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by

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Broadband demand and asymmetric cross-price effects[Ψ]

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Abstract

We consider two different qualities of broadband access, one that simply means greater access speed to Internet applications and content and a premium version that also gives access to interactive TV-centric applications. Based on a market survey we find that potential consumers of this premium broadband access do not consider basic broadband Internet access as a substitute. The price of the basic Internet-centric service does not constrain the price that may be charged for the premium TV-centric service.

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1 Introduction

Since the introduction of the Internet, developments of access speed have moved forward in increments. Residential demand for Internet access was initially derived from the demand for the basic applications, WWW and e-mail. These applications could, and still can, be utilized with narrowband access technologies such as dial-up modem (up to 56 kbps) and ISDN[1] (up to 128 kbps). Currently, telecommunications operators and content providers face a large and rather mature market for such services. Broadband access technologies allow substantially greater access speed, and make available applications or content that cannot be accessed through narrowband technologies. Examples of such applications offered by broadband ISPs today include video and audio streaming, interactive gaming, video-on-demand and high speed home-office networking.

As discussed in Hausman, Sidak and Singer (2001) this suggests that the markets for narrowband and broadband Internet access are separate markets. In an econometric analysis of US data they show that the price of narrowband Internet connectivity does not constrain the price of broadband access. Hence, in terms of the Merger Guideline test of market definitions narrowband Internet access is a separate market from broadband Internet access.

Broadband access can be offered through a number of technologies. Due to the high up-front investment necessary to establish a residential broadband local loop, companies that can up-grade an already installed access technology, i.e. cable-TV providers by means of HFC[2] modems and telecommunications providers by means of DSL-technologies[3], will have an advantage (see e.g. Clark, 1999, MacKie-Mason, 1999, and Faulhaber and Hogendorn, 2000).[4]

The speed of communication in the existing copper lines may be increased by using DSL-technologies. The DSL-technique allows higher speed through the existing copper line by installing equipment on the customer premises, and before the first switch. There are different

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[1] Integrated Services Digital Network (ISDN).

[2] Hybrid Fiber Coax.

[3] Digital Subscriber Line (DSL).

[4] In the US market the cable-TV providers have an advantage over the local telephone providers in supplying broadband (Faulhaber and Hogendorn, 2000). The situation is different in Europe where various DSL technologies seem to be the dominant technology in the market for residential customers (see e.g. Roche et al., 2001, and Dawson et al., 2002).

classes in the DSL-family. Up to now, the majority of residential broadband Internet accesses have supported speeds in the range of 300-1024 kbps, and in some cases up to 2048 kbps. Currently, the telecommunications providers offer these services by using ADSL-technology[5]. However, broadband access technologies continue to develop, and it is now possible to offer connection speeds up to 26 mbps through the twisted copper pair by use of VDSL[6]. Hence, VDSL may be seen as having superior quality compared to ADSL in the vertical dimension as it can carry all the content carried by ADSL as well as content that requires greater speed. However, as for all DSL technologies there is a trade off between distance and transmission capacity, and ADSL can be used on longer copper lines than VDSL.[7] Consequently, VDSL can use fewer of the existing copper lines, and requires fiber to be employed closer to homes.

Similarly to the leap from narrowband to basic broadband, this increase in access speed facilitates new applications. Compared to the current 'Internet centric' broadband services, such applications are likely to be 'TV centric'. A telecommunications provider that upgrades it access network by the latest DSL technologies will be able to offer not only traditional cable-TV channel packages, but also new interactive TV-services (iTV) like ability to choose from a program library, play-along games, chatting and web via the TV screen and so on. Thus, broadband access is not a homogeneous good, rather it can be offered in different versions facilitating different applications.

An important lesson from the cost side is that in urban areas where population density is high, the cost differential between offering basic broadband and premium broadband that in addition to Internet-centric applications also facilitates TV-centric applications (hereafter premium broadband) may be small. When a geographical area is upgraded such that everyone can be offered basic broadband, a large part of the homes will be within the distance required to offer premium broadband. For instance, the Norwegian telecommunications incumbent Telenor has an ADSL footprint (basic broadband) close to 1.4 million of the Norwegian households, and about 50% are within the range where VDSL (premium broadband) can be

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[5] Asymmetric Digital Subscriber Line

[6] Very high speed Digital Subscriber Line

[7] The distance from the fiber curb is also important for broadband over the cable-TV access networks. For the HFC networks built by the US cable-TV providers in the late 1990's fiber was typically deployed to serve a neighborhood of about 500-1000 homes (Gillett, 1997). When cable-TV providers like AT&T migrate their HFC networks to a fiber-to-the-curb solution fewer subscribers are allowed to share the access network – typically 20-200 homes (Gillett and Tseng, 2001).

provided.[8] Hence, the provider has the opportunity to use a targeted strategy (cherry picking) and serve a large part of the market with the premium broadband without significant additional costs.

