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Internet use in rural and remote Western Australia ☆

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Abstract

Australian telecommunications universal service policy has recently been extended to include the provision of basic data services within a contestable universal service framework. In view of this fundamental policy change, information about the demand for telecommunication services is critical if competition is to deliver intended outcomes. This analysis examines the demand for Internet in rural and remote communities in Western Australia. Toward this end econometric Internet subscription and use models are estimated on survey data collected for this purpose. Estimation results indicate price reduction will have a positive influence among existing Internet subscribers. A model of Internet subscription itself, however, suggests that demand for access is derivative of education and work requirements.

Keywords: Internet subscriber characteristics; Regional policy; Universal service

1. Introduction

Recent liberalisation of the Australian telecommunications markets has led to carrier concern regarding their costs of meeting universal service obligation requirements. Formerly, universal service was supplied by a state-owned monopoly, and supported by revenue pools obtained from more profitable services. Typically, long-distance rates had cross-subsidised those of regional connection and calling. In such deregulated markets a policy challenge is to devise methods that pursue universal service, but minimise distortion associated with the traditional supply push model. For example, Australian universal service policy is primarily directed toward ensuring affordable telecommunications services are provided to persons located in rural and remote areas (McElhinney, 2001). This orientation implies that best practice involves uniform basic service in terms of access, quality and price irrespective of location. The access efficacy of this policy

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direction requires an appraisal of how, more or less, well current supply meets underlying regional demands. Melody (2000) argues mandated supply—without reference to demand—obscures market signals and creates a barrier to service enhancement. Moreover, Parker (2000) argues welfare maximisation requires universal service policy that better reflects rural community telecommunications need. The Australian federal government, in attempting to address these issues, introduced contestable universal service arrangements for rural areas.[1] Additionally, contestability is intended to ensure that accurate costs of service provision are obtained from telecommunications carriers, and lead to a diminution of subsidies to service rural areas.

Barriers currently exist that limit the spread of telecommunication service coverage in rural and remote communities. They include, e.g., inadequate telecommunications infrastructure, lack of awareness of the benefits of information and communications technology (ICT) use, high prices and a relatively less educated community (Katz & Aspden, 1997; Bruce & Gadsden, 1999; Lentz & Oden, 2001; Parker, 2000; Strover, 2001). In rural areas, the predominance of low-income households exacerbates affordability concerns, as do long-distance call rates for dial-up connection and high ancillary service prices. Further, costs of training personnel and specialised ICT service are approximately 10-fold those of acquiring and serving a personal computer (PC) for Internet access. Importantly, demand influences that frustrate achievement of universal service policy are often ignored. Accordingly, Ramírez (2001) emphasises the need to build an awareness of potential benefits from telecommunications services, provide access to training and demonstrate pre-existing need for telecommunications services. Katz and Aspden (1997) consider relevance is key, e.g., individuals that use the Internet at work often more readily derive benefit from use. Together, such analysis suggests universal service policy can be more effective when directed at identified barriers to the more widespread adoption of telecommunication services.

This study examines the demand for Internet service in rural and remote communities located in the Central, Pilbara and Kimberley regions of Western Australia (WA)—collectively known as the North-West (NW) region. Study outcomes show economic, technology and social inhibitors impact unevenly on Internet subscription by region. Whilst particular results from this study relate to WA, these lessons are more generally relevant to sparsely populated and remotely located regions. The paper is organised as follows. Section 2 provides a description of the NW region and Section 3 presents results of a survey conducted on Internet users and non-users. Section 4 describes econometric models of Internet subscription and use. Estimation results are provided in Section 5. Implications of study findings and concluding remarks are contained in Section 6.

2. North-West profile

The NW of WA is comprised of Central, Kimberley and Pilbara statistical divisions. According to the Australian Bureau of Statistics (ABS, 2002a,b) these areas are highly productive, and supply 10% of Australian gross exports—comprised mainly of mineral and agricultural

[1] As part of this process, the federal government commissioned the Telecommunications Service Inquiry to examine the impact of telecommunication deregulation on rural communities. Key among the Inquiry's findings are that the introduction and spread of competition is likely to benefit rural and remote areas, due to a combination of growing availability of cheaper and scaleable technology, and increasing demand for a wider range of telecommunication services.

