Pricing Online Banking Services Amid Network Externalities

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Abstract

Using the particular example of online banking services, we examine the effects of pricing strategies on the demand for different modes of online banking given that the market exhibits network externalities. Most literature concerning the economics of networks deals with a single durable good where, in a multi-period setting, the consumer decides whether or not to purchase the good. Once the decision to buy is made, there are no further decisions to make. In online banking, and in most electronic service contract arrangements, customers can change their decisions in later periods, moving to another choice if they are not satisfied with the existing choice. The model presented in this paper allows such reversing of decisions, and thus, dynamically captures the effects of changes in service fees, reservation prices, and strength of network externalities on the decisions of the customer. The model also accounts for switching costs that the customer may incur when she moves from one mode to another. Departing significantly from previous literature, we assume that network externality follows a stochastic process, making the model more realistic and comprehensive. With a stylized example and numerical simulation of the dynamic stochastic program, we illustrate the use of the model in pricing online banking services.

1. Introduction

With the advent of the Internet, and the tremendous growth in communications technology, retail banks have found it attractive to offer online banking services. Online banking, also called electronic banking, home banking, or PC banking, provides the bank’s customer the convenience of conducting transactions from a home or office using a desktop computer. Estimates and projections on the use of online banking vary. From an estimated 5 million users in 1998 (The Wall Street Journal, May 15, 1998), the electronic banking users are projected to increase to about 22 million users by 2002 (The Wall Street Journal, May 15, 1998), 16 million in 2000 by Booz Allen & Hamilton, or 15 million in 2000 by Towers Perrin. Not only is a tremendous growth projected for online banking, but it is expected to be extremely profitable: the Tower Group reports that online customers will provide 30% of retail bank profits although they make up only 15% of the banking customer population.

While the increased convenience of online banking has driven customer demand, banks find it profitable to offer online banking services for other reasons also. First, there is a significant saving on transaction costs: online transaction costs are a fraction of branch transactions, and are minimal even in comparison to the costs of other electronic transactions such as ATM transactions. Further, the use of online bill payment options by customers decreases check processing and telephone call processing costs. A typical bank also sees tremendous opportunity in the web because with a Website, the bank has one single consolidated delivery channel, which if properly used can provide tremendous advantages in terms of marketing. The Website allows the bank to offer all its products visually to the customer increasing the possibilities for cross-selling. Moreover, the bank can display advertising personalized to the customer based on his or her web/bank account usage statistics or profile. Thus, without too much effort, the

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1 By the term ‘Online Banking’ we mean any kind of remote electronic transaction facility that is made possible by a desktop computer, irrespective of whether special bank-provided communication software is used, or whether Internet-based software such as a Web-browser is used.
The cross-product network effects of the community of users of one product affect the sales of another product. Product network externalities (where the community of associated with a product affects its sales), and cross-network externality effects (where the network on two types of network externality effects: direct and indirect. Banks seem to be capitalizing a major issue for the retail banking industry. The active online banking customers. Second, customer retention is to recover these sunk costs from the fee-paying active mode of online banking. In which the customer spends time and effort in initial setting up of payment options). Thus, apart from transaction management software. In the active mode, a customer can do all of the activities associated with passive online banking, and further, can use the online banking facility to make electronic payments of bills, or transfer money to accounts in other banks. Banks typically follow a two-price structure for online banking. A quick search of the web sites of various banks on the Internet shows the pricing structure in Table 1. As shown in the table, most banks provide passive on-line banking free while they charge a fixed fee for active online banking.