Hence telecommunications providers face the choice of whether to introduce a menu of broadband access products in some targeted areas. However, even if premium TV-centric broadband may be offered without significant additional costs in target areas, there will be significant fixed and irreversible costs related to introduce premium TV-centric applications. In contrast to Internet-centric applications, much of the interactive TV-centric applications are presently not available, and the development costs and/or exclusive rights payments may be high.

Whether it is profitable to introduce premium broadband in addition to basic broadband, depends on whether the willingness to pay for the TV-centric services are high enough to recover the investments, and whether the provider is able to extract this surplus. To accomplish the latter, the provider must perform a delicate balancing act since the consumers will in general consider vertically differentiated products, such as different qualities of broadband, as substitutes. Hence, when different qualities are introduced, these may compete against each other and a price reduction of one quality may cannibalize other qualities. However, as noted by Blattberg et al. (1995) in the study of the effects of a temporary price reduction, the cross-price effects for vertically differentiated products tend to be asymmetric: The sensitivity of quantity demanded for a low quality/low price product due to a change in price of a high quality/high price product is greater than the other way around. As will be discussed in section 4, such a finding in the present context may have important implications for the marketing and roll-out strategies for differentiated broadband access products.

In this study we undertake an analysis of the demand for different versions of broadband access by utilizing data gathered from a telephone survey conducted in Norway in 2001. The results are independent of the underlying technology. However, the discussion will focus on the challenges for a telecommunications provider that is upgrading its local access network. In contrast to more traditional demand studies, such as Rappoport et al. (2002), we explicitly take account of the applications and content opportunities when asking about purchasing probabilities. The respondents were asked about their purchase likelihood of two broadband access products, (i) basic broadband which simply means greater access speed to Internet-

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[8] Source: Telenor.

centric services (Product A), and (ii) premium broadband that also means access to interactive TV-centric services (Product B). To our knowledge, this is the first paper to estimate the degree of substitutability between different speeds of broadband access based on the various content opportunities they imply.

We find that the willingness to pay for TV-centric broadband access is quite high. In addition, the consumers of Product B (premium broadband) do not consider Product A as a substitute. Indeed, the demand for premium broadband is completely independent of the price of basic broadband. On the other hand, the demand for basic broadband is very sensitive to the price of the premium broadband, indicating that the consumers of basic Internet-centric broadband consider the two to be substitutes. Hence, while Hausman et al. (2001) found that narrowband Internet access is a separate market from broadband Internet access, our finding is that basic broadband Internet is a separate market from premium broadband that also support TV-centric applications. Put differently, TV-viewers and surfers are different breeds.

The study most related to the current is Andersson and Myrvold (2001). They estimated demand for basic broadband and TV-centric broadband based on data from a Norwegian experiment. In 2001 Telenor, the telecommunications incumbent in Norway, conducted an experiment where 750 households were given an option to buy broadband accesses that facilitated Internet-centric, or TV-centric applications at various prices. In contrast to the current study where the premium product bundles broadband Internet access and TV-centric access, the participant could buy the TV-centric product separately. The study did not find any effect from the prices of TV-centric access on the demand for broadband Internet access, nor from the prices of broadband Internet access on the demand for the TV-centric access. These results confirm the results in the current study.

The first, according to the authors, empirical study of broadband Internet access demand was conducted by Kridel, Rappoport, and Taylor (2002). They used survey data from households drawn from a US national household panel (NPD). In contrast to Hausman et. al. (2001), they found that narrowband Internet access was a close substitute to broadband (cable modem) Internet access. A possible explanation is that at the time of the study (1999), the market for distinct broadband application was not very developed.

A UC Berkeley study (the INDEX-project[9]) carried out a market trial during 1998-1999 where approximately 70 consumers at Berkeley were offered different access connections up

[9] Internet Demand Experiment.

to 128 kbps. The main result from the INDEX-project was that consumers displayed a low willingness to pay for up-grading the access speed to ISDN connectivity, and that technical and professional workers were the groups with the highest willingness to pay for such up-grades (see Varian, 2002).[10]

More recent analysis where the users have access to broadband with bandwidth analogous to Product A in our survey, indicates that the INDEX result remains valid at this point given the set of applications available today (Varian, 2002). Our survey indicates that a large share of the market has high willingness to pay for the premium broadband product if a set of rather sophisticated interactive TV-centric applications were available. Probably, these potential buyers are "TV-viewers" rather than professional workers.

The majority of the literature on the broadband market has analyzed the network investment costs, and the main focus has been on the investment costs connected to offer a single quality in a given footprint.[11] One example is Faulhaber and Hogendorn (2000) that develop a model of competition among broadband providers, using engineering data for a HFC network, in a metropolitan area in the United States. These analyses do not consider the fact that when a provider offers basic broadband access in a given footprint, a large portion of this footprint may be offered a premium broadband at negligible additional costs. Until now, this cherry-picking opportunity has not been given attention.

