Applying Market Mechanisms to Facilitate Interpersonal Information Exchange

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Abstract

Requesting and sharing information through computer-mediated technology is an integral part of our lives in this information age. However, when deciding whether or not and how to engage in information exchanges, parties involved often have different needs and constraints. In addition, they are often unaware of each others' needs and constraints. Such asymmetry in motivation and information leads to suboptimal allocation of attention and time and contributes to the growing problems of information overload, costly interruptions and missed opportunities. A potential solution is to employ market mechanisms to support information exchange. Markets are institutions that allow individuals to trade goods and services efficiently. Applying markets to information exchange, askers can use pricing to signal the importance of the information exchange and compensate the answerers for their time. Answerers can use pricing mechanisms to filter incoming requests, reducing interruption costs and information overload.

This dissertation studies the strengths and weaknesses of using economic markets for interpersonal information exchange. Are there costs in incorporating markets into our everyday information exchanges? How do we design these markets to maximize the benefits of market forces while minimizing the costs? Part 1 of the dissertation examines whether or not economic markets can indeed improve welfare for people involved. Part 2 studies the use of markets for question and answer (Q&A) services, a specific, but a popular type of interpersonal information exchange. Part 3 elucidates how using economic markets for information exchange may affect interpersonal relationships.

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To My Biggest Fan

My Mom

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Chapter 1

INTRODUCTION

Lisa, a young professional, came home late after a long day of work to her nine-year-old Maltese, Marble, vomiting a yellow substance. Having never encountered this before, Lisa immediately called her good friend, Brian, for advice. Brian has several dogs and would gladly have helped if had he known the purpose and urgency of the call, but he was in the middle of a movie when the phone rang, so he ignored the call. Getting no response, Lisa then sent an instant message (IM) from her laptop to her best friend, Tara. Unfortunately, Tara is busy working on a presentation and the message notification on the computer screen interrupts her train of thought. Even though Lisa got Tara's attention, Tara did not have the necessary information and was unable to help. Lisa then searched online, but searching the web gave her no concrete answers. She tried posting a request for help to online question an answer (Q&A) sites, but her query got lost in a sea of frivolous questions and answers. An hour after she got home, she still had not figured out what was wrong with Marble, and she did not know what to do.

For years, researchers and inventers have worked hard to enhance the speed, quality, and flexibility of communication technologies. There is no question that advancing technologies have drastically improved how we share and exchange information (Eisenberg, 1994; Sproull & Kiesler, 1991; Currid, 1992). With these technologies, remote collaborators can now update progress near-instantaneously via email and instant messaging (IM). Friends can coordinate activities using text messaging even while they are in transit. Couples can video-call each other and chat about their daily encounters when apart. Strangers can share their knowledge and expertise through online question and answer (Q&A) sites without ever meeting one another face to face. Like Lisa in the scenario above, we now have the means to engage with anyone, anywhere, just by pressing a few buttons.

While the speed and bandwidth of these technologies continue to improve, our limited cognitive resources have not changed. In this increasingly-connected world, technology is no longer the bottleneck of information exchange. Instead, *we* are. Our scarce human attention (Simon, 1971) is simply incapable of managing the millions of gigabytes that are sent and received every day (Coffman & Odlyzko, 2000). In 1998, there were 87.2 billion pieces of direct mail delivered to US mailboxes. By 2009, there were 3 times as many emails sent *daily* (Radicati Group, 2009), and the number of communication requests and

interruptions is only increasing. Given the increasing demand for our attention, mistakes in handling information exchange requests become costly not just for the person seeking the information, but also for the person being contacted. As illustrated by the scenario above, information overload, costly interruption, and missed requests are all real and potentially detrimental problems that we face on a daily basis when participating in information exchange (Davenport & Beck, 2001). Given our limited cognitive resources, we must find a way to help to allocate our scarce attention more efficiently so that we can maximize our gains from information exchange.

1.1 Interpersonal Information Exchange

Interpersonal information exchange is an integral part of our lives. This category covers much of our daily communication with other people, including the sharing of ideas and opinions, asking for help, and coordinating activities. Despite the fact that we engage in interpersonal information exchanges frequently, initializing an exchange is one of the most intricate and error-prone processes in communication (Goffman, 1959). Two fundamental properties of interpersonal information exchange make this process prone to error: motivation asymmetry and information asymmetry.

When establishing an information exchange, there are *senders* and *receivers*. Senders are individuals initiating and sending the exchange requests, and receivers are the recipients of the requests and the ones responding to them. Depending on the communication medium under discussion throughout this thesis, senders are also referred to as askers, requesters, or callers, while receivers are also referred to as answerers, helpers, and callees. In an exchange, there may be one or more sender and one or more receiver. However, there needs to be at least one of each for an exchange to occur. The ideas presented in this thesis should generalize to all interpersonal information exchange scenarios, but the discussion will not focus on many-sender to many-receiver exchange scenarii; instead, it will center on one-to-one information exchanges.

In general, an exchange is beneficial when the value from participation outweighs the cost, *i.e.*, when the surplus is greater than 0. Previous work has identified exchange importance and urgency as primary factors in communicators' valuation of an exchange (Kendon, 1990; Dabbish 2006). The more important and urgent it is for the communicator to obtain the information, the higher the value. On the cost side, senders and receivers may incur both accounting and opportunity costs when participating in the exchange. Accounting costs include operational costs, such as costs of the upkeep of the technology (*e.g.*, monthly internet and phone bills). Opportunity costs are the costs that individuals incur from not allocating their time and attention elsewhere. It is, in other words, the value one could have gotten if he had not participated in an exchange. This notion of opportunity cost speaks to the fact that, with all else

being equal, the cost of participating in an exchange increased with the importance of the task that is not accomplished *because of* the information exchange. Opportunity costs also include interruption costs, such as resumption costs.

It is important to note that intrinsic and social factors may also affect people's valuation of exchange. Intrinsic motivators, such as altruism and a desire to demonstrate proficiency, give communicators additional value for participating in exchanges (Deci, Koestner, & Ryan 1999; Batson, Ahmad, & Tsang, 2002). Hence, people may prefer to participate in exchanges on certain topics than others. Similarly, social factors, such as status, reciprocity, and affiliation also impact people's valuation of exchange. An exchange may be more valuable if it is with someone of higher status (Pfeffer, 1981; Kendon, 1990), someone on the same team (Gaertner & Insko, 2000), or someone with whom a future relationship is desirable (Gouldner, 1960).

Some problems in interpersonal information exchange arise because of asymmetries in motivation – benefits to the senders may not be equivalent to the benefit to the receivers and vice versa. Senders and receivers often have separate needs and constraints, and they are uniquely affected by the exchanges. Asymmetry in motivation results in an abundance of exchange requests from senders that only benefit themselves. This is why spam has been a major problem. The spammers (senders) benefit from the exchange, so they initiate the request regardless of how costly it may be to the receivers.

However, motivation asymmetry is not the only problem. The other is information asymmetry (Gruen, 1996). Information asymmetry occurs because neither senders nor receivers have all of the information to make the optimal decision on whether and how to commence the exchange. Senders know the purpose of the exchange (*e.g.*, what is the needed information) but may not know the receivers' expertise or their needs and constraints (*e.g.*, their busyness), whereas the responders know their own current status and needs, but do not know what the urgency of the exchange or what it is about until they agree to it. Information asymmetry thus leads to senders initiating exchanges at the wrong time, and receivers ignoring urgent and important requests.

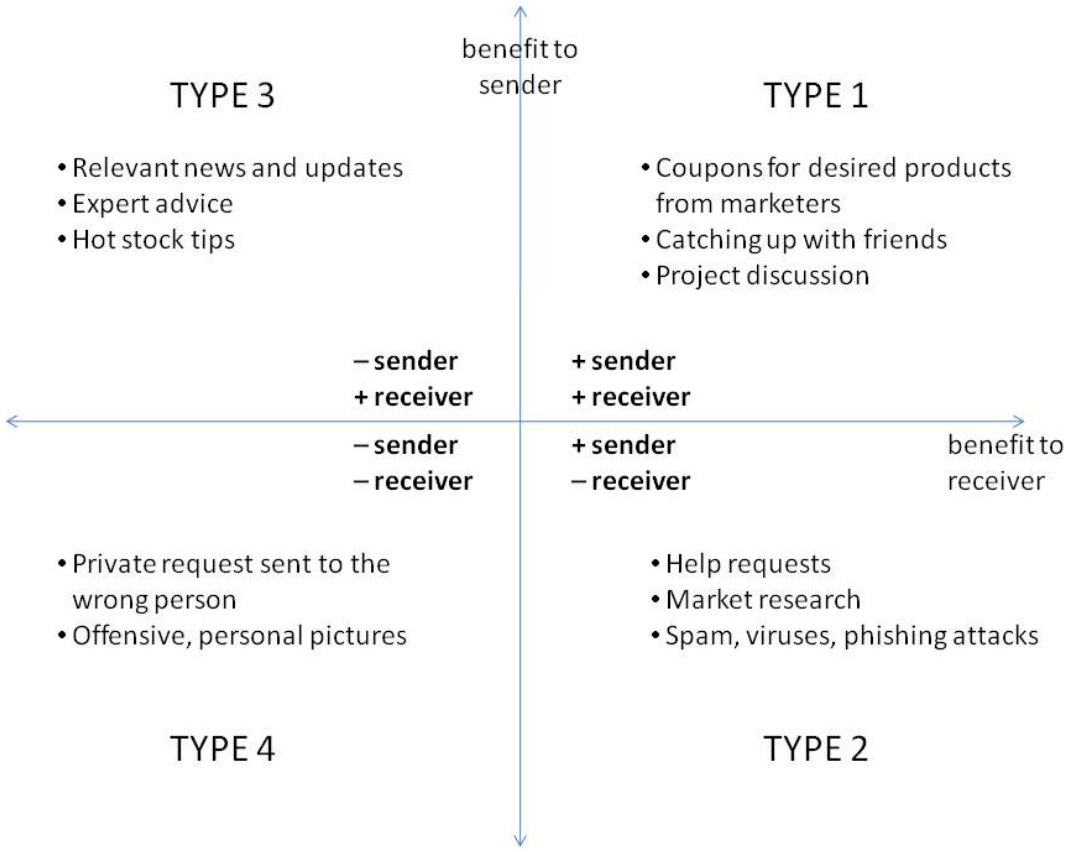


Figure 1.1 Examples of exchanges in the information exchanges space

If we break down the space of information exchanges based on how senders and receivers are affected, there are essentially four types of exchange outcomes (Figure 1.1). Type 1 exchanges are exchanges that benefit both sides of the exchange. These include mutually beneficial project discussions or receivers getting coupons for desired products from retailers. Type 2 exchanges benefit only senders, but not receivers. These include senders' requests for help and market research. Type 3 exchanges benefit only the receivers and not senders. These include a stock tip or expert advice that is desired by receivers, but the sending of which is not of benefit to the senders. Finally, type 4 exchanges benefit neither party, and normally only happen by accident. These include private or offensive messages that are harmful to both sides of the exchange. In everyday exchanges, types 3 and 4 tend to be less frequent than types 1 and 2. This is because exchanges are initiated by senders and they have no real incentive to initiate type 3 or 4 exchanges. Using this taxonomy, we can see that problems of interruption and overload are essentially requests for type 2 exchanges that are undesirable to the receivers, while missed opportunities are type 1 exchanges that are either not initiated by senders or initiated by senders but overlooked by receivers.

The goal of this thesis is to support interpersonal information exchange so that, despite motivation and information asymmetry, people will be able to maximize their scarce attention resources and participate in exchanges that are beneficial and ignore the ones that are not.

1.2 Existing Technology Solutions

Existing technological solutions try to support interpersonal information exchange in three ways: reducing overload, combating interruptions, and improving awareness.

1.2.1 Reducing Overload

In 1982, then president of Association for Computing Machinery (ACM), Peter J. Denning, described the problem of "Electronic Junk" in his President's Letter published in the Communications of ACM. Denning correctly pointed out that computing has significantly focused on generating information, and has neglected to pay attention to receiving information. His letter was a call to "save the receivers from drowning in the rising tide of information...generated" (1982).

Since then, much research has explored ways to reduce communication overload, specifically, in reducing spam in electronic mail (*e.g.*, Cranor & LaMacchia, 1998). These solutions include white/black/grey lists (Levine, 2005), human-interaction proofs (Templeton, 2007), and (collaborative and machine learning) filters (*e.g.*, Gray & Haahr, 2004; Sahami *et al.*, 1998). Despite the increase of spam from 10% of overall mail volume in 1998 to 80% (from p.26, Goodman, Cormack & Heckerman, 2007), these technology solutions have been successful in filtering the amount of unsolicited, bulk mail that people face on a daily basis.

By no means, however, are the existing technology solutions for reducing overload perfect. We still see spam in our inboxes and, occasionally, important emails are classified as spam. Researchers have continually to improve the technology to combat the increasingly-sophisticated strategies used by spammers. It has become a constant arms race (Goodman, Cormack & Heckerman, 2007). Furthermore, existing top-of-the-line filters only work for electronic mail, and do not work for other communication media such as instant messaging, phone, or mobile messaging. The primary reason is that spam filtering relies on analyzing communication purpose through the received message content, which is not available during communication initiation through most other communication media. For example, a ringing phone does not provide any information on what the phone call is about. Similarly, a text message may be too succinct to convey fully the intent of the exchange. Therefore, a good permanent solution to improve interpersonal exchange efficiency is needed, and it needs to be generalizable to support exchange on different communication media and channels.

1.2.2 Combating Interruption

Interpersonal communication is one of the most common sources of interruption in the workplace (Sproull, 1991; Perlow, 1999; Hudson *et al*., 2002; González & Mark, 2004; Mark *et al.*, 2005). These interruptions can have detrimental effects on people's primary task performance and wellbeing (Czerwinski, Cutrell, Horvitz, 2000; Bailey, Konstan, & Carlis, 2001). It is no wonder that much research has been conducted to understand and reduce the cost incurred from interpersonal communication interruptions.

One type of technology solution deals with the timing of the interruptions, as research has shown that timing can affect the cost of interruption (McFarlane, 2002; Cutrell *et al*. 2001; Zacks *et al*. 2001; Adamczyk & Bailey, 2004; Monk, 2004; Robertson *et al*., 2004; Iqbal *et al*., 2005). Various technology prototypes have experimented with deferring the request notification until the user switches tasks (Zacks *et al*., 2001; Adamczyk & Bailey, 2004; Iqbal *et al*., 2005), changes physical locations (Ho & Intille, 2005), transitions to a state of availability (Marx & Schmadt, 1996; Horvitz *et al*., 2005), or to a context that is defined by the senders to be relevant (Jung *et al*., 2005).

Another type of technology solution focuses on situationally-appropriate interruptions. The general intuition is that the appropriateness of the exchange request notification depends on the context in which people are at the time of the request. These research prototypes deliver requests through appropriate communication channels (Van den Berg, S. R., 1993; Marti, S., 1999), vary the notification level to match the context (Sawhney & Schmandt, 1999; Siewiorek *et al*. 2003; Horvitz *et al*. 1999), and use social and environmental factors to determine whether the request should interrupt or be postponed (Marti, S. & Schmandt, C., 2005).

To reduce further the attention cost to receivers of handling exchange interruptions on a per-message basis, technology agents are used to help determine when and how to interrupt. They rely on either user-set rules (*e.g.*, Matthews *et al*. 2004), or machine learning models to determine the appropriate context of interruption (Horvitz *et al*. 2002; Fogarty *et al*. 2005; Iqbal *et al*. 2005).

While combating interruption has the potential to lower interruption costs significantly, they are still far from being perfected enough to be relied on for everyday communication. But that aside, one of the key drawbacks of existing technology solutions (including overload filters) is that they tend to be receiver-side focused; relying solely on receivers' context to minimize their costs from exchanges. This design overlooks senders' needs in exchanges, which may actually affect receivers' own valuation of the exchange (Gruen, 1996). As we can all attest to, just because we are "busy," does not mean we are not willing to engage in exchanges that are truly important and urgent.

1.2.3 Improving Awareness

If a key problem preventing communicators from making sound decisions is information asymmetry, then perhaps the most straightforward solution is to improve senders' and receivers' awareness of each others' exchange context, so they can themselves make more informed decisions when initiating or receiving exchange requests.

One type of solution allows senders to convey the purpose of the exchange more clearly and efficiently to the receivers, so that the receivers may know the purpose of the exchange and can thus better determine whether and how to engage in the exchange (Milewski & Smith, 2000; Bellotti & Edwards, 2001; Pedersen, 2001; Dabbish & Kraut, 2004; Avrahami *et al*., 2007). This includes the use of urgency flags and caller ID in our existing technologies. Research systems such as the Coordinator used Speech Acts to allow people to indicate the intent and actions associated with the communication (Winograd & Flores, 1986). In everyday practice, people also use subject tags in emails to differentiate the types of email messages, which motivated the idea of using tags in IM to support the same function (Hsieh *et al*., 2008).

On the receivers' side, research has explored ways to support receivers handling of incoming communication requests in a lightweight manner. For example, Hudson & Smith (1996) explored previewing phone calls in a low-cost way. Quiet Calls is a system that allows receivers to respond to calls without talking aloud by using pre-recorded audio (Nelson *et al*. 2001).

There is also much research exploring ways to support the sharing of contextual information between remote collaborators. This includes work on media spaces (Bly *et al*., 1993). By allowing collaborators to glance and peek into others' work spaces (Gaver *et al*., 1992, Fish *et al*., 1992), or by creating a joint public space (Jancke *et al*., 2001), collaborators are able to gain a lot of informal information that can support the coordination of communication (Kraut *et al*., 1990). This set of research also includes augmenting existing communication technologies with contextual information. Awarenex, ConNexus, and Hubbub allow communicating parties to share activity-based information and provide lightweight IM communication request previews (Tang *et al*., 2001, Issacs *et al*., 2002). ProjectView IM allows collaborators to share project status (Scupelli *et al*., 2005). More recently, the Negotiator provides a light-weight interface that allows people to negotiate when to commence a synchronous communication (Wiberg & Whittaker, 2005).

While improving awareness can help senders and receivers to participate in the beneficial communications and quickly ignore the costly ones, there are two major problems in trying to improve awareness. First, this type of signaling only works if communicators have an incentive to respect each other's signals. This respect may be more prevalent among communicating partners who have existing

social relationships, but less so when the communicating partners are strangers. Consider the case of the spammer: the spammer is likely to send the communication request regardless of what the receiver is actually doing. The second problem with this type of approach is that full information disclosure has potential privacy problems. Not everyone is willing to offer full disclosure, at times, not even with loved ones.

1.3 Regulatory Solutions

Government regulations provide another way to minimize undesired phone and email communication requests from marketers. For example, the Telephone Consumer Protection Act established in 1991 created national do-not-call and do-not-fax registries. The Controlling the Assault of Non-Solicited Pornography and Marketing Act in 2004 required e-mailers to provide "opt-out" options, valid subject lines, and legitimate return addresses. Unfortunately, the impact of these regulations have been limited (Rainie and Fallows, 2004). Furthermore, even if regulation is able to reduce unwanted requests from marketers, inefficiencies of information exchange exist regardless of who is initiating an exchange. A good solution to improve exchange efficiency cannot be based solely on limiting who can or cannot initiate an information exchange with whom.

