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## A probit model of household broadband service subscription intentions: A regional analysis

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### Abstract

Much recent debate concerns the effect of carrier roll-out on access to networked services. However, whether particular groups within passed communities are unable or unwilling to subscribe to networked services is also an important policy issue. This paper sets out to identify households that are less likely to subscribe and examines whether there exists a systematic link between subscription interest and commonly accepted measures of social disadvantage. A probit regression is estimated on stated-preference subscription data obtained from a national survey of one thousand households. The results show that the potential exists for an information poor class to develop.

*Key words:* Broadband delivered services; Network coverage; Subscription interest; Information poverty

*JEL Classification:* C93; L96; O33

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### 1. Introduction

There has been substantial recent debate concerned with the potential impact of the introduction of broadband services on the wider community (Curtis and

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Means, 1991).<sup>1</sup> It is widely recognised that while networked services have many benefits, they also have the potential to further skew the income distribution toward the information rich, in as much as they enhance both the ability to generate income streams directly, and indirectly through education (Gandy, 1988). An important aspect of the debate focuses on the potential for the uneven coverage of delivered networked services. The supply side of the debate concerns network roll out. Costs and potential revenue streams suggest that roll-out will occur first in more densely populated areas. A separate set of concerns considers the question as to whether particular groups within passed communities are unable or unwilling to subscribe to networked services.

Two recent reports concerning the impact of these technological developments on the broader Australian community indicate the importance of analysing coverage of broadband service delivery.<sup>2</sup> These reports indicate that the needs of information-disadvantaged groups such as elderly, low income, unemployed, or rural and remote households are the most pressing from a policy perspective. The Broadband Services Expert Group (BSEG) states:

“.. access must be *equitable* if our society is to share the benefits of the emerging communications environment... How can we provide for people living in *rural and remote* areas, or those with *special needs*, or *poorer people*, services equivalent to those available to people living in wealthy city areas.” (BSEG, 1994; our emphasis.)

The possibility that information-disadvantaged groups may be further marginalised by the uneven coverage and take-up of broadband services is identified in a report on the future of social security, by the Minister for Social Security, the Hon Peter Baldwin MP:

“There is a risk that the disadvantaged, in particular people on social security payments, could be left behind in the development of the ‘information superhighway’. The worsening of the bifurcation of society into the *information rich* and the *information poor* is a real danger.” (Baldwin, 1995; our emphasis.)

<sup>1</sup> Broadband services are defined for the purposes of this paper as those that involve the transmission of video data or a combination of video, text or audio data.

<sup>2</sup> The final report of the Broadband Services Expert Group emphasises the need for greater understanding of the full range of potential services and the key issues in their delivery so that the community can better indicate its needs in terms of access to a broadband network. The final report of the Communications Futures Project, under the auspices of the Bureau of Transport and Communication Economics (BTCE), is an important contribution toward meeting the BSEG request. The BTCE study provides a formal model of broadband network evolution based on estimates of market demand.

The need for policy response is borne out by the recently established National Information Services Council (NISC), which argues that:

“Given the vital nature of these services to all Australians, government will need to take a key role in monitoring the development of information services, and where market forces work to exclude some groups from accessing these services, it will need to take appropriate measures to address these inequities.” (NISC, 1995.)

Both the BSEG and the Communications Futures Project final reports suggest that community service obligations may need to be redefined. BSEG argues that a set of broadband service requirements be defined to enable the needs of disadvantaged groups to be met by targeted policies. Under this scenario, priority is given to institutions such as schools, libraries, medical facilities and community centres in rural and remote areas where households are unlikely to gain access to broadband services in the near future.

More fundamentally, however, it is necessary to associate access-disadvantaged groups with commonly accepted measures of social disadvantage. The focus of this study is to determine whether several measures of social disadvantage significantly deter network subscription. Once significant factors are identified, a deeper understanding of the nature of access-disadvantage can be provided, and so enable the development of appropriate policy responses. Fulfilling universal service requirements by pricing regimes that cross-subsidise household network connection or use is inappropriate when households have lexicographic preferences over broadband services. A better policy response may be through identification of user needs and targeted consumer education programs.