Table 1
NW household profile

Region characteristic	Central	Kimberley	Pilbara	North-West
Households				
Average age (years)	33	31	30	30
Average size (persons)	2.7	3.3	3.0	2.9
Median weekly income (AUD)	500–699	200–299	500–599	n.a.
Households with annual income of				
AUD 0–51,999 (household)	14,585	5227	4,891	24,703
AUD 52,000 or more (household)	7,756	3,062	9,009	19,827
Total households	22,341	9,594	13,900	45,835
Persons under 25	12,088	6,532	9,603	28,223
Total persons	65,907	33,028	44,798	143,733
Tertiary qualified	3,041	2,079	2,485	7,605

Source: ABS (1996b, 2002a,b).
Notes: n.a. indicates not available. Average household size for North-West is calculated using the Harmonic Mean of Central, Kimberley and Pilbara.

commodities. With less than 1% of the national population spread over a land surface area of 1.5 million km^2, the NW region is considered geographically remote. Table 1 shows that 43% of NW households receive an income of at least 52,000 Australian dollars (AUD) p.a., 62% contain persons aged less than 25 years, while approximately 5% of respondents are tertiary qualified. Further details, provided by the ABS (1996a), show the Pilbara has the highest rate of Australian population decline and labour force participation, and second highest median gross weekly income. Moreover, both Kimberley and Pilbara regions are relatively young, with median population ages of 27.1 and 28.3 years, respectively.

Household data presented in Table 1 are comparable to the ABS (2000c) Internet profile reproduced in Table 2. In general, ABS report household Internet subscription is influenced by income, age and geographic location. High-income households (at least AUD 52,000 p.a.) are three times more likely to have Internet subscription, while households with a resident less than 18 years of age are 1.5 times more likely to subscribe. The ABS also reports that household Internet connection is, on average, 20% lower than in non-metropolitan areas. Comparison of NW population characteristics to the national Internet profile suggests 13,000–15,500 (30%) of NW households have Internet connection.[2]

Data on Internet activity by geographic location are presented in Table 3. The number of subscribers per access line does not vary markedly by location. However, data download increases with household isolation. Further, detail for WA regions contained in Table 4 shows average

[2] Table 1 shows the number of total households with persons under 25 years while Table 2 presents the number of residents under 18 years of age. The difference in the household age break between the two tables is due to an inconsistency in ABS classification across surveys.

Table 2
Australian household Internet subscription (%)

Household characteristic	1998	1999	2000
Income			
Less than AUD 51,999	10	12	21
More than AUD 52,000 or more	34	43	57
Resident age			
A resident aged under 18 years	25	35	48
No resident aged under 18 years	15	20	32
Location			
Metropolitan area	22	30	40
Non-metropolitan area	13	17	32
Percent of households subscribing	19	25	37

Source: ABS (2000c).

Table 3
Internet access and activity by geographic isolation at 2000

Accessibility	ISPs (number)	Points of presence (number)	Access lines (number)	Subscribers (thousand)	Data download (million Mbs)	Subscribers per line (number)	Data download per subscriber (Mbs)
WA							
Very high	99	142	34,448	301	100	8.7	331
High	15	24	2,257	n.a.	5	n.a.	n.a.
Moderate	7	18	n.a.	n.a.	1	8.2	n.a.
Low	3	10	n.a.	3	1	n.a.	285
Very low	17	45	2,969	21	6	7.1	309
Total	109	239	40,861	357	113	8.7	317
Australia							
Very high	598	1,612	437,353	3,531	941	8.1	267
High	114	403	37,282	304	66	8.2	216
Moderate	53	160	9,585	84	19	8.8	220
Low	23	63	2,675	25	7	9.3	265
Very Low	20	72	3,213	24	7	7.5	307
Total	665	2,310	490,108	3,968	1,040	8.1	262

Source: ABS (2001a).
Note: n.a. indicates not available. Point of presence refers to the number of geographic locations subscribers can access the Internet by dial-up means.

subscriber numbers per access line and their data download is higher than the corresponding Australian average. Both Central and Pilbara regions have fewer subscribers per line than state and nation averages, respectively. Data download statistics suggest Central subscribers use the Internet less intensively.

