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Research Commentary

Developing an Interdisciplinary Area of Economics and Human-Computer Interaction

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As an important component of IS research, human-computer interaction (HCI) research in IS has heavily relied on reference disciplines. Economics is less referenced despite the fact that human beings have been strongly driven by economic rules. This paper purports that economics can be of high value to HCI research, providing fresh perspectives for understanding HCI phenomena. Drawing upon concepts and theories in neoclassical economics, behavioral economics, and information economics, this paper examines five important HCI topics from various perspectives from the field of economics. Accordingly, eighteen propositions are developed, demonstrating the usefulness of economics for advancing our understanding of HCI phenomena. While claiming the benefits of referring to economics, this paper also warns HCI researchers of the potential threats of doing so. Opinions are offered about how HCI researchers can refer to economics strategically.

INTRODUCTION

> *We see things in part by how we talk about them and the concepts and constructs we use in our descriptions — (Ferraro et al., 2005, p. 16).*

Information Systems (IS) research has been characterized by and has benefited greatly from its interdisciplinary nature (Benbasat and Weber, 1996; Grover et al., 2008; Keen, 1980; Rabin, 1998; Robey, 1996). As an important component of IS research, human-computer interaction (HCI) research in information systems (IS) is concerned with the ways humans interact with information, technologies, and tasks, especially in business, managerial, organizational, and cultural contexts (Zhang et al., 2002). Being highly interdisciplinary in nature, IS/HCI (hereafter HCI) research has benefited greatly from other relatively "mature" disciplines such as psychology, business and management, information science, computing and communications sciences, and behavioral and cognitive sciences. For instance, HCI research has heavily depended on psychology, and a great number of HCI studies are built upon psychological theories (Zhang and Li, 2005). HCI researchers' reliance on certain disciplines such as psychology is indeed increasing (Zhang and Li, 2005). Some disciplines are so widely referred to that they have assumed prominence in HCI research. For instance, the Theory of Reasoned Action, a popular theory in psychology, has been dominant in IS and HCI research (Robey, 1996).

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Relying so heavily on relatively few disciplines may have lead to what can be called "inertia of theorizing": researchers habitually go to the dominant reference disciplines looking for theoretical foundations. Acknowledging both threats and promises of the diversity in IS research, Robey (1996) called for "disciplined diversity." According to disciplined diversity, researchers should not be limited to certain disciplines; instead, IS researchers should always look for the best theoretical foundations and methods that can best address the research aims. Disciplined diversity requires "an awareness of various theories and methods for addressing research aims" (Robey, 1996 p.406). However, even when the dominant reference disciplines are not the best option to address the research aim, researchers may be driven by inertia of theorizing to routinely visit the dominant reference disciplines, sometimes subconsciously, for theories and research methods. Thus, relying too heavily on a limited number of dominant reference disciplines can weaken the guidance of research aims while searching for the best theories and methods; we go to some disciplines simply because we have become accustomed to them.

With regard to HCI research, the long tradition of relying on psychology may have resulted in what Ferraro et al. (2005) refer to as "self-fulfilling" effects. That is, psychology has perpetuated itself in HCI research by promulgating language and assumptions that have become widely used and accepted. Subsequently, we have become used to using psychological terms to describe phenomena of interest. One example is that HCI researchers, influenced so strongly by psychological terminology and philosophy, have described IS users as information receivers, perceivers, processors, etc. This cognitive social psychology perspective has limitations and somewhat neglects the complexity of the context in which HCI occurs (Lamb and Kling, 2003).

This paper proposes that other disciplines may serve us better in addressing research aims in HCI research. One discipline with the potential to be of high value to HCI research is economics. The field of economics has long been interested in resource-constrained human behaviors, and shares many similarities with HCI research in terms of subject matter and level of analysis. The recent movements of behavioral economics and information economics to investigate the implications of bounded rationality and the self-interest of human beings along with the situation of information asymmetry, have strong implications for HCI research to treat IS users as "social actors" (Lamb and Kling, 2003). Nevertheless, economics has not been widely cited in HCI research (Lyytinen, 2010). Although some models, such as the Technology Acceptance Model (Davis et al., 1989) and the Cognitive Fit Theory (Vessey, 1991; Vessey and Galletta, 1991), are built upon some basic economic ideas such as the benefit-cost paradigm, economics is not a core part of them. A comprehensive review of HCI research by Zhang et al. (2009) revealed that economic theory accounts for only one percent of the theory base of the contemporary HCI research from 2003 to 2008, the same as the preceding period of 1996 to 2002.

An investigation into the potential benefits of economics for HCI research is necessary, considering the status quo of HCI research. Compared with some other sub-disciplines in information systems, HCI research is still in an early stage of development. The Association for Information Systems Special Interest Group on Human-Computer Interaction (AIS SIGHCI) was established in 2001[1]. The AIS Transactions on HCI (THCI) was launched in 2009. HCI research is a "fragmented adhocracy with low degrees of strategic and functional dependences and a high degree of strategic task uncertainty" (Zhang and Li, 2005 p. 273). We have not been very systematic and strategic about reference disciplines of HCI research. Therefore, HCI researchers should have a strategic agenda regarding how to benefit from other disciplines. It is necessary to explore the potential contributions of other disciplines such as economics. This effort may also benefit our thinking about future directions and challenges of HCI research (Benbasat, 2010; Lyytinen, 2010). In fact, Lyytinen (2010) pointed out explicitly in his research commentary on future directions of HCI research that:

> *Though HCI research has not been strongly influenced by economic theory, integrating relevant economic perspectives on the study of use processes, outcomes, and learning can greatly improve the external validity of the results (p. 24).*

To begin to work toward addressing this need, this paper has two objectives: (1) to develop some actionable new propositions for HCI research based on economic perspectives; and (2) more ambitiously, to explicitly lay out and discuss the connections between economics and HCI research and provide a starting point for HCI researchers to do more work in this area.