The econometric model employed here is not developed in the usual choice problem context since disinterested households are lexicographic toward broadband services. No trade-off between price and other service characteristics in selecting an optimal bundle occurs. The bundle of services is a corner solution and is unaffected by relative prices. Accordingly household subscription interest and sociodemographic characteristics are linked through a binomial probability rather than a discrete choice model.<sup>3</sup>

The paper is organised as follows. Section 2 provides a brief overview of the experiment and survey procedures. Data description and modifications are discussed in Section 3. In Section 4, the estimable model is specified, and a discussion of the estimation results is contained therein. Section 5 illustrates the effects of household demographic characteristics on network subscription intentions, and Section 6 presents some concluding remarks.

<sup>3</sup> Previous studies of access to telecommunications networks (for example, Perl, 1983; Taylor and Kridel, 1990; Bodnar et al., 1988) suggest that household characteristics are the strongest predictors of access by a substantial margin.

## **2. Experimental design and survey method**

Recent studies that apply diffusion models to network subscription, such as St. Clair and Madden (1995), can be useful in providing estimates of economy-wide or regional household subscription levels. However, while household expenditure data is used, other important demographic information, such as age, gender and household composition are not linked to these models. As a result little direct information is provided concerning the subscription patterns for these services for subgroups of the covered population. Further, because broadband services are not currently available, model simulations are based on parameter values taken from studies of analogous extant products and services, such as VCRs and payTV<sup>4</sup> This approach becomes less helpful when considering the take-up of radically new services.

### *2.1. Experimental design*

Econometric analysis is traditionally based on revealed preference data obtained from surveys asking for actual behaviour. When forecasts of the take-up for new products are required stated-preference data is useful. This is especially the case when new products contain attributes not included in extant products. The stated-preference method employed here generates survey questions designed to mirror the household's market decision by presenting hypothetical but realistic choice contexts. The experiment defines discrete broadband subscription alternatives as collections of service attributes. Respondents face a dichotomous decision as to whether the household is interested in considering network subscription after these broadband services are identified. The categories provided are entertainment, information and education, transactions and communications. The survey design is illustrated by Fig. 1.

### *2.2. Survey method and sampling frame*

The interviews are conducted by face-to-face survey mode. Cluster probability sampling techniques are used to locate respondents. Given a randomly drawn start

<sup>4</sup> Other research streams, such as the diffusion of innovations literature pioneered by Rogers (1983), focus on developing typologies of consumers based on demographic or psychographic variables related to their tendency to be early or late adopters of innovations. While such research is useful in segmenting the market at stages in its life-cycle, it does not account for product and consumer-specific variables that impact on service adoption. Studies based on the above methodology usually examine demand (subscription) patterns *ex-post*. Further, such studies are often economy-wide and do not link diffusion with sociodemographic variables.

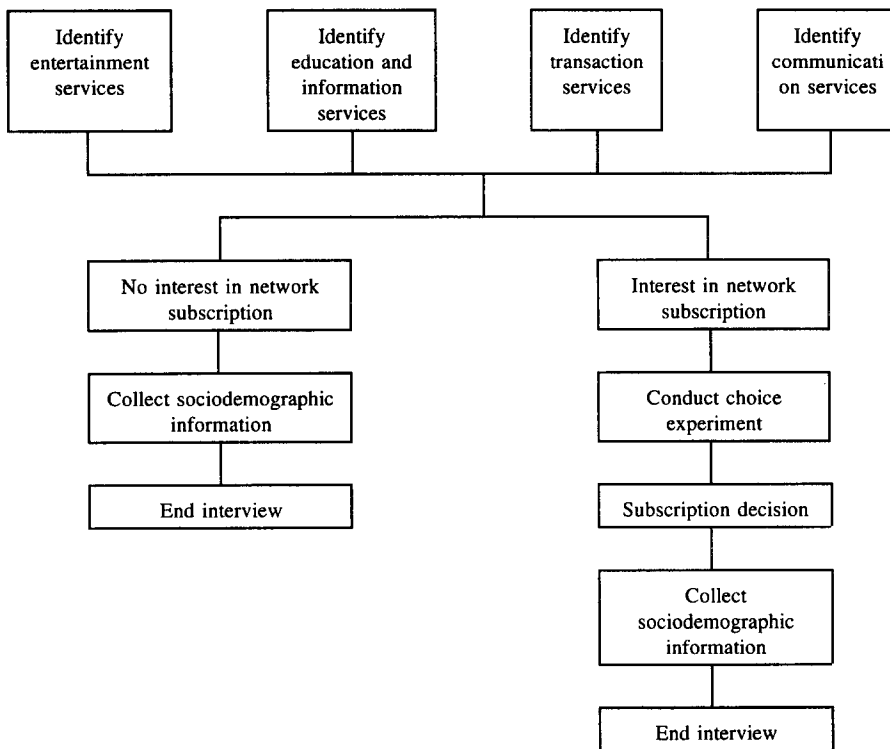


Fig. 1. Household interest and subscription choice.