The rest of the paper is structured as follows. Section 2 describes the survey and presents some descriptive statistics of the data set. Section 3 sets forth the econometric model and discusses the results. Section 4 offers some implications for broadband marketing and roll-out strategy, and section 5 concludes the paper.

2 The survey

The objective of the paper is to estimate residential demand for two qualities of broadband. In particular we are interested in purchase intensions when the households are offered the following two alternatives: Basic (Product A), and premium broadband which bundles basic broadband and interactive digital TV (Product B). As discussed above these products correspond well to ADSL and VDSL. The technical names were however never used in the survey described below.

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[10] Altmann, Rupp and Varaiya (2000) also give a overview of the results from the INDEX-trial.

[11] Recent industry reviews are e.g. Roche et al. (2001), Petkovic and De Coster (2000) and Dawson, Matkovits and Christopher (2002).

In line with the results of Blattberg et al. (1995), and Hausman et al. (2001) mentioned previously, we expect that Product B will be less sensitive to a price change in Product A, than the other way around. Data was gathered through a nationwide telephone survey in Norway. The survey was carried out in March/April 2001 resulting in useful responses from a total of 1061 households. All respondents were between the ages of 16 and 70, and described themselves as the decision makers regarding selection of telecommunications services for their household. After having obtained the usual demographic characteristics, as well as information about the household's endowment of ICT equipment and subscription to services, the interviewer turned to ask about preferences for various interactive TV applications. The respondent was asked to state his interest, on a five point scale, on applications like: Having the ability to stop the TV-program, run replays, change the camera angel, download programs from a program library, play games with others, chat via the TV screen etc.[12] While interesting in itelself, an analysis of the answers to these questions will not be conducted here.

The important thing for our purposes is that through answering the questions, the respondent should have gained an adequate understanding of the interactive TV applications and be able to give informed responses about the purchase likelihood when presented prices of the two products. The following description of the products was given:

"Product A is a high speed Internet access which implies that you may surf and download information from the Internet at far greater speeds than today. This increased speed will be particularly useful for downloading film clips, music, games, etc. You pay a fixed price per month regardless of how much data you download or upload."

"Product B is a complete solution which gives you high speed Internet AND interactive TV with the added functions we discussed earlier, such as playing games and ordering products via the TV screen and downloading movies from a program library."

The respondent was then asked about the likelihood that he would purchase either of the products when confronted with a pair of monthly fees for Product A and Product B. He was informed that the stated prices were fixed monthly fees, and that for Product B an equivalent to an ordinary cable-TV program package would be included in the monthly fee, P^B. The fee of Product A, P^A, was selected from the set {300, 400, 500}. The corresponding price set for Product B was {600, 800, 1000}. The wording of the purchase likelihood question was as follows:

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[12] The questionnaire (in Norwegian) is available upon request.

"Assume that the price of package A, high speed Internet is [P^A], and the price of the complete package with high speed Internet AND interactive TV, here referred to as package B, is [P^B]. Within a time horizon of one year, which package would you most likely choose: A, or B, or neither?"

To reduce the number of possible price combinations respondents had to compare, the respondents were first divided into three groups of equal size. Then for each group, the monthly fee for Product A would be kept constant whereas the monthly fee for Product B would be allowed to vary. Respondents in Group 1 would always be quoted a monthly fee of 300 for Product A, Group 2 would always be quoted 400, and Group 3 would always be quoted 500. Each group would then first be quoted the highest Product B price (1000) along with the monthly fee of Product A for the specific group. If the respondent chose B as the most likely purchase, the line of price questions would be ended. If the respondent answered "Product A", or "Neither", the interviewer would repeat the question, this time quoting the next price down for Product B (800), and so on.[13]

A potential weakness in the survey design is that P^A only varies between groups, whereas P^B varies both between and within groups. This may influence the responses, and thus the cross-price effects. Future research should address this issue.

2.1 Initial interpretation of survey responses

Based on the above, we construct the variable, choice, as an indicator of the purchase probability, where choice = N indicates that the respondent replied "Neither", choice = A indicates Product A, and choice = B indicates Product B. Each respondent gives rise to three observations, where each row contains the choice indicator, P^A, P^B and the demographic variables[14]. Table 1 and Table 2 show the distribution of choice for the various price combinations. The tables are read as follows: For $P^A = 400$ and $P^B = 1000$, we see from Table 1 that 37.2% of the respondents would pick Product A as their most likely choice. From Table 2 we see that 22.1% answers that they would most likely choose Product B. From each column in Table 1 we see that quantity demanded for Product A decreases when the own-price increases, as expected, and similarly for Product B in Table 2. However, there seems to

[13] For those who replied "Product B" already at the highest price, 1000, or at the middle price, 800, we make the assumption that they would also have chosen the product at each lower price in the price set for Product B. In this way we obtain a balanced sample with three observations per respondent.

