent adults a cost of 0.5, and each child a cost of 0.3 (or 30% of the first adult). It is not clear what the best equivalence scale is for Indigenous Australians (Hunter et al. 2004), but the OECD equivalence scales are widely used throughout the world and provide a sensible starting point for the analysis.

Radoll (2010) emphasises the role of the Indigenous field, which can be defined as a domain of life over which the agency of Indigenous people is paramount. The concept of Indigenous field is captured in the following analysis using household composition, where we compare households with only Indigenous residents with other households (especially where there are only non-Indigenous residents). Note that the other categories of households include those where the Indigenous status is only partially reported, and households where Indigenous and non-Indigenous people live together.

Internet diffusion and antidiffusion for Indigenous and non-Indigenous Australians: changing patterns of access to the internet

This section analyses factors associated with the changing patterns of access to the internet among Indigenous Australians. Table 1 shows the role of remoteness in the prevalence of diffusion and antidiffusion. We expect remoteness to be associated with these processes because lower levels of accessibility mean that access to information is more valuable, but the cost of providing internet infrastructure is likely to be substantially higher.

Table 1 is consistent with Radoll's (2010) observation that ICT diffusion is higher in cities and urban areas than in remote areas. The increased access to the internet is highest in major urban areas, where 66% of Indigenous households acquired internet access between 2006 and 2011. This percentage decreases gradually as the residence of the Indigenous households becomes more remote, and only 23% of very remote Indigenous households without internet access in 2006 acquired it by the time of the 2011 Census.

The rate of diffusion among non-Indigenous households is similar irrespective of remoteness. The rate of diffusion in non-Indigenous households is 63% in major urban areas; while it is slightly lower in regional areas, remote areas have a similar rate of diffusion to that observed in major urban areas (62% of non-Indigenous households in very remote areas acquired internet access between 2006 and 2011). In terms of diffusion of internet access, Indigenous households in remote areas are very different from non-Indigenous households in remote areas in that they experience relatively low rates of diffusion. One hypothesis is that Indigenous people are more likely to be found in such areas, especially very remote areas, where the cost of internet provision is likely to be very high unless costs are completely offset by subsidies.

Radoll (2010) identifies a positive interaction between Indigenous field and education/employment that may, partially at least, explain this geographic pattern in diffusion. Culture-specific factors include Indigenous agency within the Indigenous field. Employment and education outcomes in urban areas also tend to be significantly higher than those in remote areas (Gray et al. 2014).

As indicated above, it is possible that households lose access to the internet in what we call antidiffusion. Indigenous people tended to have a particularly pronounced loss of internet access in this period, with 8% of Indigenous households in major urban areas who had internet access in 2006 losing it by 2011. The analogous estimate for the non-Indigenous population in major urban areas is only 4%.

The new major finding from Table 1 is that Indigenous households were much more likely to experience a loss of access to the internet between 2006 and 2011 as the residence becomes more remote, especially those households in remote and very remote areas. For example, 46% of Indigenous people in very remote areas who had internet access in 2006 did not have internet access by the time of the 2011 Census. While the Indigenous subsample of the ACLD is relatively small, the

TABLE 1. Changing internet use by Indigenous status and remoteness, 2006–11

Indigenous and remoteness status	2006 internet status	2011 internet status			2006 population
		No internet (%)	Internet (%)	Total (%)	
Indigenous					
Major urban	No internet	34	66	100	70 500
	Internet	8	92	100	86 300
Inner regional	No internet	41	59	100	55 600
	Internet	12	88	100	50 800
Outer regional	No internet	50	50	100	64 700
	Internet	14	86	100	38 400
Remote	No internet	59	41	100	28 800
	Internet	20	80	100	10 200
Very remote	No internet	77	23	100	65 500
	Internet	46	54	100	7 300
All Indigenous (by 2006 internet status)	No internet	52	48	100	285 100
	Internet	12	88	100	193 000
All Indigenous	(unconditional)	36	64	100	478 100
Non-Indigenous					
Major urban	No internet	37	63	100	2 849 700
	Internet	4	96	100	9 297 500
Inner regional	No internet	41	59	100	1 007 100
	Internet	6	94	100	2 295 400
Outer regional	No internet	42	58	100	483 700
	Internet	6	94	100	1 003 000
Remote	No internet	40	60	100	60 000
	Internet	6	94	100	139 300
Very remote	No internet	38	62	100	16 400
	Internet	7	93	100	39 500
All non-Indigenous	No internet	39	61	100	4 416 900
	Internet	5	95	100	12 774 700
All non-Indigenous	(unconditional)	13	87	100	17 191 600

Note: The population in the last column is the estimated residential population residing in Indigenous and non-Indigenous households in the 2006 Census.