*Note:* A household is classified as interested in network subscription when the respondent agrees to participate in a choice experiment for at least one of the identified services. Choice experiment outcomes identify the of conversion from interest to subscription. The choice experiment is structured so that respondents face a discrete choice of either ‘subscribing’ or ‘not subscribing’ to individual services. Services are defined by product characteristics, including price. The levels of the characteristics are systematically varied to create different alternatives. Alternatives are placed in choice sets. Choice sets are structured so as to require the respondent to trade-off characteristics when making a choice (see Madden (1995) for a discussion). When respondents are ‘not interested’ in the service, no trade-off is made and so no information is conveyed. Respondents ‘not interested’ in services are therefore identified and excluded from the experiment after their sociodemographic characteristics are recorded.

point within the sampling area, every household in the sampling frame has an equal chance of being chosen as a start point. Around each start point, a cluster of five households is interviewed.<sup>5</sup> For a total sample size of 1015 interviews, the

<sup>5</sup> The cluster size of five households is based on usual commercial practice. A cluster of five households suggests that the interviewer is given a start point and proceeds in a systematic manner from that start point until five interviews are completed. The interviewer then moves to the next start point.

survey requires 143 randomly generated start points (approximately 20 for each city)<sup>6</sup>.

The survey was conducted on the week-ends and evenings of week days during the period April 1 through April 9, 1995. Almost 80 percent of interviews were undertaken on week-ends between the hours of 10 a.m. and 6 p.m. The remainder were conducted on week day evenings between the hours of 4 p.m. and 8 p.m. The survey was distributed to approximately 100 households in each State capital city and Canberra, while a further 300 interviews were conducted in provincial centres (centres with a population less than 100,000 persons) in New South Wales, Victoria and Western Australia.

Table 1 provides a comparison of the profile of household characteristics for the present sample and that corresponding to ABS Census data. The table shows that the distribution of household income, size, and composition in the present sample is representative of the wider population. Similarly, Table 2 shows that the distribution by respondent characteristics in the survey compares closely to that of the ABS Census.

### **3. Data**

Both household and household member data are collected. Sociodemographic data collected from the survey are classified into the groups: household income; household size and composition; household type, location and ethnicity; technical literacy, and; age, gender, employment status and occupation. The unit of analysis is the household, and where possible, household member data are combined to form household measures.

#### *3.1. Household income*

These data suggest that service interest does not increase with income. The proportion of households interested in subscription is relatively constant across income brackets. In Table 3, the income group with the greatest interest in service

<sup>6</sup> The start points are randomly generated from local Telecom White Pages directories. A start point is identified as a street corner. The household in the identified street corner is the first eligible household to interview; the interviewer proceeds along the street to the next household keeping his/her left shoulder to the fence line. The results of every door knock is recorded. In the case of non-response (absence of the main economic decision-maker or unwillingness of households to take part in survey) the interviewer moves to the next household. Non-responses are not included in the sample. If the non-response is due to absence of the main economic decision-maker, the interviewer returns to the household on the same day after conducting further interviews in the cluster area. Households not interested in broadband services form part of the sample, however, no choice experiment data is collected. Demographic data from these households is used for sample enumeration purposes.

Table 1  
Sample distribution by household income, number of members, composition and technical literacy

Household characteristic	Total sample (percent)	ABS <sup>a</sup> (percent)
<i>Household income</i>		
Less than \$10,000	4	10
\$10,000–\$14,999	10	9
\$15,000–\$19,999	6	9
\$20,000–\$24,999	6	7
\$25,000–\$29,999	7	7
\$30,000–\$34,999	8	6
\$35,000–\$39,999	6	6
\$40,000–\$44,999	6	5
\$45,000–\$49,999	5	5
\$50,000–\$54,999	7	4
\$55,000–\$59,999	3	3
\$60,000–\$69,999	7	4
\$70,000–\$79,999	5	3
\$80,000 +	10	6
Refused	10	14
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Number of household members</i>		
1	12	20
2	32	31
3	20	17
4	23	19
5	9	9
6	4	4
7	0	0
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Household composition</i>		
Single (less than 45 years old)	5	7
Single (45 to 64 years old)	4	5
Single (65 years and over)	4	8
Single with children less than 15 years	4	4
Single with children 15–25 years	8	2
Couple (less than 45 years old)	8	8
Couple (45 to 64 years old)	9	9
Couple (65 years and over)	6	7
Couple with children less than 15 years	22	24
Couple with children 15–25 years	16	10
Other	15	16
<i>Total</i>	<i>100</i>	<i>100</i>

<sup>a</sup> Source: ABS (1993).

subscription is the \$55,000 to \$59,999 bracket (83 percent are interested in subscription), while least interest occurs in the \$60,000 to \$69,999 income category (71 percent).