[14] The maximum number of observations from a selection of 1061 is hence 3183. The final selection contained 2548 responses, after eliminating incomplete responses.

be no clear relation between demand for Product B and price of Product A. In fact, when the P^B is 800, demand for Product B will *decrease* if P^A is increased from 400 to 500, which makes little sense for a particular individual since the products are mutually exclusive and hence, of course, cannot be complements. The reason why it is at all possible to observe this is because variations in P^A occur only *between* the three respondent groups, and the means are hence subject to statistical noise. The formal analysis carried out in the next section supports the hypothesis that demand for Product B is independent of Product A. A possible explanation is that the potential buyers of Product B are highly interested in the TV-centric component. Product A, which does not contain access to TV-centric applications, is hence not considered to be a substitute for Product B.

Table 1. Purchase intention frequency: Product A

	Price B:		
	600	800	1000
Price A:			
300	0.270	0.361	0.384
400	0.229	0.337	0.372
500	0.107	0.252	0.315

Table 2. Purchase intention frequency: Product B

	Price A:		
Price B:	300	400	500
600	0.395	0.410	0.450
800	0.262	0.288	0.258
1000	0.211	0.221	0.193

Tables 1 and 2 reveal a very high willingness to pay for broadband access.[15] However, there are several reasons why the results should be interpreted with caution. First, 36% of the called were not interested in participating in the survey, and another 44% were excluded for other reasons[16]. It is not unlikely that the majority of these households have a less than average interest in broadband services. Hence, the 1061 remaining responses may not adequately

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[15] The lowest price, P^A=300, would equal more than 25 hours of narrowband surfing.

[16] Illness, was not in the target group, did not respond when called back etc.

represent the population and our results may overestimate the market potential for the products.

Second, the survey is based on the respondents' answer to what they would *most likely* purchase. Formally, when given three choices such as in this survey, it suggests that the respondent's choice will be that which has a subjective likelihood of more than 33%. However, this is not synonymous with an actual purchase materializing in the future. A conservative interpretation of the results would "discount" the reported purchase intentions by some scaling factor perhaps in the magnitude of 0.5–0.7.

Third, the estimates are based on a description of a highly advanced broadband offer (Product B) with several functions (program library, choice of camera angle, etc.) that it probably will take some years to develop. The results must thus be interpreted as forecasts on product market shares, at different price combinations, several years into the future.

Hence, there is quite a bit of uncertainty attached to the level of the purchase likelihood estimates. They are probably biased upward, and ought to be supplemented with information from other sources. However, they are not very far away from the estimates obtained in a willingness-to-pay experiment in a Norwegian VDSL-trial conducted in the year 2001 (see Andersson and Myrvold, 2001).

Although there is uncertainty attached to the level of the demand for broadband accesses, there is less reason to believe that the marginal effects of the covariates should be biased in any systematic way. Hence, our results are still very useful relative to the main objective of our study which is to determine what factors influence purchasing probability, and the interdependence between the two products.

3 Econometric model and estimation results

The respondents are presented a price combination of the two products and asked to specify which alternative they are most likely to choose, Product A, Product B or Neither. The probability that an individual will choose alternative j, where j = A, B, N is modeled as

$$\Pr[\text{Choice} = \text{j}] = \theta^{j} = \frac{\exp(\beta_0^j + \beta_1^j \text{P}^A + \beta_2^j \text{P}^B + \boldsymbol{\beta}^j \mathbf{X})}{1 + \sum_{\text{k=A,B}} \exp(\beta_0^k + \beta_1^k \text{P}^A + \beta_2^k \text{P}^B + \boldsymbol{\beta}^k \mathbf{X})}, \quad (1)$$

where Ps denote prices, and **X** is a vector of individual specific variables. The coefficients of choice = N are normalized to zero. Note that in the above specification, all the variables follow the individual, i.e. the prices do not vary by the individuals' stated choice. In the terminology of Greene (1993) the model (1) is a *multinomial* logit. This is in contrast to the more common *conditional* logit specification of demand for differentiated goods where the prices vary by choice, see e.g. Anderson and de Palma (1992). However, the latter model is not appropriate for the current purposes because it imposes a symmetric cross-price effect. This holds even if a random coefficient variant is applied[17].

The model in equation (1) does not suffer from this. The marginal cross-price effects in this model are given by,

$$\partial\theta^{B} / \partial P^{A} = \theta^{B}(\beta_1^{B} - \overline{\beta}_1), \quad \overline{\beta}_1 = \theta^{B}\beta_1^{B} + \theta^{A}\beta_1^{A} \tag{2}$$

$$\partial\theta^{A} / \partial P^{B} = \theta^{A}(\beta_2^{A} - \overline{\beta}_2), \quad \overline{\beta}_2 = \theta^{A}\beta_2^{A} + \theta^{B}\beta_2^{B} \tag{3}$$

As is evident from equation (2) and (3) the marginal cross-price effects are not symmetrical by construction.

Table 3 presents the estimates of the marginal effects of the model (1), calculated at the mean of the variables.