Our interest in this paper is to examine the pricing structure that banks adopt with regard to on-line banking services. The pricing structure seems to be motivated toward enticing customers to try passive online banking for free or a minimal charge, and then move them on to active online banking. It seems to us that this strategy arises for two different reasons. First, setting up online banking service can be quite expensive. It costs about $10,000 to set up a server, and anywhere between $200,000 to $4 billion for Internet access depending on the size of the bank. Forrester Research estimates that building and maintaining a transactional Web-site can cost anywhere between $5 million and $23 million (Bank Network News, June 23, 1998). Banks would like to recover these sunk costs from the fee-paying active online banking customers. Second, customer retention is a major issue for the retail banking industry. The active mode of on-line banking (in which the customer spends time and effort in initial setting up of payment options) allows banks to “tie-in” customers. Thus, apart from fee-generation, customer retention is another reason why banks would like customers to sign up for the active mode of on-line banking. Banks seem to be capitalizing on two types of network externality effects: direct network externality effects (where the network associated with a product affects its sales), and cross-product network externalities (where the community of users of one product affect the sales of another product). The cross-product network effects of the community of users of passive online banking on the sales of active online banking seem to be at the basis of the strategy banks are adopting to sell online banking services. We examine this strategy using a multi-period game in which at the beginning of each period, the bank sets prices for the modes of online banking, and the customers choose one of three options:

- choose passive online banking,
- choose active online banking, or
- do not choose online banking at all.

We propose a stochastic dynamic programming model in which the customer is a value-maximizing agent. Value is the consumer surplus that the customer derives from using one of the modes of online banking. Using a stylized example, we discuss the various conditions under which customers choose one mode of online banking over another, switching between modes if necessary to obtain long-term benefits.

From a managerial perspective, the model predicts that customer adoption of online banking is affected by both network externality effects and by the pricing scheme. Further, the model allows us to examine the specific conditions under which customers switch from one mode of banking to another. It predicts that customers react negatively to increases in prices of passive online banking, and thus, banks will be better off in providing passive online banking free of cost to customers in order to make customers adopt the active mode of online banking (which generates revenues). In fact, this effect of cross product externality, has made banks provide passive online banking for free while charging a fee for active online banking. Wells Fargo is a classic example of how banks are beginning to perceive the effects of cross-product network externalities as projected by this model. A year ago, Wells Fargo provided only a fee-based active online banking option, but now, it provides a free passive online banking option along with the original active online banking mode for which its fee structure has not changed.

The rest of the paper is organized as follows. Section 2 discusses the relevance of network externalities in electronic banking. In Section 3 we present the mathematical model and solution methods. Section 4 presents a stylized example to illustrate the application of the model. We conclude the paper with Section 5 with a discussion of the managerial implications of the model and some of its limitations in Section 5.

2. Review of Related Literature

Network externalities refer to the change in the benefit derived by an individual consumer of a good or service with change in the total number of consumers of that good or service. The literature on network

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2 Depending on whether the bank has an arrangement with the billing agency, the bank will pay either electronically, or through a check that it generates.
externalities is varied and vast, and in this section we pick up some of the relevant strands for discussion.

2.1 Network Externalities and New Product Introduction

The introduction of new products and technologies given that consumer decisions are affected by network externalities has received some attention. This literature which discusses timing of new product introduction and customer switching between competing technologies is relevant to this paper because we are concerned with when and under what conditions customers switch between different modes of banking. Farrell and Saloner explore how consumers in a competitive market choose between two incompatible technologies [3]. They show that network externalities create consumer biases which affect purchasing decisions. Katz and Shapiro [4] show that when technology development costs are declining over time, rather than a bias toward existing products, markets with network externalities develop new incompatible technologies. They call this counter-bias “insufficient friction.” Choi uses a two-period model to study the implications of uncertainty in technological development when a firm enters a market in which an unchanging incumbent technology exists with an established user base [5]. If a buyer perceives that the expected value of the new technology (without network externality effects) exceeds the value of the incumbent technology along with externality effects, then the decision of which period to buy in will depend on the risk involved in the new technology.

2.2 Monopoly Pricing with Network Externalities

We can think of the online banking choice problem as the pricing problem faced by a monopoly. Customers do not easily change banks, and we can assume without loss of generality that they are already customers of the bank. We realize that this is a rather strong assumption. While we intend to relax this assumption in future research, we justify it for the purpose of this paper, arguing that customers are reluctant to change banks given that the initial setup is complicated and time-consuming, creating a stickiness in the market. We assume therefore, that the bank is trying to use its pricing structure to redistribute this captive customer load among its three delivery channels: branch (non-online), passive online banking, and active online banking. Considerable literature exists about monopolistic pricing with network externalities ([6], [7], [8], for example).

