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Abstract

Rapid growth in Internet use, combined with easy market entry by Internet service providers (ISPs), has resulted in a highly competitive supply of Internet services. Australian ISPs range in size from a few large national operators to niche ISPs focused on specialised service. With many ISPs currently not profitable, subscriber retention is an important aspect of survival. This study develops a model which relates the probability of subscriber churn to various service attributes and subscriber characteristics. Estimation results show that churn probability is positively associated with monthly ISP expenditure, but inversely related to household income. Pricing also matters with subscribers preferring ISPs which offer flat-rate pricing arrangements.

Keywords: Internet; Customer churn; Pricing

JEL Classification: C93; L96; O33

1. Introduction

The rapid growth in Australian Internet use, combined with relatively easy market entry by Internet service providers (ISPs), has resulted in the competitive supply of Internet services, with one ISP per 2500 customers (Department of Industry, Science and Tourism (DIST), 1998, Department of Communications, Information Technology and the Arts (DoCITA), 1998). Australian ISPs range in size from a few large national operators such as OzEmail and Telstra Big Pond, both of whom have over 200 000 subscribers, to small niche market operators. However, the current market structure is turbulent. Jack Davies, chief executive of

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America On Line (AOL), recently asserted that while two or three big companies will eventually dominate the Australian market, there is room for niche ISPs focused on business-to-business electronic commerce (Montgomery, 1998).

ISPs provide users with a networked information service by connecting to a larger ISP, or to a network service provider (NSP). NSPs consist of regional, national and international Internet backbone providers who are linked together at network exchange points. Circuits between users, ISPs and NSPs are typically provided by the public telecommunications operators (PTOs) Optus and Telstra. Effectively, ISPs are resellers who purchase bandwidth capacity in bulk from PTOs and repackage it into smaller parcels for retail sale. As such, the bulk of ISP costs comprise of interconnection and transmission costs – 48% of total industry expenses in 1997 (Australian Bureau of Statistics (ABS), 1998). Other variable subscriber acquisition costs, such as advertising, are proportional to the size of the subscriber base. Accordingly, for a given ISP flat-rate service charge, the average cost of providing Internet access falls with increases in the subscriber base. With many ISPs currently not profitable, the retention of subscribers is an important aspect of ISP survival strategy.[1]

Several Australian ISPs have adopted loss-leader strategies to quickly gain a subscriber base. This strategy is similar to the that employed by United States (US) ISPs. For instance, the Strategis Group (1998) suggest that a new ISP may have to offer an introductory price that is 20 to 30% below market rates to attract customers.[2] Although loss-leader strategies prevent full cost recovery in the short-run they can generate future revenue streams (for example, from advertising). Perhaps, more importantly, increased market share makes the ISP an attractive takeover target for larger ISPs and telcos. Accordingly, one aspect of competition between ISPs focuses on subscriber loyalty, typically measured by the churn rate. Churn is the percentage of the subscriber base which disconnects from an ISP during a defined period. In 1997, one in seven subscribers world-wide abandoned their ISP every month – a turnover five times higher than that for mobile telephones (Economist, 1997). Media reports and proprietary data suggest the Australian experience is similar. The Communications Economics Research Program (CERP, 1997) report Australian Internet churn rates of 20% in 1997, whilst Telstra (1998) describe a ''very high level'' of churn for their ISP Big Pond.

Analysis of customer retention has received recent attention in both economics and marketing literatures. Rust and Zahorik (1993) and Zeithaml et al. (1996) examine the link between service attributes and behavioural intentions, such as defection and loyalty. Li (1995) and Bhattacharya (1998) empirically analyse this

[1] ISPs recorded an operating loss before tax of 30.4 million Australian dollars (AUD) for the year ended 30 June 1997 (ABS, 1998).

[2] Greenstein (1998) reports that many US ISPs provide basic access for ten US dollars (USD), but at a lower quality of service, and so are often insufficiently funded for upgrading the network.

relationship by employing hazard rate models to relate customer characteristics to churn rates.[3] Further, Cai et al. (1998) use multi-attribute choice experiments to focus on the relationship between customer churn behaviour and the service attributes of Californian electrical utilities. In their study, various levels of service are contrasted with a range of price discounts to test the threshold points at which a loyal customer is induced to switch to a competitor. Probability estimates of churn are calculated using a logit model.