1.4 Economic Solutions

The idea of using economic solutions to support information communication has been in existence for a while. In his 1982 Letter on "Electronic Junk," Denning proposed a solution in which each user specifies an asking price and would only receive messages that have higher bid prices than the asking price (1982). The discussion that follows focuses on research on two general types of economic solutions that can be used to support interpersonal information exchange: pricing and markets. It will also seek to explain why market solutions dominate the other solutions presented here.

1.4.1 Sender-Sided Pricing Solutions

Economic solutions have been proposed to reduce spam and information overload. The general solution is to impose a monetary cost on the senders who are sending messages (Fahlman, 2002; Solan & Reshef, 2005; Krishnamurthy & Blackmond, 2004; Walfish *et al.*, 2006; Back, 2001). The idea is conceptually analogous to paying with postage stamps when sending mail. Doing so shifts the burden of identifying unwanted communication to senders, who are knowledgeable about the purpose and content of communication (van Zandt, 2004). Frivolous requests may be reduced because the incremental costs for sending a message force the senders to be selective, sending requests only if they believe that the value of

the exchange is higher than the cost to send it. This idea of economic pricing has been experimented with in the forms of stamps, taxes, surcharges and auctions (Dwork & Naor, 1993; Krishnamurthy & Blackmond, 2004).

However, like filter technologies, these mechanisms are one-sided and do not simultaneously take into account both parties' communication contexts. What is valuable to the sender may not be valuable to the receiver; the sender's willingness to pay more for a communication does not necessary make the communication more desirable to the receivers. This is perhaps why Kraut *et al.'s* empirical study on using variable rate postage to reduce spam showed that, while such mechanism reduced communication, receivers did not see postage as a signal of communication value (Kraut *et al.*, 2005). Even though unwanted exchanges may be reduced, costly interruptions from undesired exchange requests may still occur.

1.4.2 Two-Sided Market Solutions

Another type of economic solution is the use of two-sided payment markets. Economic markets are social institutions on which we have relied to organize complex, large-scale production and exchange (Smith, 1776; Hayek, 1945; Fiske, 1992). Similar to the ways in which we use markets to sell and purchase physical goods, these market mechanisms may also be used to facilitate efficient exchange of information and attention (Fahlman, 2002; Hermalin & Kats, 2004; Cheng *et al.*, 2007; Reeves *et al.*, 2008). Applied in this domain, the sender (who is requesting attention and information) is the buyer, and the receiver (who is providing the commodities) is the seller. Information, attention, and time are the resources exchanged. The information senders can financially compensate the information receivers for their time, attention, and information.

In a two-sided market, the decision on how to handle a communication is no longer made by one party; instead it is made in a distributed way, by all of the parties involved (Hayek, 1945). First, senders use the offered price to signal how valuable the exchange is to them. The guarantee of financial rewards will then act as signals, allowing receivers to know, *ex ante*, the degree to which they will benefit if they participate in the exchange. The receivers can then make informed decisions about whether or not it is beneficial for them participate. In standard economic theory, as each parties try to maximize his/her own benefits in the market, an efficient outcome can be reached (Smith, 1776).

Recently, Loder *et al.* showed analytically how this type of market can out-perform a simple sender-sided tax mechanism and even "perfect" technology filters under certain scenarii (Loder *et al.*, 2006). Conceptually, this two-sided market design is better than single sided markets and technology solutions because it enables wealth-transfer. Senders are able to share their potential gains from the exchange with

the receivers. Suppose the sender values an exchange to be $1,000 while the receiver incurs a $10 cost for participating in the exchange. Two-sided markets will enable senders to offset receivers' costs for participating in these help exchanges. A communication that originally is valuable only to the sender can be made valuable to both parties.

Therefore, with this market design, not only may there be fewer unwanted exchanges, there may also *more* mutually-beneficial exchanges. This solution not only maximizes individual gains from information exchanges, but also social welfare.

1.5 Research Problems

In theory, market pricing can mitigate the information asymmetry problem, and the transferring of incentives may reduce motivation asymmetry. If individuals behave as predicted by economic theories, then the outcome of information exchange will become more efficient.

Standard economic theories and Loder *et al.'s* proof both make certain psychologically unrealistic assumptions (Rabin, 2002), though. This is why the field of behavioral economics has arisen from the joining of economics and psychology to create more realistic models of human behavior. This field of research suggests that people are not completely rational decision makers and deciding how to use the prices can introduce additional transaction costs, such as cognitive costs (Simon, 1955; Simon, 1978; Kahneman, 2003). Furthermore, adding financial incentives to an exchange may actually undermine people's intrinsic motivations to participate, resulting in lower effort (Fehr & Gaechter, 2001; Deci *et al.*, 1999) and changing the fundamental nature of the interaction: a once altruistic, social transaction now becomes a financial exchange (Gneezy & Rustichini, 2000; Heyman & Ariely, 2004).

However, despite this growing set of behavioral economics research, it is only recently that the advances in payment technologies make market-based technologies a possible reality. On one hand, this enables us to advance our theoretical understanding by testing behavioral economic predictions in more realistic settings. On the other hand, applying market mechanisms in our technologies, such as using them for information exchange, raises additional human-computer interaction research questions.

The goal of this thesis is to address the following research questions:

1. **Can markets actually help?** Can people use market pricing to support their information exchange? Can high cognitive costs from using markets for information exchange undermine the gains from the improved efficiency?

2. **How do we design real-time markets for information exchange?** If markets can be integrated with everyday information exchange, what would such markets "look" like? What sorts of interaction support is needed to improve user experience?

3. **What are the conditions under which markets may be most useful for information exchange?** Does using financial incentives crowd out people's intrinsic motivations for information exchange? Would a market framing alter interpersonal relationships between those exchanging information?

1.6 Research Approach

For all intents and purposes, this is a Human-Computer Interaction (HCI) dissertation. What sets HCI apart from many traditional domains in the sciences or social sciences is its emphasis on technology. It makes the field applied; research findings will ultimately have an impact on how we interact with technologies. Furthermore, what is studied and how we must study it is constantly changing since technology is always advancing. These, I believe, are the primary reasons why HCI has not established a single standard research approach. If HCI becomes too rigid in its approach, over time, researchers will not be able to find the interesting research questions or offer insightful and practical answers.

It is in this nature of HCI that this work explores both practical and theoretical questions, drawing on concepts and theories from a broad range of related domains, including computer science, economics, and psychology. Answering the practical questions leads to design guidelines that may be immediately applicable to improving existing technologies, whereas answering the theoretical questions enables us to leverage new technologies to obtain a better understanding of fundamental human behaviors in ways not possible before. To answer these research questions appropriately, a mixed method has been employed in both laboratory and field settings. Laboratory testing provides the control to establish theoretical understanding of market's affect on information exchange and social relationships firmly, while field deployments and studies illuminate the real usage of information exchange markets to generate realistic design guidelines.

1.7 Impact

Findings from this study provide a better understanding of the strengths and weaknesses of applying economic markets for interpersonal information exchange. However, it can more broadly elucidate how humans interact with economic markets. Contributions include:

- Empirical support for economic markets' ability to improve the efficiency of interpersonal information exchange,
- An understanding of how economic markets affect question and answer behavior, and
- Elucidating the intricate relationship between financial rewards and social relationships.

Findings from this work can improve the design of question and answer systems to support the allocation of humans' valuable resources of attention and time. Findings can also be applied to support communication in general and to the building and sustaining of online communities. Contributions include:

- Construction of the first-ever real-time, market-based question and answer system (Q&A),
- Providing design guidelines on how to build and improve interpersonal information exchange, and
- Revealing pitfalls and challenges in leveraging financial incentives in social systems.

1.8 Dissertation Organization

The remainder of the dissertation is organized as follows:

Chapter 2 presents an empirical lab study that tests market mechanisms' ability to improve communication efficiency. Results support the claim that markets can improve efficiency. However, these markets need to be carefully designed to minimize cognitive overhead costs from using the market.

Chapter 3 explores the use of markets in a real-world setting – for question and answer (Q&A). It does so by building and testing a market-based real-time Q&A service through a field deployment and by analyzing a commercial market-based Q&A site. Findings suggest that paying more may attract more and longer answers, but perhaps not better answers.

Chapter 4 studies the impacts of financial incentives on social relationships. Findings suggest that using markets for information exchange may reduce socially-oriented interactions and undermine long-term interpersonal relationships.

Chapter 5 concludes this dissertation with a discussion of findings and presents several interesting areas of future work.

Chapter 2

MARKETS CAN HELP*

This chapter defines efficiency for interpersonal information exchange and empirically demonstrates that human users can indeed use markets to improve their exchange efficiencies, even though people are not completely rational decision makers. It also examines how certain transaction costs (decision costs) can have an impact on the efficiencies of these markets for information exchange.

2.1 Efficient Interpersonal Exchange

Loder *et al.* proved analytically that market mechanisms can be used to facilitate information communication (2006). Instead of re-presenting the proof here, the graphical model that they presented to highlight the inefficiencies in information exchange and how market helps is presented below (see Fig. 2.1).

In the graphical model presented, s denotes sender value and r the receiver value, and the <s, r> plane represents the whole exchange space. Additionally, c_s denotes the cost, to the sender, of initiating the communication while c_r denotes the cost of receiving and participating in the exchange for the receivers. The difference between value and cost is the surplus; SS for sender surplus and RS for receiver surplus.

The cost lines divide up the set of exchanges into the four types of exchange outcomes as presented in Chapter 1. Senders gain from participating in type 1 and type 2 exchanges, so they have an incentive to initiate those two types of requests. On the other hand, receivers only benefit from participating in type 1 (out of these two initiated) exchanges. Unfortunately for receivers, because of information asymmetry, they cannot tell which incoming requests are type 1 and which ones are type 2, *ex ante* to the exchange. This leads to real world problems for the receivers, where only some exchanges are desired but they cannot tell, *ex ante*, which ones. Not only are they likely to overlook some of the valuable ones, but they are also susceptible to interruption and overloading from costly and undesired exchanges. If receivers choose simply to ignore *all* incoming messages, as they sometimes do when really busy, they may miss some beneficial or even urgent exchanges. On the other hand, if receivers choose to respond to all

* Parts of this chapter are adapted from Hsieh, G., Kraut, R., Hudson, S.E., & Weber, R. (2008).

incoming requests, then they will engage in many exchanges that they wish, in hindsight, that they had not.

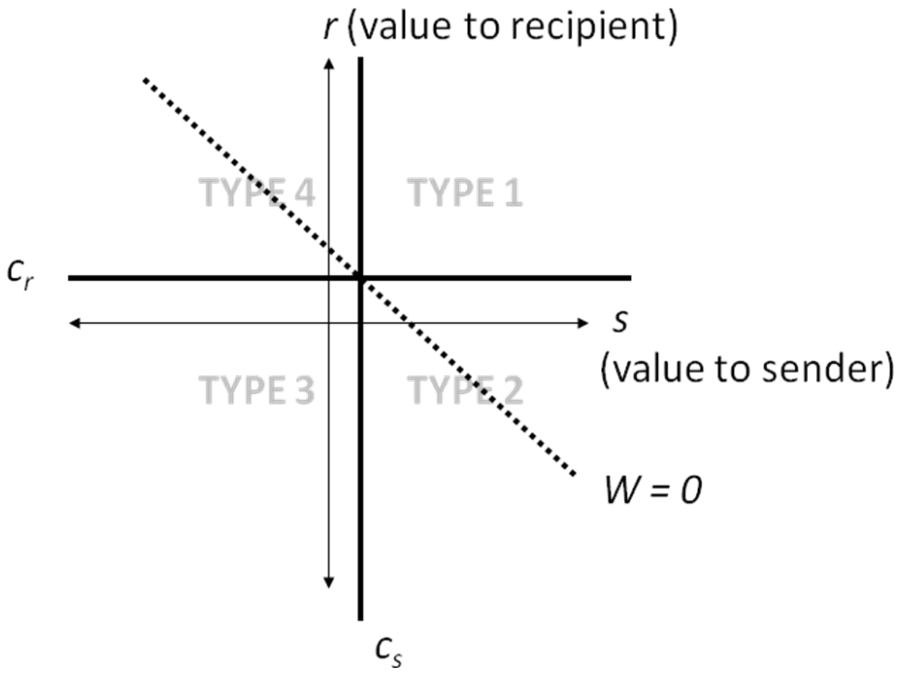


Figure 2.1 Graphical model of exchange outcomes

Given that what benefits senders may not benefit receivers, what is the desired outcome for interpersonal information exchange? It seems obvious that if an exchange results in positive surplus for both sides (type 1), then an exchange should occur. This is because both sides would gain from having this type of exchange. Similarly, if an exchange does not benefit either side (type 4) then there is no reason for it to occur. But what about the other two types of exchanges where only one side benefits (type 2 and 3)? Are there scenarii in which it is more efficient if these exchanges *do* take place? How should we define efficiency?

In welfare economics, efficiency refers to the use of resources to maximize the welfare of the society. In this setting, welfare is the combined surplus of the senders and the receivers ($W = r - c_r + s - c_s$). Efficiency is therefore maximized when all welfare-improving exchanges take place and others do not. In the graphical model, an intervention is efficient when it maximizes the number of exchanges above (and to the right of) the welfare equals zero line (W) and minimizes the number of exchanges below (and to the left of) the line.

To illustrate this idea of welfare more concretely, consider what happened to Lisa, described in the introduction to Chapter 1. Recall that Lisa's dog, Marble, is puking a yellow substance and Lisa wants to know what is wrong with him. In this type of help-seeking exchange, the primary benefactor is Lisa and responding to it may offer little or no direct reward for the person providing help. This is a type 2, one-sided exchange. While receivers may not want to be interrupted by and engage in these exchanges, from a social welfare perspective, as long as Lisa's value from help outweighs the receivers' cost to give help, then this exchange ought to take place. This is because this type of exchange will be able to result in a positive increase in the welfare of the society as a whole.

Loder *et al.* demonstrated analytically that two-sided markets can result in higher welfare than when there is no market intervention (status quo, open access) and than when other alternative solutions, such as fixed-tax and technology filters, are in place. Their proposed solution, the Attention Bond Mechanism (ABM), works by having receivers post a take-it-or-leave-it bond price. Senders, in order to engage in the exchange, must then pay the posted price. Conceptually, this type of market is analogous to consultants posting their hourly fees and clients paying them if they desire the service. ABM dominates filters and taxes because the other solutions work by maximizing the mutually beneficial exchanges (type 1) but, in doing so, also filter out the subset of type 2 and type 3 exchanges that are still welfare-improving. ABM, on the other hand, enables senders to share their gains from exchange with receivers, which allows senders and receivers both to benefit from these previously one-sided exchanges. For example, if we quantify Lisa's surplus from the exchange as $1,000, and a helper incurs a $10 cost. With this type of market solutions, Lisa can offer some of that gain to the helper (say $100), which will make both Lisa *and* the helper (and, of course, the sick dog) better off.

2.2 Unrealistic Assumptions

While, in theory, these markets can improve exchange efficiency, there are some uncertainties about their usefulness in practice. This is because economic markets and the Attention Bond Mechanism make standard economic assumptions about the users that are unrealistic.

The first assumption is that humans are *homo economicus,* or rational and narrowly self-interested actors. As many prior studies have demonstrated, *homo economicus* is an over-simplified and often unrealistic model of actual human actors (*e.g.*, Thaler, 1994; Rabin, 2002). People do not act only to maximize their own welfare. Research on public goods has shown that people are willing and sometimes do contribute to public goods even when incurring a cost (Ledyard, 1995; Fehr & Fischbacher, 2004; Benkler, 2002). This violation of a purely *homo economicus* model of human behavior raises doubts about the usefulness of

financial pricing in a market system. If people are willing to provide help regardless of the financial rewards offered or costs incurred, pricing (as signals) may be ignored. Prior work has not demonstrated empirically that using markets for information exchange can actually result in higher efficiency.

The second assumption is that we are perfect Bayesian information processors, and can make all valuation decisions right away (Rabin, 2002). Research has shown that we do not make instantaneous decisions (Card, Moran and Newell, 1983), and that making decisions incurs a cost (Simon, 1955; Simon, 1978; Coombs, 1964, Dawes, 1964, Simon & Newell, 1971; Shugan, 1980; Kahneman, 2003). As Coase points out, transaction acts may undermine the value of the markets (Coase, 1937), and, perhaps, market mechanisms that require higher deliberation cost can undermine the potential gains. This can impact the market design. Perhaps a simpler market with fewer options may result in higher efficiency gains than a more expressive, but more complex, market mechanism.

Therefore, there are two specific questions that this chapter seeks to answer. One: given that people are not perfectly rational, can economic markets still improve the overall efficiency of information exchange? Two: can high cognitive/transaction costs undermine the efficiency of economic markets? To answer these questions, the study presented herein compares the efficiencies and usages of three information exchange designs: a no market design as baseline condition, a complex variable-price market design (similar to that of ABM), and a simple fixed-price market design.

2.2.1 No Market

Consider a simple information exchange scenario between strangers. In this scenario, senders are the requesters for information and receivers are the potential providers of information. Senders are the primary benefactors when the exchange occurs, while the receivers gain nothing financially for participating in the exchange. Let us assume for this experiment that the costs are negligible on a per-exchange basis, as these costs are often amortized over a period of time. However, there are still opportunity costs — what the receivers could have gained if they did not provide help and instead allocated their time and attention resources elsewhere. Thus, senders' and receivers' valuations can be represented by these equations:

$$SS_0 = s$$

$$RS_0 = -c_r$$

These equations would predict that senders will always send out exchange requests when they need help whereas receivers will never engage in the exchange.

However, there are often non-direct factors that have impact on valuation. Non-financial motivators such as altruism may add additional costs to senders when asking for help but may also motivate receivers to provide help voluntarily, regardless of the lack of gain. Hence, what we would actually expect is that senders will refrain from bombarding providers with excessive help requests (*i.e.*, help requests will be less than 100%) and that receivers will offer some help.

$$SS_0 = s - c_{r\_\text{int}rinsic}$$

$$RS_0 = r_{Intrinsic} - c_r$$

2.2.2 Variable-Price Market

Loder *et al.* proved analytically that a two-sided variable-price market design can result in higher welfare than the no market (open access) scenario. In Loder *et al.'s* Attention Bond Mechanism (ABM), receivers post a take-it-or-leave-it price and the senders decide whether or not to pay that price for communication. Here, I use a slightly different variation ABM to contrast against the baseline no market mechanism.

In my *variable-price* design, senders place a bid on how much they would pay for the exchange, and receivers set a reservation price on how much they need to be paid to respond to an information exchange request. Communication occurs when the bid is higher than or equal to the reservation price. The final payment amount is the reservation price as set by the sender. I chose this market design as it seems more appropriate for synchronous communication. Receivers' prices may change many times over time, and they should not be required to post new prices every few seconds. Instead, this should be done solely on a need-only basis; whenever there is a request for exchange.