The “Coase conjecture” [9] which claims that a monopolist who is unable to commit to future prices in a multi-period setting will offer prices equal to marginal costs as the interval between periods becomes small. Several researchers have shown that the Coase conjecture may not hold when positive network externalities are present because quality improvements in subsequent periods could justify increases in prices.

2.3 Network Effects and Benefits in Banking

The study of network effects in banking has for the most part focused on Automatic Teller Machine (ATM) networks. Saloner and Shepard [10], found that the larger its number of branches, or the larger the number of customers, the earlier a bank adopted ATMs. McAndrews and Kauffman [11] and Kauffman, McAndrews and Wang [12] similarly concluded that the larger the benefits of network externalities, the earlier a bank adopts shared ATM networks.

Of late, attention has been given to the network effects that govern “traditional” consumer banking services such as paper checks and credit cards. Osterberg and Thomson [13] compare the network effects of paper checks to those in telephone service. In banking, there are significant network effects associated with credit cards, and the growth of the credit card market displays the characteristic explosion associated with network effects. They explain that network effects in the case of credit cards come from two sources: the number of merchants accepting the card create the increased network-dependent value for the consumer, but the number of users who want to use the card create the benefit for the merchant. Osterberg and Thomson claim that the network situation is similar for electronic payment systems, which form the core of PC banking. Kezar argues that the e-check facility, and other electronic means of payment (EMOP) will also gain acceptance (like credit cards did) once a critical mass of users is achieved [14]. Joanna Stavins [15] argues that electronic check presentment (ECP) which is often seen as the backbone to financial transactions over the Internet, demonstrates network effects: the bigger the network of participants in ECP, the more the benefits for each participant. Ouren et al [16] suggest that electronic banking could provide other kinds of network externalities with merchants like cable service providers offering incentives such as free channels in return for electronic bill payments. Electronic bill payment and presentation, Ouren et al, argue is important for the bank’s strategy since it is part of the “bank’s overall online service” (p.98).

Recent research ([17], for example) has shown that banking customers make decisions about adopting online banking based on reports that friends and relatives provide them. This source of influence on decisions to adopt online banking can be viewed as network externalities: the larger the size of the network
(that is the number of customers who have adopted online banking), the larger the effects of the network on the adoption decision. Retail banks are very cognizant of the effects of such network externality on online banking adoption decisions. An executive in ScotiaBank, Canada, summed up, "Banking is founded on trust. We want an e-commerce service we can feel safe with, because if even one customer somewhere gets hacked - well that's bad for the customer but we suffer the impact to a greater extent because of the damage to customer trust." (Bob Lounsbury of Scotiabank, a 1998 NetCommerce award winner in the Canada Information Productivity Association competition.)

In the context of online banking, there are two significant differences from the conventional notion of network externality. First, as has been discussed in marketing literature ([18], for instance), the effect of such word-of-mouth phenomena can be either positive or negative. More generally though, when 33% of respondents rely on friends and relatives for information while making decisions about adopting online banking [17], the externality effects of this network can be either positive or negative, challenging the traditional assumption that network effects are always positive. A second difference is that the word-of-mouth effect brings to the notion of network externality is that the network externality effect can be stochastic, and not a constant parameter. The model presented in this paper accommodates this change of perspective about network externality effects.

2.4 Contributions of this paper

Most literature concerning the economics of networks deals with a single durable good with the consumer deciding irreversibly whether or not to purchase the good. Once the decision to buy is made, there are no further decisions to make. In online banking, and in most service contract arrangements, this is not the case. Customers can change their decisions in later periods, moving back to an earlier choice if they are not satisfied with the mode they chose in the immediately preceding period. Our model allows the customer to reverse the decision and thus, dynamically captures the effect of service charges, reservation prices, and strength of network externalities on the decisions of the customer. Our model also assumes that the user incurs a switching cost each time she switches from one mode to another. Switching costs have not received much attention in the network externalities or pricing literature. Farrell and Shapiro [19] employ a two-period formulation assuming perfect substitutability between products of different firms. They show that when two generations of users overlap, firms will alternate between two extreme policies: sell all to the old customers, or sell all to the new customers. Beggs and Klemperer [20] develop a model where customers face an infinite horizon and there is imperfect substitutability. They find that sales are made to both new and old customers and that market shares evolve monotonically. To [21] extends this to a finite period setting and finds that most results of [20] hold, but in addition, the convergence of prices to equilibrium levels depends on the finiteness of the time horizon.

