ETLA
ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

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Kerem Tomak*

BEHAVIORAL ECONOMICS OF MOBILITY**

* Department of Management Science and Information Systems, the University of Texas at Austin, Austin, TX 78712

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ABSTRACT: In this paper, we attempt to build a bridge between mobile commerce and emerging field of behavioral economics. We first provide examples from mobile commerce and link them to behavioral economics. We then build a stylized model to assess the impact of hyperbolic discounting on the profit maximizing behavior of a monopolist firm. We find that the monopolist makes lower profits compared to exponential discounting consumers for low levels of (positive) network externalities. As the network externalities increase, first period prices increase, second period prices decrease and the profits increase in equilibrium.

Keywords: Behavioral economics, mobility, mobile commerce, information and communication technology, hyperbolic discounting, network externalities.

Introduction

Shopping is ubiquitous. Malls and individual shops face the first stage of expansion to the digital environment through fixed wired Internet. Electronic commerce initiates huge investments and leads to controversies as well as financial disappointments since mid-1990s. From early 2000 onwards, we are facing a second wave of digital commercial growth. Wireless technologies are enabling individual consumers to access information wherever they are and whenever they want.

Although the use of mobile devices is evolving rapidly, the investigation of the mobile consumer behavior is lacking. Increasing number of electronic commerce services for mobile devices coupled with swift adoption rates will enable mobile operators to provide effective customer services and gain competitive advantage. However, this can only be achieved by analogous deeper understanding of mobile users' behavior.

A tool to understand the consumer behavior within mobile context comes from the field of economics. Neoclassical economics approaches the individual as a rational decision maker faced with a series of consumption choices. Corresponding model of human behavior is called "*Homo economicus*", who is endowed with perfect rationality, self-interest and knowledge. In reality, humans are largely driven by their emotions, and emotions are often irrational. They also perform altruistic acts like charity, volunteerism, lending a helping hand, parenting and even giving one's life for one's country. These all fall contrary to the assumption of self-interest. They perform self-destructive acts like substance abuse, negative addiction, negative risk-taking, procrastination, inability to complete projects, masochism, and suicide. They are also highly ignorant about all their affairs; they can be expert in only a few topics at a time (Laibson, 2001). In parallel to the technology achievements in wireless communications, maybe relatively less rapidly, our understanding of the "homoeconomicus" is expanding towards a complementary economic perspective of the homosapiens. As we discuss in the next section, behavioral economics provides novel concepts using traditional tools. Our goal in this paper is to discuss the viability of some of the mobile business models through the lens of behavioral economics.

Impact of Mobile Technology

In this section, we provide an overview of the mobile commerce technologies which we believe impact consumers' decision making. We start with a definition of mobile commerce.

Definition: *Mobile commerce is defined as all activities related to a (potential) commercial transaction conducted through communications networks that interface with wireless (or mobile) devices.*

The most salient feature of mobile commerce is the availability of ubiquitous access to information whenever and wherever it is needed. Using a mobile device, a customer can watch streaming video and complete financial transactions while on the road. Digital content is enriched when ubiquity is coupled with location and time specific knowledge.

Constant access to information can increase efficiency and lower supplier costs for critical decision making. Examples include Siemens' wireless extension to SAP Business Warehouse backend system, UPS' tracking shipments using wireless devices, and Office Depot's logistics management system using custom wireless handheld units.

Coordination costs for buyers can also decrease. CitiGroup customers receive daily bank balance updates via SMS messages and major brokerage firms such as Charles Schwab and Merill Lynch provide wireless access to aggregated account information. In this paper, we are interested in buyer side impact of mobile technologies.

Although the number of mobile users are expanding, as the following table shows, the percentage of consumers using mobile channel to make purchases is very low according to an AT Kearney study. According to Forrester, there is an upward trend though on the expected sales closed on the mobile devices, by 2005. Interestingly, the interest in 3G applications focus on financial and payment solutions after email applications according to a Taylor Nelson Sofres survey. These are all indications of increased use of mobile devices in the future for payment purposes.

Services Used By Internet-Enabled Mobile Phone Users Globally

Country (as % of IE-mobile users)	E-mail	Banking	Purchasing	Games
Asia	10%	2%	3%	3%
Brazil	11%	7%	1%	2%
Europe	10%	3%	1%	3%
Japan	77%	4%	12%	5%
North America	27%	6%	3%	7%
Worldwide	19%	3%	3%	3%

Source: AT Kearney, August 2002

mCommerce Sales Predictions, 2001 - 2005

Device	2001	2002	2003	2004	2005
Sales closed on devices (in billions)					
PDA	0.0	0.1	0.5	1.4	3.1
Cell Phone	0.0	0.0	0.0	0.1	0.3
Sales influenced by devices (in billions)					
PDA	1.0	5.6	14.4	20.7	24.0
Cell Phone	0.0	0.0	0.1	0.3	1.3

Source: Forrester Research, January 2002

Current Mobile Phone Users' Interest In 3G Applications

Application	W Europe	E Europe	USA
On 6-point interest scale, 6 = high interest, and 1 = low interest			
E-mail	4.5	4.7	4.3
Payment Authorization/ Enablement	3.4	3.8	3.0
Banking/ Trading Online	3.5	3.4	3.2
Shopping/ Reservations	3.0	3.1	2.9
Interactive Games	2.0	2.2	2.4

Source: Taylor Nelson Sofres, May 2002

Behavioral Economics of Mobile Technology

Instant gratification is key to the use of mobile devices. Mobile services that deliver context-dependent content to the users fulfill the instant gratification behavior that consumers seek. According to a Jupiter report, consumer interest in purchasing items using a wireless device is not a priority, with only 7 percent expressing interest in conducting transactions via a wireless phone. The report adds that mobile commerce will be driven by a desire for instant gratification (www.jup.com).