Following Cai et al. (1998), this study develops a probability model for ISP subscriber churn.[4] The model relates the probability of subscriber churn to various service attributes and subscriber characteristics enabling the churn probability to be calculated. Model estimation is on data obtained from a web based survey of Australian residential Internet users. The paper is organised as follows. Section 2 describes Australian ISP industry structure, pricing and subscriber churn. Section 3 outlines the survey method and Internet subscriber profile for respondents. Summary information for these data is provided therein. A model of ISP subscriber churn is developed in Section 4, whilst generated variables and the econometric model specification are detailed in Section 5. Estimation results are reported in Section 6. Section 7 contains concluding remarks.

2. Industry structure, pricing and subscriber churn

ISP access to international and domestic telecommunications networks is a primary production input, and lower access charges should shift ISP supply outward. As reported in Table 1 public switched telephone network (PSTN) charges typically account for over half the total cost of accessing the Internet in most OECD countries. At 1997 Australian leased lines, and local-exchange, long-distance and international PSTN services were mainly provided by Optus and Telstra. Increased competition within both the PSTN and ISP markets has driven prices steadily down, but as yet they have to reach the low levels of flat-rate plans offered in the US and Canada.[5] At the end of June 1997 there were approximately 300 ISPs operating in Australia, typically offering flat-rate plans and plans which combined monthly access and usage fees. For example, Ozemail offered to high-volume users a flat-rate unlimited usage plan for AUD295 per month. Low-volume, frequent users can subscribe to the OzSaver 2 plan which offers 20 hours of access time for AUD39 per month and AUD5 (AUD2.50) per additional

[3] This approach provides churn probability estimates and complements the work of Wyner (1996) and Srinivasan (1996a,b) who provide customer valuation models.

[4] Katz and Aspden (1998) also examine ISP subscriber turbulence in their study of Internet dropouts in the US. Survey data from 1995 and 1996 shows that dropouts are younger, poorer, and less well educated than were users.

[5] The fixed local-exchange access charge is another important aspect of Internet access.

Table 1
OECD Internet access and pricing 1996[a]

Country	Income	Internet price	
	GDP per capita USD	Total price USD	PSTN share[c]
Luxembourg	42,351[b]	54.27	0.56
Switzerland	41,632	64.67	0.71
Japan	36,575	49.85	0.67
Norway	36,028	44.96	0.76
Denmark	33,125	61.56	0.77
Germany	28,720	65.49	0.74
US	28,646	28.88	0.48
Sweden	28,308	43.96	0.73
Austria	27,602	89.81	0.78
Iceland	26,976	30.87	0.43
Belgium	26,453	52.02	0.78
France	26,357	46.11	0.80
Netherlands	25,293	56.59	0.73
Finland	24,259	32.05	0.74
Australia	21,383	24.13	0.57
Italy	21,155	46.56	0.77
Canada	20,081	20.59	0.58
UK	19,883	54.47	0.78
Ireland	18,824	67.71	0.81
New Zealand	18,455	50.80	0.41
Spain	14,792	51.01	0.61
Greece	11,754	58.28	0.51
Portugal	10,822	76.66	0.64
South Korea	10,645	n.a.	n.a.
Czech Rep.	5048	n.a.	n.a.
Hungary	3576	n.a.	n.a.
Mexico	3466	94.29	0.32
Poland	2747	n.a.	n.a.
Turkey	2708[b]	64.53	0.48
Average	21,299	53.20	0.65

[a] Source: OECD (1997).
[b] Denotes 1995 GDP per capita.
[c] Total PSTN price is the average of peak and off-peak charges.

hour during the peak (off-peak) period. Australia's average Internet price of USD24.13 (AUD42.40) for 20 hours access (as reported in Table 1) is less than half the sample average and the second lowest of all OECD countries.