We focus on three main streams of microeconomics: neoclassical economics, behavioral economics, and information economics. The development of behavioral economics and information economics can be viewed as stemming from challenging the assumptions of neoclassical economics. Specifically, these two areas of economics are popular today because they directly challenge the unrealistic image of human beings in neoclassical economics. Behavioral economists argue that human beings have bounded rationality and incomplete information, use heuristics, make mistakes, and so on. Information economists study situations in which people do not have complete information about goods and services. Their research has helped economists gain a more realistic picture of human behavior. In HCI research, we have the same problems as do neoclassical economists. Contemporary HCI research has more or less made assumptions about IS users as those held in neoclassical economics. To initiate research of more relevance in

practice, we should loosen these assumptions so we can gain a better understanding of the users in real-world settings and treat them as "social actors"(Lamb and Kling, 2003). Therefore, referring to the movement of behavioral and information economics has implications for how contemporary HCI research treats IS users, a major component of HCI.

The paper proceeds as follows. First, we introduce the conceptual and theoretical foundation of this research. Second, we systematically review the implications of economics for HCI research and develop a series of propositions for future research. Finally, we conclude with a discussion.

THEORETICAL AND CONCEPTUAL FOUNDATIONS: THREE REFERENCE AREAS OF ECONOMICS [2]

As mentioned earlier, this research refers to three main streams of microeconomics: *neoclassical economics, behavioral economics, and information economics*. Again, the rationale of referring to these three main streams of economics is that they can help us to achieve more complete understanding of IS users.

Neoclassical economics is a term used for approaches to economics that focus on the utility, preferences, determination of prices, outputs, and income distributions in markets through supply and demand, etc (Campus, 1987). Often, neoclassical economists explore these variables as mediated by a hypothesized maximization of income-constrained utility by individuals and of cost-constrained profits of firms employing available information and factors of production, in accordance with rational choice theory (Campus, 1987). Neoclassical economic theory dates back to as early as the late nineteenth century (e.g., Jevons, 1879), and was further developed in the twentieth century (e.g., Chamberlain, 1933; Robinson, 1933; Samuelson, 1947). Neoclassical deviated from classical economics by adopting more "scientific" methods and views from natural science, and assuming full rationality of human beings. In addition, it adopted the revealed preference axiom which assumes that preferences will be revealed objectively in decisions and choices (Samuelson, 1947). Unlike the preceding classical economics, neoclassical economics emphasizes marginal utility rather than total utility. Neoclassical economics is the foundation of modern economics, and currently dominates the field.

Neoclassical economics makes strong assumptions about economic agents (individuals or firms). The three major assumptions are (1) people have rational preferences among outcomes that can be identified and associated with a value, (2) individuals maximize utility and firms maximize profits, and (3) people act independently on the basis of full and relevant information (Weintraub, 2002). These assumptions jointly compose an unrealistic image of economic agents, making them more or less *homo economicus* (economic man) (Pareto, 1906). As vividly illuminated by Veblen (1919), the economic agent in neoclassical economics is conceived as "a lightning calculator of pleasures and pains, who oscillates like a homogeneous globule of desire of happiness under the impulse of stimuli that shift about the area, but leave him intact." (p. 73) These three assumptions, reflecting the "normative bias" of neoclassic economics, are rarely held in reality and are thus widely challenged. Loosening these assumptions resulted in several important areas of modern economics, among which are behavioral economics and information economics.

Behavioral economics primarily challenged the first and second assumptions of neoclassical economics. Behavioral economists argue that people have bounded rationality resulting from limited information, limited computing capability, flawed memory, and uncertainties of outcomes (Becker, 1968; Kahneman, 2003; Kahneman and Tversky, 1979; Simon, 1957; Thaler, 2000; Tversky and Kahneman, 1974; Tversky and Kahneman, 1992). Drawing upon bounded rationality, behavioral economists have studied such topics as decision-making under risk (Kahneman and Tversky, 1979), the use of heuristics and rules of thumb in decision-making (Tversky and Kahneman, 1974), the complexity of decision-making (Beshears et al., 2008), mistakes (Layard, 2008), and passive choice (Beshears et al., 2008), among others. Each of these works directly challenges the unrealistic image of economic agents that were widely held in neoclassical economics by showing that individuals can make mistakes, avoid risks, use mental shortcuts and rules of thumb, and sometimes care about others' interests rather than their own.

Information economics, on the other hand, challenges the neoclassical assumption that people act independently on the basis of full and relevant information (Akerlof, 1970; Spence, 1973; Stiglitz, 1975; Stiglitz, 2000). Neoclassical economics assumes that economic agents have all the information necessary for evaluating goods and services, which is apparently incorrect. People do not always have the full knowledge of the goods or services that they are evaluating. Information asymmetry is ubiquitous. Sometimes, people take advantage of information asymmetry, for instance, when sellers intentionally hide quality problems with their goods (Akerlof, 1970). To achieve more transparency, people can choose to send signals. For example, individuals obtain degrees as signals that demonstrate their learning capacity to potential employers (Spence, 1973). Moreover, customers can do comprehensive screening to get more information about goods or services (Stiglitz, 1975; Stiglitz, 2000).