With this model, we can express senders' and receivers' valuation as:

$$SS_M = s - c_{r\_\text{int}rinsic} - payment_{Help}$$

$$RS_M = r_{\text{int}rinsic} - c_r + payment_{Help}$$

Rational senders in the *variable market* should place bids on help requests based on the value the communication has for them. For example, if they gain $0.25 from receiving the information, senders should offer to pay up to $0.25, minus the intrinsic costs discussed previously. In my setup, I allow senders to place $0 help request bids. Since help requests in the *no market* condition are essentially $0 bids, the *variable market* condition should result in about the same number of help requests as is in the *no market* condition.

Rational receivers, in this condition, should dynamically adjust their reserve prices to match their net costs from providing help. Because receivers in the *variable market* condition receive greater financial compensation when they offer help than in the *no market* condition, help should occur more frequently. I expect that senders and receivers should be able to use the market to their advantage; both getting help and giving help should improve their welfare.

2.2.3 Fixed-Price Market

While a variable market may in theory improve exchange efficiency, in practice, the expressiveness of the mechanism may result in higher cognitive decision costs. Senders and receivers have to make pricing estimations on a continuous scale, giving them an infinite number of choices. Even if we simplify the decision to a \$0.05 level (as I did for this experiment), there are still many options from which senders and receivers may choose.

To explore the issue of a cognitive transaction cost, I also studied a *fixed-price* design. In a fixed market condition, senders must offer to pay providers a fixed-price for each completed communication. In my study, the fixed price is set to \$0.20. The fixed-price condition represents a less expressive and less flexible version of the variable-price market. The payment value is restricted to just one value, instead of being opened to the continuous range of values available under the variable price mechanism. Therefore, senders and receivers can less precisely express the value and cost of the communication. This is, actually, identical to the flat-tax mechanism discussed in Loder *et al*., assuming that the tax payment is transferred to the receivers. And it is important to note that Loder *et al*. did demonstrate that the variable market solution dominates this fixed-price solution.

$$SS_{FM} = s - c_{r\_\text{int}rinsic} - \$0.20$$

$$RS_{FM} = r_{\text{int}rinsic} - c_r + \$0.20$$

In the *fixed-market* condition, rational senders should ask for help as long as the value of the communication exceeds the fixed payment threshold and receivers should offer help only if their opportunity cost to communicate is lower than the fixed payment. Similar to the variable-price condition, I expect the market to be used rationally and both getting help and giving help will lead to improvements in task performance. Because it is less fine-grained in this condition, however, the frequency of help produced by the mechanism will be lower. For example, in the fixed-price market, senders who would gain \$0.19 from receiving help would not ask for help because their gain is less than the \$0.20 fixed price.

In contrast, in the *variable-market*, requesters can offer less than \$0.19 and enable more welfare-increasing help to occur.

However, the *variable-market* may also be less effective than the *fixed-market*, producing lower overall welfare. Cognitive limitation may interact with the additional complexity of the variable market to reverse the potential gains from increased expressiveness. The fine-grained decision that must be made in the *variable market* condition is much more complicated and requires more time and attention for the decision than the coarse-grained decision in the *fixed market* condition. Instead of the binary decision of "should I pay \$0.20 for help?" senders in the *variable market* condition are instead faced with two decisions — "should I pay for help?" and, if so, "how much should I pay?" Similarly, rather than simply deciding whether or not to accept a \$0.20 payment for responding to an exchange request, as in the *fixed market* condition, receivers in the *variable market* condition must determine the precise opportunity cost.

These additional costs for using the market mechanism are a type of transaction cost incurred during the decision process, so they are hard to model as an independent factor. As Conlisk points out, there is a regress problem (Conlisk, 1996). We would need to factor in deliberation costs in our deliberation, but deliberating on deliberation adds additional deliberation costs. This results in an endless regression. Here, to provide an intuitive understanding of how these costs can impact exchanges, I will simply use $c_{s\_decision}$ and $c_{r\_decision}$ as two functions to denote the decision costs to senders and receivers respectively. Some prior research on choice problems has simply modeled these costs as number of comparisons times the cost of comparing two options (Shugan, 1980; Conlisk, 1996). Here, I chose to represent these costs, simply, with a cost function that takes in the number of alternatives (comparisons) as the argument, and these functions are monotonically increasing against the number of comparisons.

$$SS_0 = s - c_{s\_\text{int}rinsic} - c_{decision}(1)$$

$$RS_0 = r_{\text{int}rinsic} - c_r - c_{decision}(1)$$

$$SS_M = s - c_{s\_\text{int}rinsic} - payment_{Help} - c_{decision}(n)$$

$$RS_M = r_{\text{int}rinsic} - c_r + Payment_{Help} - c_{decision}(n)$$

$$SS_{FM} = s - c_{s\_\text{int}rinsic} - \$0.20 - c_{decision}(1)$$

$$RS_{FM} = r_{\text{int}rinsic} - c_r + \$0.20 - c_{decision}(1)$$

2.3 Hypotheses

In (Hsieh, 2008) more hypotheses were presented. However, here I focus on the four main hypotheses:

On Market Use:

H1. The percentage of help requests will be higher in both no-market and variable-market conditions than in the fixed-market condition; the percentage of help requests will not differ between no-market and variable-market conditions.

H2. The percentage of help exchanges will be highest in the variable-market condition, second highest in the fixed-market condition.

On Market Efficiency:

H3. Market mechanisms (fixed- and variable-market conditions) will lead to higher welfare than the no-market condition.

H4. A fixed-price (less expressive, less complicated) system will lead to higher welfare than a variable-price (more expressive, more complicated) system.

2.4 Study Setup

To test these hypotheses, I developed a study in which participants worked on a task independently in four-person sessions. Participants broadcasted help request and provided help to other participants in the session.

Each session was assigned to one of three different communication mechanisms (*variable-market*, *fixed-market*, *no-market*) and each participant played both the role of requester and provider concurrently. Tasks were solving memory/concentration puzzles.

The goal of the puzzle was to find the locations of the matching celebrity faces from a set of cards containing pairs of celebrity faces (Figure 2.2). At the start of each puzzle, the cards were placed face down. Participants were allowed to flip over two cards at once. If the two cards matched, they would remain face up; otherwise, they would be turned face down automatically. We selected this game because: (1) most participants are familiar with it; (2) it provides the participants a good sense of task progress; (3) it is quick, allowing us to collect data from repeated plays, and (4) most importantly, interruptions lead to costs similar to real life communication (players cannot continue with their own work when communicating).

Participants earned one cent for each pair of faces they matched. Participants also earned a puzzle bonus for solving the whole puzzle (*i.e.*, matching all the faces in the set). The bonus was $0.25, $0.50 or $0.75 and was randomly selected and made visible at the start of each puzzle. Variations in puzzle bonus allowed me to examine the effects of task value on participants' assessment of the value of communication. Participants had 90 seconds to work on each puzzle. After participants solved a puzzle or if the time expired before solving one, the puzzle refreshed itself (all cards turned face down with location randomized). The size of individual puzzles varied randomly from 26 to 40 cards. Puzzle value and puzzle size were not correlated, and participants were informed of this independence.

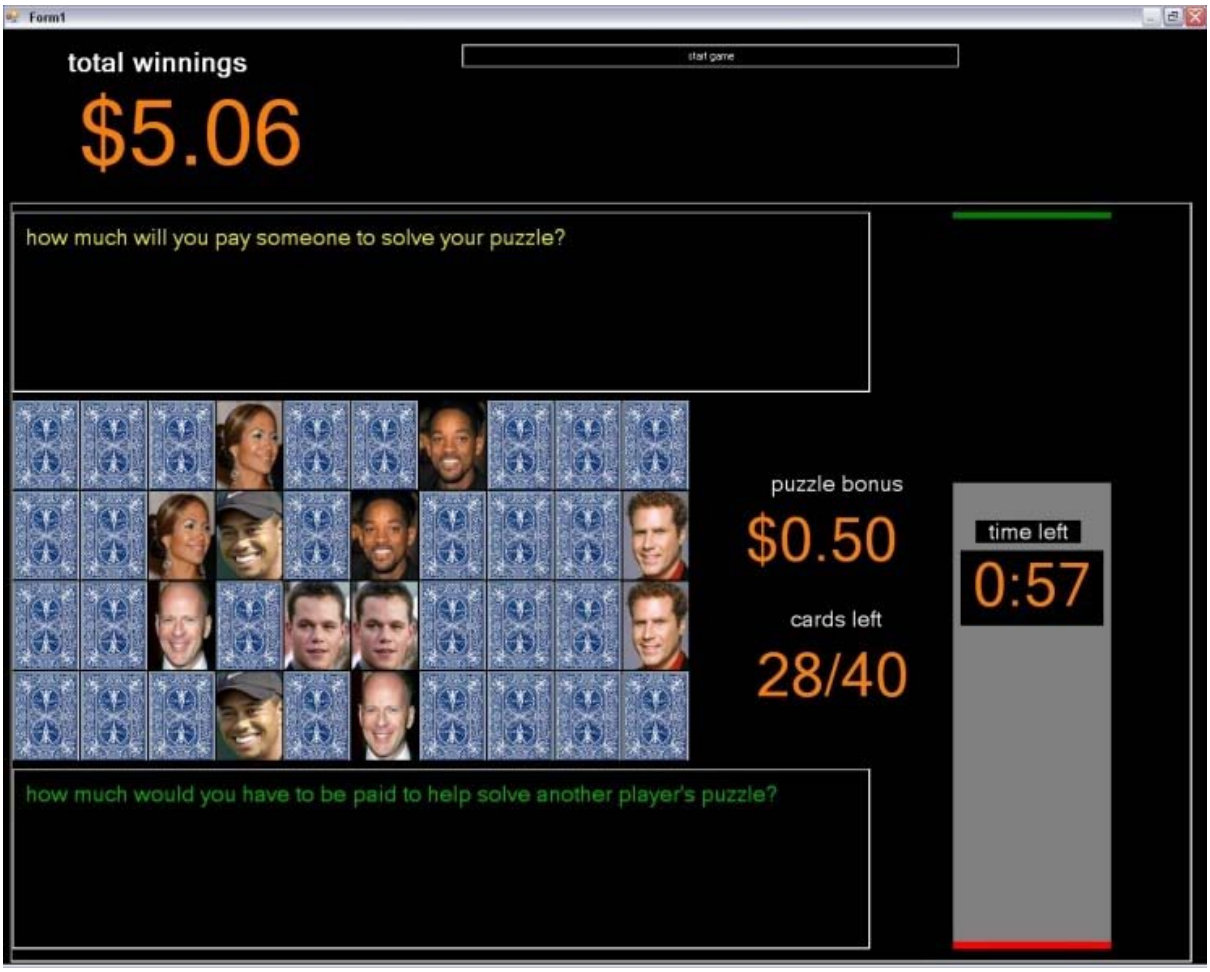


Figure 2.2 Game Interface

2.4.1 Communication Mechanism Manipulations

During each puzzle, each participant had one opportunity to ask for help from other participants in his/her session. The time for this opportunity was randomly selected, from the start of the puzzle up until 20

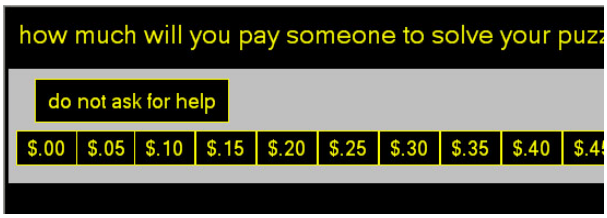
seconds remained on that particular puzzle. When this “bidding opportunity” occurred, that individual participant’s puzzle paused. Prior to continuing work on the puzzle, the participant had to decide if s/he wanted to ask for help. If s/he chose to ask for help, his/her help request was broadcast to all other players anonymously.

Participants were given one randomly-timed opportunity to ask for help during each puzzle. This design is different from what we might expect from real-world communication, where people can request for and decide to provide help at any point in their task. I chose this design because it allowed me to measure the time spent on making each decision and because it allowed random sampling of choices made at several points during the puzzle-completion process.

If a request was made, each provider’s puzzle paused. Providers then had to decide how to handle the request. When providers decided to help the requester, the software controlled the help interaction: all help exchanges were computerized and took 15 seconds. This controlled help guaranteed help exchanges when requests were accepted and enabled providers to know beforehand the exact time cost for providing help. As soon as any one provider agreed to help, all help requests to the other players were canceled. This design made the setup more representative of the real time nature of the communication — if a requester receives sufficient help from someone, no subsequent help from others will add value to the requester.

(a)

(b)



(c)

Figure 2.3 Help requesting options for (a) no-market, (b) variable-market, and (c) fixed-market

In the *no-market* condition, the interface manipulation was simple. At the bidding opportunity, participants were asked to select either "ask for help" or "do not ask for help" (Figure 2.3a). On the providers' side, providers were asked to choose between "provide help" or "do not provide help."

In *fixed-market* condition, the interface manipulation was similar to that of *no-market*. At the bidding opportunity, participants were asked to choose to pay $0.20 to "ask for help" or "do not ask for help" (Figure 2.3b). On the providers' side, providers were asked to choose between providing help for $0.20, or not providing help. For the study, selecting a different fixed-price value should not influence hypotheses; any fixed price is a less expressive version of the *variable-market* condition.

In the *variable-market* condition, requesters had the option to bid an amount from $0.00 up to the current puzzle bonus at $0.05 increments, and a separate option to select not to bid (Figure 2.3c). Unless a "reject help" option was selected, a help request was broadcast to the other players. Upon receipt of a help request, providers did not see the bid. Instead, they selected a reserve price between $0.00 and $0.75 at $0.05 increments. Providers could also directly choose not to provide help.

We chose to restrict the number of options to $0.05 increments to keep the interface consistent. Even with this simplification, the *variable-market* condition is still a much more expressive system than the *fixed-market* condition.

2.5 Results

One hundred eight (108) students from a university participated in this study for monetary reward (36 per condition). Participants were randomly assigned into one of the three conditions (between subjects). Each participant worked on the primary task for 27 minutes.

2.5.1 H1-Help Requests

I hypothesized that requesters in both the *no-market* and *variable-market* conditions would ask for help with roughly the same help request percentage, since requesters in both conditions can broadcast for help without paying. In contrast, players in the *fixed-market* condition would ask for help only for a subset of request opportunities (when their communication value was greater than $0.20).

	no-market	*variable-market*	*fixed-market*
Request Opportunities	19.6	19.9	21.1
Actual Help Requests % help requests/opportunities	11.4 (58%)	11.5 (58%)	9.1 (43%)
Instances of Help % help exchanges/requests	6.2 (54%)	6.1 (53%)	8.4 (92%)

Table 2.1 Help requests and exchanges breakdown

As I hypothesized, participants made more help requests in the *no-market* and *variable-market* conditions than the *fixed-market* ($F(2, 105)=2.39$, $p=0.096$). It is interesting to note that only about 60% of all request opportunities in the *no-market* condition led to help requests (Table 2.1). This may indicate either the strength of intrinsic motivations or the belief that help requests may go unanswered.

2.5.2 H2-Help Exchanges

I predicted that the *variable-market* condition would result in the highest percentage of help exchanges, followed by the *fixed-market* condition, and then the *no-market* condition. Surprisingly, as shown in

Table 1 line 3, my results disconfirm this hypothesis. The *fixed-market* actually led to the highest percentage of help exchanges, while the *no-market* and *variable-market* had about the same percentage of puzzles helped. The results are surprising since the *fixed-market* condition, the less expressive market, led to more help exchanges than the variable market condition ($F(2,71)=25.6$, $p<0.001$). A possible explanation is that the more fine-grained decisions in the *variable-market* leave less room for error in decision making, and may have resulted in more missed help opportunities.

2.5.3 H3-Efficiency of Market versus No-Market

Given that players in market conditions were able to use the market to improve their welfare, did the market conditions lead to higher welfare (overall earnings) when compared to the *no-market* condition?

When grouping the market conditions together, markets did perform better than *no-market* by a dollar ($9.80 to $8.80, $F(1,106) = 3.30$, $p<0.07$). This suggests some modest efficiency gains from applying market mechanisms in real world communication.

2.5.4 H4-Variable-Market versus Fixed-Market

	no-market	*variable-market*	*fixed-market*
Earning from puzzle bonus	$3.52	$3.81	$3.75
Earning from matching pairs	$2.20	$2.11	$2.17
Earnings from getting help	$3.10	$2.31	$2.78
Earnings from giving help	$0.00	$1.05	$1.67
Total Earnings	$8.81	$9.28	$10.37

Table 2.2 Breakdown of earnings by components

When analyzing the markets individually, it becomes apparent that the difference in earning between the market conditions and *no-market* condition is due mainly to the significant difference between *fixed-market* and *no-market*, and not *variable-market* and *n- market* (*no-market*=$8.81, *fixed-market*=$10.37, *variable-market*=$9.28). Pair-wise analysis shows that earning in *fixed-market* is significantly higher than *no-market* ($F(1,105)=5.94$, $p=0.02$) and marginally higher than *variable-market* ($F(1,105)=2.90$, $p=0.09$), whereas there is no significant difference in earnings between *variable-market* and *no-market* ($F(1,105)=0.5$, $p=0.5$).

When separately examining four components of earnings, we see that the overall difference between the conditions is a result of money players earn from using the communication mechanism (Table 2.2).

One possible explanation for why *fixed-market* led to higher welfare than *variable-market* is that, because it is a much simpler system, it requires less use and familiarity. Perhaps participants need to learn to use *variable-market* through experience. I therefore compared average earnings from each condition between the first and second half of the study (13.5 minutes each). While there does appear to be a general increasing trend in earnings in all conditions, the ranking of the conditions was consistent between the two stages — *fixed-market* performed the best, then *variable-market*, then *no-market* (Figure 2.4 First half earnings versus second half earnings).

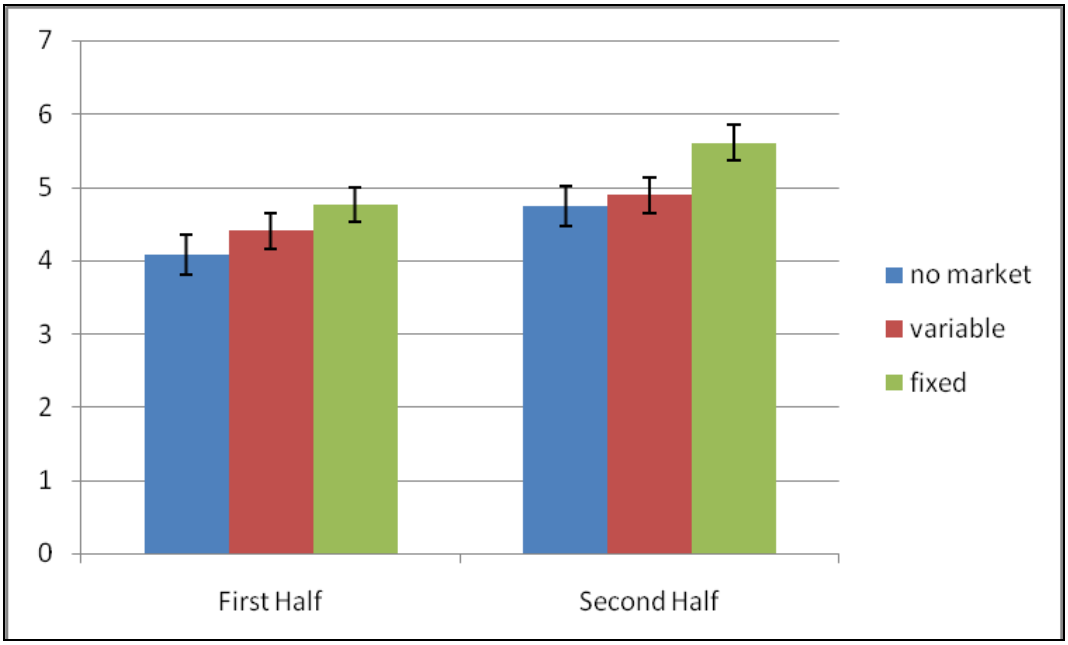


Figure 2.4 First half earnings versus second half earnings

Another explanation for this performance difference is transaction costs due to cognitive limitations. Transaction costs can have two different types of effects on the communication market. First, as mentioned in my analysis of help exchanges, the more complicated and finer-grained decision leave less room for error by both requesters and providers. Finer-grained decisions give requesters more chances to overbid for help while providers are also more likely to overprice the reserve value of their help. The greater complexity of the *variable-market* may simply add error to the behavior of requesters and providers, thus leading to fewer mutually beneficial help exchanges in the *variable- market* condition than

hypothesized. Unfortunately, given the subjective component of gains and costs for both requesters and providers, it is impossible to identify precisely such error in their behavior.