In an attempt to increase the use of mobile devices for purchases, Alon USA LP, which operates Fina gas stations and 7-Eleven outlets in the Southwest, has established an "m-commerce" system using existing cellular telephone technology and already-installed point-of-sale systems. The company is using mobile-commerce payment technology developed by Cellenium Inc. in Englewood Cliffs, N.J., that will let any cellular telephone, including aging voice-only models, conduct a mobile transaction.

Each transaction is funneled through Alliance Data Systems Inc., which already provides transaction services to Alon and other gas station and convenience store operators. Alliance Data, Cellenium and Alon have formed a partnership called Cellerate to manage, market and promote their mobile-commerce system. The Cellerate software also keeps track of customers' premium points and, in Fina's case, can offer instant gratification by automatically controlling a voice-activated vending machine to provide a customer with a free soda.

There is also instant gratification through the consumption of digital products on mobile devices. Recent mobile purchase history of the customers show that they want to buy downloadable features and extras like ring tones, games and the ability to send digital photos. In order to satisfy this demand, Handango sells digital content for mobile devices as well as software for handhelds. Nokia and MasterCard, banking on customers' desire for convenience, have run trials of a quick-pay system that attaches to a cell phone. These efforts implicate that cell phones are about instant gratification and making a social statement.

O'Donoghue and Rabin (1999, 2000) profess that due to preference for immediate gratification, people under-indulge in activities which involve immediate costs and

delayed rewards (e.g. putting off an unpleasant but necessary task) but over-indulge in activities with immediate rewards and delayed costs (e.g. overeating). Based on Strotz (1956) and Pollak (1968), O'Donoghue and Rabin (1999, 2000) distinguished between two types of consumers – (i) sophisticates, people who know that their preferences may reverse due to immediate gratification and (ii) naives, people who don't realize that their preferences may reverse due to immediate gratification. Naives exhibit immediate gratification behavior with respect to both immediate costs (procrastinate costs) and immediate benefits ("preproperate" benefits). Surprisingly, though sophisticates are able to tackle procrastination, they exacerbate immediate gratification behavior with respect to immediate benefits (O'Donoghue and Rabin, 1999).

Demand for instant gratification raises the issue of payment mechanisms available for related purchases. In the next section, we discuss economic characteristics of mobile payments.

Mobile Payments and Consumption

According to Celent, a financial services research and consulting firm, by 2004 there will be 60 million mobile payment users generating sales of $50 billion. A joint survey by Visa International and Boston Consulting predicts that combined e-commerce and m-commerce volumes will grow from $38 billion in 2002 to $128 billion in 2004.

There are increasingly more sophisticated devices that are developed together with new applications which take advantage of color screens, keyboards, and longer battery life. Introduction of these applications will drive the use of new payment opportunities that bridle the capabilities of wireless devices. Note that while these have been developed and are mostly also commercially available, their usage is indeed quite limited.

A rich example of mobile payment solutions can be found in Finland as the country has the highest mobile phone penetration rate in Europe. Dynexco, a Finnish company, has launched a payment solution called DNX MobileMoney. A customer with a DNX account can transfer funds from his bank account and pay for purchases of goods or transfer funds to other DNX accounts in real time. Payment is based on text messages sent by a GSM phone or via Internet. (www.dnxmobiiliraha.com).

Sonera Shopper is another mobile payment solution. A customer opens a Shopper account and transfers money to it from his bank account. He can pay for purchases at merchants that have joined the system by sending a text message. The customer can also pay for purchases out of his credit card account (Visa, Eurocard, MasterCard) instead of his Shopper account. In that case the customer's credit card number must be entered into the Shopper system and the customer decides when sending a text message which way he wants to pay (www.sonera.fi).

E-Pay sells branded services to merchants. At the moment, these merchants include some restaurants and ski resorts. Also in this solution, the customer first registers for a service and has his own account opened. After that, he can transfer money to this account and pay for purchases and services via mobile phone.

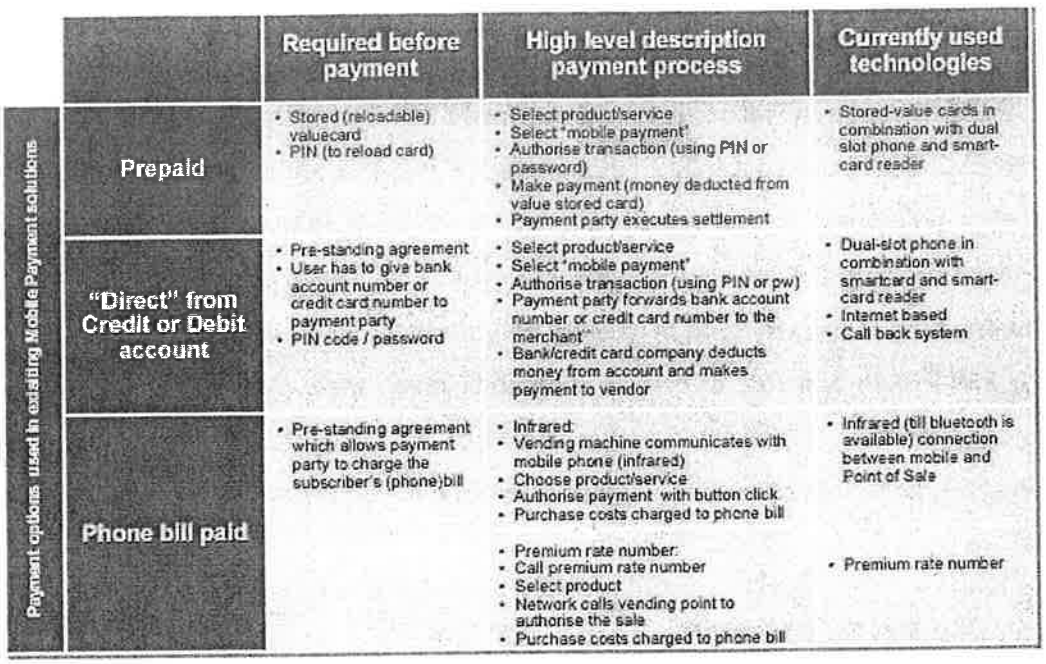
Some purchases can also be aggregated to the customer's monthly mobile phone bill. Purchase of logos or ring tones, chocolate bars from vending machines are included on the mobile bill at the end of the month. Similarly, using a service called Parkit, one can also pay for parking in some cities in Finland by calling a service number of the parking area. The parking fee will be included on the customer's telephone bill, credit card bill or a separate bill, or the customer can pay for parking by Sonera Shopper.