This paper makes a second important contribution to literature. Typical of most research on network externalities is the following model of network externality: “An individual consumer enjoys a flow benefit of α + βzt at date t if she owns a unit of hardware with a network size of zt at that time, where α and β are positive constant; β measures the strength of network externalities” [4]. Since most models are concerned with decision-making that spans only two periods, it is appropriate to assume the network effect can be represented by a constant (β). The sparse modeling literature that deals with network effects over multi-period decision making also treats the externality factor to be a constant parameter that multiplies the size of the network to obtain the network effect (e.g. [8]). We argue that the network effect need not be linear in the size of the network. In fact, more commonly, it is not deterministic at all. We thus find it more useful to model the network externality parameter as a random variable underlying which is a stochastic process. In this paper, we assume network externalities to follow a geometric Brownian motion similar to stock prices, but more generally, they can follow any stochastic process.

3. Mathematical Model

Consider a bank, B, providing two modes of online banking as discussed in the Introduction. Denote the active mode by A, the passive mode by I, and non-online mode by N. The monthly fee for mode A is pA, and the monthly fee for mode I is pI. Consider T periods. The first period begins at t = 0. Let \[t_i = t_0 + i(T - 1)], i \in \{0, 1, ..., T-1\}, represent the T equi-width periods. At the beginning of the first period, the bank sets prices p_A and p_I, and the customer chooses one of the three modes of online banking (N, I, or A) based on his/her assessment of network externality effects. We assume that during a single period, the customer is unimodal: i.e., she does not switch to another mode from the mode chosen at the beginning of the period. When the customer switches from mode j to mode k, she incurs a switching cost of C_{jk}. Let q_{ij} denote the total number of customers choosing mode j in period i.

As in previous research about pricing with network externalities ([8], for example), we assume there is a continuum of customers who are indexed by a parameter h, uniformly distributed over the interval [0, 1]. Thus, h
is the customer’s reservation price for the online banking service. If the interval $[0, 1]$ represents the market size, $h$ divides the market into three segments as follows:

$0 \leq h \leq h_t$ : represents customers who do not want online banking (those who choose option N)

$h_t \leq h \leq h_A$ : represents customers who choose the passive online banking option

$h_A \leq h \leq 1$ : represents customers who choose the active online banking option.

We argue that the customer’s decision to choose one option over another is affected by three factors: reservation prices, prices of the modes of online banking, and network externalities. Our main goal in this paper is to examine the effect of price setting amidst stochastic network externalities. We achieve this in two stages. First, we assume a fixed price vector and examine the effect of stochastic network externalities on the customer’s choice. Then, we repeat this process changing the price vector. Comparing across price vectors will allow us to observe the effect of both prices and network externalities on the customer’s decision.

The following equations describe the consumer surplus for the three modes of online banking.

For the first period:

We assume period 1 begins at time $t = 0$ and ends at $t = 1$.

$V_{I}(h, p_{I1}) = h - p_{I1}$, if the customer chooses option I which is priced at $p_{I1}$

$V_{A}(h, p_{A1}) = h - p_{A1}$, if the customer chooses option A which is priced at $p_{A1}$, and

$V_{N}(h, 0) = 0$, if the customer chooses option N.