Table 2  
 Sample distribution by respondent gender, age, status, occupation and educational attainment

Respondent characteristic	Total sample (percent)	ABS (percent)
<i>Gender</i>		
Male	46	48
Female	54	52
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Age</i>		
15–24	12	15
25–34	23	22
35–44	23	20
45–54	21	16
55–64	9	10
65+	11	16
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Status</i>		
Full-time employment	37	30
Part-time employment	11	11
Self-employed/employer	11	7
Unemployed	4	7
Domestic duties	16	23 <sup>a</sup>
Retired/aged pensioner	13	14 <sup>b</sup>
Non-aged pensioner	3	2
Secondary/tertiary student	5	6
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Occupation</i>		
Professional	35	19
Managers/administrators	11	12
Clerical	14	15
Sales and personal service	18	14
Trained/qualified tradespersons	9	13
Other tradespeople	9	20 <sup>c</sup>
Other/not stated	4	6
<i>Total</i>	<i>100</i>	<i>100</i>
<i>Highest educational attainment</i>		
Some secondary school	37	} 61 <sup>d</sup>
Completed matriculation/HSC	16	
Completed trades training	6	na.
Some technical or commercial training	4	3 <sup>c</sup>
Completed technical/commercial college	6	10 <sup>f</sup>
Some university training	6	na.
University degree/diploma	25	13
Not stated	0	13
<i>Total</i>	<i>100</i>	<i>100</i>

<sup>a</sup> Approximated by the number of people 'not in the labour force', though not including retirees.

<sup>b</sup> Approximated by the number of people 'not in the labour force' and aged 65 years or more.

<sup>c</sup> Includes 'plant and machine operators and drivers' and 'labourers and related workers'.

<sup>d</sup> This proportion represents the number of persons aged 15 years or more that are 'not qualified'.

<sup>e</sup> Approximated by 'basic vocational' category of highest level of qualification in Census.

<sup>f</sup> Approximated by 'skilled vocational' category of highest level of qualification in Census.

Source: ABS (1993).

Table 3  
Subscription interest by household income

Household income	Percent
<i>Total, all households</i>	75.4
Less than \$10,000	74.6
\$10,000–\$19,999	74.6
\$20,000–\$29,999	74.1
\$30,000–\$39,999	75.0
\$40,000–\$49,999	71.3
\$50,000–\$59,999	83.3
\$60,000–\$69,999	70.8
\$70,000–\$79,999	83.0
\$80,000 or more	77.5

### 3.2. Household size and composition

Table 4 shows that household interest in broadband service subscription is greater for households with three, four or five members. Interest is relatively low for one or two member households. This segment of the population contains a large proportion of elderly respondents.<sup>7</sup>

High levels of interest occurs in households with young through middle-aged occupants, particularly those with young dependents. Households comprised of older occupants without dependents show substantially less interest in service subscription.

### 3.3. Household type, location and ethnicity

Table 5 shows that interest appears higher in larger metropolitan centres, such as Sydney and Melbourne (80 percent of households) than those in provincial centres (72 percent).<sup>8</sup> There is also considerable service interest shown by respondents of Southern European and Asian origin.

<sup>7</sup> Approximately 25 percent of one member households have respondents aged in excess of 55 years while 20 percent of two member households have respondents in this age group. Respondents aged over 55 years are less likely to reside in large households, and comprise only 13 percent of three member households, and less than five percent of households with more than three members. BTCE (1994) suggests that usage of services is positively associated with households of three or more individuals. Perl (1983) also suggests that household size has positive effects on the probability of access to the telephone network in the US. In contrast, Ironmonger and Lloyd-Smith (1992) identify a trend of greater subscription interest from smaller households.

<sup>8</sup> Analysing Canadian data, Bodnar et al. (1988) find that the probability of having a telephone is higher in urban than in rural areas and increases monotonically with urban size.