Outside Finland, one of the most widespread mobile phone payment applications is the Germany based paybox, which was launched in May 2000. This service enables the customer to purchase goods and services and make bank transactions via mobile phone. The value of purchases or credit transfers is debited from the customer's bank account (www.paybox.net).

In Spain, a mobile payment solution called Mobipay is available which can be used for payments at real or virtual POS or vending machines. Person-to-person payments and paying for invoices are possible. Mobipay activates existing payment means, ie normal or virtual credit, debit or prepaid cards (www.mobipay.com).

In Norway, a customer can sign up and open his own Payex account at Payex's website (www.payex.no) or he can send a text message. Before using his Payex account, the customer must transfer money into it. Certain purchases can be paid by Payex via Internet.

In all the examples above, the payments are either done real time, or aggregated to the end of the month. The following table from a study by Arthur D. Little, characterizes the current mobile payment solutions with respect to the timing of payments.



Payment options used in existing Mobile Payment solutions	Required before payment	High level description payment process	Currently used technologies
Prepaid	• Stored (reloadable) valuecard • PIN (to reload card)	• Select product/service • Select "mobile payment" • Authorise transaction (using PIN or password) • Make payment (money deducted from value stored card) • Payment party executes settlement	• Stored-value cards in combination with dual slot phone and smart-card reader
"Direct" from Credit or Debit account	• Pre-standing agreement • User has to give bank account number or credit card number to payment party • PIN code / password	• Select product/service • Select "mobile payment" • Authorise transaction (using PIN or pw) • Payment party forwards bank account number or credit card number to the merchant • Bank/credit card company deducts money from account and makes payment to vendor	• Dual-slot phone in combination with smartcard and smart-card reader • Internet based • Call back system
Phone bill paid	• Pre-standing agreement which allows payment party to charge the subscriber's (phone)bill	• Infrared: • Vending machine communicates with mobile phone (infrared) • Choose product/service • Authorise payment with button click • Purchase costs charged to phone bill	• Infrared (till bluetooth is available) connection between mobile and Point of Sale
		• Premium rate number: • Call premium rate number • Select product • Network calls vending point to authorise the sale • Purchase costs charged to phone bill	• Premium rate number

Source: *Arthur D. Little*

Figure 1 Mobile payments and their timing vis a vis consumption.

Economic impact of such a separation in timing of payments and consumption can not be fully explained using neoclassical economic theory but as the following section explains, behavioral economics can help complement the insights that can be gained from the classical theory of consumption and payments.

On the behavioral economics of payments and consumption

To understand individual behavior with respect to payments and consumption we need to start with Prospect Theory (Kahneman and Tversky, 1979). Expected utility theory contends that when a rational decision-maker is faced with a choice, she will always prefer the choice that offers her highest expected utility. Utility in this theory is measured in terms of final assets. Kahneman and Tversky (1979) devised an alternative

to the expected utility theory by devising more descriptive and psychologically richer "value function" to represent utility. The value function can be imagined to be the representation of central components of the human perceived pleasure machine. The value function used in Prospect Theory has three important properties. First, it is defined over perceived gains and losses relative to some natural reference point, rather than absolute values of wealth as in the standard theory. The argument gets support from the fact that evaluation of transactions and outcomes are commonly perceived as positive or negative in relation to a reference outcome that is judged neutral. Thus depending on this reference point, each transaction is accorded the status of either a gain or a loss. Second, the value function is concave for gains and convex for losses which indicates that there is diminishing sensitivity with increasing magnitude of a loss or a gain. Hence a change from $30 loss to $60 loss affects an individual much more than a change from $5030 loss to $5060 loss. Third, the function is steeper for losses than for gains (i.e. assumes individuals to be loss averse) - the pleasure from a $100 gain is less than the pain from a $100 loss.

Mental Accounting

Mental Accounting has its roots in Prospect Theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 81) and in the works of Richard Thaler, who also developed a similar descriptive alternative to the deterministic economic theory of consumer choice (Thaler, 1980). While discussing decision frames, Tversky and Kahneman (1981) narrowly defined mental account as "*an outcome frame which specifies (i) a set of elementary outcomes that are evaluated jointly and the manner in which they are combined and (ii) a reference outcome that is considered neutral or normal*". Thaler expanded their definition and used Mental Accounting to describe the entire process of coding, categorizing and evaluating events (Thaler, 1985, 1999). He formally defined Mental Accounting as a set of cognitive operations used by individuals to organize, evaluate and keep track of her financial activities (Thaler, 1999). There are three main components of mental accounting. The first component deals with how outcomes are perceived and experienced and how decisions are made and subsequently evaluated. The second component involves assignment of different activities to specific

mental accounts (Heath and Soll, 96; Henderson and Peterson, 1992). The third component deals with the frequency with which accounts are evaluated (Camerer et al., 97). While discussing separation of payment and consumption, we are primarily concerned with the first and third components of MA.

Transactions – Payments and Consumption

In this paper we would consider a payment system to be based on one of the three possible pricing schemes – (i) prepayment pricing scheme, where payment is before consumption, (ii) pay-as-you-go pricing scheme, where payment and consumption are simultaneous and (iii) postpayment pricing schemes, where consumption is before payment. In both prepayment and postpayment pricing schemes there is temporal separation between payment and consumption while in pay-as-you-go pricing scheme there is none. Kahneman and Tversky (Kahneman and Tversky, 1984; Tversky and Kahneman, 1981) argue that how people respond to outcomes depends on whether the events are represented as belonging together in a single mental account or separately in different mental accounts. How do individuals experience, respond to and evaluate payments and consumption? Literature offers three possible answers to this question. They are described in the following subsections.

