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2000

PERGAMON

Telecommunications Policy 24 (2000) 291–304

TELECOMMUNICATIONS POLICY

www.elsevier.com/locate/telpol

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Abstract

Recent moves toward contestable universal service markets for rural areas raises issues of measuring the net cost of service provision. Measurement of net cost requires estimates of latent demand for advanced communications. This paper seeks for the first time to provide quantitative estimates of the magnitude of latent income pools available to carriers in rural WA. Estimates of latent expenditure on broadband services in rural WA are obtained using a combination of stated-preference and survey data. These expenditures increase with computer ownership, community isolation and information need. Further, the statistical model supports the commonly held belief that more distant populations have stronger information demands and are willing to pay for services. This finding suggests that carrier aversion to providing services to rural regions may not be justified on commercial grounds.

JEL classification: C93; L96; O33

Keywords: Advanced communications; Broadband service; Internet rural access; Universal service obligations

1. Introduction

Advanced communications services can improve living standards in remote and rural areas by providing important commercial, socio-economic and educational benefits (Jussawalla & Lamberton, 1982; Cronin, Colleran, Herbert & Lewitzgky, 1993; Share, 1993; Madden, Savage & Simpson, 1997). Rural access to information technology and telecommunications (ITT) has been typically promoted through universal service obligations (USOs), generally interpreted as the provision of

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0308-5961/00/$ - see front matter
PII: S0308-5961(00)00019-7

the 'plain old telephone service' (POTS). Recent technology change and market liberalisation have altered the traditional delivery of POTS through a state-owned monopoly carrier.[1] In developing countries, privatisation and the entry of new carriers has had an initial positive impact upon network access, since network expansion targets have been made a requirement of privatisation and licensing concessions (International Telecommunication Union (ITU), 1998).[2] Many developed countries, however, have stopped short of specified roll-out requirements for new carriers, instead preferring a more cooperative stance in their promotion of universal service and access to advanced communications services. This stance involves government agencies acting as a catalyst for advanced communication service adoption in rural and remote locations.

Australia's universal service policy is in transition from mandated supply through the state-owned carrier Telstra to contestable USO markets. Under the *Telstra Corporation Act* 1991, formal price control arrangements require that the price of Telstra's basket of services, as a group, must fall in real terms by 5.5% (Department of Communications, Information Technology and the Arts (DCITA) 1999c).[3] In addition, Telstra is the nominated national universal service provider for the standard telephone services. Under the *Telecommunications Act* 1997, Telstra must ensure that reasonable access of telecommunications services of social importance are provided to the whole population in an efficient and economic way; and at performance standards that meet social, industrial and commercial needs. In return for the provision of universal service, Telstra receives compensation for the net cost incurred in meeting its obligation (DCITA, 1999d).

With the recent emergence of the Internet as a mass medium, the Commonwealth Government passed legislation which requires telecommunications carriers to bear a digital data service obligation (DDSO) (DCITA, 1999b).[4] Unlike the standard telephone USO, the DDSO is a contestable subsidy scheme. The aim of contestability is to reduce costs and deliver efficiency gains. One mechanism for achieving this is the introduction of a competitive bidding system (DCITA, 1999e).

The imposition of the DDSO scheme, however, is somewhat curious given the possibility of economies of scope in the transmission of both voice and data services through a common network infrastructure. A possible rationale for its introduction is to overcome inadvertent barriers to entry in the data market created by the current USO arrangements for standard telephone (Australian Communications Authority (ACA), 1998). In effect, the current USO arrangements may have inadvertently extended the boundaries of net loss areas for entrants in carrier markets (ACA, 1998, p. 78).

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[1] The objective of making telecommunications accessible and affordable to a greater fraction of the population is easier to achieve when services are provided by a government monopoly. Government can decide where to build and what to charge customers irrespective of actual costs, provided that total revenues (plus any government subsidies) are sufficient to cover total costs (Peha, 1999).

[2] For instance, the Philippine National Telecommunications Commission required successful tenders for new licenses to install between 300,000 and 400,000 telephone mainlines, in both urban and rural areas, within five years (Pano, 1997).

[3] The basket of services includes: connections, line rentals, local trunk and international calls, domestic and international leased lines and cellular mobile telephones.