Table 4
NW access and activity at 2000

Region	ISPs	Points of presence	Access lines	Subscribers (thousand)	Data downloaded (million Mbs)	Subscribers per access line	Data downloaded per subscriber (Mbs)
Central	9	15	1,171	9	1	7.7	156
Kimberley	6	8	350	3	1	8.6	244
Pilbara	7	17	1,002	5	1	5.0	273
Perth	94	115	30,648	271	92	8.8	340
WA	109	239	40,861	357	113	8.7	317
National	665	2,310	490,108	3,968	1,040	8.1	262

Source: ABS (2001a).
Note: n.a. indicates not available. Point of presence refers to the number of geographic locations subscribers can access the Internet by dial-up means. Perth is the WA capital and Australia's fourth largest city.

Further, the ABS report 40% of WA farms, 54% of firms and 34% of households use the Internet (ABS, 2000b, 2000c, 2001b). While these statistics compare favourably with the national average, WA has the largest proportion of farms in the highest Internet cost bracket. Interestingly, twice as many large farms (valued AUD 1 million or more) subscribe to the Internet than small farms (valued less than AUD 25,000). Similarly, 80% of firms employing more than 19 persons subscribe to the Internet compared to 43% for firms employing less than 5 persons. Nearly half of WA firms use the Internet to facilitate transactions and business processes, while 7% derive income from the Internet. For individuals, tertiary qualified persons are more likely to use the Internet. Finally, 13% of adult persons conduct financial transaction via the Internet, and 8% engage in e-commerce.

3. Sampling procedures and survey data

An Internet use profile of Farms, Firms and Households located in the NW of WA was obtained from a telephone survey conducted from 31 July to 22 September 2000. The sampling frame is comprised of an exogenously stratified sample of 400 respondents. Within strata sampling was choice based. Groves and Kahn (1979) argue exogenous stratification reduces sampling error. Exogenous stratification also ensures the adequate inclusion of relevant subpopulations (strata) in the resultant sample. This is important as it is likely that Internet subscription and use will vary systematically by Farm, Firm and Household strata. Thus, sampling proportions are choice based so as to ensure sufficient observations to allow for meaningful statistical analysis by strata. Such sampling selects sufficient respondents for Farms, Firms and Households, and their subscriber and non-subscriber subpopulations. Separate survey questionnaires are prepared for these strata. The ratio of subscribers to non-subscribers reflects that of the NW population.

The Office of Information and Communication in the WA Department of Commerce and Trade predetermined the sample size. Respondents are Farm managers (22%), Firm managers

Table 5
Subscription by respondent type

	Subscribers		Non-subscribers	
	Number	%	Number	%
Firm	101	64	56	36
Household	59	38	96	62
Farm	41	47	46	53
Total	201	50	198	50

Note: One respondent declined to answer the question relating to this table.

Table 6
Non-subscription by access elsewhere

	Access elsewhere	No access elsewhere
	Number	Number
Firm	36	20
Household	69	27
Farm	11	35

Table 7
Motivation for subscribing

	Number	%
Competitive pressure	13	7
Cost savings	28	16
Customer demand	42	24
Expand sales	24	14
Overcome service reduction	41	23
Supplier ordering	27	15
Total	175	100

Note: Multiple responses are permitted.

(39%) and Household residents (39%). The sample size is 0.3% of the NW WA regional population. To ensure the sample was representative of the NW population the survey was advertised by WA government agencies to community and industry groups. In particular, the Department of Commerce and Trade's Telecentre network, electoral offices of Members of Parliament, the Shire Council of Roebourne and the Pilbara Development Commission.[3]

Summary survey data are presented in Tables 5–11. Attempts to isolate factors that may allow discrimination between Internet subscribers and non-subscribers are made through bivariate data arrays and pair-wise correlations. Table 5 shows that Firms are more likely to be Internet subscribers when compared to Farms and Households. Table 6 indicates Farms are least able to

[3] See Appendix A for further details of the survey design.

Table 8
Subscription by household location

	Internet subscription			
	No		Yes	
Remoteness (km)	Number	%	Number	%
0–50	75	78	43	72
51–100	10	10	3	5
>100	11	11	14	23
Total	96	100	60	100

Note: One respondent declined to answer the question relating to the data in the above table.