For period $i$, $2 \leq i \leq T$, the consumer surplus equations are:

$V_{I}(h, p_{I1}, q_{I1-i}, q_{A1-i}) = (h - p_{I1} + k_{II}q_{I1-i} + k_{AI}q_{A1-i})$ if the customer chooses option I which is priced at $p_{I1}$

$V_{A}(h, p_{A1}, q_{I1-i}, q_{A1-i}) = (h - p_{A1} + k_{IA}q_{I1-i} + k_{AA}q_{A1-i})$ if the customer chooses option A which is priced at $p_{A1}$, and

$V_{N}(h, 0) = 0$, if the customer chooses option N.

Here, $q_{I1-i}, q_{A1-i}$ represent the number of customers who have chosen modes I and A respectively. The parameters, $k_{II}, k_{IA}, k_{AI},$ and $k_{AA}$ represent the network externality effects. This representation of network externality is more general than assumed in literature. Not only are we able to capture the network effects in this period arising from the sales of the product in the previous period, but further, we are able to examine the network effects of the sales of one product on the other in subsequent periods. Moreover, while these parameters, $k_{xy} \in [0, 1]$, where, $x, y \in \{I, A\}$, a

$\max m \left[V_{Tm}(.) - C_{Mm}\right]$  \hspace{1cm} \text{(1)}$

In Equation (1), $h_T$ represents the vector of reservation prices, $p_T$ is the price vector, $k_{T-1}$ represents the diagonal matrix of network externality coefficients in period T, and $Q_{T-1}$ represents the number of customers in period T-1 who have chosen the various options. Thus, $k_{T-1} * Q_{T-1}$ represents the dynamic lagged network effect. $C_{Mm}$ represents the cost of switching from the mode M chosen in period T-1 to mode m in period T. ($C_{Mm} = 0$, if $m = M$.)

Before period T, the world is uncertain. Consider period T-1. Suppose the customer arrives in period T-1 in mode M. The consumer surplus she sees is the value over the current period (T-1) using the mode that maximizes the surplus plus the expected value of the surplus in the next period (T):

$V_{M}(T, h_{T-1}, M, h_{T}, p_{T}, k_{T-1}, Q_{T-1}) = \max m \left[V_{Tm}(.) - C_{Mm}\right] \hspace{1cm} \text{(2)}$

The model allows us to solve the simultaneous dynamic programming formulations in (1) and (2) to

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3 In fact, $V_{N}(h, 0) = 0$, $\forall i, i = 1..T$, i.e. the net surplus of the customer is zero for the periods in which she does not choose online banking.
obtain the optimal modes of operating. Given that several variables in these dynamic programming equations are stochastic, these simultaneous equations are not tractable. Thus, we adopt numerical solution methods such as Monte Carlo simulation techniques.

In the next section, we discuss the solution of the general model treating externality effects to be stochastic, and using Monte Carlo simulation, we demonstrate the applicability of the model in pricing decisions.

3.1 Simulating stochastic parameters over multiple periods

To illustrate, consider $K_{IA}$, the network effect of passive online banking on active online banking. Suppose $K_{IA}$ evolves stochastically over time following a geometric Brownian motion:

$$\frac{dK_{IA}}{K_{IA}} = \mu dt + \sigma dz$$

$\mu$ is the expected value of $K_{IA}$, and $\sigma$ is the standard deviation. $dz$ is a standard Wiener process. Then, following [22], one can simulate in discrete time version, the evolution of $K_{IA}$ using Monte Carlo techniques using:

$$\frac{\Delta K_{IA}}{K_{IA}} = \mu \Delta t + \sigma \epsilon \sqrt{\Delta t}$$

$\epsilon$ is a random drawing from a standardized normal distribution. From the equation above, we have the expected value of $K_{IA}$ given by $\mu \Delta t$ and its volatility by $\sigma \sqrt{\Delta t}$. Thus,

$$\frac{\Delta K_{IA}}{K_{IA}} \approx \phi(\mu \Delta t, \sigma \epsilon \sqrt{\Delta t})$$

$\phi(m, s)$ being the normal distribution with mean $m$, and standard deviation $s$.

4. Stylized Example

Consider a bank that offers the two modes of on-line banking (I and A), and also the option of branching banking (N). Suppose that the following table gives the costs of switching between modes.