Consumers Maintain Separate Mental Accounts

According to this view, individuals experience payments and consumption as discrete events and evaluate them separately as losses or as gains (Hirst et al, 1994). Thus, people experience a feeling of gain when they consume and a feeling of loss when they make a payment and these feelings are independent of one another. Thus pricing schemes are evaluated as combinations of discrete events, where one group of events are identified as gains (consumption benefits) while the other group are identified as losses (payments).

For most normal transactions, gains and losses are assumed to match one another irrespective of the timing of payments and consumption. The only way, payment systems might differ from one another is guided by the hedonic editing principles. Consider a payment system with multiple consumption events and one payment event

(payment may be either before or after consumption). Since the losses are integrated, the benefits from multiple consumption events (segregate gains) might make this pricing scheme more preferable to a consumer vis-à-vis a pricing scheme where payments (losses) are not integrated. However, the idea of payment and consumption being isolated gains or losses may be an extreme viewpoint. Unlike normal gains or losses, payment and consumption are normally linked to one another even if they are temporally separated (Thaler, 1999). But the main criticism to this viewpoint comes from the fact that loss aversion (Kahneman and Tversky, 1979, 1984; Thaler, 1985) makes the frame of assigning payments as losses hedonistically inefficient (Thaler, 1999). Imagine a thirsty consumer who has a value of $1 for a can of soda and is standing in front of a vending machine that sells soda for $0.75. Clearly though the purchase makes her better-off, if payments are deemed as losses, the consumer should reject the deal when her coefficient of loss aversion is more than 1.34 (which is less than most conservative empirical estimates of loss aversion coefficients!). Thus almost every transaction becomes hedonistically painful to the consumer unless utility derived from consumption is considerably more than the disutility of payment.

Consumers Maintain Single Entry Mental Account

This viewpoint postulates that individuals establish mental accounts that create symbolic linkages between specific acts of consumption and specific payments. Individuals combine payment and consumption events together within a mental account and evaluate the transaction only when the account is closed (Thaler, 1999). When payment and consumption are temporally separated, closure depends on which event is later. So, in prepayment pricing schemes, closure takes place with the last consumption while in postpayment pricing schemes closure takes place with last payment. A payment, by itself, is not deemed as a loss and consumption, by itself, is not deemed as a gain. However, for prepayment pricing schemes, if consumption does not take place or if the consumption is not commensurate to the payment made, then the individual might retrospectively evaluate the payment experience as a loss. On the other hand, consumption might be retrospectively evaluated as a gain, if the mental account is closed for some reason without a commensurate payment. But, in general, it is assumed that in a normal transaction, payment and consumption are commensurate to one another

though they may take place at different times. Thus, if an individual maintains a mental account for a given transaction and only evaluates the account at the time of closing, it should not matter to her whether she is paying earlier, later or as she is consuming (assuming revenue streams are discounted). But the assumption of consumers maintaining single entry mental accounts may not explain the actual feelings of loss or gain that consumers might experience in a transaction when payment and consumption are at different times. When people make payments, they often *do* experience an immediate pain of loss (Prelec and Loewenstein, 1998). For example, imagine paying for a vacation three years after you have enjoyed it. Even though the amount you are paying is commensurate to the enjoyment you derived during the vacation, the enjoyment is in the past while payment is immediate. Thus, when you make the payment, you may feel a pain of loss. In fact, your enjoyment during the vacation itself might be less since you are less burdened with the thoughts of payments that you need to make at a later time for everything you are enjoying during the vacation. In contrast, a prepaid vacation is much more enjoyable because here your enjoyment is not marred by any thoughts of future payment. A consumer who maintains a single entry mental account for the vacation transaction will not perceive any difference between the two situations[1].

Consumers Maintain Double Entry Mental Account

According to this view, individuals mentally combine payment and consumption within a single mental account but evaluate the account every time they pay or consume. Thus an individual feels a net pain or pleasure at the moment of consumption or payment depending on whether the mental account is in red or in black at that particular moment (Prelec and Loewenstein, 1998). Prelec and Loewenstein (1998) propose that the effects of the time distance from payment are nonsymmetrical for payments depending on whether they are before or after consumption. Based on anticipation and dread (Loewenstein, 1987), they argue that paying after consumption experience is hedonistically inferior to paying before consumption. Most of these arguments build on the previous research which showed that people generally like improving trends and happy endings (see last section,

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1 Besides the mental "pain", there is of course "physical" pain or hassle in conducting a payment, (e.g., do I have the right change for a vending machine, in any case I have to look for it in my pocket etc.).

Loewenstein and Prelec, 1991, 1993; Kahneman et al., 1993; Ross and Simonson, 1992). Prelec and Loewenstein (1998) formulate a double-entry mental accounting theory that describes the reciprocal interactions between pleasure of consumption and pain of paying. According to this model, a consumer's pleasure from consumption is undermined by an imputed cost of making a payment and her pain from payment is buffered by an imputed benefit derived from that payment. *Imputed Cost* of payment is a disutility that reduces the pleasure of consumption by bringing in negative thoughts of payment associated with that consumption. *Imputed Benefit* of consumption is a utility that buffers the pain of paying by bringing in positive thoughts of consumption that payment will pay for. Thus utility from consumption experience is equal to utility from consumption less imputed costs of payment and disutility from payment experience is equal to disutility from payment less imputed benefits of consumption. The consumer's net utility in the transaction mental account is the summation of net utility from payment account and net utility from consumption account.