Indigenous rate of antidiffusion in remote areas is also high at 20%. In contrast, 7% and 6% of non-Indigenous households in very remote and remote areas lost internet connectivity over the same period. One explanation for the substantial change in internet connectivity in these areas for Indigenous households is the need for reinvestment in household infrastructure over time, which is disproportionately concentrated in poorly maintained housing (Memmott et al. 2012). Alternatively, it may reflect the failure of residents to look after internet investments over time. Of course, it is also possible that there is some wilful destruction of the infrastructure rather than just a failure to invest in household ICT infrastructure that may have a high rate of depreciation in certain circumstances. In large households embedded in complex kinship networks and communities, it might not be that 'permanent' householders do not look after infrastructure but rather that the large number of 'visitors' passing through households may not look after the technology

as well as the person responsible for its maintenance or those who want to use the internet in the longer term.

The failure to invest in infrastructure in remote areas may be the responsibility of individuals, communities or the government sector. Householders may be personally responsible for access to the internet, and, if adequate resources are available, investment and reinvestment in the latest technological infrastructure is likely to be the individual's responsibility. It has been observed that the main reason for non-Indigenous people living in remote areas is that they have a well-paid job that attracted them to live in the area (Gray et al. 2014). If that is the case, such households will have more resources (wages) to invest in internet access. However, to the extent that employers are trying to attract good workers with the nonwage characteristics of the jobs advertised, access to the internet may also be a necessary part of the remuneration package. The job itself may involve access to the internet at work.

In an Indigenous household, the government and local community are more likely to have played a role in the initial investment in ICT infrastructure, which may be more communal in nature. If Indigenous householders and communities feel less ownership and individual responsibility for that infrastructure, they may be less inclined to maintain it when it breaks down.

Antidiffusion is largely an Indigenous phenomenon – the highest estimate of antidiffusion in non-Indigenous households is lower than the lowest Indigenous estimate for antidiffusion in Table 1. Irrespective of the reason for the breakdown of the internet infrastructure, it is clearly a substantial concern in Indigenous households, especially in very remote communities. We will return to this discussion in the concluding section. In the meantime, we examine some of the factors that Radoll (2010) identifies as being associated with ICT diffusion.

Factors associated with diffusion and antidiffusion of internet access

The rate of diffusion increases with equivalised household income for both Indigenous and non-Indigenous households (Table 2). That is, households with more resources (as indicated by equivalised income) have higher rates of diffusion. Among households with more than $1000 income per week, more than 70% of Indigenous and non-Indigenous households acquired access to the internet between 2006 and 2011 (70% and 79%, respectively). Low-income households (equivalised income $1–$399 per week) are about 30 percentage points less likely to acquire internet access (43% and 49% for Indigenous and non-Indigenous households, respectively).

The most problematic income category in understanding the role of poverty is households with zero or negative incomes. This category can include self-employed workers and businesses for whom it is difficult to measure income accurately. Income may be reported by individuals, but it may be hard to attribute income separately to the household and the business. Another issue is that such households can have a temporary loss of income; however, if the households have wealth, they could sell assets and otherwise dissave, and use this income to maintain wellbeing and invest in internet access. The rate of diffusion is lower for both Indigenous (30%) and non-Indigenous households (54%) with zero or negative income, but the rates of diffusion are markedly higher for the non-Indigenous. This is consistent with non-Indigenous people having greater wealth (Howlett et al. 2016) and being more likely to set up businesses than Indigenous people (Hunter 2015).

As noted above, the rate of antidiffusion is not substantial for the non-Indigenous group (varies between 3% and 7%). The Indigenous estimate of antidiffusion for the highest income group is 7%, whereas the two lowest income categories have substantial estimates for antidiffusion at 29% and 17%. Antidiffusion is again a particularly Indigenous phenomenon, concentrated in households with a low level of resources. This is consistent with the assertion that the lack of resources is a major reason that internet access is lost.