Table 9
Internet subscription and farm location

	Internet subscription			
	No		Yes	
Remoteness (km)	Number	%	Number	%
0–50	9	20	20	49
51–100	10	22	5	12
>100	27	59	16	39
Total	46	100	41	100

Note: Means test that distance has no impact on Internet adoption is 1.946 (0.055). Levene's test that variances of groups are equal 0.204 (0.653). Probability values are in parentheses.

Table 10
Household Internet subscription and education

	Internet subscription			
	No		Yes	
Education	Number	%	Number	%
University degree	11	12	14	20
Associate diploma	1	1	5	7
Skilled vocational	19	21	14	20
High school	59	66	38	54
Total	90	100	71	100

seek alternative local access. Twenty per cent of respondents have Internet access via a telecentre or library, 15% from work, 13% through an associates, account and 3% utilise Internet cafés.

Table 7 suggests a common reason for Firm Internet subscription is underlying customer demand and to access services removed from towns. Examination of survey responses under the Customer Demand section reveals a common comment that customers wish an ability to communicate with suppliers by email. Another motivation is to make cost savings and expand sales.

Table 11
Farm Internet subscription and tertiary training

	Internet subscription			
	No		Yes	
Degree	Number	%	Number	%
No	39	55	32	45
Yes	7	44	9	56
Total	46	53	41	47

Note: Means test that tertiary training has no impact on Internet adoption is −0.80 (0.42). Levene's statistic that variances of the two groups are equal is 2.59 (0.11). Probability values are in parentheses. Means statistic adjusted for unequal variances.

Comparison of Tables 8 and 9 shows that Household subscription does not appear influenced by distance, whereas Farms are more likely to not subscribe as distance from the nearest town increases.

Finally, Tables 10 and 11 provide evidence that education is an important factor in determining Household and Farm subscription. More than half of sampled Households, where a resident is associate diploma or tertiary qualified, subscribe. For Households and Farms, education and work are motivators to establish connection, while Firms perceive subscription as offering an alternative communications channel. While price is cited as a subscription inhibitor, analysis suggests that this response may reflect a perceived lack of utility compared to other telecommunication services, such as mobile telephones.

4. Models of Internet subscription and use

Multivariate econometric models are employed to relate factors that influence patterns of Internet subscription and use by the NW population. Internet subscription and use are treated as separate decision processes. Subscription is analysed using a discrete choice model that relates the subscription probability to factors that identify access, alternative and complementary communications channels, expense, ICT ownership and training. In particular, a binomial logit model identifies the importance of determinants of NW Internet subscription by sample strata. That is, the 0–1 variable SUBSCRIPTION splits the sample into Internet SUBSCRIBER (=1) and NON-SUBSCRIBER (=0) subgroups. A separate Internet use model considers the relationship between HOURS online (once connected) to the explanatory variables. This model is estimated by ordinary least squares.

Prior analysis of ICT networks direct selection of particular explanatory variables for both models (Rappoport, Taylor, Kridel, & Serad, 1998; Kridel, Rappoport, & Taylor, 1998; Madden, Savage, & Simpson, 1998; Madden, Savage, Coble-Neal, & Bloxham, 2000). These variables are listed in Table 12. The explanatory powers of alternative specifications are considered for both the subscription and use models. General model specifications are pared down according to goodness-of-fit criteria. Model results reflect basic characteristics common across Internet subscribers but largely absent from the Internet non-subscriber population.

Table 12
Model variables

Variable	Description
DISTANCE	Distance between respondent residence and the nearest town in kilometres
EMPLOYEES	Number of persons employed full-time
EXPENSE	Monthly communications budget
FAX	=1, if the respondent owns a facsimile machine; =0, otherwise
INCOME	Annual income
LINES	Number of communications lines installed
PC	Number of personal computers installed
PERSONS	Number of persons residing in the household
PRICE	Average hourly cost of Internet access
SELF-EMPLOYED	=1, if respondent operates and owns the business; =0, otherwise
TERTIARY	=1, if respondent is degree qualified; =0, otherwise
TRAINING	=1, if respondent has vocational, trade or tertiary qualification; =0 otherwise