Another possible transaction cost effect is that more time and attention may be required to make a decision. Participants in *fixed-market* only have to decide whether or not to request/offer help for $0.20, instead of determining the exact communication value as they do in the *variable-market condition*. The simplicity of the decision at hand could significantly reduce the time required for decisions. I, therefore, compared the time players spent on each decision and found a significant difference in decision time (Table 2.3). *Fixed-market* is lowest at 1.774 seconds, then *no-market* at 2.165 seconds, and then *variable-market* at 2.881 seconds ($F(2,105)=18.45$, $p<0.0001$). If we compare the total time used on decisions between the *variable-market* condition and the *fixed-market* condition, participants spent, on average, 70 seconds more on their decisions in the *variable-market* condition. Based on *fixed-market* participant performance, having 70 extra seconds can yield an additional $0.40 in earnings. While this alone may not explain all of the earning difference between *fixed-market* and *variable-market*, it does contribute to some of it.

	no-market	*variable-market*	*fixed-market*
Time Spent on Decisions	2.165s	2.881s	1.774s

Table 2.3 Time spent on decision

It is interesting to note that decision time in *fixed-market* was also significantly faster than *no-market*. One possible explanation is that the decision in market mechanisms may be dominated by weighing extrinsic costs and benefits, while the decision in *no-market*, based on intrinsic motivation, may be more convoluted and require more time.

2.6 Discussion & Limitations

If humans are rational self-interested agents, then communication would never occur when receivers have nothing to gain. In the scenario of questions and answers, no help would be offered, as the sender is the only party benefiting financially from such an interaction.

But as this study shows, help in the *no-market* condition occurred as frequently as in the expressive market condition (*variable-market*). This means that, even between anonymous strangers, people do not act solely to maximize their own personal, immediate monetary gain. Prior work on public goods and

altruistic behavior provide evidence that people voluntarily help others, especially when they expect others to do so. In this kind of problem, players face a decision to help others, but at a personal cost that exceeds one's personal benefit (*e.g.*, Ledyard, 1995). The results presented herein, like results from these prior studies, demonstrate that the strong predictions of self-interest and rationality (which postulate that no voluntary help will occur) are wrong.

Thus, individuals' willingness to help others voluntarily should be an important factor to remember as we evaluate market-based communication mechanisms. Often, we use the *no-market* condition as a baseline comparison point, but communication behavior in the *no-market* condition is neither as straightforward nor as inefficient as traditional economic analyses suggest. Even without explicit incentives, implicit incentives can have significant impact on communication decisions. Moreover, while this study's results assumed a simple additive effect between extrinsic and intrinsic motivations, explicit incentives may sometimes "crowd out" implicit incentives, thereby reducing the willingness of individuals to help voluntarily (*e.g.*, Deci & Koestner & Ryan, 1999). Further research is required to explore such effects in this communication market domain.

Compared to Loder *et al.'s* analytical proofs, one of the most important findings in this study is that the fixed-price mechanism led to the most exchanges of help and the highest overall earnings. This is especially significant because our fixed-market is actually identical to a flat-tax mechanism, where the tax payment is transferred to the receivers, and that Loder *et al.* showed analytically that the more expressive market is superior in comparison. The richer communication available through the variable market should have led to better allocation of resources.

I put forth two possible explanations for the *fixed-market* condition outperforming the *variable-market*. One is that the additional complexity and extra options available in the *variable-market* condition may have led to more errors in requesting or granting help. The other is that the *variable-market* condition may have introduced additional decision costs, which I indirectly measured by considering the time it took to make decisions. As we demonstrated in the results, the more complex decision took longer, resulting in a $0.40 earnings difference, which explains some of the overall earnings difference.

2.6.1 Practical Contributions

One of the underlying motivations of this work was to test whether people can use market mechanisms in real-time to improve communication efficiency. My work demonstrates that people can, to a certain degree, use prices as signals to reflect their communication value and reserve prices to filter out unwanted communication. However, the fact that a fixed-price mechanism led to better performance than a variable pricing mechanism poses many implications for human-market communication interactions. First, for

real-time synchronous communication, a fixed contract or a limited option market design might be more suitable to reduce the transaction cost. Having a more expressive market might not be able to offset the loss in time spent on decision-making. More generally, if highly expressive markets are to be applied to facilitate resource management in our everyday technologies, designers of human-market communication interfaces must consider human decision costs, such as time.

Another set of technology implications deals with non-optimal use of markets. To maximize the gain of efficiency from markets, humans need to act like agents from economic models. When they do not, technology interventions may be introduced to provide guidance for how markets should be used.

2.6.2 Limitations

The stylized task used in the study exhibits many features representative of everyday tasks (deadline, task value, and noticeable incremental progress). While it lacks realism, the simplification does allow communication costs and benefits to be modeled and provides for clear analysis the influences of the mechanisms on task performance.

There were two specific controls in this study setup that are unrealistic. One is that the content and the quality of help exchange were controlled. The other is that relationship between communicators is also controlled – the exchanges were anonymous. To understand fully the strengths and weakness of employing market mechanisms for information exchange, we must examine the market's impact on exchange quality and social relationships.

Chapter 3

MARKETS FOR Q&A*

This chapter applies market mechanisms to information exchange in question and answer (Q&A) setting. It examines how paying for answers affects both the type and the quality of exchanges in Q&A services. This is accomplished by experimenting on a real-time Q&A service built (mimir) by the author and through analyzing usage on a commercial pay-for-answer Q&A site (Mahalo Answers).

3.1 Question and Answer Services

Q&A sites are increasingly popular. These sites offer an alternative to traditional search engines and act as communities where users can contribute and share knowledge. Users can ask questions and have them answered by other users. The generated content can then provide archival value and support knowledge searches in the future. Yahoo! Answers, one of the most popular Q&A sites, averaged about 80,000+ questions and 4 million unique visitors daily (Google trends for Yahoo Answers).

Q&A services differ in many subtle yet important ways. One difference is the media in which the exchanges take place. Most of these Q&A services are asynchronous, where users interact with each other through a website. However, others like Aardvark and Twitter Answers have expanded to include synchronous communication media, enabling real-time asking and answering of questions through instant messaging (IM) and short messaging service (SMS). Another difference is the answerer population. Some services leverage social networks to decide to whom to target the questions (Aardvark, Quora, Facebook). Others rely on a group of pre-screened "experts" to answer the questions (Google Answers). The breadth of topics the Q&As cover also differs. Some Q&A services serve a particular niche (*e.g.*, StackOverflow for programming questions) while others are broad and general Q&A services (*e.g.*, Yahoo! Answers). And finally, social Q&A services differ in the incentives offered. Most sites have incorporated some form of a reputation-based system to motivate contributors in the community, using badges and points. Yet another subset of social Q&A services, which is the focus of this chapter, use market mechanisms to facilitate Q&A.

* Parts of this chapter are adapted from Hsieh, G. & Counts, S. (2009) and Hsieh, G., Kraut, R., & Hudson, S.E. (2010).

3.1.1 Non-Productive Usages of Q&A

Like other communication media, Q&A services are hindered by motivation and information asymmetry between askers and answerers. Askers and answerers face similar problems of exchange overload and missed opportunities. Many have pointed out the overabundance of low-quality and non-productive exchanges on Q&A services (Leibenluft, 2007). These non-productive usages offer little direct benefit to the askers and can drown out important and serious questions and germane and useful responses posted. Without proper support, these frivolous questions may significantly undermine the usefulness of these Q&A sites for information exchange.

# Questions Analyzed	200
Average # of Answers	2.8 (SD=3.27)
% with answers	80%
% with best answers	56%
Average time until first answer (hh:mm:ss)	2:52:30
Average time until "best" answer (hh:mm:ss)	4:18:17

Table 3.1 Live QnA statistics

I began this thread of research by examining the makeup of questions in a non-paid Q&A site, Microsoft's Live QnA (MSN QnA). Live QnA started in August 2006 and by 2008 had more than 290,000 total registered users, 600,000 questions and 1.8 million answers. For my analysis, I randomly sampled 200 questions from Live QnA. I analyzed the questions and answers on various measures to understand the efficiency of this Q&A system (Table 3.1). Note that, in Live QnA, community voters determined the best answer to a given question, and that additional answers cannot be added to the question after the best answer has been selected. Question askers could vote as well, with their votes carrying three times the weight of non-askers.

I analyzed the composition of the questions asked on Live QnA using the question type breakdown employed by Harper *et al.* (2008). For this, I recruited 9 coders to categorize each of the 200 questions as "factual question," "advice question," "opinion question," or "not a question" (inter-rater reliability

α=0.89). Factual questions are questions asking for objective data, pointers to content etc. Opinion questions are questions asking for others' thoughts on a topic of general interest. Advice questions are questions asking for personal advice, recommendations based on the questioner's individual situation. Not questions are discussion-oriented questions and spam.

As suspected, there were a fairly high percentage of submitted inquiries that were not real questions (13%, Figure 3.1). We also recruited 8 coders to rate the seriousness of the questions asked, using a 5-point Likert scale where 1 is not serious, 3 is moderately serious and 5 is very serious (inter-rater reliability α=0.74). A serious question is defined as a question to which the coders believed the question asker really wanted an answer. I used this to get a sense of the percentage of "real" questions, as opposed to joking or frivolous questions. I took the median across participant ratings to get the seriousness rating per question. The mean of these ratings was 2.63 (SD=0.76).

A one-way ANOVA indicated a significant difference for seriousness across the four question types. Post-hoc analyses showed that advice (M=2.93) and factual (M=2.78) questions were significantly more serious than opinion (M=2.42) and non-questions (M = 2.13); all pair-wise p's < .01, except for the differences between advice and factual, and opinion and non-questions).

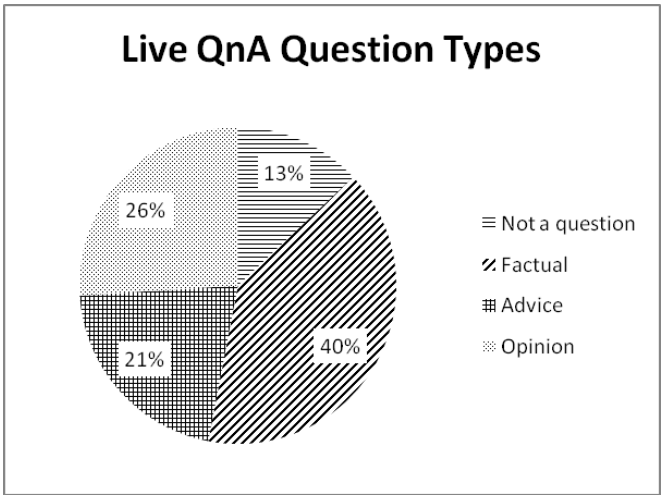


Figure 3.1 Breakdown of the types of question asked on Live QnA

Related research on Yahoo! Answers confirm the general concern that a high percentage of exchanges are not exchanging information, but instead are for social discussion (Adamic *et al.*, 2008) and that these discussions yield little or no archival value (Harper *et al.*, 2009). As Yahoo! Answers continue to grow,

"its overall quality as an information source for factoid question-answering degrades." (p.737, Liu & Agichtein, 2008).

3.1.2 Markets for Information Exchange

For the purpose of high quality information exchange, it appears that there is room for improvement. To maximize the limited answering resources availble, we need to ensure that these resources are allocated to the most valuable questions. As I have shown in the previous chapter, market models should be able to improve these exchanges. Applied in this domain, question askers can promise a financial payment for answers when asking questions. The pricing can act as signals to make the more valuable questions more prominent. Answerers can then filter questions based on the posted price, and, by answering the higher-paid questions to maximize their owns gains, also ensure that the most important and urgent questions receive due attention. This is very similar to the *variable-price* design presented in the previous empirical study.

There have been, in fact, a number of market-based Q&A sites launched within the past few years (*e.g.*, Google Answers, Mahalo Answers, Just Answers, UClue, AskBright). However, despite commercial interests, none of the market-based Q&A services has been successful. Google Answers, one of the earliest pay-for-answer sites, lasted for only three years and was shut down in 2006. The fate of Google Answers begs the question: are there real benefits in using markets for information exchange? How should we best utilize the market forces in Q&A? To answer these questions, I examine two aspects of Q&A that may be altered by a pay-for-answers design: question asking and question answering. Specifically, will question askers use the markets appropriately and signal their needs through pricing? Will answerers be motivated by financial incentives?

3.2 Field-Experiment with mimir

In order to study the impact of markets on Q&A through a controlled field experiment, I built my own Q&A service, mimir. It is the first real-time market-based Q&A system. Therefore, aside from the theoretical contributions, mimir is also, in and of itself, a research contribution, offering a design combining markets with real time Q&A services.

3.2.1 Hypotheses

3.2.1.1 Question Asking

Research in the general help-seeking domain suggests that people consider the costs and benefits when deciding whether or not to ask for help (*e.g.*, DePaulo & Fisher, 1980). On one hand, askers must determine how much they can gain from having the answers: the more useful the answers are to people's successful goal attainment, the more likely it is that they will ask for help. On the other hand, there are costs associated with requesting help. While there are, by definition, no monetary costs associated with free Q&A sites, there are psychological and social costs. Receiving help may reduce one's sense of competence and may also reduce one's external reputation (*e.g.*, Wills, 1976; Wills, 1978). Prior work examined how aversion to indebtedness influences people's willingness to ask questions (*e.g.*, Fisher *et al.*, 1981; Greenberg & Shapiro, 1971) and showed that people who do not anticipate being able to return a favor are less willing to ask for help (*e.g.*, Greenberg & Shapiro, 1971). In general, however, the effects of these costs tend to be weaker for help-seeking on online Q&A sites than in face-to-face exchanges, because the questions are not targeted to any particular answerer, and because of anonymity.

How is the question-asking decision affected by the availability of payment systems? From a cost-benefit perspective, paying for help affects whether or not to ask a question in that it raises the cost of asking for help. Prior work has shown that askers are less likely to ask for help when getting help reduces their gains (*e.g.*, getting partial credit on an academic task) (DePaulo & Fisher, 1980). Similarly, recent related research on using financial payments to fight spam has shown that requiring a financial payment when sending help requests can make senders more selective in the messages they send (Kraut *et al*., 2005). We expect the same effects in the Q&A scenario – the additional cost will make askers more selective in the questions they ask. With all else equal, a market-based system should reduce the number of questions asked and will especially limit the asking of frivolous questions. Therefore, it will raise the overall seriousness of the questions. Askers are thus, in a sense, using paying as a way to signal that their need is non-frivolous.

H1. The market system will lead to higher average seriousness in questions asked, but will result in fewer total number of questions asked.

3.2.1.2 Question Answering

Paying for answers can also affect question answering. The underlying assumption of a Q&A market is that people are motivated by financial incentives. People prefer more money to less money and would

therefore put in more effort to ensure compensation when more money is offered (*e.g.*, Prendergast, 1999).

However, research in both psychology and experimental economics has shown that monetary incentives can crowd-out intrinsic and social motivators (Lepper, 1973; Deci & Ryan, 1985; Fehr & Gaechter, 2001; Frey & Jegen 2000). According to self-determination theory (Deci & Ryan, 1985), financial incentives may be perceived as controlling; people who are financially rewarded for working on a task may feel that they are doing so because of the tangible rewards, rather working on the task for its own sake.

Prior studies in the domain of Q&A have found contrasting results. Comparing answer quality on Google Answers, a pay-for-answer service, to popular free Q&A services, Harper *et al.* found that higher pay resulted in better answers (2008). However, another study by Chen *et al.* showed that while higher pay led to *longer* answers (*i.e.*, more effort) it did not result in *better* answers (2008). Chen *et al.* pointed out that a major difference in these studies was the assessment of only the officially-selected answer, while other studies assessed all answers. It is, therefore, possible that while paying more does not solicit a higher quality single best answer, it may solicit a higher quantity of high quality answers. My work builds on prior work by studying the impact of paying on answering effort (answer length) and answer quality in a controlled field study and through a longitudinal study of a commercial Q&A site. The general hypothesis is that paying does help.

H2. The market system will result in longer answers.

H3. The market system will have higher overall answer quality.

3.2.2 Design of mimir

mimir is a desktop application running on the users' computers. It is designed to be similar to a chat broadcast system such as AOL Instant Messenger (AIM), but it is designed specifically for the purpose of Q&A. When users have a question, they can broadcast their questions to other users. This is similar to Zephyr and IBM's Communication Tools (Ackerman & Palen, 1996; Weisz *et al.*, 2006). By default, all incoming question will trigger a "toast" notification in the corner of the user's screen, similar to an incoming email notification.

All questions are presented in a list view in the main window of the application (Figure 3.2). When a user clicks on a question in the list, a separate answer window appears to the right of the main window. In this answer window, users can read selected question and the list of answers in reverse chronological order. Each answer shows its respective answerer's alias and the amount of time elapsed since it was posted.

Question askers are allowed to "answer" their own questions. This allows the askers to clarify or to add additional information to the question. However, question askers are not allowed to select their own answers as the "best answer." In the version deployed, only the question asker could determine the best answer, but it is easy to imagine extending a collaborative voting design to this interface. Once a "best answer" is selected the question is marked as answered.