Table 4  
Subscription interest by household size and composition

Household size and composition	Percent
Total, all households	75.4
<i>Household size (number of household members)</i>	
1	58.2
2	65.6
3	85.4
4	85.7
5	87.6
6 or more	68.6
<i>Household composition</i>	
No dependents and household head aged less than 25 years	90.5
No dependents and household head aged 25–44 years	87.5
No dependents and household head aged 45–64 years	61.5
No dependents and household head aged 65 years or over	29.9
Single or couple with at least one dependent aged less than 15 years	86.8
Single or couple with at least one dependent aged 15–25 years	80.5

### 3.4. Technical literacy

Technologies listed in Table 6 are roughly classified by the consumer market first release date. No clear pattern in technology ownership and service interest is apparent, although there is some interest from households that own, rent or use recent household technologies such as home banking services, facsimile machines and modems.<sup>9</sup>

Table 5  
Subscription interest by household location and ethnicity

Household category	Percent
Total, all households	75.4
Rental property	80.2
Located in Sydney or Melbourne	78.0
Located in a provincial centre <sup>a</sup>	72.5
South European ethnicity <sup>b</sup>	88.9
Asian ethnicity <sup>c</sup>	85.7

<sup>a</sup> For the purposes of this study, provincial centres are defined as those with a population of less than 100,000 persons.

<sup>b</sup> Respondent born in Italy, Malta, Greece, Cyprus or Yugoslavia.

<sup>c</sup> Respondent born in China, Japan, India, or South East Asia.

<sup>9</sup> The proportions of households in the present survey that own or rent various technologies correspond closely with the results of the latest Keig Report on New Media and Technology.

Table 6  
Subscription interest by technology ownership and use

Technology owned/rented	Percent
Total, all households	75.4
<i>More recent household technologies</i>	
Personal computer	73.8
Modem	76.7
CD-ROM/Multimedia centre	74.8
Video game machine	72.6
Facsimile	78.6
Mobile phone	71.0
Home banking service	79.7
<i>Less recent household technologies</i>	
CD player	76.0
Video-cassette recorder	75.4
Automatic teller machine card	75.8
TV with teletext	64.2

### 3.5. Age, gender, employment status and occupation

Household interest appears stronger for younger respondents, and declines monotonically with respondent age. Table 7 shows that while more than 90 percent of respondents aged 15 through 34 indicate an interest in the services, only

Table 7  
Subscription interest by respondent characteristics

Respondent characteristics	Percent
Total, all respondents	75.4
<i>Age</i>	
Less than 25 years	90.4
25–34 years	90.5
35–44 years	82.5
45–54 years	78.9
55–64 years	56.0
65 years or more	32.0
<i>Gender</i>	
Male	78.8
Female	72.5
<i>Employment status</i>	
Full-time employee	85.8
Part-time employee	77.9
Self employed	88.8
Student	95.6
Domestic duties	70.0
Unemployed	76.2

27 percent of respondents aged 65 years and over would consider subscription.<sup>10</sup>

Network subscription interest is higher for males than females. Employment status also appears to be associated with interest. Students exhibit the greatest interest in broadband network subscription. Respondents undertaking domestic duties seems less interested.

### *3.6. Measures of social disadvantage*

NISC (1995) identify disadvantaged groups that should have equal access to networked services as including rural, remote and ethnic communities, the elderly, those on low incomes, women, unemployed, and the disabled.

Rural and remote communities comprise between 15 and 33 percent of the Australian population.<sup>11</sup> NISC suggests that barriers to the delivery of networked services to these communities include lack of choice of delivery systems, lack of untimed access to essential services, data transmission limitations, and affordability factors.<sup>12</sup> Individuals with non-English speaking backgrounds comprise over 20 percent of the population. Difficulty in communicating because of language barriers act to isolate them from broader society. Approximately 25 percent of the population are aged over 50 years, and 11 percent are aged in excess of 65 years. Both proportions are increasing. The elderly often find interface technologies complex and this acts as a barrier to service adoption. The accepted definition of low income households are those whose income is significantly below the average given the particular needs of their families. The Australian Council of Social Services estimates that approximately one third of Australian households can be characterised as low income. NISC suggests that women face a number of barriers to access of new services. These include affordability, lack of familiarity with new technologies and labour market status. Unemployment can hinder communication service use by limiting access to computers and so on, commonly available in work situations. The level of service interest for each of the groups is presented in Table 8.