IMPLICATIONS OF ECONOMICS FOR HCI RESEARCH

In this section, we discuss in detail how HCI researchers can benefit from economic research. The discussions are organized around important HCI topics (Table 1). To ensure that this research offers actionable suggestions and strong implications for future HCI research, this paper refers to Benbasat and Barki's (2007) five proposed courses of action in technology adoption research. The proposed courses of action most relevant to this research include: antecedents of user beliefs, a longitudinal relationship between user beliefs and system use, and system use and its impacts. We supplement this list with two additional focal topics in HCI research: user technology adoption and satisfaction. This final list, albeit neither conclusive nor inclusive, provides a good coverage of the foci of contemporary HCI research. These topics are considered important in other studies as well (e.g., Swanson and Ramiller, 1993; Zhang and Li, 2005).

Table 1: Implications of Economics for Major HCI Topics

HCI Topics	Relevant Economic Concepts and Theories	Implications from Economics: Propositions
User technology adoption	• User preference and product comparison • Prospect Theory • Reference-dependence principle	P1: The phenomena of user technology selection are more salient and ubiquitous than user adoption of a given IS. P2: One compares available ISs in terms of (2a) specific features/attributes/functionalities, and (2b) the utilities of ISs when they have different attributes and are for different purposes. P3: IS comparisons are reference-dependent. That is, comparisons between two ISs are dependent on ISs that one currently uses.
Antecedents of user beliefs, intention to use (Interface design features)	• The law of diminishing marginal utility • Satiation • Information asymmetry • Information seeking	P4: The impacts of IS attributes on (4a) user beliefs, (4b) intention to use, and (4c) user satisfaction follow the law of diminishing marginal utility: The impact of improvement of IS attributes decreases. P5: After certain thresholds, continued improvement of an attribute of an IS may have a negative impact on (5a) user beliefs, (5b) intention to use, and (5c) satisfaction. P6: Users may have misbeliefs about an IS as a result of incomplete or inaccurate information about and/or limited interactions with the system. P7: The differences in user beliefs about an IS may result from the fact that users interact with different IS features. P8: Motivated by predicted utilities (i.e., potential benefits) of using an IS, users may actively collect information about that IS, bearing some costs, to form more accurate beliefs.
Longitudinal nature of the relationship between user beliefs and system use	• The benefit-cost paradigm • Risk aversion • Bounded rationality • Passive choice • Changing preferences	P9: Both perceived benefits and perceived costs of IS selection, use, and substitution influence users' intention to select/use/substitute ISs. P10: Perceived costs of selecting, using, and substituting an IS have a larger impact on users' intention to select/use/substitute that IS than perceived benefits (e.g., usefulness). P11: Prior system use can lead to more accurate beliefs about an IS. P12: Experienced users' beliefs better represent the true preferences for an IS and/or IS features than inexperienced users' beliefs. P13: User perceptions have little or no impact on intention to use or system use when the system is chosen as the default and thus is chosen / accepted passively. P14: People who passively choose an IS are more likely to have disconfirmed expectations. P15: User beliefs and intention to use vary over time because of (15a) mistakes, (15b) changing marginal utility, and (15c) changing tastes
System use and impact of system use	• Bounded rationality • Bounded self-interest • The assumption of utility-maximization	P16: IS users are not optimizers in selecting/accepting ISs. Instead, they may simply choose the ISs or IS features that are good enough for their job. P17: Facing problems and thus actively reflecting upon their use of ISs, users may still not change their use of ISs. Instead, they may stick with the ISs and IS features that they are currently using because of limited cognitive capability to value the alternative ISs or IS features, complexity of these alternatives, limited personal experience with them, risk aversion, procrastination, etc. P18: Self-interest positively moderates the relationship between system use and job performance: IS users may aim at promoting others' or the organization's benefits instead of their own. As a result, when one's self-interests are weak, system use has a weaker impact on his/her own job performance.

User technology adoption will be reexamined first because most of Benbasat and Barki's (2007) proposed courses of action are centered around this topic. Then, the remaining topics will be discussed from economic perspectives. The discussion on satisfaction will be integrated into discussions on other topics. Table 1 summarizes these topics and the implications derived from economics that we have manifested as propositions. Next, we will provide in-depth elaborations on each of the eighteen propositions.

User Technology Adoption

We first reexamine from an economic perspective a focal topic in HCI research: user technology adoption. During the past two decades, HCI researchers have paid much attention to the study of user technology adoption; in fact, it is one of the most mature topics in IS research (Venkatesh et al., 2003). HCI researchers have been arguing, based primarily on psychological theories, that users' intentions to use an IS are largely based on their attitudes toward and perceptions of using that IS (Davis et al., 1989; Thompson et al., 1991). Recently, researchers began criticizing the research on user technology adoption, arguing that the focus on this topic has distracted IS researchers from other important phenomena, and that the prior research on user technology adoption has not yielded actionable suggestions for system design and management (Benbasat and Barki, 2007; Goodhue, 2007; Straub and Burton-Jones, 2007).

One of the reasons why contemporary research on user technology adoption lacks actionable suggestions for practice is that it fails to properly model the phenomenon of user technology adoption. The contemporary research on user technology adoption is deeply rooted in a scenario: a system is given to users and users need to make a decision with regard to whether or not to accept and use it. In this scenario, users accept or continuously use given ISs, rarely referring to other systems. Although IS researchers have studied user technology adoption from various perspectives, this vision has rarely changed.

However, actual instances of the above scenario (in which people make decisions regarding whether or not to accept a *given* IS) have become less typical. During the past two decades, advances in information technology and telecommunications infrastructure have radically changed the relationship between users and information systems. First, due to economies of scale in the IT industry, information systems have generally become much less expensive. The Open-Source Software (OSS) movement, providing high-quality freeware to users, has also significantly lowered the average cost of software applications.

Second, people have more IS options for both work and non-work purposes. The development of computer hardware and software has followed Moore's Law: the capacity of hardware and software is doubled every eighteen months (Moore, 1965). As a result, the application of ISs are not limited merely to work; more and more ISs are being designed for non-work purposes. The enhanced mobility of new ISs makes the use of ISs in non-work contexts ubiquitous.