[4] This has two aspects: a general digital data service and a special digital data service. The general data service provides a minimum 64 kbps ISDN equivalent service on demand to 96% of the population. The special digital data service provides a satellite link to the 4% of the population located beyond the reach of the fixed line telephone network. To facilitate take-up of the satellite service, the Commonwealth provides a 50% subsidy on the purchase cost of the receiver dish and related equipment (DCITA, 1999b).

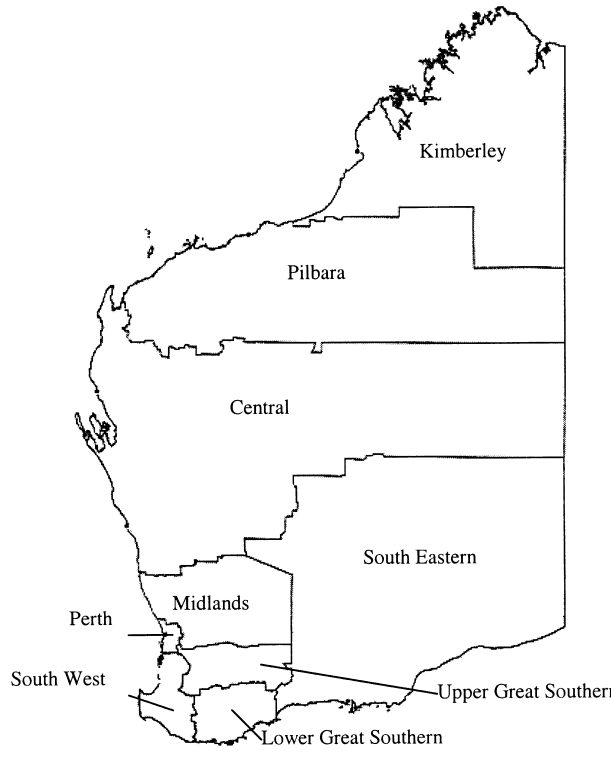
Clearly, estimates of the true net cost of universal service is required to extract maximal gain from a competitive process. Internationally, regulatory agencies have struggled to measure the universal service problem and estimate the funding needed to address it. Indeed, many employ the same traditional cost-of-service approach that has been employed to regulate the incumbent (Weller, 1999). In Australia, recent attempts to measure the cost of universal service have resulted in Telstra's claim that the net cost for 1997–1998 was AUD1.83 billion, substantially higher than the AUD253 million compensation paid by the Commonwealth (DCITA, 1999a).

At the state level, problems of measuring the total net cost of universal service has been a key inhibitor to carrier entry in local markets. In an attempt to overcome carrier aversion the WA government has established the Office of Information and Communications (OIC). The OIC's role is to work within the USO framework and identify policy issues and developing strategies to encourage greater levels of service throughout WA. A strategic focus for the OIC is the coordination and provision of government services on-line and providing information to carriers and the community at large which is likely to have a positive impact on both the demand and supply of rural advanced communications services. At a practical level, the OIC facilitates rural adoption of these services by providing a number of education fora to raise public awareness of how to use the new infrastructure and government services available on-line. In addition, the OIC provides information to carriers in order to stimulate interest in expanding the array of services available (Department of Commerce and Trade, 1999b).

The challenge for government and carriers alike is to estimate the potential demand for advanced communications services as an input into estimates of net cost in specified areas. This study identifies the latent demands of farms, households and small business in rural WA communities in terms of advanced ITT access, and investigates the Internet's ability to satisfy those needs. Survey data are collected to enable the identification of key drivers of latent demand for broadband services in rural WA. In doing so, this study seeks to provide important inputs into the OIC's mission and policy initiatives. Further, by estimating both the demand for substitution and content the study assesses the popularly held belief that rural communities are deprived of advanced communications services. Two statistical models are estimated using a combination of stated-preference and survey data to relate subscription and latent broadband service expenditures to various geographic and technology variables. The paper is organised as follows. Section 2 profiles rural WA. Section 3 describes the survey method used, while Section 4 reviews the sample data. Section 5 provides econometric analyses. Section 6 contains conclusions and policy implications.