<sup>10</sup> BTCE (1994) proposes that older people may have more purchasing experience whereas younger people may be more adaptable or open to learning about new services. Analysis of ABS consumption expenditure data (ABS, 1987) shows that younger age groups spend more on electronic forms of recreation such as home computer equipment, television and audio equipment than older age groups. In contrast, Perl (1983), Taylor and Kridel (1990) and Bodnar et al. (1988) all indicate a positive relationship between age and probability of access to telephones in the US and Canada. However, there are substantial differences between a basic telephony service and proposed broadband communications such as video telephony and video conferencing considered here.

<sup>11</sup> Depending on whether non-capital city populations are included or excluded.

<sup>12</sup> These barriers already exist in the delivery of telephone services and will carry over into the delivery of new services. Moreover, even if services are accessible, the absence of some basic and many more advanced telecommunications services in the past may act as a barrier to the adoption of new networked services, with the technical literacy hurdle comparatively higher than for most metropolitan-located households.

Table 8  
Subscription interest by disadvantaged groups

Disadvantaged group	Percent
Total, all households	75.4
Non-metropolitan communities <sup>a</sup>	72.5
Ethnic communities	
Southern European	88.9
Asian	85.7
Elderly people (aged 65 years or more)	32.0
Low income households (below the poverty line)	73.5
Females	72.5
Unemployed	76.2
People with disabilities <sup>b</sup>	68.6

<sup>a</sup> The sampling frame encompassed all state capital cities and Canberra and provincial centres in New South Wales, Victoria and Western Australia.

<sup>b</sup> Proxied in the survey by non-aged pensioners.

These data suggest that households where the head is born in Southern Europe or Asia have substantial interest in service access. The converse is true of elderly respondents and, to a lesser extent, the disabled, females and non-metropolitan households.

### 3.7. Variables generated

Variables developed here are based on the notions of social disadvantage considered above and previous studies of network access (in particular Infosino, 1980; Brandon, 1981; Perl, 1983; Bodnar et al., 1988; Taylor and Kridel, 1990). The list of variables developed for inclusion in the econometric model are listed below in Table 9.

## 4. Econometric specification

This study focuses on household demographic characteristics and how they affect stated network subscription interest. A binary probit model is used to relate the probability of interest in broadband service subscription to household socio-demographic variables. A dichotomous (0, 1) variable is used to classify households as interested (*INTEREST* = 1) or not interested (*INTEREST* = 0) in service subscription. The model is of the form

$$P_i = F(\beta_1 + \beta_2 x_{i2} + \dots + \beta_K x_{iK}) = F(x_i' \beta) \quad (1)$$

where  $P_i$  = the probability that household  $i$  is interested in network subscription,

Table 9  
Generated variables

Variable	Description
NISC variables	
<i>ASIA</i>	= 1, if at least one household member cites their country of origin as China, Japan, Vietnam, India or other Asian country; = 0, otherwise
<i>EUROPE</i>	= 1, if at least one household member cites their country of origin as Italy, Malta, Greece, Cyprus or Yugoslavia; = 0, otherwise
<i>FEMHEAD</i>	= 1, if the household head is female <sup>a</sup> ; = 0, otherwise
<i>HH5565</i>	= 1, if the respondent is aged 55 through 64 years; = 0, otherwise
<i>HHMORE65</i>	= 1, if the respondent is aged 65 years or over; = 0, otherwise
<i>NAPENS</i>	= 1, if the respondent is a non-aged pensioner; = 0, otherwise
<i>POVLINE</i>	= 1, if income per household member is below the poverty line <sup>b</sup> ; = 0, otherwise
<i>UNEMPLOY</i>	= 1, if the respondent is unemployed; = 0, otherwise
Other variables	
<i>HHSIZE</i>	Number of household members
<i>HHLESS25</i>	= 1, if the respondent is aged less than 25 years; = 0, otherwise
<i>HH2534</i>	= 1, if the respondent is aged 25 through 34 years; = 0, otherwise
<i>HH3545</i>	= 1, if the respondent is aged 35 through 44 years; = 0, otherwise
<i>KIDS</i>	Number of children under 15 years
<i>LOWEDUC</i>	= 1, if the respondent has only primary or some secondary education; = 0, otherwise
<i>PTEMP</i>	= 1, if the respondent is part-time employed; = 0, otherwise
<i>RENT</i>	= 1, if household is renting accommodation; = 0, otherwise
<i>SEMPHH</i>	= 1, if at least one household member is self-employed; = 0, otherwise
<i>TECHLIT</i>	= 1, if the respondent uses a computer at work, school or TAFE, and household owns or rents a computer, a multimedia device and a modem; = 0, otherwise
<i>WCOLLAR</i>	= 1, if at least one household member is either a student or employed in professional, management, teaching or technical occupations; = 0 otherwise

<sup>a</sup> The survey defines the household head as the person in the household responsible for most of the larger purchase decisions.