5. Estimation results

Tables 13 and 14 contain estimation results for both SUBSCRIPTION and HOURS models by respondent strata. Model results clearly demonstrate the importance of sample stratification as the drivers and inhibitors of Internet subscription are very different for these strata. The Farm model suggests subscription is driven by FAX and TRAINING variables. Simply, FAX demonstrates information need whereas TRAINING indicates the capacity to understand and operate relevant technology. DISTANCE inhibits subscription—clearly, this relates to lack of physical access. For Firms the only significant driver identified is PC. This PC variable most likely captures information need, in a similar manner as the FAX variable does for Farms. The explanation of Household subscription is more complex, and related to DISTANCE, PERSONS and SELF-EMPLOYED variables. Taken together increasing distance from the nearest town and the number of residents increase likelihood of Household subscription. These factors appear to swell local populations of subscriber interest. The importance of SELF-EMPLOYED in the Household model implies NW respondents are using the home as a de facto office.

Diagnostic statistics for the HOURS models indicate they are well specified for all strata. Table 14 shows that Farm Internet use is less when a facsimile is in operation. This finding suggests Internet use can, more or less well, substitute for Internet transmissions. Farm respondents with a facsimile machine spend approximately 17% less time online than respondents without a facsimile machine. For Firms, the LINES, PRICE and EMPLOYEES variables are statistically important in describing use. LINES appear to act as proxy for the extent of underlying communication need. PRICE indicates that reduction by an AUD 1 per hour leads to an additional 30 min spent online per month. HOURS spent online decreases with the number of persons employed, which may indicate a greater need for small Firms to be online. Finally, for Households, PRICE and FAX variables appear to inhibit and drive Internet use, respectively. The estimated negative PRICE coefficient implies an AUD 1 reduction per hour for connection leads respondents being online for 14 more hours per month. Coefficient for FAX suggests an underlying information need that

Table 13
Subscription model estimates

Variable	Coefficient	*t*-ratio
FARMS		
Constant	−0.50	−0.89
DISTANCE	−0.05	−2.38
FAX	0.91	1.67
PERSONS	0.04	1.03
TRAINING	1.06	1.62
Observations	29	
FIRMS		
Constant	−0.16	−0.50
LINES	0.01	0.09
EXPENSE	0.00	0.51
PC	0.29	2.54
EMPLOYEES	0.01	0.51
Observations	157	
HOUSEHOLDS		
Constant	−1.68	−3.47
DISTANCE	0.28	1.89
PERSONS	0.25	1.93
INCOME	0.00	0.87
SELF-EMPLOYED	1.23	2.08
Observations	148	

can be complemented by email and web browsing. Respondent Households with facsimile equipment are likely to spend an extra 5 hours online monthly.

6. Conclusions

This study analyses sample rural and remote WA Internet subscription and use data. The sample is stratified so as to allow for separate consideration of the subscription and use profiles for Farms, Firms and Households, respectively. Within strata sampling is choice based to ensure adequate strata coverage. Separate analysis by strata is important as it is likely that Internet subscription and use will vary systematically. These survey data suggest isolation has little impact on Internet subscription, except the local isolation of Farms from their nearest town. Moreover, it appears that Internet subscription is largely determined by a need to communicate for work and educational purposes, and that among Internet subscribers, reduction in subscription price yields increased time online. For Firms, scale of operation has a positive impact, suggesting small firms spend less time online than larger ones.

Table 14
Hours model estimates

Variable	Coefficient	*t*-ratio
FARMS		
Constant	28.90	5.25
DISTANCE	−0.28	−0.84
FAX	−0.17	−6.68
PRICE	0.03	1.06
TERTIARY	0.44	0.04
Diagnostic statistics		
Observations	41	
σ^2	23.51	
$\bar{R}^2$	0.56	
DW	2.11	
FIRMS		
Constant	11.93	4.03
LINES	1.91	2.67
PRICE	−0.52	−3.32
INCOME	0.00	0.51
EMPLOYEES	−0.82	−1.70
Diagnostic statistics		
Observations	48	
σ^2	10.69	
$\bar{R}^2$	0.25	
DW	2.01	
HOUSEHOLDS		
Constant	73.39	3.23
PERSONS	0.61	0.11
PRICE	−14.13	−3.18
EXPENSE	−0.04	−0.33
FAX	5.00	3.42
Diagnostic statistics		
Observations	29	
σ^2	41.53	
$\bar{R}^2$	0.48	
DW	2.67	

Note: σ^2 is residual standard deviation. $\bar{R}^2$ is adjusted coefficient of variation. DW is the Durbin–Watson statistic.