<table>
<thead>
<tr>
<th>Table 2. Switching Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Mode N</td>
</tr>
<tr>
<td>Mode N</td>
</tr>
<tr>
<td>Mode I</td>
</tr>
<tr>
<td>Mode A</td>
</tr>
</tbody>
</table>

Here, to stay in the same mode will not cost the customer anything, but to switch to another mode may have an associated cost. The switching cost is not just the fee one has to pay, say for active online banking, but includes a mode entrenchment factor. For example, once a customer has switched to mode A and has set up all the bill paying facilities, then, if she switches back to mode N, she suffers from the inconvenience of not having online bill payment services. The mode entrenchment factor accounts for the reluctance of customers having to give up the convenience of banking in a particular mode.

Suppose that for the customer under consideration, the minimal reservation prices for I and A (as discussed in the model) follow geometric Brownian motion with means $h_I$ and $h_A$. Further, let $K_{IA}$ and $K_{AI}$ both follow geometric Brownian motion with means $k_{IA}$ and $k_{AI}$ respectively. Let the standard deviations for all these variables be 0.3. We model the decision over 30 periods. We now illustrate the use of the model to study the impact of network externalities and pricing structures on the customer’s purchase decisions.

4.1 Effects of Network Externality

In this sub-section we study the effect of network externality on consumer adoption given a fixed price vector.

4.11. Effect of direct network externalities associated with passive mode ($k_{II}$). To study the effect of changing $k_{II}$, let us set the other parameters as follows:

<table>
<thead>
<tr>
<th>$h_I$</th>
<th>$h_A$</th>
<th>$p_I$</th>
<th>$p_A$</th>
<th>$k_{II}$</th>
<th>$k_{AA}$</th>
<th>$k_{IA}$</th>
<th>$k_{AI}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.4</td>
<td>0.0</td>
<td>0.4</td>
<td>variable</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

We assume, thus, that there are no other network externality effects, except those caused on mode I by users of mode I. Also the parameters for the prices of passive and active online banking are chosen to mimic the current price settings of banks for online services: passive online banking is set to be free ($p_I = 0$), while active banking is not ($p_A = 0.4$). As Figures 1 and 2 indicate, it is more profitable, given the price and reservation price structure for the modes, to choose mode I initially. The variations in reservation prices, however, make it beneficial to switch to mode A after a few periods. With, $k_{II} = 0.2$, this switch happens in the first period after period 10 when the difference in benefits exceeds the switching costs. As $k_{II}$ increases, it becomes increasingly profitable to stay in mode I for correspondingly longer periods of time before switching to mode A. Further, the model allows us to capture the effect of network externalities on the customer’s benefit function. As the figures show 1 and 2 show, the
customer derives increasing benefit in mode I with increase in the value of \( k_{II} \).

4.12. Effect of network externalities associated with active mode \((k_{AA})\). We refer to Figures 3 and 4 for this discussion. To isolate the effects of \( k_{AA} \), we now set \( k_{II} = 0 \), and examine the effects of changing \( k_{AA} \) on the customer’s decision on on-line banking. The other parameters are as follows.

\[
\begin{array}{cccccccc}
\text{\( h_I \)} & \text{\( h_A \)} & \text{\( p_I \)} & \text{\( p_A \)} & \text{\( k_{II} \)} & \text{\( k_{AA} \)} & \text{\( k_{IA} \)} & \text{\( k_{AI} \)} \\
0.2 & 0.4 & 0.0 & 0.4 & 0.0 & \text{variable} & 0.0 & 0.0 \\
\end{array}
\]

Given this price structure, with \( k_{AA} = 0.2 \), it is most beneficial for the customer to choose mode I and remain in it all the time (Figure 3). However, we see that with increasing \( k_{AA} \), it becomes profitable to quickly switch to mode A, and remain in it for sometime and then switch back to the no-fee passive mode of online banking. However, network externality effects increase (Figure 4), the active mode of online banking becomes increasingly attractive. Thus, the model allows us to directly observe the effects of changing network externality factors associated with the active mode on the customer’s decisions.