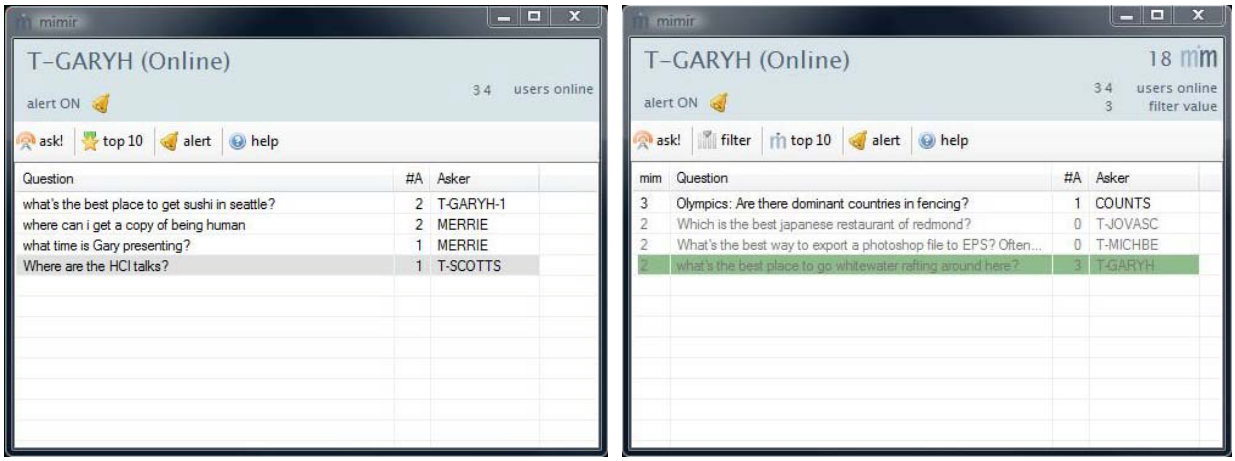


Figure 3.2 Client windows for mimir: (Left) no-market system and (Right) market system

3.2.2.1 Baseline, No-Market Version (No Market System)

The baseline comparison condition is a no-market system with a simple top ten list. The top ten list displays the aliases of the top ten users (who provided the highest number of best answers). The list is viewable by clicking the "top 10" button in the main application window (Figure 3.2, Left). The top ten list was included in the no-market baseline system because most existing Q&A systems, such as Live QnA, have some sort of reputation system built-in.

3.2.2.2 Market-Based Version (Market System)

The experimental version was the market-based system, which used an artificial currency called mims. When asking a question, the question asker attaches an escrow payment (in mims) to the question. By default, the payment amount is set to 0 mim (Figure 3.3). During the experiment, participants in this experimental condition were given $5 worth of tokens (20 mim) to begin, and the number of tokens they had at the end of the study were converted into lunch coupons (4 mim = $1 lunch coupon), whereas the no-market participants were told that they would receive a $5 lunch coupon at the end of the study for installing and running the system.

Mimir users can filter incoming questions based on the number of mims offered. For example, users can set their mim filter value to 5, which will suppress notifications for questions offering less than 5 mims. They can reach the filter control by clicking on the "filter" button on the client window (Figure 3.2, Right).

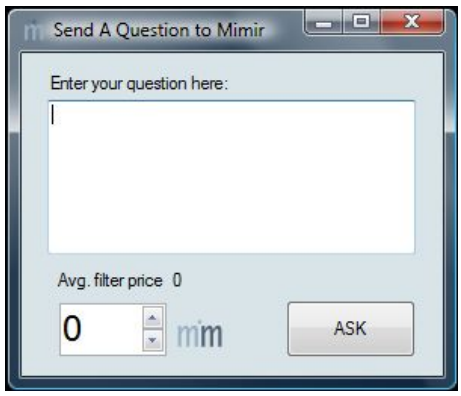


Figure 3.3 Market system's question asking window

As with all economic markets, the Q&A market mechanism needs to be designed carefully in order to prevent misuse. Question askers might try to have their questions answered for free, while answers might try to get paid even though they did not provide an adequate answer. To mitigate misuse, I used the following design:

1. An escrow payment is deducted from the asker's account as soon as the question is asked.
2. If after a day the question receives no answer, then the question is removed and the payment is fully refunded to the question asker.
3. If there are answers, the escrow payment is rewarded to the user who posted the best answer the instant the best answer is selected as the best answer by the question asker.
4. If after three days none of the answers is selected as the best answer, then the question asker will receive a partial refund. 1-10 mim questions will incur a 1 mim "service" fee, 11-20 mim questions will incur a 2 mim fee, and so on.

This design allows question askers to decide if their questions have been answered, while also increasing the cost to questions askers who want to abuse the system.

3.2.3 Deployment and Study

The mimir systems were deployed and used by interns at a major technology corporation (Microsoft). Users were recruited via email from the interns' mailing list, which had around one thousand individual interns' email addresses. The list of intern emails was randomly split in two: one group of interns received email invitations to try out the market system, the other the no-market system.

The usage period lasted for three weeks. To study overall usage and to analyze the questions and answers, I recorded usage and content posted to mimir. To explore users' perception of the system, at the end of the second week of the study, I conducted a questionnaire asking users to rate general Q&A quality along multiple dimensions, such as the importance of the questions asked, and whether or not they had found mimir to be valuable. The questionnaire used a 5-point Likert scale, with 1 as strongly disagree, 3 as neither disagree nor agree, and 5 as strongly agree.

In addition to the community generated questions and answers, I also submitted an identical set of controlled questions to both systems in order to study answering behavior in a more controlled fashion. Out of 60 answered questions randomly sampled from Live QnA I selected 24 questions to ask—eight factual questions, eight advice questions, and eight opinion questions. I posted the questions to each version of the system over the course of 5 days at the end of the study period. To make the questions appear more natural, I varied the offered mim value on the controlled questions in the market condition, based on the question difficulty. Five coders rated the questions on question difficulty (α=0.60); I then used these ratings as general guidelines to select the offered mim values —low difficulty questions were offered 0 or 1 mims, medium difficulty questions were offered 2 or 3 mims ,and high difficulty questions were offered 4 or 5 mims. Alternatively, I could have chosen to randomize the mim values completely, but if mim values had been randomly assigned, some hard questions would have low value while some easy questions would have high value, which would have elicited unrealistic answering behavior.

In order to appear as though the test questions were coming from a variety of askers, I used ten different aliases of real interns who were not participating in the study to post the questions (I obtained their permission before posting the questions.) The questions were posted at random times during the day; the same questions were posted to each system at the same time. I minimized the interaction with the two mimir systems when using these aliases. I did, however, decide that it would be important to select the best answers occasionally, as a typical user would. Since it is possible that the time *when* a best answer is selected would impact the users' answering behavior, I selected the best answers in the two systems at the same time.

3.2.4 Results

	No-Market	*Market*	Live QnA
#questions	68	50	200
Avg. #answers	3.18 (SD=2.86)	2.14 (SD=1.6)	2.8 (SD=3.27)
% with answers	90%	86%	80%
% with best answers	52.5%	58%	56%
Avg. time till first answer (hh:mm:ss)	1:14:44	1:17:07	2:52:30
Avg. time till best answer (hh:mm:ss)	3:41:51	4:35:26	4:18:17
Avg. seriousness	3.36 (SD=0.70)	3.23 (SD=0.70)	2.63 (SD=0.76)

Table 3.2 Usage comparison between mimir and Live QnA

During the 3 weeks of use, 108 users installed the mimir system- 58 for the market system and 50 for the no-market system. During this period, there were typically around 20 users logged onto the market-based system and around 25 users logged onto the no-market system. Most of the users were between the ages of 18-22 and male (7 females total). Thirty-one (31) users from each condition completed the second-week questionnaire.

There were 68 questions asked through the no-market system and 50 questions asked through the market system, a non-significant difference. In the no-market condition, 30 users asked questions and 37 users answered. Questions asked covered a wide range of topics, from questions regarding the company and the internship, to restaurant recommendations, to programming help.

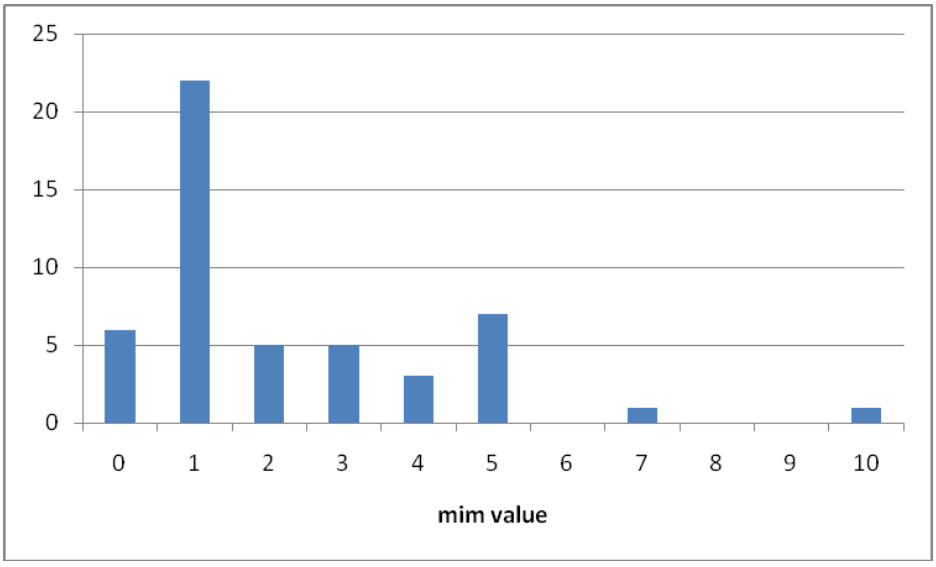


Figure 3.4 Breakdown of number of questions asked and mim offered in the market system

In the market system, most of the questions were offered 1 mim. The highest paid question was 10 mim and there were 6 questions that did not offer any pay (Figure 3.4).

Compared to 200 randomly-selected questions from Live QnA, participants using mimir posted fewer non-questions (Figure 3.5). In addition, the questions asked were of higher seriousness on average (Table 3.2, last row, $F(2,315)=31.2$, $p<0.001$). This could be due to a number of things. For example, users might have been more careful with what they asked through mimir because intra-organizational deployment made each individual user feel more accountable or because knowing that the other users were fellow interns allowed for better targeting of questions.

3.2.4.1 Question Asking

Usage results indicated a non-significant trend toward more questions asked in the no-market system, but was there a difference in the seriousness of questions asked? To answer that question, I had the questions rated in terms of seriousness of the question asked and the 4 types of questions asked.

Results indicate that the seriousness of the questions asked were not significantly different between the two conditions (market=3.23 and no market=3.36, $t(116)=1.01$, $p=0.31$). However, results of the survey of users show that those in the market condition perceived the questions asked to be of higher importance than the users of the no-market system (Likert rating of 2.78 to 2.39, $t(60)=1.72$, $p=0.04$, 1-tailed).

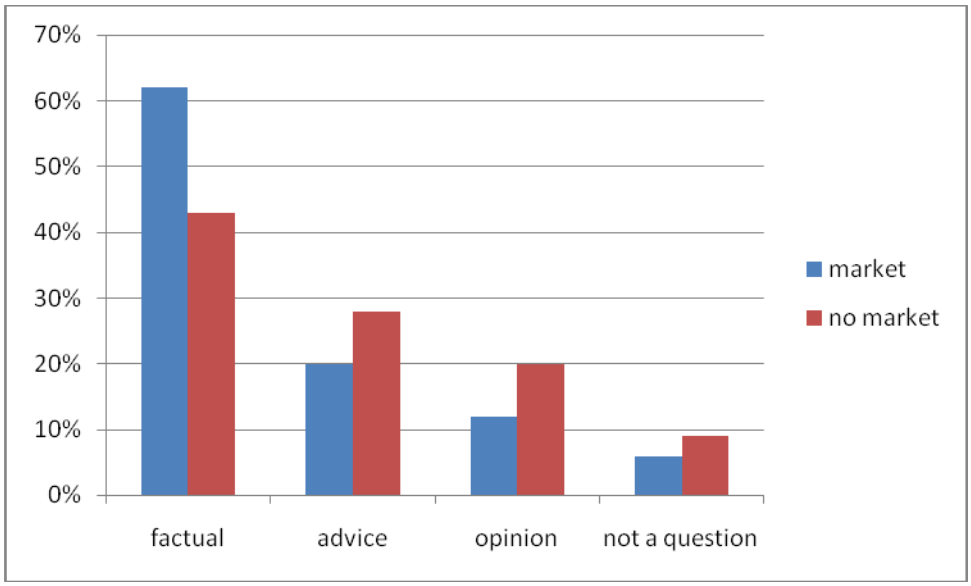


Figure 3.5 Comparison of types of quesitons asked between mimir systems

When comparing question types (Figure 3.5), the market system had more factual questions. However, the difference is not significant.

These analyses shows that usage and perception both trend toward supporting hypothesis 1, that market system resulted in fewer frivolous and discussion oriented questions.

3.2.4.2 Question Answering

Due to the non-normality of answer length, lengths were log-transformed in analysis. Three (3) answers were removed as outliers. Analysis of the answers to the controlled questions supports the hypothesis that paying results in higher effort – market condition resulted in longer answers than the no-market condition (LS-Means 95.5 to 49.0 characters, $F(1,109.4)=12.39$, $p<0.001$).

To study the market's impact on answer quality, I compared the results of the 24 test-bed questions I had asked through mimir. Only 1 of the 24 questions in the no-market system did not receive any answers, compared to 5 questions in the market system. On average, the no-market condition had 3.1 answers, compared to 2.1 in the market condition ($t(114)=11.73$, $p=0.02$). In terms of speed, the no-market system seemed to be the faster in getting the first answer. While the measured speed of first response was not significantly different across conditions, users in the no-market system perceived the questions to be answered more promptly (3.57 to 3.17, $t(59)=1.93$, $p=0.03$, 1-tailed).

To address answer quality, eight individual coders were presented with the 24 test-bed questions and all the corresponding answers that were given on Live QnA, as well as the no-market and market systems in a random order across conditions. The coders were asked to rate the answer as either "not an answer," or to use a 1 to 5 Likert scale, where 1 is extremely poor, 3 is average and 5 is excellent. I removed the answers that were not answers, and then took the median from the coders' ratings and compared the answer quality across conditions. Inter-rater reliability was very good (α=0.90).

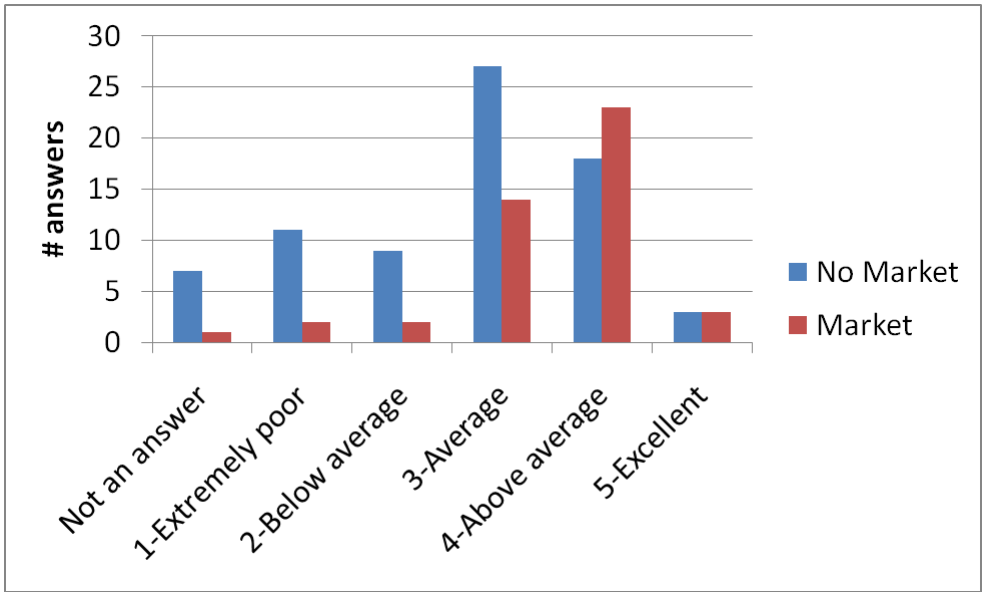


Figure 3.6 Number of answers by quality rating, between mimir systems

The results showed that there was a significant difference in answer quality rating. Specifically, the answer quality in the market system M=3.52) was significantly higher than that of the no-market system (M=2.93; F(1,207)=11.75, p=0.001). If we look at the breakdown of number of answers by quality rating (Figure 3.6), we see that higher percentage of the answers in the market condition were above average.

This point is further supported by examining the questions that had an answer in the no-market system, but did not receive and answer in the market system. One example, taken from our 24 test-bed questions, is, "Why didn't Daniel Negreanu play very well in 2005?" Daniel Negreanu is a professional poker player. To answer this question, one would either (1) spend some time researching or (2) actually follow the professional poker tours in general and Daniel Negreanu's game specifically. In our market condition, no answers were given. However, in the no-market condition, within two minutes an answer, the only answer to the question, was received. The answer, "lol donkaments," was clearly not helpful and was rated by our coders as "not an answer." This goes to show that while questions may be responded to more quickly in the no-market condition, it did not necessarily help by actually answering the question.

3.2.5 Discussion

Findings suggest that the market and the no-market systems provided different types of value to Q&A. The market system, as I had hypothesized, was better able to screen out non-serious questions. It also was able to reduce the number of low-quality answers. The no-market system, on the other hand, had more usage: more questions and more answers per question.

By introducing monetary or token-based payments, Q&A becomes a more serious question and answering service. It becomes less like asking a friend and more like paying for professional help, and this changes how the system is used. Even though question askers could ask 0 mim questions, most of them did not do so; instead, they focused on more serious, work-related questions and on factual questions that were more likely to be answered. As one user put it most succinctly, "it [the market] makes me not want to ask stupid questions."

3.2.5.1 Practical Contributions

Just how can a designer build a successful real-time market, then? The discussion below will focus on how to improve market design based on user feedback.

Users in the market system thought that the market condition was an interesting addition to a Q&A system and that it could provide added incentives. It was not clear whether the market condition offered more incentives than a good reputation system, but perhaps it provided incentives to a different group of users who are extrinsically motivated.

A number of questions arose regarding the payment mechanism. Several participants asked whether it was possible to split the offered payment to award multiple answerers, since many questions elicit more than one worthy answer. In fact, during the study, one user actually asked an additional identical question after receiving answers just so he could pay two answerers who had both provided good answers. Another user suggested allowing other users to add additional payments to an existing unanswered question if they also have the same question. Still others have suggested allowing users to place time-based payments. For example, if the question is answered within a certain time, the user will pay more. While I did not have time to explore these payment designs, I gladly acknowledge them and other promising variations to explore in future work.

Given our findings that markets negatively impact the Q&A community, what can we do? One possibility is to allow two different classes of questions in a Q&A system. One type can be opinion questions, while another can be factual and advice questions that will require an escrow payment. This differentiation can allow the socially conducive questions to co-exist with more serious questions that are important and

urgent. Reputation can be created for people in both groups: the best opinion posters and the best question answerers. Users who are only interested in one kind of usage can focus easily on the type of questions that are of more interest to them.

Another possibility is to remove the monetary incentives altogether and instead use tokens without money or extrinsic goods attached to them. This could work well within an organization where the users can be held accountable for their actions. In that case, the token market can still be used for signals and filtering as social and corporate norms will prevent individuals from exploiting the token system. Earning tokens can be viewed as a fun intra-corporate activity, as opposed to a professional one. An example of this type of token system for communication is Attent built by Seriosity, which was shown to help its users to prioritize email exchanges (Reeves *et al*., 2008).