Among the three alternatives discussed above, double entry mental accounting gives the most sound theoretical explanation and offer best empirical verification as to why different pricing schemes might be viewed differently by consumers. A central assumption of Prelec and Loewenstein's (1998) model is "prospective accounting" in which expected utility or disutility from future payment and consumption is given more weight than utility or disutility from past experiences of payment and consumption. The assumption also agrees with the empirical work of Gourville and Soman (1998) who found prepaid sunk costs (like prepayments) to fully depreciate with passage of time. We show a pictorial representation of the prospective accounting assumption in *Figure 1* (adapted from Prelec and Loewenstein, 1998). Under prospective accounting assumption, the experience of consumption and payment is enhanced by prepayment. Imagine the context of paying for and enjoying a vacation. If the vacation is paid for a long time in advance (point A), then the imputed cost of enjoying the vacation is essentially zero and the vacation feels almost free. If the vacation is recently prepaid (point B), then imputed cost is not negligible but still relatively small due to payment depreciation (see Gourville and Soman, 1998). Imputed costs are highest if the payment needs to be made right after consumption (point C) and then the costs gradually decrease as payment is pushed to the

future (point D). Given this nature of prospective accounting, Prelec and Loewenstein (1998) predict strong debt aversion contrary to the standard predictions. They show that for most feasible ranges of discount factors consumers find it less painful to prepay than to pay later. Consumers are found to prefer prepayment pricing schemes even if it involves paying more for the same usage. This result is further strengthened by a recent experimental study (Ariely and Silva, 2002) where the authors asked the subjects to choose between various payment systems which were differentiated with respect to timing of payments and consumption. The findings revealed that the subjects strongly preferred prepayment pricing schemes like subscription mechanisms over payment systems based on non prepayment pricing schemes.

Alternative Theoretical Arguments

In spite of the theoretical rationale and empirical findings on the contrary (Prelec and Loewenstein, 1998; Ariely and Silva 2002), payment systems based on postpayment or pay-as-you-go pricing schemes are still popular and widely used by consumers. One of the more popular examples of a traditional payment system that relies on postpayment schemes is that of credit cards (Prelec and Simester, 2001). Why? Is it because payment systems based on prepayment pricing schemes are yet to evolve or is it because consumer preference for prepayment schemes is not as strong as Prelec and Loewenstein (1998) predicted?

Overall, past literature has indicated that consumers may take two perspectives while evaluating a transaction experience – (i) a hedonic efficiency perspective, which is based on the assumption that consumers love pleasure and hence, they should prefer whatever pricing scheme gives them least pain and/or most pleasure (this is a short-run or myopic perspective) and (ii) a decision efficiency perspective – consumers have objectives beyond current transaction, and hence they might prefer choosing pricing schemes that will benefit them in the long run even though the pricing scheme is less hedonistic in the short term. For example, take the case of a payment system that keeps a consumer aware of what she is spending but makes her go through a more painful (and more memorable) payment process (Soman, 2001; Dutta, Jarvenpaa and Tomak, 2003). Though payment system is efficient from a decision efficiency perspective, it is

hedonistically inefficient as it is more painful. The consumer keeps better control of her finances if she is more aware of her spending. But, increased awareness comes mainly from increased salience of the payment process which makes the act of making a payment more painful to the consumer. Thus, there are obvious trade-offs between the two perspectives. Ariely and Silva (2002) did attempt to take into account both perspectives while investigating impact of payment systems based on different pricing schemes. Their results indicated that people are more inclined to adopt a hedonic efficiency perspective than a decision efficiency perspective. However, increased popularity and sustained use of payment systems based on postpayment or pay-as-you-go pricing schemes like credit card, direct billing solutions do indicate that neither hedonistic nor decision efficiency superiority of prepayments are yet to be fully established.

Hyperbolic Discounting

Hyperbolic discounting is a way of accounting in a model for the difference in the preferences an agent has over consumption now versus consumption in the future. For α and g scalar real parameters greater than zero, under hyperbolic discounting events t periods in the future are discounted by the factor $(1+\alpha t)^{-g/\alpha}$. The expression hyperbolic discounting describes the "class of generalized hyperbolas". This formulation comes from a 1999 working paper of C. Harris and D. Laibson, which cites Ainslie (1992) and Loewenstein and Prelec (1992). In dynamic models it is common to use the more convenient assumption that agents have a common discount rate applying for any t-period forecast, starting now or starting in the future.

One reason hyperbolic preferences are less convenient in a model is not only that there are more parameters but that the agent's decisions are not time-consistent as they are with a constant discount rate. That is, when planning for time two (two periods ahead) the agent might prepare for what looks like the optimal consumption path as seen from time zero; but at time two his preferences would be different (About.com, 2003)

In a simple model of a two-period monopoly firm, we compare the profits and prices for two cases. Our benchmark case is the standard exponential discounting which we assume both firms and consumers adopt. In the case of hyperbolic discounting, we

fix the α parameter in a specific form of hyperbolic discounting, $\frac{1}{1+\alpha t}$. In both cases, second period sales of the monopoly firm faces positive network externalities from the first period. This represents the mobile firms' customer base and its impact on the use of (mobile) technology at a later stage.

Our model and analytic solutions are given at the appendix. Following figures show the cases for which the exponential discounting parameter is set at $\delta = 0.9$ and the hyperbolic discounting parameter is $\alpha = 0.2$. For this example, we see that the profits when consumers are believed to have hyperbolic discounting are lower for low levels of network externalities. As the network externality effect increases, the profits also increase. This may be due to the fact that the monopoly can benefit from those consumers who value first period consumption over the second period by charging them higher than the exponential discounting case for high levels of network externalities. This is also seen in figure 3 where for high levels of e first period price is higher in the hyperbolic discounting case than the exponential discounting.

The monopoly can then add to the profits by charging less in the second period in order to avoid the Coase conjecture which predicts market failure in the second period for such a monopoly firm. This can be easily seen in figure 3 where first period price under exponential discounting decreases as network externalities increase but the second period price remains at its highest possible rate. The neoclassical monopolist tries to charge lower prices in the first period to attract consumers in the hopes of charging them a higher price in the second period. In this case, the market share in the first period is ½, whereas the second period marketshare is 0. This implies that the monopoly firm sells only in the first period as the consumers expect to be charged a higher price in the second period.