2. Rural Western Australia

Some indication of the geographic scale, and degree of isolation, of WA can be gleaned from Table 1 and Fig. 1. While the State has a land surface area of 2.5 million km^2 (km), one-quarter the size of the US, it has a population of 1.7 million persons. Two-thirds of the population reside in the State's capital city, Perth. Most of the remaining population are located in the contiguous Midlands, South West, and Great Southern (Upper and Lower) regions (Australian Bureau of Statistics (ABS), 1997). WA has 50% larger land surface than its nearest state Queensland, and has the lowest population density of all the states. WA's gross state product (GSP) per capita is relatively high due to the scale of its agriculture and mining sectors. International comparisons



Source : ABS (1997)

Fig. 1. Rural Western Australia.

show that WAs land surface area is reasonably comparable to Alaska, however, the population density of Alaska is one-half of WA's. Alaska and WA are also principally dependent for their income on resources and agriculture, and experience harsh climates. Further, in terms of GSP, both states are highly productive relative to their national averages, although Alaska's GSP is double that of WA.

Despite its relatively small population, GSP growth regularly exceeds that of the OECD.[5] The mining sector accounts for 17% of GSP, and grows at an average annual rate of 12.7%. Other major contributors to growth are pharmaceutical and medical products, and telecommunications equipment. In rural WA, mining, agricultural and fishing industries dominate economic activity and exports (ABS, 1997). Industry in the South West and Great Southern regions is predominantly agriculture. The South West is marked by its rapidly developing tourism and viticulture industry, large-scale forest industry and a highly productive farming sector.

[5] WA living standards are generally high with life expectancy estimated to be 81 yr for females and 75 yr for males. In rural areas gross revenue product per capita is USD28,000 on average, compared with the State average per capita income of USD18,000. Infant mortality is 6.5 per thousand live births and there is on average one doctor per 415 persons (ABS, 1997).

Table 1
Selected region characteristics

Country	Population density	Area (1000 km^2)	Gross domestic product (GDP)[a] per capita (USD)
Australia			
Australian Capital Territory	129.2	2	19,048
New South Wales	3.6	801	16,471
Northern Territory	0.2	1349	15,789
Queensland	4.7	1731	7380
South Australia	1.5	983	13,965
Tasmania	7.0	68	12,458
Victoria	20.3	227	16,670
Western Australia	0.7	2529	18,063
Great Southern (Lower)	1.2	40	na
Great Southern (Upper)	0.4	4	na
Midlands	0.5	110	na
South West	5.6	28	na
France	108.0	546	22,381
Germany	235.0	350	22,086
India	337.0	2973	1688
Indonesia	113.0	1826	2786
United States			
Alaska	0.36	1700	40,200
Colorado	14.73	270	32,390
Montana	2.31	381	21,802
New Mexico	5.49	315	26,155

[a]GDP for whole countries and GSP for Australian and US States. All figures as at 1997. Selected States only.
Source: ABS (1998a,b), Central Intelligence Agency (CIA) (1999), US Department of Commerce (1997), Virtual Australia CyberNet (1999).

In terms of ITT penetration, the ABS (1998a) report that 42.3% of households in Perth have a personal computer which is comparable to the national average of 45.9%. The national average for computer ownership among households located outside of major Australian cities is 36.4%. The ABS (1998a) estimate that 53.4% of farms have computers compared to the national average of 44.8%. Internet subscription is 13.9% for Perth households compared to the national average of 16.9%. Only 5.6% of households located outside of Perth and 10.2% of farms have Internet access (ABS, 1998b). Australia-wide, 7.7% of households located outside State capital cities and 11.8% of farms have direct access. Less than 2% of the population is employed in WA's ITT sector. However, according to the WA Department of Commerce and Trade (1999a), total income from ITT represents more than 5% of GSP and expected growth for 1999 is 30%.

3. Experimental method and survey implementation

Data relating to Internet subscription in rural areas are not readily available. The approach adopted here is to obtain estimates of both actual and latent demand for communication service in

rural WA from survey data. Latent demand expenditures are generated by placing survey respondents in a hypothetical market situation. To ensure responses are sensible, stage one of the survey requires respondents to describe their current entertainment, telephone, computer use and expenditures. This procedure reminds respondents of their current use and budget limits. In the second stage of the survey, respondents are informed of the services which are potentially available to them through on-line delivery. A brief description of generic education, enhanced communications, entertainment, and transaction services likely to be provided through their telephone, TV or personal computer are provided. After describing each service, the respondent is offered subscription. The decision is made without consideration of current price or availability. The third stage elicits respondent's demand for services to be offered and their associated expenditure.[6]