By the end of 1998 the Australian Internet market had grown to over 600 ISPs. Table 2 provides a small cross-section of the available plans for both large and small Australian ISPs during November 1998. The range of prices, flexibility in pricing packages (longer or shorter fixed rate periods) and variability in the threshold number of ''not charged'' reflects both the nature of price and non-price competition between Australian ISPs. For instance, Ozemail and Telstra Big Pond

Table 2
Australian ISP Residential pricing profiles, 1998 (AUD)

ISP	Low use		Medium use		High use		
	Usage fee	Setup fee	Usage fee	Setup fee	Usage fee	Setup fee	Excess volume/time
AOL AUSTRALIA	9.95/3h/month		29.95/15h/month				4/h
CONNECT.COM	10/3h/month 20/8h/month		30/14h/month 40/21h/month		50/27h/month 70/45h/month 100/65h/month 150/100h/month		3.50/h (peak) 1.75/h (off-peak)[a]
MAGNADATA	37.50/12 months		31.25/6 months		25/3 months 49/50h/month		2.00/h
ONE.NET	1.95/h or $0.25/Mb	19.95	1.95/h	19.95	1.95/h	19.95	
OZEMAIL	19.95/7h/month		30/20h/month		55/30h/month 85/50h/month 160/100h/month 44.95/month unlimited		5/h (peak) 2.5/h (off-peak)
PRIMUS	8.95/5h/month 14.95/10h/month				29.95/month or 75/quarter unlimited hours with 200mb/month limit		1.50/h
Q NET	120/year	30	650/year	60	2000/year	450	0.25/Mb or 2/h
TELSTRA BIG POND	9.90/2h/month		35/20h/month		50/30h/month 44/month unlimited		3.5–5/h
UP'N'AWAY SOLUTIONS	5–10/month		23/month		33–38/month		

[a] Peak time is 7am–midnight; off-peak is midnight–7am.

provide 20 hours of monthly access for AUD30 and AUD35, respectively. AOL entered the Australian market in late 1998 and is expected to provide unlimited access at a low monthly flat-rate. Another potentially large supplier, cut-rate carrier Primus Telecommunications, launched a national Internet division in December 1998.[6] As such, effective price has fallen dramatically. Q Net offer 90 hours per month for AUD25, One.Net provide 56 hours for AUD29.95, whilst

[6] ISPs also compete on the basis of service quality. In general, ISPs choose the level of service, in terms of reliability and speed, according to the size and profitability of the subscriber base. Speed of access (the capacity of ISP modems) is also an important consideration for potential subscribers. High speed connections to backbone networks are expensive, as are other service attributes such as web hosting, which are costly in terms of assembly, maintenance and marketing. An ISP may differ in the speed of its modems in the rate at which it transfers information to backbone networks. This rate is vulnerable to break down and interruption, particularly at peak times. Such features depend on the fixed cost investment in hardware and software along with active monitoring by ISP staff (Greenstein, 1998).

Telstra, Ozemail and Primus provide unlimited monthly access for AUD44, USD45 and AUD25, respectively. The intense competition between ISPs is affecting customer retention. Minimising churn leads to an increase in the installed base of subscribers through time compared to an ISP with higher churn. Further, the sales cost per retained subscriber is reduced, since attracting new subscribers is expensive in terms of advertising, product differentiation and special offers.

3. Survey method and internet subscriber profile

A profile of Australian residential ISP subscribers was obtained from a web survey conducted from October 13 through November 3 1997. A questionnaire was posted to the CERP web site and advertised to Internet subscribers through national print media and by hyperlinks attached to participating ISP home pages. Respondents were asked to supply information on their ISP, Internet use and expenditure, pricing plan and socio-demographic background. A further question asked respondents to indicate whether they intended to change their ISP within the next twelve months, and their reason for intended churn. During the period of the survey 1257 ISP subscribers completed the questionnaire from which 592 valid responses were obtained.

Approximately 20% of respondents indicated their intention to churn during the period November 1997 to October 1998. Table 3 lists factors considered important by subscribers in choosing their ISP. Personal recommendation, access reliability (dropout rate and connect time), affordability, help desk support and access speed are considered important. Interestingly, only 13% of ISP subscribers consider the available content and value added services as important. Service features deemed important in deciding whether subscribers intend to remain with their current ISP are reported in Table 4. Whilst affordability is important, reliability and access speed are also of concern to subscribers. Technical support, 24 hour help desks

Table 3
Reason for subscriber ISP choice (%)[a]

RECOMMENDED	37
RELIABLE ACCESS	35
AFFORDABLE	34
HELP DESK SUPPORT	30
CONNECTION SPEED	30
LOCAL CALL ZONE	24
CONTENT	13
PROVIDED WITH COMPUTER PURCHASE	13
ISP STAFF INSTALLED THE COMPUTER	10
ISP OFFICE CONVENIENTLY LOCATED	5

[a] The respondent allowed multiple responses.