Third, people have more freedom in choosing what ISs to use. A prime example is computer-mediated communication. Ten years ago users were largely limited to sending and receiving emails. Now, we have various communication systems, such as Windows Live Messenger, Skype, and embedded chatting/phone services in Gmail, among others, for both synchronous and asynchronous communications. HCI research needs to reflect these changes. Specifically, users are more and more often challenged with selecting ISs from a variety of alternatives rather than accepting given ISs. This topic can be temporarily called user technology selection..

- **Proposition 1:** The phenomena of user technology selection are more salient and ubiquitous than user ado ption of a *given* IS.

The switch of attention from user technology adoption to user technology selection introduces opportunities to borrow ideas from economics, a field which has long been interested in individual's preferences and choices. One phenomenon that is closely related to user technology selection is system comparison. Prospect Theory, a well-known theory in behavioral economics, states that "perception is reference-dependent: the perceived attributes of a focal stimulus reflect the contrast between that stimulus and a context of prior and concurrent stimuli" (Kahneman, 2003, p.1454).

There are two types of between-system comparisons. The first type is the comparison between two or more systems with similar features (i.e., substituting or competing systems). The concept of relative advantage and the associated phenomenon of IS substitution (replacing the old system with a new one) fall into this category. Relative advantage is defined as "the degree to which a new system is perceived as being better than the alternative it supersedes" (Karahanna et al., 2002 p. 327). For instance, Choudhury and Karahanna (2008) studied how people compare traditional and electronic marketing channels in terms of convenience, trust and efficacy of information acquisition. To

study this type of between-system comparison, in-depth investigations into the attributes that distinguish one technology from another are needed. The Attribute Typology may be a good start (Lefkoff-Hagius and Mason, 1993).
The second type is the comparison between systems with different attributes and used for different purposes: one can compare a bicycle to a kayak and decide which to purchase for a vacation. In the IS realm, a user can decide if he/she wants to choose a word processor or a new gaming system. In this instance, the basis of comparison is not differences in functionalities, but the utility that can be obtained from each system. The compared utilities can be instant utility (e.g., flow), experienced utility (e.g., satisfaction), remembered utility (e.g., enjoyment), decision utility (e.g., intention to use), and predicted utility (e.g., perceived usefulness) (Kahneman et al., 1997). This type of IS comparison has rarely been studied in HCI research.

Both types of IS comparisons are closely related to the current "basket" or "network" or "grid" of ISs. This is called reference-dependence in economics (Bateman et al., 1997; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). For instance, if one already has a laptop, the likelihood that he/she chooses a laptop over an iPhone is lower than if he/she does not have a laptop yet. Therefore, how a system is compatible with the current basket of ISs is one factor that influences a user's decision to select this system.

- **Proposition 2:** One compares available ISs in terms of (2a) specific features / attributes / functionalities, an d (2b) the utilities of ISs when they have different attributes and are for different purposes.

- **Proposition 3:** IS comparisons are reference-dependent. That is, comparisons between two ISs are depend ent on ISs that one currently uses.

Antecedents of User Beliefs

IS researchers have recently started paying more attention to the antecedents of user beliefs, especially those related to the IT artifact, hoping for more actionable suggestions for system design and management. For example, researchers have studied the vividness and interactivity of websites (Jiang and Benbasat, 2007) and task-relevant and mood-relevant cues of websites (Parboteeah et al., 2009). The basic idea is that users can evaluate the design features of IS and then integrate their evaluations to form their own opinions (Sethi and King, 1999). Existing studies often assume that such integration of evaluations is linear, manifested in the popular use of linear models. As a result, monotonic relationships between IT attributes and user beliefs are assumed.

The law of diminishing marginal utility in economics has implications for how we view the impact of IT attributes on user beliefs. According to the law of diminishing marginal utility, the consumption of an additional good can increase overall utility. However, the marginal utility of additional goods and services decreases. For instance, a person obtains less utility from the third apple than from the first one that he or she eats. Marketing researchers found a similar phenomenon: the addition of a new feature to a product is more salient and has larger impact on users when the product is inferior than when it is superior (Gatignon and Robertson, 1993; Nowlis and Simonson, 1996; Srull and Wyer, 1989). In other words, when one attribute (e.g., vividness) of an IS is less developed, an improvement of this attribute has a larger impact on user beliefs than when that attribute began at a relatively high level. Consider a system that has low vividness (e.g., only static texts). A single addition of a vividness feature (e.g., a video demonstration with narration) may significantly enhance user perception of the vividness of this IS. When an IS already has a lot of vividness features, on the other hand, an additional vividness feature is less salient and does not significantly contribute to users' perceptions of the vividness of the system.

The above discussions can be generalized to the impact of IS attributes on intention to use and user satisfaction. First, prior research has shown that IS attributes impact user perceptions (Davis et al., 1989), user satisfaction, and intention to use (DeLone and McLean, 1992; DeLone and McLean, 2003). Second, as discussed earlier, user beliefs, user satisfaction, and intention to use can all be viewed as utilities, although they are different types of utilities.

- **Proposition 4:** The impacts of IS attributes on (4a) user beliefs, (4b) intention to use, and (4c) user satisfacti on follow the law of diminishing marginal utility: The impact of improvement of IS attributes decreases.

Satiation phenomenon. A phenomenon closely related to the law of diminishing marginal utility is satiation. Economics research tells us that the consumption of goods or services can be satiated, that is, the marginal utility of goods or services can be zero or negative after a threshold. Consider how a person might feel about the 10th apple he eats within one hour. The same holds true for information systems. The marginal utility of one attribute of an information system (e.g., ease of use) is diminishing, and upon one point (the satiation point), the marginal utility of that attribute becomes zero. Moreover, after that threshold additional improvement of that attribute may actually have negative effects on user beliefs, intention to use, and satisfaction. For example, an IS that is too easy to use may be considered naïve. It is noteworthy that not all things have satiation points (e.g., diamonds). Therefore, the type of IS attributes may be an issue to be considered when studying the satiation phenomenon.