Table 3 is consistent with diffusion being more prominent among non-Indigenous households that work relatively intensively (more than 40 hours worked per week by members of the household). There is no simple relationship between diffusion and work intensity among Indigenous households, so it appears that access to more work is not the driving factor for diffusion of internet access among Indigenous households. It may be that internet access allows non-Indigenous householders to work longer hours; however, the crucial issue for Indigenous workers' access to the internet is that work intensity appears to be a 'push factor' for non-Indigenous households acquiring internet access between 2006 and 2011. In contrast, antidiffusion is only weakly associated with work intensity for both Indigenous and non-Indigenous households.

TABLE 2. Transitions in internet access between 2006 and 2011 by Indigenous status and equivalised total weekly household income

	Internet access in 2011 (%)			
	Indigenous		Non-Indigenous	
Internet access in 2006	No internet access	Internet access	No internet access	Internet access
	Equivalised total household income (weekly)[a] Negative/nil income			
No internet access	70	30	45	54
Internet access	29	79	6	94
	$1–$399			
No internet access	57	43	51	49
Internet access	17	83	7	93
	$400–$599			
No internet access	42	58	39	61
Internet access	11	90	5	95
	$600–$999			
No internet access	35	65	30	70
Internet access	7	93	4	96
	$1000 and above			
No internet access	29	70	21	79
Internet access	7	94	3	97
	Total			
No internet access	51	49	40	60
Internet access	12	89	4	96

a Grouped into those categories for which we have consistent information between 2006 and 2011.
Note: Estimates weighted by 2006 estimated residential populations.

Table 4 reports the internet access in 2006 and 2011 by highest educational attainment in the household. Education is strongly associated with diffusion for both Indigenous and non-Indigenous households. Like the results reported for income, there is a strong association between antidiffusion and education among Indigenous households. However, unlike the result for income, antidiffusion is relatively prominent among one group of non-Indigenous households: those with low educational attainment.

Radoll (2010) argues that young people in households can facilitate the process of diffusion or acquiring internet access. Young people tend to be more aware of technological developments, and this may assist in the installation and maintenance of relevant hardware and software. The presence of young people in households can drive higher demand for ICT-related services because the internet provides educational resources, materials and even access to assessments. Table 5 confirms that households with people aged 25 or older have lower rates of diffusion than those with some younger residents (aged under 25). If anything, the presence of young people in the non-Indigenous households is more important than their presence in Indigenous households. The rates of diffusion are almost double among non-Indigenous households with young people in them, compared with those where everyone is aged over 25. Indigenous households with some younger people have diffusion rates that are just over 10 percentage points higher than those in other Indigenous households.

The role of young people does not appear to be important for antidiffusion. The rates of antidiffusion are between 12% and 13% for Indigenous households in Table 5; for non-Indigenous households, the rates of antidiffusion are low for all entries. Having young people in a household may increase the demand for internet access (i.e. for diffusion), but their presence is irrelevant for the breakdown or loss of internet access.

TABLE 3. Transitions in internet access between 2006 and 2011 by Indigenous status and household labour force status

	Internet access in 2011 (%)			
	Indigenous		Non-Indigenous	
Internet access in 2006	No internet access	Internet access	No internet access	Internet access
	Household labour force status No hours worked in the household			
No internet access	47	55	30	70
Internet access	10	84	5	95
	1–39 hours worked in the household			
No internet access	53	47	33	67
Internet access	14	86	5	95
	40–79 hours worked in the household			
No internet access	44	57	23	77
Internet access	9	91	3	97
	80+ hours worked in the household			
No internet access	50	51	19	81
Internet access	9	91	4	96
	Total			
No internet access	49	51	25	75
Internet access	10	90	4	96

Note: Estimates weighted by 2006 estimated residential populations.

Of course, just because a person uses the technology, this does not make them a technical expert in maintaining existing hardware.

The final factor associated with diffusion and antidiffusion is Indigenous composition in the household. There is no strong association between diffusion and the extent of identification as Indigenous in the household (Table 6). If anything, 'mixed' households, where Indigenous and non-Indigenous people live together, are more likely to experience diffusion (68%) than Indigenous-only households (50%). Non-Indigenous-only households are only slightly more likely to experience diffusion than 'mixed' households (72% as opposed to 69% for non-Indigenous residents in mixed households).