Table 4
Key service features (%)[a]

	Not important	Reasonably important	Very important
RELIABLE	0	15	85
ACCESS SPEED	0	24	76
INEXPENSIVE USAGE CHARGES	1	52	47
INEXPENSIVE ACCESS FEE	1	52	47
TECHNICAL SUPPORT	6	63	32
24 HOUR HELP DESK	15	65	20
VALUE ADDED SERVICES	28	64	9

[a] The respondent allowed multiple responses.

and value added services clearly matter less. Table 5 shows that access price and reliability are the most common reasons for subscriber churn.

4. A model of ISP subscriber churn

The likelihood that an ISP subscriber churns is examined here in the context of a discrete choice. Discrete choice theory argues that subscribers consider ISP attributes, such as reliability and help desk support, when deciding on whether to churn (McFadden, 1981). To the extent that customers with similar demographic characteristics exhibit similar preferences, demographic profiles can be associated with the probability of making a decision to churn. Accordingly, ISP j's service attributes (z_{jn}) and subscriber demographic characteristics (s_n) allow the n^{th} subscriber's satisfaction to be defined by the indirect utility function:

$$U_{jn} = U(z_{jn}, s_n) \qquad j = \{\text{churn, not churn}\} \tag{1}$$

It is convenient to decompose indirect utility (1) into observed (V_{jn}) and unobserved (e_{jn}) components, viz:

$$U_{jn} = V_{jn} + e_{jn} \tag{2}$$

Table 5
Reason for subscriber churn (%)[a]

ACCESS PRICE	34
UNRELIABLE ACCESS	29
NOT SPECIFIED	22
OTHER ISP	7
POOR SERVICE SUPPORT	4
BILLING COMPLAINTS	3
LACK OF VALUE ADDED SERVICE	1

[a] The respondent allowed multiple responses.

The probability of churn is equivalent to the probability that the *n*th subscriber derives greater utility from churning than from remaining with the ISP. That is:

$$\text{Prob}(\text{churn} \mid j) = \text{Prob}(U_{\text{churn},\,n} > U_{\text{not churn},\,n}) \tag{3}$$

When the unobserved e_{jn} are independently, identically distributed according to the cumulative normal distribution the functional relationship between revealed utility and the likelihood of churn is binomial probit.

5. Variables and econometric model

Variables included in the churn model are grouped into four categories. Economic variables include household income, price (monthly expenditure) and the ISP pricing structure (flat-rate or usage based). Usage variables describe the manner in which ISP subscribers use the Internet. Internet use by generic service group (education, hobby or work related), applications (browsing or email) and subscriber Internet tenure are considered. ISP choice variables measure factors underlying the respondent's choice of ISP. Respondent and household socio-demographic variables considered here are those found to be important in other studies (Katz and Aspden, 1997; Madden and Simpson, 1997; Kridel et al., 1998; Madden and Savage, forthcoming). The list of all variables included in the econometric model is provided in Table 6.

A binomial probit model is used to relate the probability of a subscriber leaving their current ISP with economic, Internet use, ISP attributes and socio-demographic variables. A dichotomous (0,1) variable is used to classify subscribers as to whether they intend to churn (CHURN = 1) or are unlikely to churn (CHURN = 0) within the next twelve months. The model is of the form:

$$P_{jn} = F(x'_{jn}\beta) \tag{4}$$

where P_{jn} is the probability the *n*th subscriber will churn from ISP *j*, x_{jn} a vector of ISP attributes and subscriber (and household) socio-demographic characteristics, β is the parameter vector to be estimated and $F(.)$ is the cumulative normal distribution function. In (4) the parameters relate changes in the explanatory variables to the direction of change in the churn probability.