4.13. Effects of cross-product network externalities. An interesting aspect of this model is that it incorporates the effects of cross product network externalities. To observe this, we set the parameters as follows:

\[
\begin{array}{cccccccc}
\text{\( h_I \)} & \text{\( h_A \)} & \text{\( p_I \)} & \text{\( p_A \)} & \text{\( k_{II} \)} & \text{\( k_{AA} \)} & \text{\( k_{IA} \)} & \text{\( k_{AI} \)} \\
0.2 & 0.4 & 0.0 & 0.5 & 0.0 & 0.0 & \text{variable} & 0.0 \\
\end{array}
\]

Figures 5 and 6 show the effects of changing cross-product externalities on the customer’s benefit function. We see that cross-product externalities in this setting have dramatic effects. With low values of \( k_{AA} \), the pricing structure make the passive mode of online banking more attractive than the active mode but after 13 to 14 periods, the cross-network externality makes the active mode more beneficial. Ultimately, with very high cross-product externalities, it is most profitable to choose and remain in mode A forever (Figure 6). Interestingly, this means that the customer would like to switch to the active mode, despite the fact that the fee \((p_A)\) is higher than his reservation price and that in any single period she may have negative benefits. However, as we will see in the following discussion about prices, it is not possible to charge arbitrarily high prices for active banking. At some point, the customer will see that the benefits of network externality do not match the cost of the active online banking service.

4.2 Effects of Pricing

In this section, we examine the effect of pricing on customer adoption of online banking.

4.21. Effects of changing the price of the active mode \((p_A)\). In the discussion about network externalities, we saw that with increasing externality, customers would be willing to pay the higher price for active online banking. In this section, we examine the effects that changes in the price charged for active online banking have on the benefits seen by the customer. Let us assume the following parameter settings:

\[
\begin{array}{cccccccc}
\text{\( h_I \)} & \text{\( h_A \)} & \text{\( p_I \)} & \text{\( p_A \)} & \text{\( k_{II} \)} & \text{\( k_{AA} \)} & \text{\( k_{IA} \)} & \text{\( k_{AI} \)} \\
0.2 & 0.4 & 0.0 & \text{variable} & 0.2 & 0.2 & 0.15 & 0.15 \\
\end{array}
\]

We have set the externality effects for both modes of online banking to have the same means and variances so as to minimize the effects of externalities on our discussion in this section. Figures 7 and 8 show the variation of benefits with the variation in fees for active banking. When the difference between the reservation price is positive or zero, i.e., when \((h_A - p_A) \geq 0\), then the customer chooses the active mode of online banking. This may be attributed to the fact that the reservation price for active online banking is higher than that for passive online banking., or perhaps to the finding that given network externalities, new technologies are readily adopted by the market at the expense of old ones. However, as the price increases beyond the threshold where \((h_A - p_A) = 0\), we see that the customer switches to the active mode in period 2, stays in mode A until period 7, and then switches forever to mode I (Figure 8). As the price increases further, the more expensive active mode of online banking becomes a non-option.

5.2.3 Effects of changing the price of the passive mode \((p_I)\). In our discussion so far, we have set the fees charged for the passive mode of online banking, \(p_I = 0\). We now examine how changes in the price charged for passive online banking affect the benefits seen by the customer. Let us assume the following parameter settings:

\[
\begin{array}{cccccccc}
\text{\( h_I \)} & \text{\( h_A \)} & \text{\( p_I \)} & \text{\( p_A \)} & \text{\( k_{II} \)} & \text{\( k_{AA} \)} & \text{\( k_{IA} \)} & \text{\( k_{AI} \)} \\
0.2 & 0.4 & \text{variable} & 0.55 & 0.2 & 0.2 & 0.15 & 0.15 \\
\end{array}
\]

Figures 9 through 12 show that customers react negatively to increases in the price of the passive mode of online banking. Initially, there is a spurt of enrollment for the active mode, but the passive mode being less expensive, becomes more attractive in period 8, and almost until period 24, customers are willing to use the passive over the active mode of online banking. As the price, \(p_I\) increases further, the passive mode becomes less attractive, and there is a lot of switching between the two modes. Ultimately, when the price of both modes are unattractive, users may switch to the non-online banking mode (Figure 12), until network
Research