Table 3. The demand for differentiated broadband services

		Marg. eff	t-ratio	Mean
	Product A			
CONST		-0.218	-2.60	1.000
AGE3039	Respondents age is between 30 and 39	-0.078	-2.66	0.281
AGE4049	Respondents age is between 40 and 49	-0.018	-0.61	0.226
AGE5059	Respondents age is between 50 and 59	0.085	2.06	0.202
AGE60+	Respondents age is above 60	-0.189	-4.51	0.113
INC400	Household income is 300 to 499 thousand NOK	0.005	0.10	0.257
INC600	Household income is 500 to 699 thousand NOK	0.023	0.51	0.452
INC800	Household income is 700 to 899 thousand NOK	-0.011	-0.21	0.153
INC1000	Household income is above 900 thousand NOK	-0.007	-0.13	0.082
MALE	Respondent is male	0.046	2.33	0.584
HHM015	Number of household members below 15 years	0.024	2.18	0.763
UNIV	Respondent holds a university degree	0.030	1.52	0.420

[17] See Sethuraman et al. (1999).

PCONLY	Household has a PC, but not Internet connection	0.157	4.74	0.148
INSLOW	Household has a slow-speed Internet connection	0.070	2.37	0.570
INHS	Household has a high-speed Internet connection	-0.023	-0.46	0.066
INMONTH	Households monthly Internet spending	0.173	3.88	0.148
CABEL	Household has cable television	0.037	1.52	0.442
CACOST	Cable television is included in rent	-0.008	-0.27	0.162
SATEL	Household has a Satellite antenna	0.028	1.22	0.305
TVNUM	Number of television sets in the household	-0.015	-0.99	1.555
VIDNUM	Number of video recorders in the household	0.003	0.14	0.986
P^B	The price of product B, in 1000 NOK	0.409	7.13	0.800
P^A	The price of product A, in 1000 NOK	-0.608	-5.37	0.407
	Product B			
CONST		0.450	5.32	1.000
AGE3039	Respondents age is between 30 and 39	-0.047	-1.60	0.281
AGE4049	Respondents age is between 40 and 49	-0.150	-4.92	0.226
AGE5059	Respondents age is between 50 and 59	-0.065	-1.67	0.202
AGE60+	Respondents age is above 60	-0.122	-3.13	0.113
INC400	Household income is 300 to 499 thousand NOK	-0.051	-1.11	0.257
INC600	Household income is 500 to 699 thousand NOK	-0.030	-0.66	0.452
INC800	Household income is 700 to 899 thousand NOK	-0.039	-0.78	0.153
INC1000	Household income is above 900 thousand NOK	0.025	0.46	0.082
MALE	Respondent is male	0.059	2.97	0.584
HHM015	Number of household members below 15 years	-0.009	-0.76	0.763
UNIV	Respondent holds a university degree	-0.015	-0.73	0.420
PCONLY	Household has a PC, but not Internet connection	-0.036	-1.01	0.148
INSLOW	Household has a slow-speed Internet connection	0.091	3.12	0.570
INHS	Household has a high-speed Internet connection	0.191	4.22	0.066
INMONTH	Households monthly Internet spending	0.066	1.45	0.148
CABEL	Household has cable television	-0.004	-0.16	0.442
CACOST	Cable television is included in rent	-0.068	-2.14	0.162
SATEL	Household has a satellite antenna	-0.010	-0.42	0.305
TVNUM	Number of television sets in the household	0.002	0.17	1.555
VIDNUM	Number of video recorders in the household	-0.006	-0.29	0.986
P^B	The price of product B, in 1000 NOK	-0.565	-9.70	0.800
P^A	The price of product A, in 1000 NOK	0.046	0.40	0.407

Notes:

1) The number of observations is 2548
2) LogL is –2528, restricted LogL is –2763. Average predicted probabilities are: 0.29 for product A, and 0.30 for product B.
3) The first column of numbers displays the marginal effects (not the estimated coefficients), the second displays the asymptotic t-values of these effects, and the last displays the means of the right-hand side variables.

As is well known, logit models have a potential weakness in the assumption of independence of irrelevant alternatives (IIA). We have employed the specification test proposed by Hausman and McFadden (1984), separately for the coefficient sets of the two products. Hence, we have re-estimated the demand for Product A, excluding observations where choice = Product B and vice versa. The logit estimates of these regressions are shown in the appendix. The Hausman test statistics for the coefficients of Product A and Product B are 17.57 and 10.81, respectively. The test statistics are asymptotically χ^2 distributed with 23 degrees of freedom. In other words, we cannot reject the IIA assumption.

Turning to the estimated marginal effects we see that purchase intentions mostly decline with age, and males are more prone to state purchase intentions for both products than females. Neither education nor income seems to affect demand[18]. Respondents that already have basic broadband are not interested in Product A – obviously. However, they display very strong purchase intentions for Product B. Presumably, these respondents are early adopters and although they probably make out a small group, they will still be a likely target for broadband which enables TV-centric services. Furthermore, respondents with a high Internet bill today have strong purchase intentions for Product A, confirming that the heavy users will be among the first to upgrade to basic broadband. As opposed to early adopters favoring the new content possibilities of Product B, the heavy users may instead be attracted to Product A simply because of a price structure – the flat rate would be less expensive than a usage based tariff for heavy users. As expected, if the payment for cable television is included in the rent, the demand for Product B declines.