6. Model results

Estimated partial effects (transformed parameter values) which indicate the magnitude of the response, and adjusted asymptotic t-values are reported in

Table 6
Independent variables

Variable	Description
Economic variables	
INCOME1	=1, if weekly household disposable income<AUD 160; =0, otherwise
INCOME2	=1, if AUD 160≤weekly household disposable income<AUD 400; =0, otherwise
INCOME3	=1, if AUD 400≤weekly household disposable income<AUD 700; =0, otherwise
INCOME4	=1, if AUD 700≤weekly household disposable income<AUD 1200; =0, otherwise
MONTHLY BILL	=average monthly expenditure on Internet access
FLAT RATE	=1, if ISP payment is a flat-rate monthly (or annual) fee with no usage fee; =0, otherwise
TIMED USE	=1, if ISP payment is based on usage with no flat-rate fee; =0, otherwise
Internet use variables	
BROWSE	=1, if the Internet is used mainly to web browse; =0, otherwise
EDUCATION	=1, if the Internet is used mainly for educational activities; =0, otherwise
EMAIL	=1, if the Internet is used mainly to email; =0, otherwise
HOBBY	=1, if the Internet is used mainly for hobby activities; =0, otherwise
TENURE	=number of months a respondent has been using the Internet
MOVED	=1, if the respondent has subscribed to more than one ISP; =0, otherwise
WORK	=1, if the Internet is used mainly for work related activities; =0, otherwise
ISP choice variables	
CONTENT	=1, if the respondent subscribed to their ISP because of available value-added content; =0, otherwise
HELP DESK	=1, if the respondent subscribed to their ISP because of available help desk facilities; =0, otherwise
PACKAGE	=1, if the respondent subscribed to their ISP because it is linked to a computer purchase; =0, otherwise
RELIABLE	=1, if the respondent subscribed to their ISP because of perceived reliability; =0, otherwise
SPEED	=1, if the respondent subscribed to their ISP because of advertised access and download speeds; =0, otherwise
Socio-demographic variables	
AGE	=subscriber age
MALE	=1 if the respondent is male; =0, otherwise
NUMBER	=number of persons residing in the household whom use the ISP account

Table 7.[7] The model is well specified. Homoskedasticity of the error process is supported by a likelihood ratio test ($\chi^2_{\text{calc}} = 37.5$) at the 99% critical value.[8] A goodness of fit measure proposed by McElvey and Zavoina (1981) provides an R^2 statistic of 0.49. Further, the model correctly predicts 82.3% (487 of 592) of the sample observations, and there is no obvious bias in predicting churn. A likelihood ratio test rejects the hypothesis that the set of coefficients are not significantly different from zero at the 1% level ($\chi^2_{\text{calc}} = 115.16$). Another likelihood ratio

[7] The marginal effect for a binary independent variable, such as INCOME1, is computed as

$$\text{Prob}[\text{CHURN} = 1 \mid \bar{\mathbf{x}}^*, \text{INCOME1} = 1] - \text{Prob}[\text{CHURN} = 1 \mid \bar{\mathbf{x}}^*, \text{INCOME1} = 0] \quad (5)$$

where $\bar{\mathbf{x}}^*$ denotes the mean values of all other independent variables.

[8] The likelihood ratio test of the hypothesis of homoscedasticity is based on: $\lambda = n \ln s^2 - \Sigma_g n_g \ln s_g^2$, where $n = \Sigma_g n_g$, s^2 is the pooled least squares residual variance.