3.2.6 Limitations and Generalizability

While this study was able to improve our understanding of markets for information exchange, due to the limitations in study duration and population size, a follow-up study is needed to understand, fully, the market's impact on Q&A in a real-world setting.

3.3 Longitudinal Study of Mahalo Answers

To improve our understanding of how markets impact Q&A, I conducted a longitudinal research on Mahalo Answers, a new pay-for-answers Q&A site. This allowed me to examine the impact of markets on Q&A over a longer period of time using a much larger population. In this longitudinal study, I introduce additional hypotheses to examine and, at the same time, re-examine some hypotheses from the previous study.

3.3.1 Hypotheses

3.3.1.1 Question Asking

In the mimir work, I found that question askers are influenced by the market system and they are less likely to ask frivolous questions when they have to pay. However, it is unclear why that is. I had hypothesized that result, believing that people are making a cost-benefit analysis and that the frivolous questions are, in general, less valuable. However, it could also be that people find it inappropriate to ask these frivolous question when they are paying. To what extent is the decision determined by the economics, and to what extent is it determined by social expectations?

In this study, instead of using a single metric of seriousness to represent question value, I focus on metrics of importance, urgency, and difficulty to approximate the question value. In general, one would expect factors such as importance (seriousness from the previous study, or how much the asker really wanted an answer), urgency, and difficulty (how hard it is to acquire the answers) to influence askers' valuation. These factors have been shown to affect people's communication valuation (Dabbish, 2006).

H1. People are more likely to pay for answers to questions that are more valuable —important, urgent, and difficult to answer.

H2. People offer higher rewards for answers to questions that are more valuable —important, urgent, and difficult to answer.

Aside from benefits and costs, decisions to pay or not pay may also be influenced by existing social norms. Prior work has suggested that there are two types of social interactions — exchange and communal (Clark & Mills, 1993) — and that monetary rewards may be perceived as violation of norms when used in communal interactions (Clark & Mills, 1993; Aggarwal, 2004). For example, paying for dinner is expected at a restaurant, but may be insulting when eating a home-cooked meal. This suggests that if askers' goals are to acquire commodities (*i.e.*, information), then they may be more willing to pay. However, if the goals are mainly social in nature (*e.g.*, conversational), then askers may think it is inappropriate to pay.

Research has classified Q&A questions into categories: factual, advice, opinion, and non-questions (Harper *et al*., 2008). Factual questions seek objective data, or pointers to content; advice questions seek recommendations on an asker's individual situation; opinion questions seek others' thoughts on a topic of general interest; and non-questions are general discussion posts or spam. Factual and advice questions are informational questions, while opinion questions are categorized as conversational questions — their goal is to stimulate a discussion (Harper *et al*., 2009).

Using this classification for questions, if users follow existing social norms when using the payment system, we would expect question askers to be more willing to pay for informational questions, which seek facts and advice, than for conversational questions.

H3. People are more likely to pay for answers to questions seeking information than for questions initiating conversations.

3.3.1.2 Question Answering

Using Mahalo Answers, I re-examined the effects of paying on answer length and quality.

H4. The market system results in longer answers.

H5. The market system will have higher overall answer quality.

I also examine the effects of paying on the number of answers. Do higher-paid questions attract more answerers? Is it worth it to pay more?

H6. The market system results in more answers.

3.3.2 Mahalo Answers

To examine the impact of financial incentives on Q&A, I conducted a study of Mahalo Answers. Mahalo Answers is a pay-for-answers Q&A site, launched on December 15, 2008. According to Mahalo Answers, by mid-February 2009, the site had about 15,000-25,000 visitors per day.

Google Answers will be used as a comparison point in this paper since it has been the most often studied pay-for-answer Q&A site (Chen & Ho, 2008; Edelman, 2004; Harper *et al.*, 2008; Rafaeli *et al.*, 2007). There are two major differences between these two sites. First, Google Answers used a set of "researchers" chosen by Google to answer questions, whereas anyone who joins Mahalo Answers can answer questions and earn the financial rewards. Second, Mahalo Answers allows both free and paid questions, while Google Answers only allowed paid questions. This enables us to compare the usage differences when the questions are paid versus when they are not paid, which was not feasible in prior studies of Google Answers.

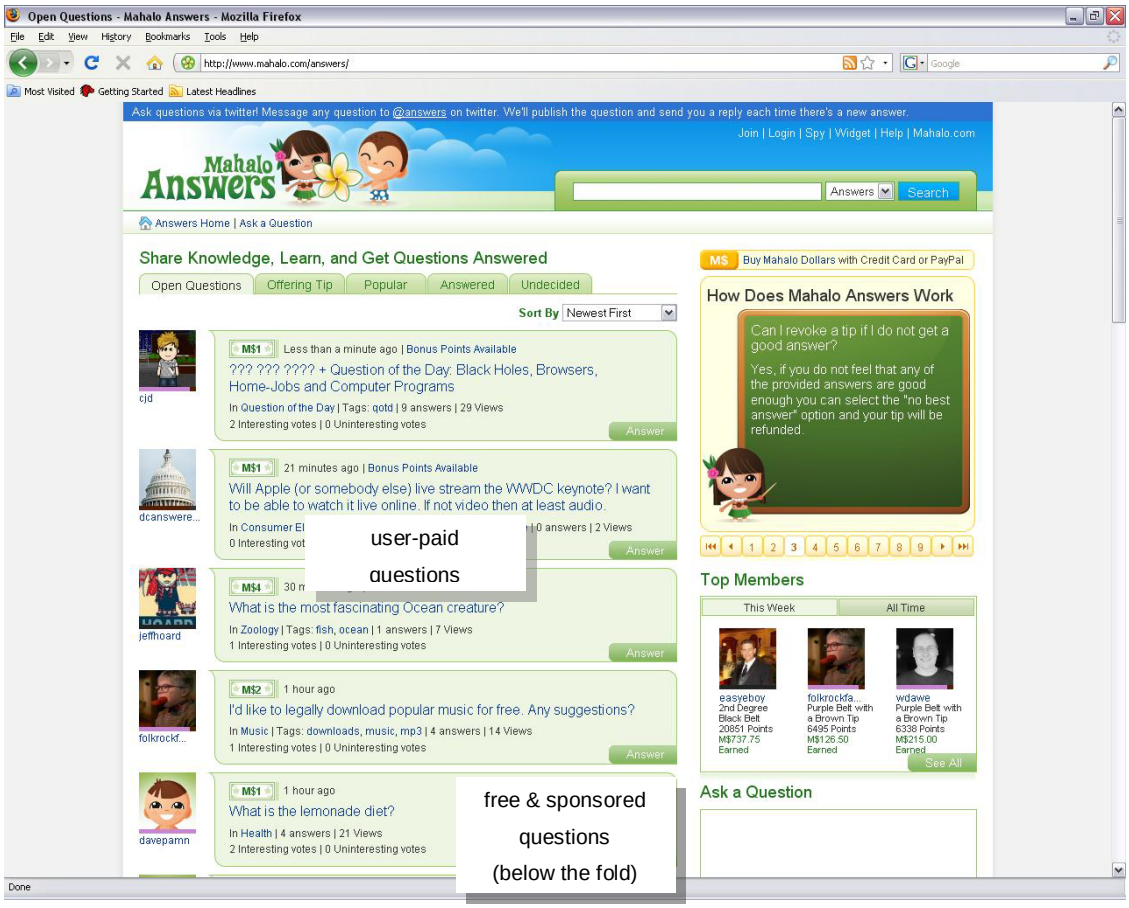


Figure 3.7 Screenshot of Mahalo Answers

On Mahalo Answers, if askers choose to pay for answers, the minimum payment is one Mahalo Dollar (M$1), which costs one US Dollar to purchase. Questions paid for by the users are displayed separately from free questions on the site's home page. The paid questions are shown immediately above the screen fold, and the free questions are below the screen fold (Figure 3.7).

Within the first three days of posting a question, the asker can select any answer as the best answer (and consequently reward the answerer with the payment, if one was offered). During the first 3-4 days, the question asker can also indicate that there was "no best answer" to receive a full refund on the question. Afterwards, if the best answer is not chosen, then the other members of the community can vote to select the best answer. Once answerers have earned more than 40 Mahalo Dollars, they can choose to cash out, at which point Mahalo Answers takes a 25% cut. In other words, cashing out M$40 will give the user $30.

Each answerer can only give one answer per question, but there can be multiple answerers per question. If an answerer's answer is selected as the best one, the question asker can choose to rate it on a 5 point scale, where 3 is "good" and 5 is "above and beyond."

There were two major changes to Mahalo Answers during our data collection. First, around February 20, Mahalo Answers started sponsoring, or paying for, the free questions posted on the site as an effort to increase site traffic. These sponsored questions are still posted to the same place as the free questions. Mahalo sponsored M$0.25 per question initially, but the value varied over time. Even though Mahalo Answers automatically sponsored the questions when they were received, Mahalo Answers removed the sponsored payments at their discretion. The second major change was that around February 24, Mahalo Answers started accepting questions asked through Twitter. Additionally, Mahalo Answers started actively pulling in questions that were not intended for Mahalo Answers from public Twitter accounts.

To account for these changes, in one of my analyses on question-asking decisions, I removed questions posted after February 20 so that I could focus on usage without the influence of company sponsorship, and also to ensure that questions were intentionally asked by askers.

3.3.3 Data Collection

I contacted Mahalo Answers for their data. While they stated their intent to offer a public API or make their data available, this did not occur. So instead, I wrote a Java program to gather the questions and answers posted on Mahalo Answers. Due to site moderation, I was unable to gather some posted questions that had been deleted. Also, while Mahalo Answers allows users to ask each other direct, private questions, I was constrained to only the public questions. I was able to gather a total of 22,205 public questions and 71,091 answers posted on Mahalo Answers between Dec. 04, 2008 and May 05, 2009. For analyses, I removed all posts posted before December 15, 2008, before the site was launched publicly. I also removed all posts after April 27, 2009 to ensure that I analyzed only questions that were closed to any new answers.

	Google Answers (Rafaeli *et al.*, 2007)	MA <Feb. 24	MA Full
Period of Study	6/2002-5/2006	12/2008-2/2009	12/2008-4/2009
Duration	48 months	2 months	4 months
# user-paid questions	~2,700	~1,600	~1,300
# free & sponsored questions	N/A	~2,500	~3,500
# answers provided	~1100	~17,000	~15,000
# comments sent	~3700	~5,600	~5,000
# users who joined	N/A	~6,900	~5,500
Avg. $ of question, user-paid only	$20.90	$2.52	$2.70
Rated answers	~680	~2000	~1700
Avg. answer rating (5 point scale)	4.63	3.73	3.85
System price range	$2-200	$1-100	$0.25-101

Table 3.3 Comparison of per month statistics of Mahalo Answers (both reduced dataset of usage prior to February 24 and our full dataset) to Google Answers.

3.3.3.1 General Site Statistics

Mahalo Answers had more answers per question than did Google Answers (Table 3.3). This was due to the fact that each question at Google Answers could only be answered by one Google Answers Researcher. This also resulted in comments being heavily used on Google Answers as an alternative mechanism through which to give answers (Rafaeli *et al.*, 2007). On average, the price of questions offered on Google Answers was much higher than the price offered on Mahalo Answers.

	Coding Category	Descriptive Text
Question Types	**Factual**	The question is asking for facts (objective data or pointers to content).
	Opinion	The question is asking for opinions (questions seek others' thoughts on a topic of general interest; these questions do not have a "correct" answer and may be answered without reference to the question asker's needs).
	Advice	The question is asking for personal advice (questions seek recommendations based on the asker's own situation; answerers must understand the question asker's situation to provide a good answer).
	Non-question	The question is spam / not a question.
Question Value	**Sincerity (Importance)**	How sincerely did the question asker want an answer to the question?
	Urgency	How urgently did the question asker want an answer to the question?
	Difficulty	How much work would it require an average high school educated person to answer this question? Keep in mind that work includes both getting the answer and also formulating the answer.
Question Politeness		How rude or polite is the question?
Question Archival Value		I think high-quality answers to this question will provide information of lasting/archival value to others.

Table 3.4 Rated characteristics of question

3.3.3.2 Rating Question Characteristics

I randomly selected 800 questions posted by non-Mahalo employees: 400 were user-paid, 400 were not. Questions were then rated by workers on Amazon's crowd-sourcing service, Mechanical Turk. Given only the question text from Q&A exchanges, workers rated each question on nine separate dimensions using Likert scales. Recent research has shown the feasibility of using Mechanical Turk to collect ratings and annotations (Snow *et al*., 2008). Unpublished demographic studies have shown that >75% of the workers on Mechanical Turk are from the United States and that >70% of Turkers have a bachelor's degree (Ipeirotis, 2008), so most of the raters should be proficient in English.

First, the question types were rated. Unlike prior research, instead of classifying questions into mutually exclusive question types, the instrument asked coders to rate the extent to which the question asked for facts, asked for opinions, asked for advice, or did not ask for anything in particular (spam). (Table 3.4). Question types are not mutually exclusive; a question may have both high opinion and advice ratings, indicating that it is asking for both opinions and advice.

Raters also rated questions on three dimensions that might indicate the askers' valuations of having the questions answered. This included perceived sincerity and urgency, and difficulty of the question. Sincerity was defined as the extent to which question askers wanted answers to their questions, that was then used as a proxy for importance. Coders also rated the politeness of the question, which might affect responsiveness (Burke & Kraut, 2008). These ratings were used as independent and control variables in

data analyses. Finally, coders rated the questions on an outcome measure: archival value. Questions with higher archival values can improve the usefulness of the Q&A repository.

To improve the quality of the ratings, coders who gave ratings with very low variance, used noticeable patterns, or did not spend enough time determining ratings (<20 seconds per question) were removed. After this filtering process, there were 401 raters and each rated 19 questions on average. The ratings were standardized per rater (z-score) by subtracting the rater's mean ratings determined by the rater's standard deviation. When standardized, 0 means an average rating, +1 means a rating that is one standard deviation above the average, and -1 means a rating that is one standard deviation below the average. The final dataset had, on average, 9.4 ratings per question. To check the reliability of the ratings, intraclass correlation reliabilities were calculated, which indicated what proportion of the variance was associated with questions and not with the judges. The general rule of thumb is that ICC = 0.40 to 0.59 is moderate, 0.60 to 0.79 is substantial and 0.80 is outstanding (Landis & Koch, 1977). Most of our ratings had an intraclass correlation of around 0.60, except for the "not a question" and politeness ratings (Table 3.5, last row).

	Factual	Advice	Opin.	Not Q	Sincere	Urgent	Diff.	Polite	High Arch.	Is Paid	Avg. Answer Length	Ans. Count	Is Rated
Factual	1.00												
Advice	0.03	1.00											
	0.44												
Opinion	-0.45	0.35	1.00										
	0.00	0.00											
Not Q	-0.30	-0.21	-0.03	1.00									
	0.00	0.00	0.42										
Sincere	0.29	0.43	0.04	-0.51	1.00								
	0.00	0.00	0.29	0.00									
Urgent	0.29	0.47	-0.05	-0.33	0.63	1.00							
	0.00	0.00	0.15	0.00	0.00								
Difficult	0.39	0.24	-0.15	-0.33	0.43	0.48	1.00						
	0.00	0.00	0.00	0.00	0.00	0.00							
Polite	0.13	0.30	0.07	-0.37	0.59	0.35	0.20	1.00					
	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
High Archival	0.47	0.44	-0.01	-0.37	0.56	0.43	0.45	0.37	1.00				
	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.00					
Is Paid	0.05	0.07	0.10	-0.02	-0.04	-0.00	-0.01	-0.05	0.09	1.00			
	0.14	0.07	0.00	0.40	0.26	0.95	0.79	0.20	0.01				
Avg. Ans Len	0.04	0.14	0.11	-0.03	0.11	0.11	0.17	0.03	0.12	0.21	1.00		
	0.29	0.00	0.00	0.40	0.00	0.00	0.00	0.33	0.00	0.00			
Ans. Count	-0.15	0.10	0.26	0.05	-0.05	-0.09	-0.18	-0.01	0.00	0.32	0.06	1.00	
	0.00	0.00	0.00	0.15	0.16	0.02	0.00	0.75	0.99	0.00	0.11		
Is Rated	-0.11	0.08	0.22	-0.00	0.04	-0.01	-0.05	0.04	0.04	0.25	0.11	0.22	1.00
	0.00	0.02	0.00	0.91	0.32	0.82	0.12	0.24	0.24	0.00	0.00	0.00	
ICC reliability	0.62	0.61	0.59	0.42	0.58	0.62	0.61	0.44	0.58				

Table 3.5 Correlation table (with significance) of rated characteristics and dependent variables for all 800 questions

3.3.4 Results

The analyses are broken up into question asking, answering, and archival use. In question asking, I explore what question characteristics predict whether the question is paid. In question answering, I analyze whether paying improves answer length, count, and quality. Finally, I examine whether higher payments predict higher archival value.

3.3.4.1 Question Asking

Many significant correlations were found between the rated characteristics of questions posted on Mahalo Answers. First, results confirmed findings from prior work that the degree to which the question asks for facts and advice correlates positively with the degree to which the question seems sincere (Hsieh & Counts, 2009), and has higher archival value (Harper *et al*., 2009). The results also showed that the degree

to which the question asks for facts and advice correlates positively with degree of perceived question urgency and difficulty, but that the opinion nature of the question does not. Furthermore, while factual and opinion ratings were negatively correlated, advice and opinion ratings were actually positively correlated (Table 3.5).

To test which question characteristics predict whether a question is paid, a random-effects logistic-regression model was built (using STATA's xtlogit command). The dependent variable is whether the question is paid or not (binary). The question asker is modeled as a random effect and the independent variables are the four ratings of question types, and value-characteristics of sincerity, urgency, and difficulty. Two control variables are included: the number of other questions the asker asked previously (log transformed[1]) and the amount of Mahalo Dollars the asker had earned through answering (log). These variables are included because askers' usage of the system may change over time, especially if they have learned how valuable help on the site may be, or if they have already earned credits that can be used to pay for answers.

As mentioned previously, I used the set of questions posted before February 20 for this analysis (333 questions: 205 paid, 128 free). This way, I could examine askers' decisions without the influence of site sponsorship, and ensure that askers intentionally posted to Mahalo Answers.

Is Paid 0=free, 1=paid	n=333		Model	
	Mean	SD	Odds Ratio†	SE
Factual	-0.04	0.47	5.19*	3.99
Opinion	0.03	0.44	1.17	0.88
Advice	-0.01	0.48	3.67	3.06
Not Question	0.02	0.38	0.57	0.46
Sincerity	-0.03	0.48	0.43	0.38
Urgency	-0.03	0.50	3.38	3.01
Difficulty	-0.03	0.50	0.24	0.20
Prior Q. (log)	1.48	1.40	2.07	0.78
Prior Earn (log)	0.84	1.56	2.07	0.85

* $p < 0.05$

Table 3.6 Random-effects logistic regression model predicting "is paid" (H1 & H3), using questions posted before February 20 (n=333)

†Odds ratio is a measure of effect size. It indicates how a unit increase in a variable affects the likelihood of the question being paid, holding all others factors constant.