The outlook changes once we introduce hyperbolic discounting. The first period market share becomes $\frac{1}{2} - \frac{0.855e}{0.9+e}$ which is decreasing but positive in e, converging to 0.05 while the second period market share is $\frac{0.9+2.71e}{2(0.9+e)}$, which is increasing in e, converging to 0.95. Hence, by taking instant gratification, or present biased preferences

into account, the monopoly can benefit from more smooth pricing in the first period and gradually increasing second period pricing.

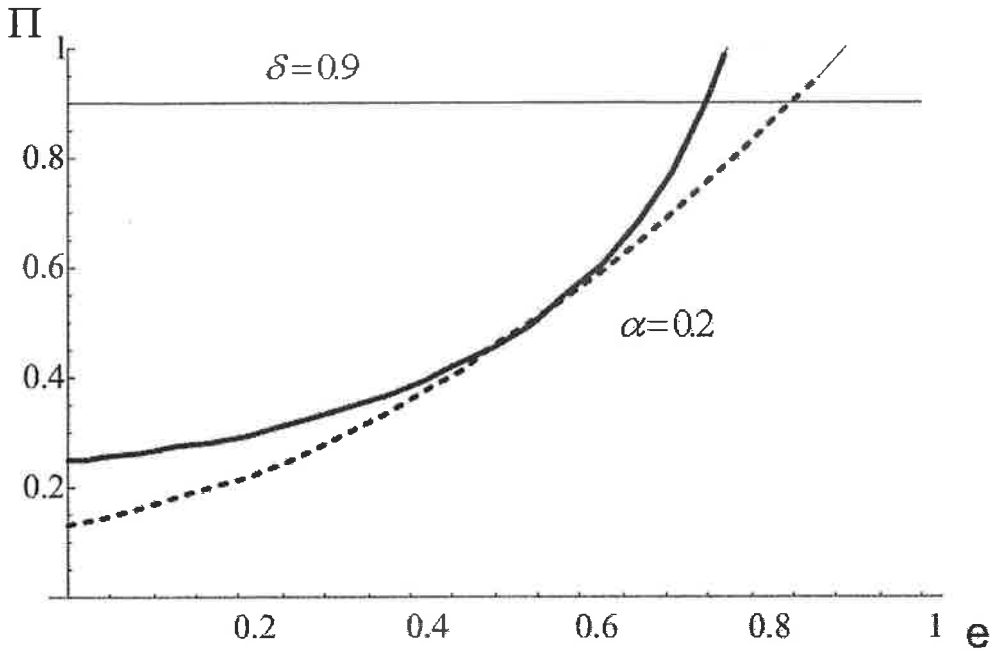

Figure 2 Profits and first period price of a monopoly firm with and without hyperbolic discounting of the consumers. Alpha represents the hyperbolic discounting parameter.

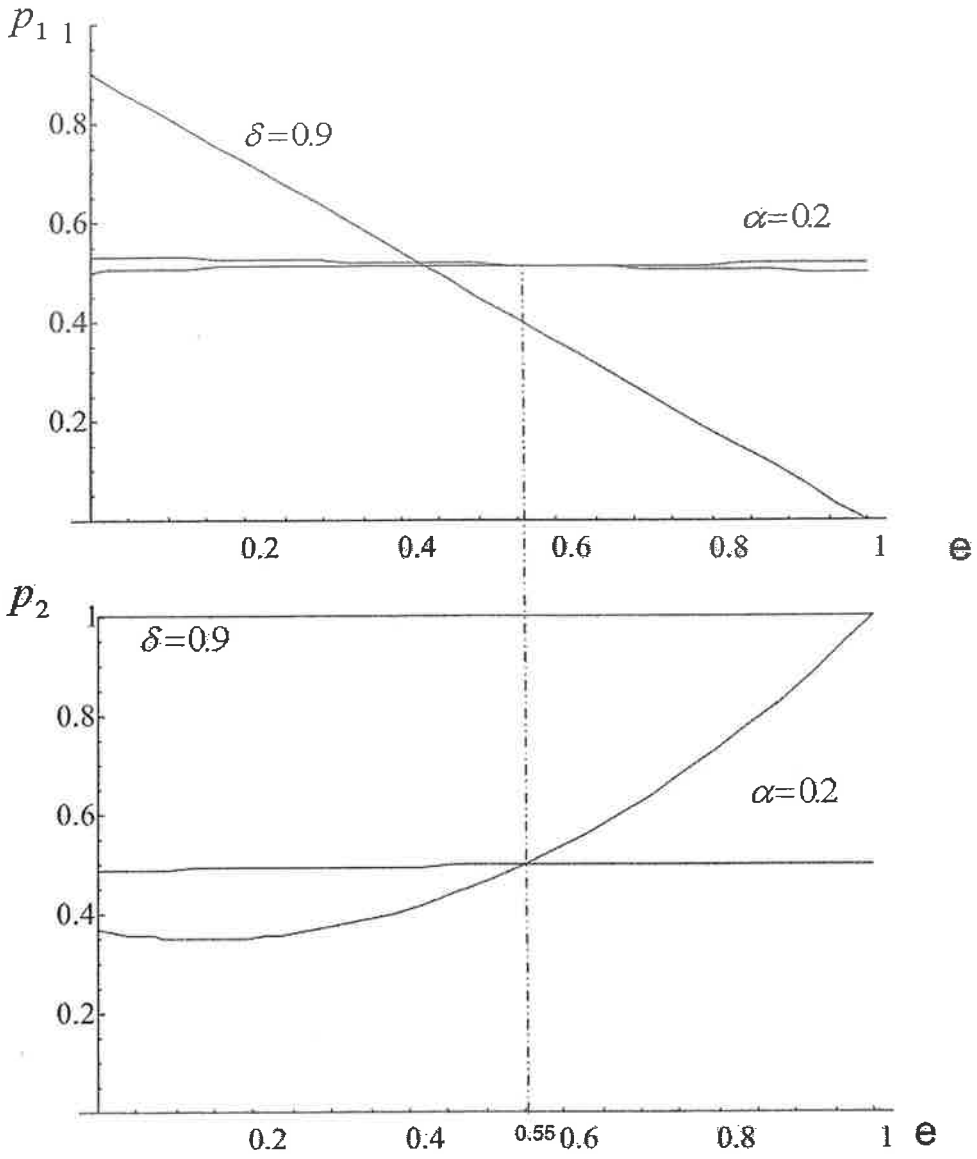

Figure 3 First and second period prices with and without hyperbolic discounting of the consumers. Alpha represents the hyperbolic discounting parameter