Consistent with the analysis above, the Indigenous-only households experience the highest prevalence of antidiffusion (14%). However, there is no strong association of antidiffusion with Indigenous composition in the household. The internet is somewhat more likely to be lost in mixed households than in non-Indigenous households, but the difference is not substantial (8% or 9% as opposed to 5%).

Overall, the Indigenous composition of the household does not appear to be as important as identified by Radoll (2010). One reason may be that the analytical construct of the Indigenous field is not adequately captured by the household composition measure in Table 6. Another explanation may be that Indigenous-only households are predominantly found in remote areas, and hence it is difficult to identify the role of the Indigenous field unless other factors associated with diffusion and antidiffusion are controlled for. Empirically, this could be achieved using multivariate techniques such as regression analysis, which we will briefly discuss in the concluding section.

TABLE 4. Transitions in internet access between 2006 and 2011 by Indigenous status and highest education status in household

	Internet access in 2011 (%)			
	Indigenous		Non-Indigenous	
Internet access in 2006	No internet access	Internet access	No internet access	Internet access
	Highest year of school completed by any household member Did not go to school; Year 8 or below			
No internet access	76	24	74	26
Internet access	32	71	19	81
	Year 9 or equivalent; Year 10 or equivalent; Year 11 or equivalent			
No internet access	53	48	43	57
Internet access	14	86	7	93
	Year 12 or equivalent			
No internet access	41	59	25	75
Internet access	9	91	4	96
	Total			
No internet access	51	49	38	62
Internet access	12	88	5	95

Note: Estimates weighted by 2006 estimated residential populations.

TABLE 5. Transitions in internet access between 2006 and 2011 by Indigenous status and age of youngest person in household

	Internet access in 2011 (%)			
	Indigenous		Non-Indigenous	
Internet access in 2006	No internet access	Internet access	No internet access	Internet access
	Age of youngest person in household 0–4 years			
No internet access	51	49	15	85
Internet access	12	88	3	97
	5–14 years			
No internet access	50	50	16	84
Internet access	12	88	3	97
	15–24 years			
No internet access	46	54	20	80
Internet access	12	88	5	95
	25 years or older			
No internet access	61	39	57	43
Internet access	13	87	7	93
	Total			
No internet access	52	48	39	61
Internet access	12	88	5	95

Note: Estimates weighted by 2006 estimated residential populations.

TABLE 6. Transitions in internet access between 2006 and 2011 by Indigenous status and household composition

	Internet access in 2011 (%)			
	Indigenous		Non-Indigenous	
Internet access in 2006	No internet access	Internet access	No internet access	Internet access
	Indigenous status			
	Aboriginal/Torres Strait Islander people only			
No internet access	50	50	na	na
Internet access	14	87	na	na
	Non-Indigenous people only			
No internet access	na	na	28	72
Internet access	na	na	5	95
	Aboriginal/Torres Strait Islander and non-Indigenous people in household ('mixed' households)			
No internet access	31	68	31	69
Internet access	9	91	8	93

na = not applicable

Notes: Estimates weighted by 2006 estimated residential populations. This table only reports those households where Indigenous status was reported for all householders. There are small differences between the Indigenous and non-Indigenous statistics in 'mixed' households because the Australian Census Longitudinal Dataset (ACLD) is based on person data and the household characteristics associated with that person. There is no reason to expect these statistics to be the same, because Indigenous and non-Indigenous ACLD individuals often live in different mixed households.

The ongoing digital divide

This paper has focused on the processes that underlie the ongoing digital divide between Indigenous and non-Indigenous Australians: the processes of internet diffusion and antidiffusion. However, we should also ask ourselves whether the ICT diffusion or antidiffusion documented above led to a systematic change in the digital divide. This research is motivated by 2006 Census data that showed that 43% of Indigenous households and 64% of non-Indigenous households had access to the internet – a differential that implied that more than one-fifth of Indigenous households needed to get access to the internet before there is digital equity in Australia. This section examines how the dynamics of internet access described above have affected this digital divide.