[1] Logarithmic normalization used in our analyses is base 10, after adding a base value of 1

Table 3.6 shows the results for the logistic regression. In this analysis, the logistic regression estimates the probability that the question is paid (is paid=1). In logistic regression analyses, the probability is presented in odds, and the odds ratio (fourth column of Table 3.7) is the odds that a question is paid over the odds that a question is not paid. If the odds ratio is greater than 1, the presence of the predictor variable suggests higher odds that the question is paid, and the inverse. Results show that when a question's factual rating is one standard deviation above the mean, the odds of it being paid were 5.19 times higher, which is equivalent to a 30% increase in the probability that the question is paid (based on post-estimation where other factors were held to be at their means and the assumed random effect is 0). Although advice ratings also had a high effect size (24% probability increase), it was not significant in the model (p=0.11). The opinion and not a question ratings were not significant predictors of whether or not a question was paid. Similarly, none of the other characteristics was a significant predictor, although urgency rating had a high positive effect (+22% higher probability) and difficulty had a high negative effect (-26% lower probability).

Given that all of the user-paid questions are intentionally posted by the Mahalo users, to examine what factors impacted askers' decision on how much to pay, I was able to use all (n=400) of the user-paid questions, instead of only the subset posted before February 20 used previously. I used the same set of independent and control variables. The dependent variable here is the reward value. Because the dependent variable is not normally distributed, it is split up into three tiers: $1 questions (n=235), $2-3 questions (n=104) and $4-100 questions (n=61). An ordered logistic regression is used to account for the three reward levels.

Reward Level $1, $2-3, >$3	n=400		Model	
	Mean	SD	Odds Ratio	SE
Factual	0.03	0.44	1.33	0.40
Opinion	0.05	0.42	1.38	0.43
Advice	0.03	0.47	1.18	0.35
Not Question	0.01	0.40	1.15	0.38
Sincerity	-0.02	0.43	1.32	0.49
Urgency	-0.00	0.45	0.89	0.30
Difficulty	-0.00	0.46	4.60***	1.38
Prior Q (log)	1.93	1.42	0.51***	0.06
Prior Earn (log)	1.57	2.00	1.22**	0.09

*** p < 0.001, ** p<0.01

Table 3.7 Ordered logistic regression model predicting reward value (H2), using user-paid half of the full dataset (n=400)

Table 3.7 shows that the only significant predictor of reward value (besides the control variables) is the question difficulty — the more difficult the question, the higher the pay. Recall that, interestingly, difficulty was not predictive of whether or not a question was paid. This supports the general intuition that the pay decision is two-staged, and that there are different factors influencing the decisions in each stage. This is addressed in more detail in the discussion.

3.3.4.2 Question Answering

In general, paid questions had more answers than free questions (4.2 : 2.2 answers), but this might be because paid questions were immediately visible on the homepage of Mahalo Answers, while free questions were not (Figure 3.7). Therefore, instead of comparing the answers of paid and free sections, I focus on how the increase in reward price affects answers. Since there were no significant interface changes to the paid section of the site during the data collection period, I used the full set of paid questions (400) and their answers for the following analyses.

All of the models in this section use the same set of independent and control variables. The independent variable is the question-reward, broken down into three tiers ($1, $2-3, $4-$100). The control variables include the types of questions asked, sincerity, difficulty, and politeness. All are question characteristics that might impact answerers' decision to respond. These models also all use question asker as a random effect.

Average Answer Length (log)		n=399†		Model
	Mean	SD	Coef.	SE
Reward ($2-3)		n=104	0.22*	0.09
Reward (>$3)		n=61	0.25*	0.11
Factual	0.00	0.47	0.17	0.10
Opinion	0.03	0.44	0.33**	0.10
Advice	0.01	0.47	0.04	0.10
Not Question	0.02	0.40	0.04	0.11
Sincerity	-0.02	0.44	0.31*	0.13
Difficulty	-0.01	0.46	0.14	0.10
Urgency	-0.00	0.45	-0.06	0.12
Politeness	-0.02	0.37	-0.19	0.12

** p < 0.01, *p < 0.05

Table 3.8 Random-effects regression model predicting logged average answer length (H4), using user-paid half of the full dataset (n=400)

†One of the questions did not have any answers, making it an outlier in the analysis. This question was removed.

First, I will explore how question-reward affects answer length. Due to the non-normality of average answer length, a log transformation was applied. Table 3.8 Random-effects regression model predicting logged average answer length (H4), using user-paid half of the full dataset (n=400) shows that $2 or more questions elicit 22%-25% longer answers (on the logged length) than $1 questions. However, the improvement between middle and high tiers is not significant. The model also showed that both opinion and sincerity ratings correlated positively with longer answers (Table 3.8).

Answer Count	n=400 All (μ=4.2)		n=400 Star (μ=3.0)	
	IRR†	SE	IRR	SE
Reward ($2-3)	1.00	0.09	0.92	0.08
Reward (>$3)	1.25*	0.14	1.33*	0.15
Factual	0.93	0.09	0.88	0.08
Opinion	1.38**	0.14	1.50***	0.16
Advice	1.18	0.11	1.04	0.11
Not Question	1.08	0.11	1.08	0.12
Sincerity	1.02	0.13	0.98	0.13
Difficulty	0.81*	0.10	0.88	0.09
Urgency	0.08	0.10	0.98	0.11
Politeness	0.06	0.11	0.90	0.10

*** p < 0.001, ** p < 0.01, *p < 0.05

Table 3.9 Random-effects negative binominal models predicting answering count (H5), using user-paid half of the full dataset (n=400)

†IRR is the incidence rate ratio, which gives a relative measure of the effect of a given variable, like odds ratio.

I then explored the effects of financial rewards on answer count. Two dependent variables were used: the total number of answers to the question and the number of answers from "star" answerers (defined as those with average asker-rating above the median, *i.e.* above 3.66 out of 5). Negative binominal regressions were used for both of these models and the effects were similar (using STATA's xtnbreg command). Table 3.9 shows that middle-tiered rewards did not increase the number of answers a question received compared to the baseline $1 rewards, although high-tiered rewards (>$3) did. High-reward questions had 1.25 times more answers than baseline questions and also 1.33 times more answers from "star" answerers. Control variables show that opinion questions in general got both more answers *and* more answers from "star" answerers, while more difficult questions got fewer answers (no significant impact on number of answers from "star" answerers).

The last model in this section explores the relationship between reward value and answer quality. The preliminary analysis tested two potential measures of quality: whether the asker chose a best answer and whether the best answer had at least a good rating (>=3). Because the results were similar, only the model of whether the best answer had at least a good rating will be presented.

Is Answer Rated Positively 0=no, 1=yes		n=400		Model
	Mean	SD	Odds Ratio	SE
Reward ($2-3)		n=104	1.76	0.74
Reward (>$3)		n=61	1.42	0.73
Factual	0.03	0.44	0.75	0.34
Opinion	0.05	0.42	3.09**	1.54
Advice	0.03	0.47	0.90	0.42
Not Question	0.01	0.40	1.36	0.69
Sincerity	-0.02	0.43	1.46	0.89
Difficulty	-0.00	0.46	0.38*	0.18
Urgency	-0.00	0.45	2.21	1.16
Politeness	-0.02	0.37	1.10	0.58

** p < 0.01, *p < 0.05

Table 3.10 Random-effects logistic regression model predicting is best answer rated positively (H6), using user-paid half of the full dataset (n=400)

Results from the logistic regression model (Table 3.10) show that the reward value may predict whether or not answer is rated positively. Higher reward value (>$2) resulted in an increase of 8-13% in the likelihood that the question is rated positively. However, because the effects were not significant, we cannot reject the null hypothesis that higher-reward questions solicit better answers. It should also be noted there are two significant variables in this model: opinion rating (+28% higher probability) and question difficulty (-24% lower probability).

3.3.5 Discussion

The hypothesis that askers may be affected by cultural norms when deciding how to use the pay-for-answer system is supported by the results, which show that people are more likely to pay for certain types of questions, but not necessairiy more valuable questions. Also, supporting prior findings, higher financial rewards on Mahalo Answers did elicit longer answers and a higher number of answers, but not necessarily improve the “best answers,” as rated by the question askers. Finally, higher payment values indicate higher archival value. The implications are discussed below in detail.

3.3.5.1 Question Asking

How do question askers choose whether to pay for answers in a monetary-enabled Q&A system? The mimir study has used expected utility to explain why there seem to be more serious questions when askers have to pay for answers — askers pay more if the questions are more valuable.

However, the results of the studies presented herein suggest that the decision on whether to pay is not made with a simple cost-benefit analysis; rather, the decision may be impacted by perceptions about how financial rewards should be used. Past work points out that different types of incentives have different usages and meanings in different scenarii (Zelizer, 1994). Financial rewards are used primarily in exchange relationships, but not in social, communal relationships. Applied in the Q&A domain, information seekers may feel that paying is appropriate when they are purchasing facts (and potentially advice) from the answerers, but when askers seek to initiate a conversation, which is the intent of the opinion questions, users may not think that financial compensations are necessary, or even appropriate.

The exchange versus communal relationship does not seem to map directly to the distinction between informational and conversational questions. Part of the problem is that while factual and advice questions are both classified as informational, advice questions actually positively correlate with opinion questions (conversations), as shown by the correlation data presented herein. Perhaps a better way to classify the question is simply to rate *how* informational and *how* social the question is. Informational and social dimensions may also be a more useful breakdown when designing interaction support. While questions can be *both* informational *and* social, questions with high informational ratings will be more functional, with emphasis on getting high-quality answers, whereas questions with high social ratings will be more oriented towards generating interesting discussions. For these social questions, perhaps other types of recognition, as opposed to a simple best answer selection, may be better employed (*e.g.*, slash dot ratings – controversial, humorous, etc.).

In addition to deciding whether to pay, askers must also determine how much to pay. Analysis of question rewards shows that question difficulty predicts how much askers pay. One reason why the measures of importance and urgency may not predict payment is that they were judged by outsourced raters rather than the asker. Despite that limitation, the result is still interesting because it shows that whether to pay and how much to pay are two distinctive decisions in pay-for-answer systems. This is perhaps due to the two-stage process used in paying for answers — askers first select whether they want to pay, then how much. More research is needed to explore how interface designs may be affecting the use of e-commerce services.

3.3.5.2 Question Answering

The examination of Mahalo Answers presented herein also builds on prior research in answering research questions on how financial rewards impact answers. The results support the hypotheses that paying more can result in longer answers and a greater number of answers, though not higher quality best answers (as judged by askers, in this study).

As mentioned before, one experiment showed that increasing rewards improved answer quality (Harper *et al.*, 2008), while one showed that it did not (Chen *et al.*, 2008). One explanation for these conflicting results is that the studies with positive effects used ratings from all of the answers, while the other study compared ratings from the single, best/official answer. The findings of the research presented herein support this explanation. While the reward value did not seem to affect best answer quality, the study found that questions with higher pay did result in more answers from "star" answerers. Prior work has found that answerers with higher reputation scores, to whom I refer to as "star" answerers, provide significantly higher-quality answers (Chen *et al.*, 2008). This would suggest that while paying does not improve the quality of the individual best answers, higher payment can elicit a higher number of high-quality answers. Perhaps when judged as a combined whole, the quality may be higher.

There are some subtleties in the results that need to be highlighted. First, analysis of average answer length shows that there is a diminishing return of reward value on length, perhaps due to a ceiling effect. But at the same time, only high-value payments increased the number of answers. One potential explanation is that questions with rewards in the high tier (>$3) are more salient, and therefore more attractive, since majority of paid questions on Mahalo Answers (80%) fell within the $1 and $3 range.

One major difference between Google Answers and Mahalo Answers is that Google Answers only allowed for one answerer to provide the official answer. The results of this study suggest that the real benefits of a pay-for-answer may be realized when more than one answerer is allowed to contribute per question. Allowing multiple answerers to answer the same question is not only more natural (reducing the need for other answerers to answer using the comment option, as was done on Google Answers), but can also be more beneficial to question askers and the extended community of information seekers by providing them with more answers from "star" answerers on the site and potentially offering more tangential yet still valuable answers for archival readers.

3.3.6 Limitations and Generalizability

In analysis of answer quality, the asker's rating was used as a proxy. However, it is a weak measure of best answers' actual answer quality because (1) not all questions are rated, (2) askers may use positive

ratings to establish rapport with answerers for future interaction, and (3) askers who pay more may over-rate (cognitive dissonance) or under-rate (have higher standards) the answers they receive. This should be considered when interpreting the analysis of payment's effect on answer quality.

Because the questions were randomly selected, the findings should generalize to other questions on Mahalo Answers. Also, because the questions were collected from a real-world, commercial site, various site-specific features need to be considered when comparing this study's findings to other pay-for-answer Q&A sites. I have already discussed some of the differences attributable to interface differences between Google Answers and Mahalo Answers, but it is also important to keep in mind that Mahalo Answers is a fairly recently-launched site. Despite that, most of the findings presented should generalize to other pay-for-answer services, especially to inform us on how users behave during the early, and important, stage of adoption.

3.4 Conclusion

In this set of work, I have demonstrated the strengths and weaknesses of markets for information exchange, both in a controlled field study and through a longitudinal study of a commerical pay-for-answer Q&A site. This work showed that in general, markets can improve the quality of questions and answers, but it also results in somes potential drawbacks of imposing financial rewards on social relationships. In the next chapter, I will more closely examine this intricate relationship between financial rewards and social relationships

Chapter 4

MARKETS & SOCIAL RELATIONSHIPS

This purpose of this chapter is to facilitate understanding of the impact of markets on social relationships. To do so, I re-analyze the data from the mimir study and present two additional studies on how financial incentives affect social-orientation.

4.1 Motivation

Suppose you need help translating a paragraph from English to Thai. The translation requires proficiency in both languages, and it will take time and effort. From everyday experience, you know that financial rewards can motivate people to work on tasks on which they would otherwise not be willing to work, but you also know that even strangers are sometimes willing to help each other without any promise of financial compensation. Would you choose to offer a small financial reward when asking for help? How might offering financial rewards affect the help you receive and your future interactions with the potential helper? Should your decision change if this potential helper is a friend versus a stranger?

Financial incentives are commonly used to motivate behavior in our society. Most of our labor force is motivated by financial incentives in the form of wages and salary. Proponents have long argued that financial incentives act as strong motivators to influence performance or other desired behaviors and "few would disagree that money has been and continues to be the primary means of rewarding and modifying human behavior in industry" (p.94, Opsahl & Dunnette, 1966; see also Jenkins *el al.*, 1998; Locke *et al.*, 1980). After all, these types of incentives can easily invoke people's self-interest (Batson & Powell, 2003) and as Garret Hardin, famous for his "Tragedy of the Commons," once said, "never ask a person to act against his own self-interest" (p.27, Hardin, 1977).

Others have argued against the use of financial incentives as motivators. The main argument against financial incentives is the crowding-out of intrinsic motivation (Deci, Koestner, & Ryan, 1999; Titmuss, 1970; Lepper, 1973). According to Cognitive Evaluation Theory, financial incentives may be perceived as coercive and reduce people's sense of autonomy, which can, in turn, lower their intrinsic motivation (Deci & Ryan, 1985). The offered financial incentives may then cause a change in people's preferences; the

amount of time and effort individuals are willing to offer without payment is decreased (Frey & Jengen, 2000). This effect is used to explain why volunteers, a group of intrinsically motivated individuals, may volunteer less when paid (Frey & Gotte, 1999).

However, to date, there is no conclusive evidence in support of a general undermining-effect for performance-contingent financial incentives (Eisenberger *et al*., 1999; Cameron *et al*., 2001). In fact, the evidence seems to suggest that at least for "simple" jobs, for which "the aggregate measures of performance are available," pay-for-performance can indeed increase output (Prendergast, 1999). In a meta-analysis of 39 empirical studies conducted from 1984 to 1996, Jenkins *et al.* also found that financial incentives improve performance quantity, although not necessarily performance quality (1998).

While much of the prior research has focused on studying how different financial mechanisms adversely affect intrinsic motivation and individual output, more recent research has suggested yet another potential drawback of financial rewards – the potential undermining of social relationships (Gneezy & Rustichini, 2000b; Heyman & Ariely, 2004). In a study involving the administering of monetary fines for parents who show up late to pick up their children from daycare, researchers found that monetary fines actually resulted in more late-coming parents (Gneezy & Rustichini, 2000b). Similarly, in a separate study, researchers found that for small value amounts, people work harder on their tasks when they are given candies (social gifts) instead of the equivalent amount of money (Heyman & Ariely, 2004). These researchers explained this phenomenon by arguing that the introduction of financial incentives (fines or rewards) causes people to adopt a financially-oriented norm of interaction. On the other hand, without incentives, or when using social rewards, people adopt a socially-oriented norm of interaction. In the daycare scenario, instead of perceiving the daycare teachers' staying late to look after their children as a kind, generous act, when fines are introduced parents started to consider the act as a paid service and felt justified in picking up their kids late because they were paying for it. Unfortunately, these prior studies offered this social norm explanation without any direct measures of social relationships or norms of interaction. Without offering additional evidence, prior findings may be explained by other factors.

Further complicating this issue is that, around the same time as these economists were examining the effects of financial incentives, Vohs *et al.* did demonstrate that priming people with money made them less social, but Vohs *et al.* offered a different explanation (2006). They found that when primed with money people prefer to play and work alone, are less likely to seek and provide help, and put more physical distance between themselves and new acquaintances. Instead of attributing the findings to changes in social norms, they suggested that the observed behavioral difference is because money brings about a self-sufficient orientation, that people "put forth effort to attain personal goals and prefer to be

separated from others" (p. 1154). While they may be correct in that people are more self-sufficient when primed with or offered money, this self-sufficiency effect alone cannot explain the aforementioned daycare-study findings. Increase in self-sufficiency should reduce parents' reliance on daycare providers and hence decrease the number of late-coming parents, as opposed to the increase in late-coming parents that was found. Therefore, I posit that, independent of money's impact on self-sufficiency, money still may change people's social orientation and social relationships.

Understanding how financial incentives affect social relationships is extremely timely. Advancements in communication technologies and electronic payment services are changing how we seek and give help, and when we can use financial compensation to obtain help. We now have the ability to broadcast our everyday questions and help requests to thousands of strangers through increasingly popular question and answer (Q&A) services. Yahoo! Answers, one of the more popular Q&A services, boasts about 80,000+ questions a day (Harper *et al.*, 2008). At the same time, advancements in electronic payment services have significantly decreased the transaction costs and made it feasible for us to compensate strangers for help on even trivial, low-value, tasks. Coupling these technologies together, we can build services that enable us to get higher-quality help from more people, on a wide-range of tasks.