- **Proposition 5:** After certain thresholds, continued improvement of an attribute of an IS may have a negative impact on (5a) user beliefs, (5b) intention to use, and (5c) satisfaction.

Information asymmetry, an important concept in information economics, also has implications for studying the impact of IS attributes on user perceptions. HCI research has more or less assumed that users can form proper beliefs about an IS based on limited interactions with a limited number of features of an IS. Although we have acknowledged that people can further explore an IS to discover more about it (e.g., Jasperson et al., 2005), we have not yet taken seriously the fact that people can actually have misbeliefs about an IS. This assumption—that users always have necessary information to form proper beliefs—is also held in neoclassical economics, and information economists have systematically addressed problems with this assumption (Akerlof, 1970; Spence, 1973; Stiglitz, 1975; Stiglitz, 2000). When evaluating goods and services, people may have misbeliefs resulting from information asymmetry. Similarly, users may form inaccurate perceptions of or misbeliefs about an information system due to limited or incorrect information. Also, people may use different features of an IS; a user may base his/her beliefs about an IS merely on the features he/she uses. Generalizing beliefs about some features to beliefs about the whole system may be problematic. Studying user beliefs about IS features or feature groups and differentiating core features and optional features (Harrison and Datta, 2007; Jasperson et al., 2005) may be necessary for understanding the misbeliefs about ISs.

- **Proposition 6:** Users may have misbeliefs about an IS as a result of incomplete or inaccurate information a bout and/or limited interactions with a system.

- **Proposition 7:** The differences in user beliefs about an IS may result from the fact that users interact with di fferent IS features.

Desire for information. People can be active information seekers. In criticizing Akerlof's seminal work on information asymmetry and quality uncertainty (Akerlof, 1970), Stiglitz (2000) argued that "Akerlof ignored the desire of both some sellers and buyers to acquire more information [about the product]" (p.1452). Therefore, a user may proactively screen, verify, and search for information about an information system. Nevertheless, this information searching behavior may be costly (Stiglitz, 2000). Users need to use up mental resources, time, and sometimes money to evaluate and compare ISs. Therefore, they need motivation, intrinsic or extrinsic, to be willing to actively search for information about an IS. Since people do not yet know the IS being evaluated, their motivation is based mostly on predicted utilities (e.g., usefulness).

- **Proposition 8**: Motivated by predicted utilities—i.e., potential benefits—of using an IS, users may actively c ollect information about that IS, bearing some costs, to form more accurate beliefs about it.

Longitudinal Nature of the Relationship between User Beliefs and System Use

The relationships between user beliefs and system use/ intention to use have been studied extensively in HCI. For instance, the well-known Technology Acceptance Model posits that two user beliefs about an IS, namely perceived usefulness and perceived ease of use, influence users' intention to use and actual usage of this IS (Davis et al., 1989).

The *cost-benefit paradigm* in neoclassical economics has implications for the relationships between user beliefs and system use. It has been widely held in economics that people make decisions based on considerations of both benefits and costs. Neoclassical economics assumes that people are constrained by resources such as income and natural resources and people maximize the resource-constrained utility (Campus, 1987). The scarcity of resources makes cost an important factor.

In HCI research, however, the benefit-cost paradigm is at most implied in some studies. Few studies have directly addressed the cost issues, with few exceptions (e.g., Burnham et al., 2003; Galletta et al., 2006; Liang and Huang, 1998). HCI researchers have paid a lot of attention to the motivations of accepting an IS. Motivation—extrinsic (e.g., perceived usefulness) or intrinsic (e.g., perceived enjoyment)—is a benefit concept. That is, people are motivated by the benefits they can get from using an IS. The other side of the story, resource-constraints, is somewhat neglected. For instance, when we talk about user technology adoption, we do not consider the price of the technology. This absence is partially due to the organizational contexts in which user technology adoption is often studied. In non-organizational contexts (e.g., households' acceptance of technology, Brown and Venkatesh, 2005), price is apparently an important concern. Consider the following scenario that exemplifies the importance of studying cost: although a user thinks a system is useful and easy to use, he or she still does not accept it simply because he or she cannot afford it. One way of tackling this problem may be distinguishing intention to use from intention to purchase. While the

former is more based on an imagined scenario in which no resource-constraints are present, the latter is more realistic in situations in which constraints are present.

Technology selection, use, and substitution are not cost-free, and the costs are not limited to monetary costs. Prior research has identified switching costs that can be classified into three categories: procedural, financial, and relational switching costs (Burnham et al., 2003). Liang and Huang (1998) also studied the transaction costs, including search cost, comparison cost, examination cost, negotiation cost, payment cost, delivery cost, and post-service cost in customer acceptance of products in electronic markets. Their results show that transaction costs have a significant influence on user acceptance. In short, users are social actors in complex contexts that may induce procedural, financial, and relational switching costs. Switching to a new system can change one's work procedures, induce financial losses, and generate new relationships with others. People also encounter costs associated with the delay, unfamiliarity with, and depth of a system (Galletta et al., 2006). In addition, people may also develop psychological commitment resulting from perceived sunk costs such as the time and effort invested in learning a system (Samuelson and Zeckhauser, 1988).

- **Proposition 9**: Both perceived benefits and perceived costs of IS selection, use and substitution influence u sers' intention to select/use/substitute ISs.