Conclusion

Behavioral economics provides new perspectives to understand various aspects of consumers' consumption and payment behavior. In this paper, we highlight some of the aspects which we believe can help technology companies form market strategies, especially in the mobile commerce area.

Mobile devices provide a new frontier for firms to reach consumers. They enable companies to better comprehend consumers' purchasing behavior by tracking their spending and consumption patterns in real time. We show that this understanding may help firms make more profits and better position themselves in the marketplace.

Mobile payments and consumption inherit characteristics which can be explained using concepts from behavioral economics. Instant gratification, mental accounting, hyperbolic discounting are a few which we focus on in this paper. We build a stylized model which compares exponential to hyperbolic discounting within a network externalities framework. We find that when consumers are assumed to have present biased preferences, which is usually the case for instant gratification as the literature suggests, a monopolist may make more profits and charge more strategically to keep all the consumers purchase his/her services.

Although we do not mention it in this paper, the wealth of the consumer, hence the size of the payment is as important as the timing of the payments: buying a latte is no pain at all, buying a restaurant meal is a minor pain, buying a computer is a major pain & buying a car is a massive pain. Consequently, the use of mobile payments will be confined to medium to low value items until/unless mobile phones are accepted by the consumers as payment instruments.

On the technology side, there are emerging payment tools such as Bluetooth enabled point of sale devices. Global wireless access to any media (voice, data, video) mobile services from /to wherever you may be (home, offices, hotels, airports, in the air, or at the beach) and for any device (cellphones, PDAs, Internet aware appliances, ATMs, POS devices, Kiosk, PCs, Laptops, etc). is already available. "Bluetooth", WAP, DSL, and cable modems that integrate seamlessly, Personal Area Networks (PAN) and devices with long distance high-bandwidth wired/wireless internet and public telephone network access make it possible.

Bluetooth's advantage is that it is much less expensive to implement. Thus it can be used in various POS devices. A supermarket in Sweden, ICA Ahold, completed a successful test of wireless Bluetooth payments enabled by Ericcson phones in 2000. Customers used their mobile telephones to make purchases, check their account balances, and receive special offer information. Bluetooth sends wireless signals between devices equipped with a Bluetooth chip on the 2.45 GHz ISM band. Depending on the strength of the signal, compatible Bluetooth devices can communicate at distances of up to 80 metres, although distances of up to 10 metres are more common. Lack of standards is slowing the wide adoption of Bluetooth payment systems. Security is also a concern since Bluetooth can transmit messages over relatively long distances, which poses a greater threat to payment information since it can be intercepted en route.

Radio Frequency Identification Device (RFID) is another technology solution which has a wide application and direct impact on the payment systems. Since 1997 this technology is used in Ski passes in Switzerland , in Swatch watches, some of which can store credit, as well as more recently in London Underground electronic tickets.

A retail outlet using RFIDs can allow the consumers walk out the store while charging the card they setup previously. RFIDs prevent theft, help guarantee quality, provide absolute 100% precision about what stock remains in the food store and when products are close to sell-by dates. They also mean a consumer can pay for products and services ranging from bottles of wine to travel tickets, using a card that never leaves their pocket. This will obviously increase the separation between payments and consumption further, making payments more transparent and the pain less apparent. One can foresee the negative impact on the level of debt the consumers might accumulate in the United States.

There are several dimensions over which this work can be extended. We use a very simple model of hyperbolic discounting. The model can be extended to include a more generalized form of hyperbolic discounting function and instead of two periods, multiple periods can be considered. Mental accounting can also be an important avenue to explore. For initial work in this area see Balasubramanian, Dutta and Tomak (2003) or Balasubramanian and Tomak (2003).

Finally, behavioral economics provides new policy guidance to financial and governmental institutions which look into regulating or deregulating competition in mobile telecommunications markets. This is especially important when financial debt in the U.S. has reached new heights.

A cross-cultural study to assess the international differences in consumption and payments as well as present biased preferences can be extremely interesting. For instance Finland-U.S. comparison would potentially reveal major differences, not only at the consumer level, but also a the legislation and policy levels. Unlike in Finland, in the U.S. personal bankruptcy is a right that the consumers can exercise whereas in Finland "only death" can free one from his/her accumulated debt.

Considering these implications of payment systems, understanding payments and consumption in this new area of mobile technology based consumption may increase social welfare and ignorance will never be a bliss for the future generations.

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Appendix

A Model of Durable Goods Monopolist with Network Externalities

One product, two periods. With and without hyperbolic discounting.

In order to build our model, we use the following notation:

Variable	Description
p_1	First period price
p_2	Second period price
Π	Profit
e	Level of network externality
δ	Exponential discount factor
α	Hyperbolic discount parameter

We assume that the consumers are distributed uniformly along the [0,1] interval. The firm knows the distribution of the consumers but not their exact location. In the first period, the net consumer surplus is $v_1 = u - p_1$. In the second period, the net consumer surplus with hyperbolic discounting is $v_2 = \frac{1}{1+\alpha}(u - p_2 + e(1-u))$; with exponential discounting, it is given by $v_2 = \delta(u - p_2 + e(1-u))$.