Importantly, better and more effective policy needs to consider subscription and use demands. Moreover, broadening policy focus to include demand influences permits a wider range of strategy to be employed, including those aimed at increasing effective demand for existing services. Additionally, evidence presented here suggests current expenditures on universal service subsidies would be better directed at education and training rather than at trying to reduce the subscription price. Further, analysis of end-user preferences will provide insight into which services are likely

to provide the greater benefit, as well as highlighting inhibitors to wider adoption of advanced telecommunications services. Finally, this study suggests consumer welfare estimates for services in remote areas of Australia would provide further assistance to government in making best use of scarce funds for universal service programs.

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Appendix A. Survey design

Respondents are asked to supply information concerning their subscription, ISP, Internet use, expenditure, pricing plan, home technology and socio-demographic background. The questionnaire consists of a 14-page A4 document. A maximum of 35 questions are included as follows:

(a) One question identifies respondent as Farm, Firm, or Household.
(b) Two questions indicate the local remoteness of the respondent.
(c) Eight questions relating to subscription, frequency of use and expenditure of standard telecommunications services such as fixed-line telephone, mobile telephone, facsimile and number of communication lines connected.
(d) One question identifies respondent as Internet subscriber or non-subscriber.
(e) Three questions assess the quality of telecommunications service.
(f) Seven demographic and economic questions elicit gender, age, occupational status, income group and household size and composition.

Of respondents currently subscribing to the Internet:

(g) One multiple response question to identify most frequent Internet applications.
(h) One question relates to PC ownership.
(i) One question identifies the reason for initial subscription.
(j) Four questions concern the timing and duration of Internet use.
(k) Three questions identify the purpose of Internet use.
(l) Three questions relate the mode, frequency and amount of recent ISP billing.

Of respondents not currently Internet subscribers:

(m) One multiple response question identifying reasons for not subscribing.
(n) Three questions relate to the presence of alternative Internet access points.
(o) Four questions to isolate factors that encourage subscription.

Given several population segments are surveyed the questionnaire is designed so that the 'specific' information requests vary by respondent type and profile. Specifically, Microsoft Access

is utilised to develop an interactive survey questionnaire with a tree structure so that only relevant questions 'appear'. Most of the questions are conditional on earlier responses and provide the best opportunity to explore specific issues with follow-up questions without unnecessarily burdening respondents. On average, respondents took an average 20 min to complete the survey. Focus group feed back, prior to conducting the survey, showed the design substantially improved both response accuracy and questionnaire completion. During the period of the survey 400 persons completed the questionnaire from a pool of 523 respondents.

A critical aspect in the survey design is the identification of the proportion of residents not accessing online services through Internet subscription. An aspect in deciding to subscribe to the Internet is whether access to the Internet is available through work, neighbours or government facilities, such as telecentres and libraries. Capturing non-subscribers ensures that the sample provides an accurate reflection of NW residents Internet subscription and use. To avoid sampling bias, the veracity of the sample from which inferences are drawn is checked ex post by a series of indicative comparisons against ABS data for the NW (ABS, 1996a, 1998a,b, 2000a). Where possible sample data collected is compared against known population characteristics derived from various official statistical sources such as the ABS census, labour force and industry surveys. As a result, the following indicative comparisons are presented to provide some indication of the representativeness of sample data.

In relation to Household and Farm respondents, survey results indicate that 21% of respondents hold a diploma or degree, compared to 28% for the regional population. A further 20% of sampled Households and Farms have skilled vocational trade qualifications compared to 31% reported by the ABS. The proportion of persons aged under 15 years from this survey is 25% compared with 24% for the regional population. Seven per cent of Household respondents receive an income between $120 and $299, compared to 13% for the regional population. Also, 12% earn an income between AUD 300 and AUD 499 compared to 15% for the regional population. Among higher income recipients, 21% report an income of AUD 1000–1499 compared to 17% for the regional population. Approximately 20% of respondents report a non-Australian origin compared with the Census estimate of 11%.

Annual revenue by Farm reveals that 29% report a revenue band of AUD 200,000–499,000 p.a. compared to 25% for the population. The most common industry classification for sample Firms is Retail (20%) compared with 19% reported in ABS (2000).

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