Quite surprisingly however, neither the number of television sets or video recorders, nor ownership of a satellite antenna or cable television affects purchase intentions. This suggests a negative answer to our question of whether TV-viewers and surfers are different breeds. However, the lack of effect of the number of television sets and video recorders may be because they pick up the size of the household/apartment. The survey also included a set of questions where the respondents were asked to report the frequency of which they watched the following kinds of TV programs: News, sports, debate programs, movies, programs for children, soap, reality TV and TV-shopping. We ran an additional multinomial logit regression with the scores from these variables included as regressors (not reported). Neither

[18] The latter may seem strange in view of the strong asymmetric cross-price effects. Recall however that the products are mutually exclusive and slutsky-symmetry hence does not apply.

of the variables had a significant positive effect on the demand for Product A. News and programs for children had a negative effect on the demand for Product B, while, still for product B, debate programs and reality TV had a highly significant positive effect, movies had a significant positive effect, and soap and TV-shopping also had a positive but not significant effect. This suggests that TV-viewers and surfers are indeed different breeds.

Both products have a highly significant, negative own price effect. The cross-price effect in the equation for Product A is positive and highly significant indicating that Product B is a strong substitute for Product A. However, the reverse does not hold: The marginal effect of P^A on Product B is very low and not significantly different from zero.

Table 4 provides estimates of own price elasticity and cross-price elasticity of demand for Product A and Product B, along with their asymptotic standard deviations, based on the results in Table 3. The elasticities are calculated at average prices, i.e. 400 for Product A and 800 for Product B.

Table 4. Price elasticities

	P^A	P^B
Product A	-0.84 (0,11)	1.13 (0,06)
Product B	0.06 (0,11)	-1.51(0,06)

Std dev in parenthesis

We see that the own price elasticity of Product B is greater than that of Product A. Hence a 10% price increase for Product B reduces its quantity demanded by 15.1% whereas a 10% price increase for Product A reduces its quantity demanded by only 8.4%. This is in line with expectations as higher priced, higher quality products generally tend to be more price sensitive. Furthermore, the own-price elasticity of Product B is within the relevant range Rappoport et al. (2002) find for broadband access in the US, and the own-price elasticity for Product A is within -0.84 to -1.05, which they consider the range of “existing econometric estimates” (p. 9).

In terms of cross-price elasticities, we establish the asymmetries that were suggested by the results in Tables 1 and 2. A price increase (decrease) of Product B by 10% increases (decreases) quantity demanded for Product A by 11.3%. This indicates that many households consider Product B to be a close substitute for Product A, presumably due to the overlapping of broadband Internet access. However, the demand for Product B is not only less dependent on the price of Product A, but actually completely independent. A possible explanation is that most of the Product B consumers are primarily interested in the TV-centric content, and Product A will hence not be considered to be a substitute by these households.

The marginal effects and elasticities presented above are calculated at the mean of the prices. Sethuraman et al. (1999) discuss various cross-price measures and argue that the asymmetry in the cross-price effect between two vertically differentiated products may be exaggerated when measured as an elasticity simply because the high quality product has a higher price and may have a larger market share. In a study of grocery products they find that the asymmetric price effect is present when measured as a cross-price elasticity, but tend to disappear when measured as an absolute cross-price effect. The latter is a measure designed to overcome the scaling problems described above. It is defined as $(\partial\theta^J / \partial P^K)(0.01P^c)$, where P^C is the market share weighted average price, here Product A and Product B. The interpretation is the change in purchase probability of product J when the price of product K changes by one percent of the average market price.

Table 5 compares three measures of the cross-price effect computed at all possible price-combinations of Product A and Product B.[19] The measures are: The *marginal* cross-price effect as specified in equations (2) and (3), the *absolute* cross-price effect as defined in Sethuraman et al. (1999), and finally the cross-price *elasticity* $(\partial\theta^J / \partial P^K)(P^K / \theta^J)$.

[19] For simplicity the figures in Table 5 are calculated from a multinomial logit specification where only the prices were included. Excluding **X** has a negligible effect on the coefficient estimates because the prices are orthogonal to **X** by construction (caused by the design of the survey).