Risk aversion. Most of the benefits of using an IS can be more accurately depicted as predicted utility, defined as one's beliefs about the experienced utility of future outcomes (Kahneman et al., 1997). For instance, the perceived usefulness of an IS is actually a user's evaluation of the potential benefits that can be obtained from using the IS in the future. Because a user may have limited interactions with a limited numbers of IS features, perceptions of these potential benefits can be mistaken and uncertain. Therefore, perceived usefulness is essentially an expectation of future benefits of using an IS (Bhattacherjee, 2001; Compeau and Higgins, 1995; Venkatesh et al., 2003). A user may or may not reap the expected benefits. A typical scenario is that after making an attempt, a user gives up on an IS or an IS feature that does not yield the expected benefits. Prospect Theory explicitly models the role of uncertainty in decision-making (Kahneman and Tversky, 1979; Thaler et al., 1997; Tversky and Kahneman, 1974). One important argument is that people in general show risk aversion, giving more weight to potential costs than to the predicted benefits. In other words, perceived costs are generally more influential than perceived benefits in decision-making.
Proposition 10: Perceived costs of selecting, using, and substituting an IS have a larger impact on users' intention to select/use/substitute that IS than perceived benefits (e.g., usefulness).

Recently, due to increasing interest in post-adoption system use, researchers started paying more attention to the longitudinal mutual influence of user beliefs and system use. For instance, Kim and colleagues studied how prior beliefs influence subsequent beliefs and intention to use, and prior system use influences current beliefs (Kim, 2009; Kim and Malhotra, 2005). Bhattacherjee (2001) studied how prior expectations of an IS influence subsequent user satisfaction and intention to use that IS. The longitudinal relationships between beliefs and system use, given their importance in studying post-adoption system use phenomena, deserve more attention.

Bounded rationality. Classical expected utility theory assumes that people make rational choices under risk and preaches two principles: utility maximization and choice invariance (Chen and Liang, 2006). The former postulates that people always make decisions to maximize utility; the latter implies that people make the same choice every time they face the same set of options. Both principles are challenged, primarily by behavioral economists (e.g., Kahneman and Tversky, 1979).

People have limited computational skills and seriously flawed memories and often use mental heuristics and rules of thumb in decision-making, especially when encountering complex or unstructured problems (Jolls et al., 1998; Simon, 1957). For instance, most people know that their retirement plans are not optimal and indicate that they plan to adjust retirement plans soon, but few of them actually do so (Jolls et al., 1998). Therefore, users' perceptions of information systems, especially those of high complexity, may not be based on rational reasoning and careful calculations. Rather, they may form their perceptions of an IS based on heuristics and rules of thumb, using only limited information about this IS. For instance, users may base their perceptions of the usefulness of an information system on merely a few features of that system and conceive the whole system as having the same level of usefulness as these features.

The complexity of an IS can be another source of misbeliefs. As a result of high complexity, people use mental shortcuts, which are a major source of misbeliefs (Jolls et al., 1998). The problems with the complexity of an IS can be solved to some degree by system use. Behavioral economists argue that long-run choices are more accurate and reflect people's true preferences better than short-run choices, especially for complex choices (Plott, 1996). For instance, in making financial decisions such as an investment in retirement and using credit cards, experienced account holders can usually avoid the mistakes made by inexperienced account holders and enjoy lower fees and better terms and returns (Choi et al., 2003). Thus, behavioral economists have argued that we should give more weight to the behaviors of high-tenure workers, which usually reveal the normative (i.e., true) preferences (Beshears

et al., 2008). According to Beshears et al. (2008), "it is therefore the asymptotic behavior that reflects the normative preferences" (Beshears et al., 2008 p.1791).

Applying these findings to IS research, we argue that people can to some degree adjust and realign their beliefs with the true nature of an IS via more system use. We should take experienced users' beliefs as a better indicator of what users truly want from an IS.

- **Proposition 11:** Prior system use/experience can lead to more accurate beliefs about an IS.

- **Proposition 12:** Experienced users' beliefs better represent true preferences for an IS and/or IS features th an inexperienced users' beliefs.

Passive choice. The focus of HCI researchers' attention on the relationship between user beliefs and intention to use or actual system use assumes that IS users are active decision makers, meaning that they draw upon their own perceptions in making decisions regarding the acceptance and use of an IS. However, behavioral economists have found that people do not always follow the path from belief to intention. Instead, very often people passively choose the "default" option (Beshears et al., 2008). It is possible that sometimes one intends to use an IS not because of his or her beliefs about the usefulness, ease of use, and enjoyment of the system, but simply because it has been so widely used by others that it has become the default choice. A closely related yet distinct concept that has been studied in IS research is information cascade. Information cascade occurs "when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behavior of the preceding individual without regard to his own information" (Bikhchandani et al., 1992). In such situations, people disregard their own opinions and simply follow others' behavior. IS researchers found that information cascades exist in online users' choices of software products (Duan et al., 2009).

- **Proposition 13:** User perceptions have little or no impact on intention to use / system use when the system is chosen as the default and is thus chosen / accepted passively.

Passive choice is a reason why revealed preferences (system use / intention to use) do not represent the actual preferences of a user (Layard, 2008). Duan et al. (2009) showed that people are likely to adopt inferior products in an information cascade, a special case of passive choice. In an information cascade situation, product rankings are unstable (Duan et al., 2009). This shows that people substantially adjust their perceptions of products that they chose passively. In short, a passively chosen product may not represent the actual preferences of an individual. Passive choices are likely to induce discrepancies between the expected and the actual outcomes, or in Bhattacherjee's (2001) terminology, disconfirmation.

- **Proposition 14:** People who passively choose an IS are more likely to have disconfirmed expectations.