To ensure the sample is representative the surveyed regions are chosen to reflect the composition of WA rural areas. The survey is implemented in the Great Southern (Lower and Upper), Midlands and South West regions of WA. The sampling frame is comprised of 65 respondents. Interviews are conducted with 18 farmers/pastoralists, 37 small to medium business enterprises that operate in small towns (less than 500 persons) and 10 private residents of small towns. The sample was obtained from a survey conducted from 1 October through 5 November 1998.[7]

Survey data are used to generate demographic, socio-economic, information need, geographic and technology variables. Previous studies of telecommunications service access indicate demographic and socio-economic variables are considered likely to explain latent demand for broadband delivered services (Perl, 1983; Bodnar, Dilworth & Iacono, 1988; Taylor & Kridel, 1990). Geographic variables are included because they are informative for policy formation. Finally, respondents' use of modern technology can stimulate the adoption of advanced telecommunications services.

4. Survey results

Monthly telephone expenditure is 88 Australian dollars (AUD) for households, AUD183 for farms and AUD223 for business. These expenditures compare well with Bureau of Transport and Communications Economics (BTCE) (1995) estimates of AUD38 and AUD652 for monthly household and business telephone expenditure. Current telephone use is dominated by local calling, whilst farms and business have a greater proportion of long-distance calls. International call volumes are comparatively small. The finding that 11% of respondents have direct access to the Internet is similar to the ABS (1998a) estimate of 13% across all non-metropolitan subscribers. Business and farms are more likely (than households) to use the Internet. Average monthly Internet transmissions for business and farms are seven and five, respectively, and are related predominantly to electronic mail, net surfing and business orders. Those not having direct access cited the service as unimportant, too expensive or have no computer access. A comparable ABS (1998b) survey reports that of the respondents residing in WA, the most common reasons for not having direct Internet access (Table 2) are that it is too expensive (33%), uninteresting (22%) and insufficient

[6] A summary of the survey questionnaire is presented in the Appendix.

[7] To avoid small sample bias, the veracity of the results are checked by a series of indicative comparisons. Respondents are questioned as to their current telecommunications use. Estimates of current use are compared against current expenditure. A second indicative check is concerned with ensuring the sample is representative of the industry and population composition within WA. Finally, survey outcomes are compared with secondary data.

Table 2
Direct Internet access, all respondents

Response	Frequency	Percent
All		
No	58	89
Yes	7	11
Households		
No	10	15
Yes	0	0
Business		
No	33	51
Yes	4	6
Farms		
No	15	23
Yes	3	5
Total	65	100

Table 3
Broadband service interest by respondent group (%)

Internet service		Respondent group			Total
		Household	Business	Farm	
Communication	No interest	11	29	3	43
	Subscribe	5	28	22	54
	Unsure	0	0	3	3
Education	No interest	8	22	5	34
	Subscribe	6	35	23	65
	Unsure	2	0	0	1
Entertainment	No interest	3	35	11	49
	Subscribe	12	22	17	51
	Unsure	0	0	0	0
Transaction	No interest	9	25	3	37
	Subscribe	5	32	23	60
	Unsure	2	0	2	3

computer capacity (13%). Sample computer ownership is 20% for households, 70% for business and 72% for farms. This compares with ABS (1998a) survey data which shows that overall, 40% of WA households outside Perth and 53% of farms own a computer. Australia-wide, the ABS (1998a) survey reports that as at June 1997, 63% of small business utilise computers.

Most respondents (88%) state they are adequately informed of potential information and communication services. This awareness is reflected in sample subscription intentions with a small undecided category for all groups. Business and farms indicate the greatest level of interest across service categories. Households show least interest in using electronic transaction and enhanced communications services (Table 3).

Table 4
Monthly facsimile transmissions, all respondents (number)[a]

Purpose	Household	Business	Farm	Total
Business orders	1	25	15	41
Household orders	0	0	1	1
Market information	0	6	9	15
Not applicable	9	10	1	20
Other	0	2	6	8
Weather	0	5	11	16

[a]Multiple responses are allowed.