For the hyperbolic discounting case, we find the marginal consumer who is indifferent between consumption in either periods by equating the net consumer surpluses from each period and solve for u:

$$u_1^* = \frac{e + (1+\alpha)p_1 - p_2}{e + \alpha}$$

Similarly, the marginal consumer indifferent between buying or not buying in the second period is given by

$$u_2^* = \frac{p_2 - e}{1 - e}$$

The derived demand functions are then given by

$$D_1 = 1 - u_1^*$$
$$D_2 = u_1^* - u_2^*$$

Thus the profit function of the monopoly firm is simply $\Pi = p_1 D_1 + \delta p_2 D_2$.

The maximization problem we solve to find the optimal prices and profit level is the following.

$$\max_{p_1, p_2} \Pi$$
$$D_1 \le 1$$
$$D_2 \le 1$$
$$u_2^* \ge 0$$
$$p_1, p_2 \ge 0$$

The lagrangian that corresponds to the problem above is $\ell = \Pi - \lambda_1(D_1 - 1) - \lambda_2(D_2 - 1) - \lambda_3(-u_2^*)$.

Finally, the system we solve is given by

$$\frac{d\ell}{dp_1} = \frac{d\Pi}{dp_1} - \lambda_1(-\frac{(1+\alpha)}{e+\alpha}) - \lambda_2(\frac{(1+\alpha)}{e+\alpha})$$
$$\frac{d\ell}{dp_2} = \frac{d\Pi}{dp_2} - \lambda_1(\frac{1}{e+\alpha}) - \lambda_2(-\frac{1}{e+\alpha} - \frac{1}{1-e}) - \lambda_3(-\frac{1}{1-e})$$
$$\lambda_1(D_1 - 1) = 0$$
$$\lambda_2(D_2 - 1) = 0$$
$$\lambda_3(-u_2^*) = 0$$
$$p_1, p_2, \lambda_1, \lambda_2, \lambda_3 \ge 0$$

The only feasible solutions to this system are given below.

Solution 1: $\lambda_1 > 0, \lambda_2 = \lambda_3 = 0$

The solution in this case is

$$\lambda_2 = \frac{(-1+e)(e+\alpha) + (1+\alpha)(-1+e+2e^2-3\alpha+5e\alpha)\delta + (-1+e)^2(1+\alpha)^2\delta^2}{2(1+\alpha)^2}$$

$$p_1 = \frac{e+\alpha+(1-e)(1+\alpha)\delta}{2(1+\alpha)}$$

$$p_2 = \frac{e+e^2-\alpha(1+3e)+(1-e)^2(1+\alpha)\delta}{2(1+\alpha)}$$

$$\Pi = \frac{(e+\alpha)^2 + 2(1+\alpha)(e+e^2-\alpha(1+3e))\delta + (1-e)^2(1+\alpha)^2\delta^2}{4(1+\alpha)^2}$$

$$D_1 = \frac{e+\alpha-(1-e)(1+\alpha)\delta}{2(1+\alpha)}$$

$$D_2 = 1$$

For this solution to yield positive prices and demand, the following conditions need to hold: $\delta < \frac{\alpha}{1+\alpha}$, $e < \min\{\frac{\alpha-(1+\alpha)\delta}{1-(1+\alpha)\delta}, 1\}$.

Solution 2: $\lambda_1 = \lambda_2 = \lambda_3 = 0$

This is the interior solution which yields

$$p_1 = \frac{(1+\alpha)\delta((2-e)(e+\alpha)+(-1+e)e(1+\alpha)\delta)}{(e+\alpha-(-1+e)(1+\alpha)\delta)^2}$$

$$p_2 = \frac{e+\alpha}{e+\alpha+(1-e)(1+\alpha)\delta}$$

$$\Pi = \frac{(1+\alpha)\delta(\alpha(1+e(-1+\delta))+e\delta)}{(-1+e)(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

$$D_1 = \frac{(1+\alpha)\delta(1+\alpha(2-\delta)-\delta)}{(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

$$D_2 = \frac{(1+\alpha)(1-e-(1+e)(1+\alpha)\delta)}{(-1+e)(-1+e+2(1+\alpha)(1+e+2\alpha)\delta+(-1+e)(1+\alpha)^2\delta^2)}$$

Solution 3: $\lambda_1 = 0, \lambda_2 > 0, \lambda_3 > 0$

$$\lambda_2 = e\delta - \frac{e+\alpha}{1+\alpha}$$

$$\lambda_3 = \frac{e+\alpha}{1+\alpha} - (1-e)\delta$$

$$p_1 = \frac{e+\alpha}{1+\alpha}$$

$$p_2 = e$$

$$\Pi = e\delta$$

$$D_1 = 0$$

$$D_2 = 1$$

For this system to yield a feasible solution, $e > \frac{e+\alpha}{\delta(1+\alpha)} > (1-e)$ *and* $e > \frac{1}{2}$ has to hold.

Solution 4: $\lambda_1 = \lambda_2 = 0, \lambda_3 > 0$

This yields the following

$$\lambda_3 = \frac{(-1+e)(e+\alpha)+(1+\alpha)(2e^2-\alpha+3e\alpha)\delta+(-1+e)e(1+\alpha)^2\delta^2}{2(1+\alpha)(e+\alpha)}$$

$$p_1 = \frac{e+\alpha+e\delta(1+\alpha)}{2(1+\alpha)}$$

$$p_2 = e$$

$$\Pi = \frac{(e+\alpha+e(1+\alpha)\delta)^2}{4(1+\alpha)(e+\alpha)}$$

$$D_1 = \frac{1}{2} - \frac{e(1+\alpha)\delta}{2(e+\alpha)}$$

$$D_2 = \frac{1}{2} + \frac{e(1+\alpha)\delta}{2(e+\alpha)}$$

For this to yield a feasible solution, $e < \frac{1}{\delta(1+\alpha)}$ has to hold.

ELINKEINOELÄMÄN TUTKIMUSLAITOS (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

Puh./Tel. (09) 609 900
Int. 358-9-609 900
http://www.etla.fi

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