Table 5. Cross-price effects at different price combinations

			Product A			Product B		
Pa	Pb	Rel diff	Marginal	Absolute	Elasticity	Marginal	Absolute	Elasticity
500	600	0,18	0,301	0,993	1,076	-0,032	-0,107	-0,039
400	600	0,40	0,367	1,213	1,049	0,025	0,083	0,024
500	800	0,46	0,344	1,214	1,182	0,004	0,014	0,007
300	600	0,67	0,436	1,397	1,010	0,088	0,282	0,065
400	800	0,67	0,406	1,421	1,129	0,057	0,199	0,077
500	1000	0,67	0,363	1,283	1,195	0,030	0,105	0,073
400	1000	0,86	0,411	1,419	1,112	0,071	0,246	0,145
300	800	0,91	0,463	1,543	1,060	0,111	0,369	0,117
300	1000	1,08	0,448	1,433	1,015	0,110	0,353	0,176

As is evident, the asymmetric cross-price effects depicted in Table 2 and 3 hold whatever measure is employed, and at all price combinations.

The figures are sorted by the relative price difference (P^B minus P^A divided by the average price) between Product A and Product B. We see that all measures on the cross-price effect, except the cross-price elasticity of Product A, tend to increase in the price difference (the cross-price-effect of Product B is never significantly different from zero however).[20] An interpretation of the above results is that the closer the two prices are, the more customers have already selected the premium product, Product B. Hence, the pool of Product A customers with a willingness to pay for interactive TV is smaller the closer the prices are, and the smaller is the effect of a decrease in P^B on the migration from Product A.

4 Strategic implications

In this section we discuss some potential strategic implications of our estimation results. Fundamental to our discussion are the strong complementarities between broadband access (ADSL/VDSL) and content (Internet-/TV-centric). Indeed, in the survey, we only focused on the content implications of the broadband access, and the network technology (ADSL/VDSL)

[20] These results are in contrast to Sethuraman et al. (1999) who find that brands that are priced closed to each other tend to have a larger cross-price effect. The results are not comparable for several reasons. Firstly, the present effects are simply obtained from interpolation of the model – we have not tested for the effects. Secondly, Sethuraman et al. consider quite different products mainly grocery products, and finally the present study consider only two products , whereas Sethuraman et al. study markets with many more brands.

was invisible to the respondents. However, from a supply side point of view, access and content are distinct. We take the perspective of a telecommunications incumbent that considers whether to offer basic broadband in the form of ADSL-technology to a given footprint.

As discussed in the introduction, consumers in densely populated areas of the footprint may be offered premium broadband through VDSL at negligible additional costs to the provider. In these areas, the main obstacle related to introduction of VDSL is probably not the network investment costs. The main current obstacle seems to be the lack of attractive interactive TV-centric applications. The cost of acquiring such applications (through own development or purchase of property rights) are probably high and definitely sunk, but the marginal costs of distribution of premium content are negligible. Thus, ex post, basic broadband and premium broadband are identical from a cost perspective. Hence, the question for the provider is whether the additional revenues from introduction of premium broadband cover the up-front investments. According to our study, the additional willingness to pay for premium broadband access is quite substantial. Indeed the price combination that maximizes the incumbent's revenues is 400 NOK for basic broadband (Product A) and 1000 NOK for premium broadband (Product B) with (400, 800) as a very close runner up.[21] For reasons mentioned earlier however, the absolute values of this willingness to pay should be interpreted with care.

More important, and probably more robust, are the results with respect to the telecommunications provider's *ability* to extract this additional willingness to pay - whatever the level may prove to be. In general, a provider's ability to extract additional consumer surplus from introduction of a premium product is constrained by the problem of screening.

From the literature on second-degree price discrimination we know that a monopoly provider will use quality degradation (or very similar quantity discrimination) to deter consumers with high willingness to pay from choosing the service intended for consumers with low willingness to pay.[22] Degradation of the low-end service, either by price or by quality, may be essential to make introduction of the premium product profitable. The results from the present study however, tell us that degradation of the low end product, i.e. basic broadband, is unnecessary (unprofitable). The price of basic broadband does not constrain the demand for premium broadband. Put differently, there is no screening problem.

[21] Based on calculations from the figures in Table 2.

[22] The seminal paper is Mussa and Rosen (1978). Shapiro and Varian (1998) give applications of such strategies in the Internet industry.

This result may be important for the deployment of premium broadband as degradation of basic broadband may be very costly and perhaps not an option at all for the providers. Recall that basic broadband is offered to all customers in the footprint. Quality degradation only towards the customers within the target area of the premium broadband is probably not a sustainable option for regulatory reasons. The incumbents will probably be forced to offer basic broadband as a wholesale service. To what extent rivals succeed in the market place seems to differ significantly between different countries. In Germany the incumbent, Deutsche Telekom, had a market share of 96% in the ADSL market in 2002. In the ADSL market of the UK, the market share of BT was 62% (Dawson et al., 2002). Hence, ex ante wholesale price regulation will limit the possibility to practice both general degradation, and degradation only in the target area for VDSL.[23]

Summing up, a given low price of broadband Internet access, whether caused by regulation or competition, does not affect the profitability of the premium broadband access product. Finally, in the new European regulatory framework for electronic communication services (Framework Directive) that comes into force from July 2003, ex ante regulation will not be implemented on "emerging markets". If this definition applies to VDSL it will certainly be important for the incumbent to grasp the first-mover advantage and adopt a cherry-picking strategy in the deployment of broadband access.