<sup>b</sup> The poverty variable is derived from the March quarter 1995 estimates of poverty lines in Australia. These estimates for different family types are translated to gross annual earnings and compared with the household income information from the present survey. Where household income from all sources and before taxation is lower than the corresponding poverty level for that household type, the poverty variable takes the value of one.

$x_k$  = observed household sociodemographic characteristics,  $\beta_k$  = parameters on household characteristics,  $F(\cdot)$  = the cumulative distribution function.

In the probability model above the parameters  $\beta_k$  relate to the changes in the explanatory variables  $x_k$  to changes in the probability of interest in service subscription. While the signs on parameters indicates the direction of the relationship between the explanatory variable and the probability of interest in service subscription, the parameter value is not directly interpretable as the effect of a change in an explanatory variable on the mean, or expected value, of the dependent variable. The results reported here are transformed so that they can be interpreted in this manner.

#### 4.1. Results

Results of the estimated probit regression are shown in Table 10. The model appears to fit well. Homoskedasticity of the error process is supported by a likelihood ratio test ( $\chi^2_{\text{calc}} = 17.5$ ).<sup>13</sup> Another likelihood ratio test rejects the hypothesis that the set of coefficients are not significantly different from zero at the one percent level ( $\chi^2_{\text{calc}} = 233$ ).<sup>14</sup> The goodness of fit measure, proposed by McElvey and Zavoina (1975) provides an  $R^2$  statistic of 0.497.<sup>15</sup> The model correctly predicts 80.9 percent (735 of 909) of the sample observations. A naive model, which always predicts that interest in subscription is zero, predicts 24.5 percent (223 of 909) of the observations correctly.

The marginal effects associated with the parameter estimates are displayed above in Table 10.<sup>16</sup> The estimates measure the partial impact of the corresponding variable on the likelihood of household interest in network subscription, all other factors constant. The asymptotic  $t$ -statistics indicate whether a particular parameter estimate is statistically different from zero, that is, the variable has no impact on *INTEREST*.

The parameter estimates indicate that subscription interest is lower when the household head is aged over 55 years and greater when the head is younger (less than 35 years). Less interest is reported when the head is a female or employed on

<sup>13</sup> The likelihood ratio test of the hypothesis of homoscedasticity is based on

$$\lambda = n \ln s^2 - \sum_g n_g \ln s_g^2,$$

where  $n = \sum_g n_g$ ,  $s^2$  is the pooled least squares residual variance.

<sup>14</sup> The likelihood ratio statistic is defined as

$$\lambda = \log(\hat{\sigma}^2 \hat{Q})_c - \log(\hat{\sigma}^2 \hat{Q})$$

and the degrees of freedom for the chi-squared test is the number of parametric restrictions imposed.

<sup>15</sup> The formula suggested by Zavoina and McElvey is:

$$E[y^*|y] = yf = \beta'x + \lambda,$$

$$R^2 = N^*[\text{var}(yf)/(1 + \text{var}(yf))]$$

where  $\lambda$  is the inverse Mill's ratio. This measure does not correspond to any  $R^2$  measure in the linear regression model.

<sup>16</sup> The coefficients associated with the parameter estimates are displayed in the appendix.



Table 10  
Estimation results

Variable	Partial effect	Asymptotic <i>t</i> -statistic
Constant	0.240	4.51
NISC variables		
ASIA	0.206	1.90
EUROPE	0.270	2.29
FEMHEAD	-0.081	-1.92
HH5565	-0.106	-2.04
HHMORE65	-0.295	-5.37
NAPENS	-0.033	-0.77
UNEMPLOY	-0.049	-0.69
Other variables		
HHSIZE	-0.008	-0.60
HHLESS25	0.153	2.48
HH2535	0.115	2.22
HH3545	0.005	0.12
KIDS	0.061	2.95
LOWEDUC	-0.121	-3.96
POVLINE	-0.006	-0.15
PTEMP	-0.109	-2.35
RENT	-0.025	-0.70
SEMPHH	0.078	1.72
TECHLIT	0.004	0.07
WCOLLAR	0.090	2.49