5. Conclusion, Caveats, and Future Research

We have developed a model to study the pricing of online banking services given network externalities that arise not only because of increase in the user base of one mode of online banking, but also because of network effects across modes. In this paper, we made some significant contributions to existing literature on pricing with network externalities. First, we were able to model the cross-product externality effects and study the implications of these on choices of banking customers given different modes of online banking. Second, departing from previous research which models network effects as linear in the size of the network, we modeled network externality effects as stochastic reflecting various random biases that affect customer decisions. This reflects more accurately the phenomenon by which both network size and “word of mouth” affect customer decisions. Finally, by modeling the decision making process across a multi-period, finite horizon, we were able to overcome the limitations of existing two-period models or infinite horizon models to reflect more accurately real-world phenomena such as product life-cycles that extend over multiple periods with finite horizons.

The practical implementation of the model we proposed will necessitate overcoming measurement problems. Banks will have to find accurate stochastic process parameters to represent reservation prices, and network externality effects, and that may not be easy. However, the model can be used effectively in what-if scenario analysis while setting prices for online banking services. Under certain conditions, for example, the model shows that it does not make sense to have a free passive mode of online banking. The customer preferences are such that they would rather pay and have active online banking. Perhaps this is the kind of customer base that Wells Fargo sees (see Table 1), and therefore, it is best for the bank to not offer passive online banking service at all. On the other hand, the model predicts that the cross product network externality effects can be significant enough for banks to entice customers to the active fee-paying mode of online banking by offering a passive mode free of charge. Wells Fargo’s recent change to incorporate a free passive online banking option perhaps is a validation of this prediction.

A second limitation of this model is that it assumes that a bank fixes prices at the outset of the multiperiod game, and does not react to demand during the multiple periods. In real world situations banks adjust prices based on demand. It is possible to simulate such dynamic pricing behavior in our model as presented here, but it is cumbersome to do so. It involves considering the decision making to be a sequence of one-period games, and changing the initial conditions of each game in the sequence so that they reflect the demands and prices of the previous period. A more elegant approach would be to model prices as following a stochastic process similar to the one underlying the reservation prices and network externality effects. This is part of our ongoing research.

6. References


<table>
<thead>
<tr>
<th>Bank Name</th>
<th>Passive Online Banking</th>
<th>Active Online Banking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nations Bank</td>
<td>Free</td>
<td>$5.95/month</td>
</tr>
<tr>
<td>BankOne</td>
<td>Free</td>
<td>$4.95/month</td>
</tr>
<tr>
<td>Wachovia Bank</td>
<td>Free</td>
<td>$5.95/month</td>
</tr>
<tr>
<td>Huntington Bank</td>
<td>Free</td>
<td>Free first 3 months, then $3.00/month</td>
</tr>
<tr>
<td>Wells Fargo</td>
<td>Not Available in 1998</td>
<td>$5.00/month (Free if average account balance &gt; $5000*)</td>
</tr>
<tr>
<td>Chase</td>
<td>Free</td>
<td>$2.95/month + 0.50 for each bill payment</td>
</tr>
</tbody>
</table>

*To perform a rough translation, even at the low lending interest rate of 1.5%, this turns out to be equivalent to an income of approximately $6.25/month for Wells Fargo.

![Figure 1. KII = 0.2](image1.png)

![Figure 2. KII = 0.8](image2.png)

![Figure 3. KAA = 0.2](image3.png)

![Figure 4. KAA = 0.8](image4.png)
Figure 5. $K_{IA} = 0.2$

Figure 6. $K_{IA} = 0.8$

Figure 7. $p_A = 0.2; p_I = 0$

Figure 8. $p_A = 0.8; p_I = 0$

Figure 9. $p_A = 0.55; p_I = 0.1$

Figure 10. $p_A = 0.55; p_I = 0.2$

Figure 11. $p_A = 0.55; p_I = 0.6$

Figure 12. $p_A = 0.55; p_I = 0.8$