5 Concluding remarks

TV-viewers and surfers are different breeds. At least, we cannot reject the hypothesis that the price of basic Internet-centric broadband Internet does not affect the demand for a premium broadband product that also includes interactive TV-centric applications. The result is robust, and holds whatever measure of the cross-price effect is used. The main uncertainty is connected to the survey design.

The results imply that basic broadband is a separate market from premium broadband which also incorporates interactive TV-centric applications, at least as far as the consumers are concerned. Lessons from the cost side tell us that when an area is upgraded to offer basic broadband, a large part of the households in the region may be offered a superior product that also allows for interactive TV-centric applications at virtually the same cost. The provider

[23] Also, it is possible that basic broadband in the future will be imposed universal service obligations (USO), forcing the incumbent to offer ADSL countrywide at a uniform price. USO on premium broadband (VDSL) is however highly unlikely.

then has the opportunity to adopt a cherry picking strategy, and serve a part of the households with premium broadband. Our analysis indicates that there is a willingness to pay for such a product once the applications are available. This cherry-picking strategy may be necessary to make the broadband deployment profitable given that the revenue potential from basic broadband with the current set of applications is limited.

Finally, note that the survey assumed the existence of a set of interactive TV-centric applications where most of them are not currently available. Indeed, the main obstacle that prevents a premium broadband product from being offered to a large part of the population is not the access costs, but the lack of available applications.

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Appendix

Logit estimates of Product A

		Coefficient	t-ratio
CONST		-0.486	-1.52
AGE3039	Respondents age is between 30 and 39	-0.579	-3.33
AGE4049	Respondents age is between 40 and 49	-0.426	-2.55
AGE5059	Respondents age is between 50 and 59	-0.966	-5.39
AGE60+	Respondents age is above 60	-1.312	-5.81
INC400	Household income is 300 to 499 thousand NOK	0.055	0.22
INC600	Household income is 500 to 699 thousand NOK	0.180	0.73
INC800	Household income is 700 to 899 thousand NOK	-0.011	-0.04
INC1000	Household income is above 900 thousand NOK	0.080	0.26
MALE	Respondent is male	0.398	3.70
HHM015	Number of household members below 15 years	0.131	2.05
UNIV	Respondent holds a university degree	0.155	1.41
PCONLY	Household has a PC, but not Internet connection	0.823	4.73
INSLOW	Household has a slow-speed Internet connection	0.629	4.02
INHS	Household has a high-speed Internet connection	0.471	1.72
INMONTH	Households monthly Internet spending	1.009	3.96
CABEL	Household has cable televison	0.191	1.41
CACOST	Cable television is included in rent	-0.177	-1.08
SATEL	Household has a Satellite antenna	0.169	1.32
TVNUM	Number of television sets in the household	-0.116	-1.41
VIDNUM	Number of video recorders in the household	0.045	0.44
P^B	The price of product B, in 1000 NOK	1.106	3.70
P^A	The price of product A, in 1000 NOK	-3.220	-7.83

Notes:

1. The observations where choice = product B is excluded. The number of remaining observations is 1788
2. The table reports the estimated coefficients (not the marginal effects).

Logit estimates of Product B

		Coefficient	t-ratio
CONST		1.446	4.73
AGE3039	Respondents age is between 30 and 39	-0.529	-3.17
AGE4049	Respondents age is between 40 and 49	-0.958	-5.58
AGE5059	Respondents age is between 50 and 59	-1.353	-7.51
AGE60+	Respondents age is above 60	-1.233	-5.98
INC400	Household income is 300 to 499 thousand NOK	-0.293	-1.20
INC600	Household income is 500 to 699 thousand NOK	-0.165	-0.70
INC800	Household income is 700 to 899 thousand NOK	-0.302	-1.14
INC1000	Household income is above 900 thousand NOK	0.095	0.32
MALE	Respondent is male	0.519	4.84
HHM015	Number of household members below 15 years	0.015	0.24
UNIV	Respondent holds a university degree	0.004	0.03
PCONLY	Household has a PC, but not Internet connection	0.162	0.87
INSLOW	Household has a slow-speed Internet connection	0.734	4.83
INHS	Household has a high-speed Internet connection	1.164	4.80
INMONTH	Households monthly Internet spending	0.831	3.20
CABEL	Household has cable televison	0.106	0.78
CACOST	Cable television is included in rent	-0.354	-2.07
SATEL	Household has a Satellite antenna	0.072	0.58
TVNUM	Number of television sets in the household	-0.028	-0.34
VIDNUM	Number of video recorders in the household	-0.044	-0.43
P^B	The price of product B, in 1000 NOK	-1.979	-6.81
P^A	The price of product A, in 1000 NOK	-0.294	-0.75

Notes:

1. The observations where choice = product A is excluded. The number of remaining observations is 1816
2. The table reports the estimated coefficients (not the marginal effects).

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