*Frequencies of actual and predicted outcomes*

Actual	Predicted		Total
	0	1	
0	104	119	223
1	55	631	686
Total	159	750	909
Log-likelihood	-391.813		
$R^2$	0.497		

a part-time basis. When the household head has a relatively low level of education interest is significantly reduced. Subscription interest is greater for households in which the household head is from Asia or Southern Europe. Those households where at least one occupant is employed in a white collar occupation are more likely to be interested in subscription. Households with self-employed occupants show significant interest in subscription. Finally, household interest increases with the number of children under the age of 15 years.

The chi-square statistic is applied for to test the joint hypothesis that set of NISC variables have no impact on the probability that the households will be more or less interested in network subscription. The reported statistic ( $\chi^2_{\text{calc}} = 42.9$ ) clearly rejects the null hypothesis at the one percent level. Finally, parameters are

Table 11  
 Predictions by age of household head and NISC category

	Level of service interest		
	Observed	Predicted	Deviation <sup>a</sup>
Total, all households	75.4	75.5	-0.1
<i>Age of household head</i>			
less than 25 years	90.4	90.7	-0.3
25–34 years	90.5	90.4	0.1
35–44 years	82.5	82.8	-0.3
55–64 years	56.0	56.7	-0.7
65 years and over	32.0	32.4	-0.4
<i>NISC variables</i>			
ASIA	85.7	89.3	-3.6
EUROPE	88.9	90.8	-1.9
FEMHEAD	70.0	69.2	0.8
NAPENS	68.6	66.9	1.7
POVLIN	77.7	77.6	0.1
UNEMPLOY	76.2	79.0	-2.8

<sup>a</sup> Deviation = Observed - Predicted.

estimated for both metropolitan and provincial subsamples. A likelihood ratio test indicates that the coefficients are not significantly different at the one percent level. This result is not surprising. A test that would be more interesting from a policy perspective involves the comparison of the estimated coefficients from this study with those derived from a survey of rural and remote areas.

## 5. Model predictions

The predictive ability of the model is examined above by comparing the actual and predicted levels of subscription interest segments of the population. Table 11 shows that these deviations are usually small in absolute value terms.

## 6. Conclusions

The model fitted here describes network subscription interest in terms of household sociodemographic characteristics. Results from the probit regression suggest household characteristics are strong predictors of network subscription intentions, which include measures of social disadvantage identified by NISC (1995). This outcome implies that if unchecked a class of information poor could develop leading to a further bifurcation of Australian society. Standard approaches

to address problems of access-disadvantage through the direct subsidisation or implicit cross-subsidisation are unlikely to be successful without ancillary measures, such as targeted education programs.

Several directions for further research are apparent. Household groups that have not been identified by the surveys undertaken here include the rural and remote populations of Australia. Second, now that certain groups are identified as less likely to subscribe to networked services, second stage case study analysis is required to identify the underlying reasons for this disinterest in subscription. Finally, choice models that provide income and price elasticity estimated for the interested covered population are required.

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### Appendix 1

Table A.1  
Estimated probit coefficients

Variable	Coefficient	Asymptotic <i>t</i> -statistic
Constant	0.865	4.39
NISC variables		
<i>ASIA</i>	0.743	1.89
<i>EUROPE</i>	0.975	2.28
<i>FEMHEAD</i>	-0.292	-1.92
<i>HH5565</i>	-0.382	-2.05
<i>HHMORE65</i>	-1.063	-5.53
<i>NAPENS</i>	-0.201	-0.77
<i>UNEMPLOY</i>	-0.177	-0.69
Other variables		
<i>HHSIZE</i>	-0.030	-0.59
<i>HHLESS25</i>	0.553	2.46

<i>HH2535</i>	0.415	2.20
<i>HH3545</i>	0.019	0.12
<i>KIDS</i>	0.221	2.92
<i>LOWEDUC</i>	-0.437	-3.96
<i>POVLINE</i>	-0.020	-0.15
<i>PTEMP</i>	-0.392	-2.34
<i>RENT</i>	-0.090	-0.70
<i>SEMPHH</i>	0.280	1.72
<i>TECHLIT</i>	0.014	0.07
<i>WCOLLAR</i>	0.326	2.48

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