Table 5
Enhanced access, all respondents (%)

Response	Household	Business	Farm	Total
No	90	84	83	85
Yes	10	16	17	15
Total	100	100	100	100

Table 6
Current telecommunications, all respondents (%)

Service quality	Household	Business	Farm	Total
No response	0	5	0	3
Satisfactory	100	81	50	75
Unsatisfactory	0	14	50	22
Total	100	100	100	100

Estimation of latent demand for broadband delivered services requires a review of the current consumption of substitute services. These services include computer, facsimile, fixed-line telephony and mobile telephony. Table 4 shows facsimile use against respondent type. Given the form and nature of the information sent and received, it is perhaps the technology that can most readily substitute for email delivered via the Internet (Tables 5 and 6).

Table 7 shows the interest in subscription to broadband delivered services, for respondents without Internet access, measured by total monthly experiment expenditure. Using this measure, it would appear that the youngest group are the most willing to pay, and that willingness to pay declines with age. Weighting the average monthly expenditure for each age group by the numbers in each group, yields an average monthly expenditure of AUD63 (Table 8).

Table 9 presents willingness to pay for broadband delivered services by respondent annual income band. The correlation coefficient indicates a positive correlation between income and

Table 7
Monthly expenditure by age (for respondents without Internet access)

Age	Experiment expenditure (AUD)[a]	Frequency
15–24	149	2
25–34	68	5
35–44	74	5
45–54	58	10
55–64	45	5
Over 65	10	2
Average	63	

[a]The sample means experimental expenditure should be treated with some caution. Due to the small sample size the confidence intervals are large.

Table 8
Monthly expenditure by gender (for respondents without Internet access)

Gender	Experiment expenditure (AUD)	Frequency
Female	75	12
Male	55	17
Average	63	

willingness to pay. This is expected because, as income rises, the price of communications services represents a smaller portion of consumer income. Moreover, the majority of higher income respondents are in occupations allow a greater opportunity to experience the benefits of modern ITT services.

Demand for broadband delivered services and computer ownership are considered complementary. Tables 10 and 11 show the propensity to subscribe to broadband delivered services is positively associated with computer ownership.

A number of surveys, such as the Yankee Group (1998), find a strong positive association between mobile phone ownership and Internet subscription. However, for the WA sample of rural users, mobile phones are a poor predictor of Internet subscription.[8] Table 12 shows that the total expenditure for broadband delivered services is slightly higher for mobile telephone users compared with non-users.

Table 13 presents latent broadband service expenditure by distance from the nearest provincial population centre.[9] The significant partial correlation suggests, controlling for computer ownership and the number of facsimiles sent and received per month, the degree of isolation has a positive impact on latent expenditure. Indeed, from Table 13 it appears that respondents located more than

[8] Of the seven respondents with direct Internet access, only two owned a mobile telephone.
[9] Provincial centre is defined as a town with population greater than 20,000.

Table 9
Monthly expenditure by respondent income, all respondents

AUD	Average expenditure	Frequency
Up to 15,000	40	2
15,001–20,000	15	3
20,001–30,000	10	3
30,001–40,000	65	3
40,001–50,000	35	6
50,001–60,000	98	3
More than 60,000	73	6
Average	48	
Correlation	0.422 (0.018)[a]	

[a]The probability of the correlation under the null hypothesis that the statistic is zero is in parentheses.

Table 10
Monthly by computer ownership, all respondents[a]

Own	Experiment expenditure (AUD)	Frequency
No	51	24
Yes	95	34
Average	77	

[a]Seven nil responses are recorded.

Table 11
Monthly expenditure by facsimile ownership, all respondents

Own	Experiment expenditure (AUD)	Frequency
No	59	19
Yes	88	46
Average	80	

250 km from a major town are prepared to pay considerably more for broadband delivered services (Table 14).

The survey data presented in this section suggest Internet access is close to the national average, despite households and farms having substantially lower computer ownership. Interest in broadband delivered services, proxied by monthly latent expenditure, appears to decrease with age but increase with income. These data also suggest that information need (reflected in monthly facsimile transmissions), technology variables (computer and facsimile ownership) and geographical location may be useful indicators of latent broadband service expenditure. Further insight, can be gained by specifying a more precise relationship using econometric analysis.

Table 12
Monthly expenditure by mobile telephone ownership, all respondents

Own	Experiment expenditure (AUD)	Frequency
No	70	43
Yes	89	22
Average	77	

Table 13
Monthly expenditure by distance from provincial centre, all respondents[a]

Distance from provincial centre (km)	Experiment expenditure (AUD)	Frequency
0–50	42	14
51–100	60	6
101–150	46	13
151–200	38	2
201–250	32	11
251–300	78	8
Average	49	

[a]Eleven nil expenditure responses were recorded. km is kilometres.