Table 7 reports the access to the internet in the 2016 Census by Indigenous status and Indigenous region. There is some good news in that there has been some convergence in internet access. Access in Indigenous households increased to 75%, whereas it increased to 86% for non-Indigenous households. That is, the digital divide between Indigenous and other Australians fell from a differential of 21% in 2006 to only 11% in 2016. One reason for this is that it gets harder to increase the rate of internet access as that rate approaches 100%. The dwellings remaining without internet access may not want ICT services or may be particularly difficult to provide these services for. This phenomenon is what economists call diminishing marginal returns from investment. Indeed, as Indigenous access to the internet improves, we should expect diminishing marginal returns to become more important. The relatively high rates of antidiffusion among Indigenous households point to potential difficulty in achieving digital equity. Unless the rate at which Indigenous households lose ICT services can be lowered substantially, the digital divide cannot be eliminated.

Table 7 illustrates that the dynamics of internet access lead to a larger digital divide in more remote regions. The table is grouped into regions within states and territories, with the first region in each group being the most urban region, or the state or territory as a whole. Where a region is dominated by a city with more than 100 000 residents, the digital divide is less than 10 percentage points. As a region becomes more remote, the digital divide tends to increase. The largest differential between Indigenous and non-Indigenous internet access is in Apatula, Northern Territory, where the digital divide is more than 50 percentage points. It is not that the internet access of non-Indigenous households is particularly high in these remote regions; rather it reflects the particularly low level of internet access in Indigenous households in remote areas.

TABLE 7. Internet access in 2016 by Indigenous household status and Indigenous regions

Indigenous region	Indigenous household (%)	Other households (%)	Digital divide (%)
New South Wales			
Sydney–Wollongong	82.3	88.1	5.8
Dubbo	68.4	76.1	7.7
Northeastern NSW	66.3	76.4	10.1
Northwestern NSW	53.1	72.4	19.3
NSW Central and North Coast	78.8	81.7	2.9
Riverina–Orange	71.2	77.7	6.5
Southeastern NSW	77.3	81.9	4.5
Victoria			
Melbourne	85.4	87.9	2.5
Victoria excl. Melbourne	76.6	80.8	4.2
Queensland			
Brisbane	84.6	88.5	3.9
Cairns–Atherton	64.9	84.0	19.1
Cape York	67.1	81.8	14.7
Mount Isa	58.2	84.1	25.9
Rockhampton	75.4	81.2	5.7
Toowoomba–Roma	71.3	79.9	8.7
Torres Strait	68.2	89.0	20.8
Townsville–Mackay	71.7	83.6	11.9
South Australia			
Adelaide	77.0	83.3	6.2
Port Augusta	52.3	74.5	22.2
Port Lincoln–Ceduna	62.0	79.3	17.3
Western Australia			
Perth	79.4	89.0	9.5
Broome	61.3	88.6	27.3
Geraldton	57.4	82.1	24.7
Kalgoorlie	55.5	84.4	28.9
Kununurra	39.6	84.8	45.2
South Hedland	61.4	91.2	29.8
Southwestern WA	69.6	83.2	13.5
West Kimberley	47.3	85.0	37.7
Tasmania			
Tasmania	78.8	80.1	1.3

TABLE 7. *continued*

Indigenous region	Indigenous household (%)	Other households (%)	Digital divide (%)
Northern Territory			
Darwin	74.4	88.9	14.5
Alice Springs	63.2	87.8	24.7
Apatula	27.5	78.2	50.7
Jabiru–Tiwi	53.2	81.6	28.4
Katherine	47.8	83.9	36.0
Nhulunbuy	55.7	90.5	34.8
Tennant Creek	45.5	83.8	38.3
Australian Capital Territory			
ACT	88.1	91.9	3.8
Total Australia	**75.3**	**85.8**	**10.5**

Concluding remarks

This paper pinpoints several factors associated with Indigenous households being connected to the internet and hence having access to ICT: remoteness, income, employment, education and demography (including household composition). The internet is crucial for ensuring adequate connection to services and society. Resources, at least in the form of household income, are identified as being important in ensuring that Indigenous people have access to the internet and maintain access to ICT over time. The analysis identified antidiffusion as a real policy issue that will potentially lead to further social exclusion and a failure to close the gaps in socioeconomic outcomes. The challenge is to address the factors associated with the loss of internet access, but more research is required to provide clear policy guidance.