Changing preferences. The assumption of rationality in neoclassical economics has also resulted in an erroneous principle of choice invariance (Chen and Liang, 2006). That is, if people always made rational decisions, they would always make the same decision every time they face the same situation. Behavioral economists have attacked this principle by studying changing preferences (Diamond, 2008; Jolls et al., 1998). For instance, when facing two options, applications A and B, a person may choose application A at Time 1 (T1), and application B at Time 2 (T2). Assuming no revisions or updates are made to applications A and B between T1 and T2 and the situations are similar, we cannot fully understand this phenomenon of changing preferences using existing HCI models.

Behavioral economics offers several implications for understanding changing preferences over time. Specifically, several factors may account for changing preferences (Diamond, 2008; Layard, 2008). First, people may make mistakes at Time 1 (T1) and correct for them at Time 2 (T2). As mentioned earlier, people may mistakenly choose an inferior IS, especially in passive choice mode. They may realize this mistake after interacting with the chosen IS, and if they have a chance, users may correct this mistake by choosing a different IS. Second, the marginal utility of application A becomes smaller after it is chosen and consumed at T1 (changing marginal utility of application A). If one buys a laptop at T1, then he/she is likely to choose a different IS at T2. Third, people may have different "tastes" over time.

- **Proposition 15:** User beliefs and intention to use vary over time because of (15a) mistakes, (15b) changing marginal utility, and (15c) changing tastes.

System Use and Its Impact on Job Performance

System use has been receiving more and more attention. First, IS researchers have argued that system use has been too simply defined and measured (Burton-Jones and Straub, 2006; DeLone and McLean, 2003; Jasperson et al., 2005). Second, IS researchers are switching their attention from initial acceptance of IS to post-adoption system use and its impact. Both require systematic investigations into system use. System use has been considered one of the promising areas of IS research (Benbasat and Barki, 2007). IS researchers have been trying to yield deeper understandings of system use from various perspectives (Ahuja and Thatcher, 2005; Barki et al., 2007; Beaudry and Pinsonneault, 2005; Jain and Kanungo, 2004; Jasperson et al., 2005; Singletary et al., 2002; Sun and Zhang, 2008). System use is often studied with respect to job performance. One of the motivations driving the study of system use is the mixed findings of prior studies regarding the impact of system use on job performance. Promoting job performance is the very reason for developing ISs (Torkzadeh and Doll, 1999). System use is therefore expected to significantly impact job performance. However, too often IS researchers have failed to observe the expected strong relationship between system use and job performance (Goodhue and Thompson, 1995; Guimaraes and Igbaria, 1997; Pentland, 1989). This is puzzling to IS researchers and has motivated them to investigate the reasons for the weak correlation between system use and its impacts.

The assumption of utility-maximization. One immediate implication from economic research concerns the nature of the relationship between system use and job performance. From economic perspectives, system use can be viewed as a utility-realization process; people realize the utility of goods and services through consumption. Similarly, the utility of ISs can only be realized through system use. The limitation of the utility-maximization assumption has implications for studying initial technology adoption and post-adoption system use.

First, people may not choose or accept the ISs that have the highest utility. Roger (1995) argued that the dominant perspective of the work on diffusion of innovation is that adopters make independent, rational choices guided by goals of technical efficiency. This assumption results in "proinnovation biases," or presumptions that innovations will always benefit organizations (Abrahamson, 1991).

In reality, people do not always maximize utility. One reason is bounded rationality (Simon, 1957). The assumption that people always maximize utility holds true only if two conditions are met: the performances of alternatives are certain and people have complete information about them. Both conditions are rarely present. Uncertainties are ubiquitous in decision-making and there are costs associated with acquiring information (Simon, 1957). As a result, people only possess bounded rationality and make decisions by satisficing (Simon, 1957). That is, they choose an option that is "good enough," and which may or may not be the best one that can enhance job performance the most. Sethi and King's research (1999) confirmed this phenomenon, showing that the information combinatorial rules used by individuals may not always be given average weight; instead, the rules may be conjunctive, disjunctive, or interactive. Many reasons account for this, such as limited cognitive capability, risk aversion, complexity of the choices, procrastination, limited personal experience, third-party marketing, and passive choice (Beshears et al., 2008; Kahneman, 2003).

- **Proposition 16:** IS users are not optimizers in selecting/accepting ISs. Instead, they may simply choose the ISs or IS features that are good enough for their job.

During post-adoption system use, people do not always try to promote job performance by adapting their use of ISs. HCI researchers have studied variations in post-adoption system use. For instance, people can change their system use (e.g., feature exploration) to cope with new situations, such as new tasks (Beaudry and Pinsonneault, 2005; Jasperson et al., 2005; Sun and Zhang, 2008). However, we cannot assume that people will know the alternatives, (i.e., the ISs or IS features that fit the tasks better). Furthermore, even if they do know, we cannot assume that they will switch to those ISs or IS features. Lending and Straub (1997) showed that people may continue to use a sub-optimal system even if they know there exist alternative technologies that might offer a better fit. The performances of new ISs or IS features are uncertain and there are costs associated with getting to know them. The reasons mentioned above—limited personal experience with the new ISs or IS features, procrastination, risk aversion, etc.—may apply. These factors can keep users committed to the old ISs or IS features. The phenomenon of users failing to change their use of ISs when facing problems can be temporarily named as "passive use." Therefore, post-adoption system use includes not only habitual/automatic use and active use (e.g., feature exploration), but also passive use. This may explain why people do not always adjust their system use to achieve the highest possible job performance.

- **Proposition 17:** Facing problems and thus actively reflecting upon their use of ISs, users may still not change their use of ISs. Instead, they may stick with the ISs and IS features that they are currently using because of limited cognitive capability to value the alternative ISs or IS features, complexity of these alternatives, limited personal experience with them, risk aversion, procrastination, etc.