Table 14
Latent expenditure model, dependent variable: LE

Variable	Coefficient estimate	*t*-ratio
Constant	1.09	1.78
COMPUTER	1.18	1.91[a]
FACSIMILE	4.47	3.10[b]
DISTANCE	0.78	2.04[c]
$n = 54$		
Adjusted R^2		0.29
HET		0.85
NORMAL		1.23
RESET		1.68

[a]Denotes significant at the 10% level.
[b]Denotes significant at the 1% level.
[c]Denotes significant at the 5% level.

HET is Ramsey's test for heteroskedastcity using the square of the fitted values. NORMAL is based on a test of skewness and kurtosis of the residuals. RESET is Ramsey's test for functional form misspecification using the square of the fitted values.

5. Econometric analysis

A statistical model is estimated which relates latent broadband service expenditure to technology, information and geographical variables. The level of interest in broadband delivered service is gauged by determining latent broadband service expenditure.[10] Latent expenditure data are related to COMPUTER, FACSIMILE and DISTANCE through the multiple regression model:

$$\mathrm{LE} = \beta_0 + \beta_1 \mathrm{COMPUTER} + \beta_2 \mathrm{FACSIMILE} + \beta_3 \mathrm{DISTANCE} + \varepsilon, \quad (1)$$

where LE is latent expenditure, β are unknown parameters and ε is an error term representing the unexplained variation in the dependent variable.

COMPUTER indicates computer owners are willing to pay 18% more than those respondents that do not own a computer. FACSIMILE represents an underlying need for information, and DISTANCE shows that latent expenditure on broadband delivered services increases by an average AUD0.56 per 100 km.[11]

6. Conclusions

Rural access to telephony and ITT has typically been promoted by government-owned carriers through mandated USOs. However, recent moves toward contestable USO markets raises the need for reliable estimates of the total net cost for service provision to specific geographic areas. In order to maximise the expected gains from the USO competitive tender process, government and privately-owned carriers require estimates of latent demand. This paper seeks for the first time to provide quantitative estimates of the magnitude of latent income pools available to carriers in rural WA.

Estimates of latent expenditure on broadband services in rural WA are obtained using a combination of stated-preference and survey data. Respondents indicate they are prepared to pay, on average, AUD63 per month for broadband delivered services. These expenditures increase with computer ownership, community isolation and information need. Further, the statistical model supports the commonly held belief that more distant populations have stronger information demands and are willing to pay for services. This finding suggests that carrier aversion to providing services to rural regions may not be justified on commercial grounds. Given the positive correlation between computer ownership and broadband delivered service demand, government might wish to consider subsidies directed at increasing computer purchases. An issue not considered here, but worthy of study, are the role of alternative media, datacasting through digital television signals and extension of the mobile telephone network, to meet rural communication needs.

[10] The expenditure variables is generated in response to the question: how much are you prepared to pay per month for the broadband service just described?

[11] The estimated coefficient for DISTANCE is adjusted to take account of data transformation.

Acknowledgements

We acknowledge assistance from the Office of Information and Communications, Western Australian Department of Commerce and Trade. Helpful comments were received from Phillip Skelton and Peter Farr, Gloria McQuillan from the Office of the Hon. Hendy Cowan MP and participants at the Communications Research Forum 1999. Research assistance by Sharliyn Quek and Craig Tipping are gratefully acknowledged. Any opinions, findings or conclusions expressed in this paper are those of the authors and do not reflect the views of the named institution or individuals.

Appendix A. Survey questions

A survey of factors believed correlated with rural telecommunications demand, including economic, demographic and system features, was developed. Forty-three questions are included as follows:

(a) Five questions indicate availability and access of communications services.
(b) Four questions concern the timing and duration of communications use.
(c) Five questions identify the purpose for using the Internet.
(d) Five questions relate the mean, frequency and amount of recent telephone billings.
(e) Eight questions elicit latent demand for broadband delivered services.
(f) Five questions identify the most frequently used applications.
(g) Three questions ask for details of home technology stocks.
(h) Eight demographic and economic questions elicit gender, age, occupational status, income group and household or business size.

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