Table 7
Estimation results

Variable	Partial effect	Standard error	Asymptotic *t*-ratio
CONSTANT	−0.4845	0.1326	−3.6530[a]
Economic variables			
INCOME1	0.1349	0.0756	1.7841[b]
INCOME2	0.0889	0.0559	1.5887
INCOME3	0.0672	0.0432	1.5552
INCOME4	−0.0557	0.0393	−1.4167
MONTHLY BILL	0.0034	0.0009	3.8993[a]
FLAT RATE	−0.0792	0.0392	−2.0205[a]
TIMED USE	0.0165	0.0460	0.3595
Internet use variables			
BROWSE	−0.0912	0.0410	−2.2219[a]
EDUCATION	0.0305	0.0313	0.9744
EMAIL	0.2024	0.1041	1.9442[a]
HOBBY	0.0037	0.0320	0.1146
TENURE	−0.0021	0.0015	−1.3690
MOVED	0.0738	0.0182	4.0654[a]
WORK	0.0611	0.0325	1.8804[b]
ISP choice variables			
CONTENT	0.0568	0.0650	0.8735
HELP DESK	−0.0251	0.0433	−0.5801
PACKAGE	−0.0467	0.0600	−0.7788
RELIABLE	−0.0874	0.0502	−1.7428[b]
SPEED	−0.0606	0.0474	−1.2796
Socio-demographic variables			
AGE	−0.0048	0.0013	−3.5228[b]
MALE	0.1390	0.0468	2.9722[b]
NUMBER	0.0268	0.0143	1.8742[b]
Log-Likelihood	−240.9		
R^2	0.488		

Likelihood ratio tests for subsets of parameters

	χ^2_{calc}	$\chi^2_{crit\ (0.99)}$
Economic	36.87	18.48
Internet use	27.44	18.48
ISP choice	20.74	15.09
Sociodemographic	23.42	11.34

[a] Denotes significance at the 5% level.
[b] denotes significance at the 10% level.

statistic is applied to test the joint hypotheses that each subgroup of independent variables (economic, Internet use, ISP choice, socio-demographics) identified in Table 6 separately have no impact on the probability that Internet users will churn.

The calculated Chi-squared statistics reported in Table 7 clearly rejects the null hypothesis at the 1% level for all subsets of parameters.

The parameter estimates indicate that subscribers in low income households (weekly household disposable income of less than AUD160) are more likely to churn. Further, the probability of churn is greater the higher the monthly ISP expenditure, and less when a flat-rate pricing (rather than some form of timed usage charging) structure is employed by the ISP. Churn is more likely when the subscriber has had an account with another ISP and when the Internet is used for work related purposes. For subscribers who chose their ISP on the basis of reliability, churn is less likely. The churn probability is higher for males and households where the ISP account has multiple users. Younger subscribers are more willing to seek alternative ISPs.

7. Conclusions

Rapid growth in Internet use and low barriers to ISP entry have fuelled the substantial growth of the Australian ISP market. ISPs are by and large unprofitable due to the difficulty in capturing sufficient revenues to offset costs. As the acquisition of subscribers is expensive, it is important to ISP survival that they retain their current subscriber base. ISPs have sought to segment the market by offering a range of pricing packages, in an environment of strong price competition. This article develops a probability model of ISP subscriber churn to allow the determinants of this behaviour to be isolated.

The empirical results provide some focus regarding ISP subscribers' churn. There is a general industry belief that subscribers are highly price responsive and will churn to gain small discounts. This concept is consistent with the economic notion that consumers are rational and will choose the lowest price if nonprice attributes are the same. This proposition is indirectly supported with the reported churn probability positively associated with monthly ISP expenditure. The pricing structure also matters with subscribers preferring ISPs which offer flat-rate pricing arrangements. Further, subscribers in low income households are more likely to churn.

The results for nonprice attributes are similarly enlightening. The most important ISP characteristic, other than prices, is reliability of service. The manner in which a subscriber uses the Internet is also important in explaining subscriber ISP churn. When subscribers' primary use is email and where use is work-related churn is more likely. However, where the subscriber's main use is browsing, they are less likely to churn. Further, subscribers with a churn history are more likely to churn. The importance of these variables is that they are observable to the ISP and can be of assistance in maintaining a subscriber base. Finally, our results also indicate that customer characteristics are important in explaining subscriber churn.

The likelihood of churn is higher for males and the ISP account has several users. Younger subscribers are more likely to churn.

Some extensions of this study may prove beneficial. It would be useful to develop questions which would educe the magnitude of price reductions required for a subscriber to churn from an ISP. Consideration of the level of pricing (rather than just the pricing scheme), and a wider range of Internet use and demographic variables. To assist ISP network planning some insight into the willingness of subscribers to pay for reliability should be gained. Future work should also consider Internet traffic congestion. Whilst price competition had led to customers switching ISPs, low flat-rate pricing schemes have also encouraged excessive use.

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