Bounded self-interest. The assumption of self-interest held in neoclassical economics is also challenged by

behavioral economists, although not as strongly as the assumption of rationality (Jolls et al., 1998). People do not always maximize their own interests. Instead, they may "care, or act as if they care, about others, even strangers, in some circumstance" (Jolls et al., 1998 p.1479). In IS research, a more relevant factor is the organization's interests: Individual users may consider both their own and the organization's interests simultaneously in choosing, adopting, and using ISs. DeLone and McLean (1992) proposed a link from system use to the impact of ISs on individuals and the impact on organizations. That is, individual impact can be aggregated to form the organizational impact of ISs. Economists' arguments about self-interest, however, suggest another possibility: the potential impact of ISs on organizations can influence individuals' decisions regarding IS acceptance and use. An individual may sometimes choose the ISs that have the highest predicted utility for the organization, but not the best options for him/herself. Burton-Jones and Gallivan's (2008) work on system use at various levels may be a good start for studying how system uses at individual and organizational levels influence each other.

- **Proposition 18:** Self-interest positively moderates the relationship between system use and job performanc e: IS users may aim at promoting others' or the organization's benefits instead of their own. As a result, whe n one's self-interests are weak, system use has a weaker impact on his/her own job performance.

DISCUSSION

This paper explores how HCI researchers may benefit from economic research. This work covers only some of the important and basic economic concepts and theories and discusses their potential contributions to HCI research, paving the way for future research to expand upon this framework. As demonstrated above, economics can render fresh new perspectives for studying a variety of HCI phenomena. In this paper, applying economic concepts and theories helped us develop eighteen propositions. These propositions certainly do not represent all the benefits we can get from economics. However, they sufficiently demonstrate the value of economics for HCI research. Needless to say, much more work needs to be done to connect these two disciplines. We strongly encourage HCI researchers to do more in-depth investigations into how we can take advantage of well-established economic research.

By claiming the potential importance of economic theories for HCI research, this paper by no means implies that HCI researchers should do a complete overview of all economic theories to see what we can borrow from them. Because of the possible drawbacks of relying too much on reference disciplines to provide the theoretical foundations for IS research (Benbasat and Weber, 1996; Robey, 1996), we advocate a more modest approach: investigating what implications economic research may have for current topics in HCI research. After all, research aims determine theoretical foundations and methods (Robey, 1996). This paper focuses on several important topics in HCI research and draws upon relevant economic concepts and theories to understand these topics.

We should be aware of both the pros and cons of referencing other disciplines. Ever since the term "reference discipline" was introduced at the first annual conference on information systems (now ICIS) by Keen (1980), the debates over the pros and cons of referring to other disciplines by IS researchers have never stopped (e.g., Benbasat and Weber, 1996; Grover et al., 2008; Rabin, 1998; Robey, 1996). While the benefits of referring to other more "mature" disciplines such as psychology and economics seem obvious and have been widely acknowledged and reflected in our research, we need to be aware of the potential threats of doing so. Several issues are noteworthy.
First, we must refer to economic theories strategically. We should learn from economics without sacrificing the focus of HCI research and without dismissing and disintegrating HCI as an emerging field. It seems very attractive and exciting at first glance to adopt concepts and constructs directly from economic literature. It may be the most convenient way to refer to economic research. However, "adopting successful concepts directly from some reference disciplines does not make them more legitimate for the study of IS" (Grover et al., 2008 p.43). How to reconcile economic theories and HCI phenomena in terms of their assumptions and different levels of analysis is crucial yet difficult. HCI researchers need to be careful about how to conceptualize new or re-conceptualize existing HCI concepts from economic perspectives. Fortunately, HCI research shares a lot of similarities with microeconomics at the level of analysis, which makes referring to (micro)economics easier.

Second, we should avoid adopting economic theories mechanically (Grover et al., 2008). HCI researchers should be aware of the importance of centralizing the HCI phenomena of interest and then using the economic theories of reference as theoretical support that can better explain the phenomenon. We should resist the temptation to find an economic theory that has not yet been used in HCI research and then look for an HCI phenomenon to fit it.

Third, we must think carefully about the theoretical contributions of introducing the referenced economic theories. Adopting a new economic theory does not in itself guarantee significant theoretical contributions. Instead, we should give careful thought to whether or not an economic theory has the potential to add something new to our current understanding of the HCI phenomenon of interest.

Fourth, IS researchers have been arguing that IS research can actually be a reference discipline for other disciplines, claiming that IS research can pay back its debt to its reference disciplines by contributing back to them (Baskerville and Myers, 2002). Nambisan's work in new product development (2003) is an exemplar of how other disciplines can benefit from IS research. That said, we are not suggesting that HCI research, by incorporating economics, should be able to contribute to economics research in the near future. For now, HCI researchers should focus on how to benefit from economics.

CONCLUDING REMARKS

Economics has not yet been a main reference discipline for HCI research. However, we believe that HCI research has a lot to learn from economics. Insights gained from economic research can be helpful when we face the future challenges in HCI research described by (Benbasat, 2010; Lyytinen, 2010). Economics is a mature discipline with a long history, and can benefit HCI research conceptually, theoretically, and methodologically. Thus, the propositions developed above are neither conclusive nor inclusive. Nevertheless, we hope they can serve as a starting point for researchers to do much work in the inter-disciplinary area of economics and HCI to improve the study of users and their interactions with information systems.

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[1] Of course, a lot of HCI research was conducted before the formation of AIS SIGHCI. Here we use this as an indicator of the immaturity of the HCI area.

[2] Economics addresses problems at various levels such as individuals, firms, industries, and even nations. In this research, we only refer to those economic theories and concepts at the individual level, i.e., those in microeconomics, given their relevance to HCI research.

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