It is always salutatory to ask the 'so what' question: are these observations important in the long run? For example, increasing decentralised access to the internet through mobile services may be reducing the significance of relatively fixed household infrastructure. While there may be some truth in this observation, it would be a mistake to ignore the role of fixed infrastructure, because mobile devices generally have more limited functionality than desktop devices, and mobile internet connectivity can often be much slower and more strongly affected by the environment and surrounding infrastructure. Certainly, the ongoing investment in the National Broadband Network is an acknowledgment of this reality. Notwithstanding these reflections, even mobile internet access is captured in the census through individuals at the household level.

Radoll (2010) identified 'structure' and 'agency' as key features of the Indigenous household ICT adoption process, especially in the intersection of the fields of employment and education (structures) with the Indigenous field (structure) and Indigenous agents (agency). Using these concepts of structure and agency, the theory asserts that the intersection of the Indigenous field and external fields, along with the interactions between structures and agency, produces new practices by Indigenous agents that lead to Indigenous household ICT adoption. Most of the factors identified in this paper are 'structural' in nature, with the possible exception of the household composition by Indigenous status. Future research should examine the relative significance of the various factors after controlling for confounding factors.

ACLD data allow multivariate analyses of changes in internet access that take into account the intersections of fields of employment and education with some aspects of the Indigenous field. Radoll's (2010) analysis points to the potential importance of (positive) interactions between these fields on the diffusion of ICT. However, like most statistical analysis, it is not possible to provide much insight into the role of 'agency' as opposed to structural issues. Nonetheless, multivariate analysis of the ACLD can test the posited interactions identified by Radoll (2010).

To understand the processes of ICT diffusion and antidiffusion, we need longitudinal data that collect information at more than two points in time. This could be done by a calendar[3] or collecting more waves of data. As pointed out above, the census is asked only once every five years because it aims to cover the whole Australian population. It is very expensive to augment the census with more questions, such as a calendar, so the only realistic option to extend the above analysis of ICT use

over time is to include information from another census. Given that the 2016 Census will be added to the ACLD data in the near future, we suggest that this analysis be repeated using data from the last three censuses.

While there is a need for truly longitudinal analyses, such as provided by the Household, Income and Labour Dynamics in Australia survey, it will likely be possible to exploit ACLD data on Indigenous Australians to provide further insights into the characteristics of people who changed their access to the internet over time. Multivariate analysis of changes in internet access can provide empirical insights into the processes of diffusion and antidiffusion. This paper identifies some overall facts that can be further understood using panel data analysis techniques based on household- and individual-level characteristics identified by Radoll (2010). Identification of the characteristics of households associated with ICT diffusion and antidiffusion would place policy makers in a better position to target their policies appropriately and bridge the widening digital divide.

Notes

1. The census guide (ABS 2011b) provides a rationale for its question on internet access:
   The Internet is changing the way we communicate, find information and conduct financial transactions. The answers to this question will be used to measure how widespread household access to the Internet, both broadband and dial-up, has become in Australia. This information will be used for planning purposes by both government and private sectors to enale wider and improved service delivery.
2. The census guide (ABS 2011b) provides instructions that seem to contradict the questionnaire (advises that people with more than one type of internet connection should report the most frequently used one, not the one that comes first in the list as advised in the questionnaire). The instructions on how to answer Question 59 on internet access say:

   For this question, if the Internet access at the dwelling is via: ADSL; Cable; Fibre; Fixed or Mobile wireless broadband (excluding access through a mobile phone); or Satellite connection, then the dwelling has a broadband connection. Therefore, mark the second box.

   If the Internet access at the dwelling is via a phone line dial-up system or ISDN, mark the third box.

   If the only Internet access available at the dwelling is via a mobile phone or another type of connection, mark the last box.

   When answering, consider all Internet access available at the dwelling, regardless of whether it is paid for by someone in the dwelling, by a business or by someone else.

   If the dwelling has more than one type of Internet access, mark the most frequently used type of connection.

   WiFi/wireless router users: Some households in Australia use a WiFi/wireless router within the dwelling to provide Internet access to WiFi-enabled devices, such as set-top boxes, or laptops. When marking either the second or third box, consider whether the connection to the dwelling is dial-up or broadband, regardless of what type of router is used within the dwelling.
3. Calendars are commonly used in longitudinal surveys to collect information on episodes of a particular phenomenon, over a period of time, and not just collecting information at several points in time.

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