However, if introducing financial incentives changes people's social orientation toward a more exchange-based paradigm, then this may inhibit the long-term success of these services. People in exchange relationships will focus on the inputs and returns and will contribute only to fulfill the functional, task-oriented goals of these services, *i.e.*, answering the question. Socially-oriented communication, or interactions that are off topic and unrelated to productivity may be minimized as they are deemed frivolous. This might actually be an undesired and undesirable side effect of using financial incentives. Social interactions are critical in certain types of exchanges, such as in health-related topics where emotional support is vital (Galegher *et al.*, 1998). In addition, reduction in socially-oriented communication may also hinder socialization, which is vital for these online services in attracting and retaining newcomers and for sustaining critical mass (Barge & Schlueter, 2004; Bauer *et al*., 2007; Saks, Uggerslev, & Fassina, 2007; Lampe & Johnson, 2004;). For example, if Q&A services do not have sufficient answerers, many questions can go unanswered. At the same time, without enough questions from askers, answerers will have nothing to which to contribute and may turn to participate in other available Q&A services. Therefore, for these help-exchange services, socially-oriented interactions will need to be carefully balanced with the task-oriented interactions. Given that these technologies are now available, the question is no longer *whether* we can utilize financial incentives to support our many day-to-day help requests, but rather, *should* we?

Following are three studies on how financial incentives affect interpersonal relationships. The first study, examines the impact of financial incentives on help exchanges and social relationships in the domain of Q&A. Results show that, when comparing a market-based Q&A service to a no-market version, financial incentives encouraged higher effort and resulted in higher-quality help responses. However, people who receive financial incentives for helping become more exchange-oriented, focusing more on the instrumental value than the social interactions. They become less likely to engage socially. The second study revealed that offering financial rewards changes people's subsequent allocation decision: if financially rewarded, people are more likely to adhere to exchange-based norms of allocation. They become more likely to allocate based on equity, or individual input, than equality, splitting it 50-50. The third study shows that preexisting communal orientation does not blunt the impact of financial incentives. Friends are just as likely as strangers to change norms of interaction when money is involved. Findings advance the theoretical understanding of the perception and effects of using financial incentives, and also provide practical contributions regarding leveraging financial incentives to support interpersonal exchanges.

4.2 Social-Relational Costs of Financial Incentives

Standard economic theory assumes that individuals act rationally to maximize their utility (*homo economicus*). In this standard economic model, individuals have a supply (s) of resources, such as effort and time that they are able to put into an activity. Given that the supply curve is positively sloped, relative price theory stipulates that the higher the compensation (price), the more supply people are willing to commit to the activity. We can see from the graphical representation that the increase of price from p to p' should increase resources provided from q to q' (Figure 4.1). If there are other additional types of incentives offered, the additional incentives should increase the amount of resources people are willing to commit, at any given price. This would shift the supply out, *i.e.*, from s to s' (Figure 4.1). Using this model, we can see why standard economic theory predicts that paying more should result in higher individual output.

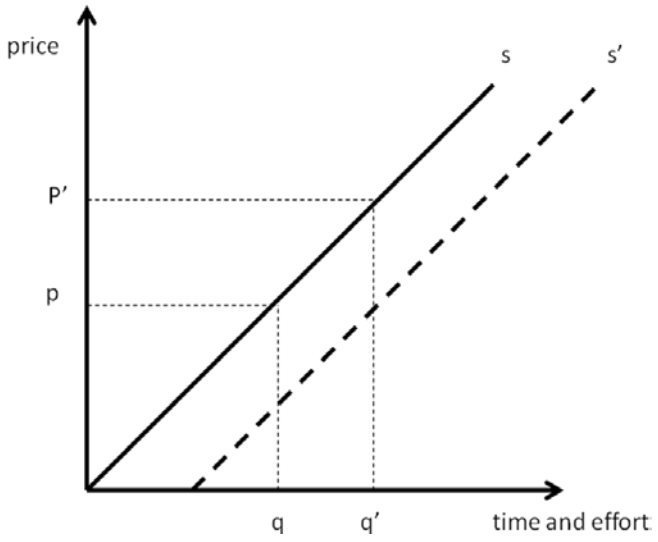


Figure 4.1 Relative price effect on time and effort on task

The notion that increasing incentives leads to higher output is also supported by numerous psychology theories, such as expectancy theory, agency theory, reinforcement theory, goal-setting theory, and equity theory. (Vroom, 1964; Opsahl & Dunnette, 1966; Jenkins *et al.*, 1998; Bonner & Sprinkle, 2002). Expectancy theory (*e.g.*, Vroom, 1964) suggests that people consciously act to maximize pleasure and to minimize pain. Because financial incentives are instrumental in getting more material goods and that money also has symbolic value (*e.g.*, prestige, status), people try to maximize their outcome of interest – more money. Agency theory (*e.g.*, Baiman, 1982 &1990; Eisenhardt, 1989) proposes that rational individuals try to maximize their utility, which is a function of wealth and leisure. Higher incentives results in higher individual economic well-being. Therefore, higher financial incentives encourage more effort, which then increase the probability of achieving the desired outcomes. Reinforcement theory argues that tying financial incentives with performance will reinforce performance (Komaki, Coombs, & Schepman, 1996). With goal-setting theory, Locke *et al.* have proposed that monetary incentives may cause people to set goals when they otherwise would not, may cause people to set more challenging goals than they otherwise would, and may result in higher goal attainment (Locke, Shaw, Saari, & Latham, 1981). Equity theory argues that people seek equality between the inputs they bring and the outcomes they receive (Adams, 1963). Inequality — too low or too high of a financial reward — results in behavioral or cognitive changes to restore the balance. These theories all hypothesize that increase in financial incentives can increase performance or effort on task.

Thus we should expect to confirm the first hypothesis:

H0. Offering higher financial rewards raises the effort and quantity of work.

4.2.1 Relational Implications of Offering Financial Incentives

In addition to affecting people's decisions on what tasks to work on and how much effort to put in, can financial incentives also affect social relationships? They can, because of the socially and culturally-embedded meanings in offering financial incentives.

In interpersonal relationships, what we give to one another symbolizes and conveys meaning (Mauss, 1954; Belk & Coon, 1993). Schwartz points out that "gifts are one of the ways in which the pictures that others have of us in their minds are transmitted" (1967). Parents choose to give cars to boys and dolls to girls to express their image of the children as "masculine" car-playing boys, or "feminine" doll-playing girls. Camerer likens gifts to signals, in that they convey the "intentions of partners in a personal relationship" (p. 199, 1988). Similarly, Ruth *et al.* suggest that what is given conveys a vision of the "trajectory of the interpersonal relationship" to the receiver (1999).

The embedded meanings carried by the goods exchanged make the giving of goods a complicated process. Levi-Strauss has likened the process to "a skillful game of exchange [that] consists of a complex totality of maneuvers, conscious or unconscious." This is apparent when considering the process of selecting a greeting card. We might spend a considerable length of time selecting the most appropriate and meaningful card, despite the fact that the prices of the cards are similar (Levi-Strauss 1965; Sherry, 1983). But if offering money also conveys a certain meaning, then what is it? How is offering financial rewards different from *not* offering any financial rewards?

Social relationship theory can help to elucidate the difference. This theory distinguishes between two general types of interpersonal relationships: exchange and communal relationships (Clark & Mills, 1979; Clark & Mills, 1993). This distinction can be traced back to Goffman's differentiation between economic and social exchange (1961). In an exchange relationship, benefits are given in response to or in expectation of equivalent benefits from another. On the other hand, in a communal relationship, motivations for the giving of benefits are based primarily on need. Exchange relationships are "exemplified by relationships between strangers or people who do business with one another," while communal relationships are "often exemplified by relationships with friends, family members, and romantic partners" (Clark *et al.*, 1987). In exchange relationships, people are motivated to gain benefits for the self, while in communal relationships, people feel a degree of responsibility for the welfare of the partner (Mills *et al.*, 2004). While Fiske has proposed a more elaborate breakdown of relationship types (1992), this discussion will focus on the more general breakdown of communal (social) vs. exchange (financial).

Prior work on gift exchange supports the idea of dichotomy in interpersonal exchanges. When studying giving and reciprocity among the Japanese Americans in Honolulu, Johnson found that the nature of the gift changed as intimacy decreased, from personal items to specific amounts of money (1974). When interacting with those closer in intimacy and sociability, a generalized reciprocity is used, where gifts are exchanged in a flexible and spontaneous manner because they are based on immediate needs of the recipient. In contrast, for those outside the close circle of family and friends, gift-givers "define the degree of obligation more exactly, demanding that the debt be repaid in full at the appropriate time" (p. 301).

In contemporary US culture, money is closely associated with the exchange relationship, but not with the communal relationship. This may be largely due to the western view of monetary exchanges – that money results in commodification (Marx, 1932), and that financial relationships represent "asocial selfish individualism" (Sahlin, 1965) and are "heartless" (Simmel, 1950). However, economic pricing also supports exchange-based relationships from a practical perspective — it affords the tracking of debts and credits. Money's ability to support easy calculation of rates of contribution and proportionate distribution is necessary for the tit-for-tat nature of exchange-based relationships (Fiske, 1992).

This underlying association has resulted in various social rules regarding when and where we should use money. In general, money is used in business settings where equivalent and prompt exchanges are preferred, but not in more social and intimate settings. For example, we expect to give financial compensations after a meal at a restaurant (exchange-oriented relationship) but not after dinner at the home of a friend (communal-oriented relationship). Fiske & Tetlock also point out that not only do we find it difficult to estimate the monetary value of loyalty and friendship, we find it morally offensive to try (1997). Lea & Webley sum this up:

> What seems to lie at the root of these social rules is a perhaps-unformulated belief that to give someone money is to move the transaction out of the realm of ordinary social exchange into a different, economic, sphere, so that what should be a gift or a means of thanks becomes payment – and that is something quite different (p. 165, 2006).

Extending this idea to help-exchanges, requesters may also feel the need to adhere to these existing social rules when they enter into a market-based system. They may be less likely to pay if their exchange goal is primarily socially-oriented, as opposed to task-oriented.

H1. People are less likely to offer financial rewards for help when their primary goal is to socialize.

4.2.2 Effect on Social Relationships

On the other side of the exchange, due to the aforementioned associations between financial incentives and exchange-based norms, offering financial incentives may then be perceived as an expectation for responses that adhere to exchange-based norms. Receivers would feel obliged to respond accordingly, otherwise, and if what is expected and what is given in return is unbalanced, cognitive tension may be generated (Seipel, 1971). Therefore, when financial incentives are offered, receivers may now behave in a less socially-oriented and a more task-oriented way. As Simmel puts it, money turned the world into an "arithmetic problem" (Quoted in Zelizer 1989, p. 344).

H2. People are less likely to respond socially when financial rewards are offered.

The effect paying, though, does not stop there. It extends beyond a single interaction because what we experience affects subsequent interactions. Sherry's model of gift exchange suggests that there are three stages of gift exchange — the gestation stage (antecedent to the actual exchange), the presentation stage (exchange process), and the post-exchange reformulation stage. It is after the exchange, during the reformulation, stage that relationships are "realigned" and that social bonds may be "strengthened, affirmed, attenuated, or severed" (Sherry, 1983). When financial transactions occur, the exchange-orientation between those who have just interacted may then increase as both sides try to realign their relationships to what they believe is appropriate. In addition, because individuals learn what norms to apply based on their prior interactions, they may further extend their exchanged-based orientations when interacting with others in similar contexts (Clark & Jordan, 2002).

One way to observe the change in social orientation is by examining people's subsequent allocation decisions. In general, exchange-orientation leads to equity-based allocation, where shared resources are allocated based on individual inputs, and communal-orientation leads to need-based allocation, where shared resources are given to those in need (Clark & Mills, 1993). When there is an absence of evidence for differential needs, an equality-based allocation (50-50 even split) is used, since the default assumption is that the needs are equal (Pataki *et al*., 1994). Related research has found that pairs of friends are more likely to divide shared earnings from a task equally, regardless of performance, whereas pairs of strangers are more likely to divide the rewards based on an equity norm (Austin, 1980). The stronger the existing communal orientation between friends, the more likely it is that they will come to an equality decision versus equity (Thompson & DeHarpport, 1998). Similarly, two people are more likely to be perceived as friends if they divide a restaurant check equally than if they divide it according to what each person has ordered (Greenberg, 1983). More recently, research showed that the difference in distribution norms is already visible in elementary school children (Pataki *et al.*, 1994). If offering financial rewards does make

helpers more exchange-oriented, we would expect helpers to allocate shared resources based on equity instead of equality.

H3. Recipients of financial rewards are more likely subsequently to allocate shared resources based on equity instead of equality.

The effects of financial incentives on social relationships are perhaps the strongest when financial rewards are used between strangers. This is because, between strangers, the exact relationships and norms of exchange are relatively undefined; there exists only a partial contract (Gneezy & Rustichini, 2000a). What is offered then acts as a prototypical contract (van Baal, 1975), and a starting mechanism for social relationships where certain norms of reciprocity are expected (Gouldner, 1960). While the use of financial incentives would be a bigger violation of norms in an existing communal relationship and result in drops in mood (Williamson *et al.*, 1996) and liking (Clark & Mills, 1979), unless exchange norms are repeatedly violated, we should not expect those in an already established communal relationship to change their relationship orientation. This is mostly because of self-selection. Those who choose to be in communal relationships are more likely to believe that communal norms are the ideal for them, therefore, they would strive to adhere to that ideal (Clark & Jordan, 2002). Hence, we can expect that an existing relationship orientation may interact with the effects of financial incentives. The change to an equity allocation should be less likely to occur between friends than strangers.

H4. Recipients of financial rewards are more likely subsequently to allocate shared resources based on equity instead of equality with strangers, but not with friends.

4.3 Re-analysis of mimir

If offering financial incentives changes people's relationship orientation as suggested in prior work, then there should be some measurable social differences. Here, I hypothesize that financial incentives will reduce the socially-oriented exchanges between people.

To study this, I invited participants to use one of two questions and answers (Q&A) services, where one service was market-based while the other was not (same experiment as the one presented in Chapter 3). I then analyzed the questions and answers to investigate whether financial framing reduced the socially-oriented interactions between askers and answerers.

Q&A is a great domain to use to test my hypotheses for two important reasons. One, these services have become a mainstream medium for people seeking answers and help. Two, the computer-mediated interactions allow for recording the content of help interactions so that we may more easily analyze the

impact of financial incentives on both the level of effort put forth in providing help and also the social nature of the interactions.

4.3.1 Method

4.3.1.1 Participants and procedures

Here, I re-analyzed the data collected from the field experiment with mimir, which was presented in Chapter 3. This was a between-subjects experiment, where half of the participants used a no-market version of mimir and half of them used the market version. The two interfaces are mostly identical, with the exception that the market version uses an artificial currency called the mim, and that users have the option to pay for answers using their mim.

The study lasted for three weeks. There were 58 participants who installed the market system and 50 participants who installed the no-market system. Participants in the market condition were given $5 worth of tokens (20 mim) to begin, and told that the number of tokens they had at the end of the study would be converted into lunch coupons (4 mims = $1 lunch coupon). The no-market participants were told that they would be given $5 lunch coupon at the end of the study for having installed and run the system.

4.3.1.2 Measures

During the study, participants' usage of the system was recorded, including such information as the questions asked and answers given. In order to test the answering behavior in a controlled fashion, I submitted an identical set of 24 questions to both systems.

To determine the social nature of these Q&A exchanges, raters from Mechanical Turk were recruited. They were presented with the questions and answers individually, and asked to give a -50 to 50 score, where 50 indicates a strong agreement and -50 a strong disagreement with the statement "the answerer wants to socialize with others." I limited the task to workers from the US to ensure that raters would be proficient in English. After removing outliers from the ratings an Intra-Class Correlation Reliability (ICC) of 0.65 was achieved.

In addition to these measures, I also conducted a questionnaire asking participants to rate their perception of the system. One of the questions asked the participants to rate their sense of belonging to their mimir community.

4.3.2 Results and Discussion

Recall that 68 participant-asked questions were posted in the no market system and 50 participant-asked questions were posted in the market system (). In the no-market condition, 30 participants asked questions and 37 participants answered. Questions asked covered a wide range of topics, from questions regarding the company and the internship, to restaurant recommendations and programming help.

	No-Market	Market
#Participants	68	60
#Naturalistic Questions	68	50
#Controlled Questions	24	24
#Participants who asked questions	30	20
#Participants who answered questions	37	31

Table 4.1 General usage statistics

I presented how financial incentives affect answer length (effort) and answer quality in Chapter 3. The results support the hypothesis that paying raise the effort of the work. This confirms the utility of using financial incentives to support the task-oriented goals of Q&A.

I also hypothesized that the market condition resulted in less social usage; both less socially-oriented questions (hypothesis 1) and less socially-oriented answers (hypothesis 2). The results supported these hypotheses as well. The market condition resulted in questions that were less social (LS-Means 15.8 to 10.7, $F(1, 40.1)=128.15$, $p<0.001$). Also, the answers to the set of controlled questions in the market condition were also found to be less social (LS-Means 3.76 to -0.52, $F(1, 115.9)=3.53$, $p=0.06$). The analyses of the questions' and answers' social ratings were both repeated measures analysis of variance (ANOVA) in which the question asker or question answerer was repeated, and the condition (no-market or market) was the between-pair factor. Question asker or answerer were modeled as a random effect, since some askers asked multiple questions and some answerers answered multiple questions.

A good demonstration of the difference in interactions can be seen by the following question and answer exchanges that occurred. During the study, two askers independently asked the same question in both systems – "who else is online right now." In the no-market version, the question received an answer

stating that there is a number of users count visible on the mimir application window. It was a succinct and very functional answer. In the no-market system, on the other hand, the question resulted in a roll call, where 11 participants responded using emoticons and other symbols. This example shows that not only did the answerers in the no-market system interpret the same question in a more social manner, they also responded more socially.

Based on the responses to the questionnaire, this reduction in the socially-oriented usages of mimir may have impeded the forming of the mimir community. Participant responses about their sense of belonging in the mimir community, market system participants felt that they belonged to their mimir community less than the no-market system participants (2.49 to 3.04, $t(60)=2.26$, $p=0.03$).

These findings demonstrate the social drawback from using financial incentives. On one hand, financial incentives may be used to encourage effort and performance on tasks, supporting the task-oriented goals. However, these financial rewards may reduce socially-oriented interactions, which may then impede relationship building.

4.4 Experiment 2

To offer additional proof that financial incentives alter social norms, experiment 2 examines how offering financial incentives affect allocation decisions. Prior work suggests that allocation decision is dependent on social norms; those under exchange-based norms are more likely to use an equity decision rule, as opposed to an equality decision rule (Pataki *et al.*, 1994). Therefore, if offering financial incentives leads to a change in social relationships, from communal to exchange-based, then people who are paid should be more likely to allocate joint earnings based on equity.

In this experiment, small financial incentives were used for two reasons. First, the impact of financial incentives on social orientation should be dependent on whether or not financial incentives are offered, not how much is offered. This is because the signaling effect of money for exchange-based norms should occur as long as financial incentives are offered. Second, using small incentives may help to tease apart the proposed social norms effects of money (Gneezy & Rustichini, 2000b; Heyman & Ariely, 2004) from the self-sufficiency effects of money (Vohs *et al.*, 2006). Similar to the mimir experiment, Vohs *et al.* found a reduction in helpful behaviors when people are primed with money. However, this reduction of helpfulness only occurred when participants were primed with sufficiently high amounts of money. I argue, however, that their findings are intrinsically different from the social norms effects I am suggesting in this work. I would be able to validate this point if changes in allocation decisions occur when only small amounts of money are offered.

4.4.1 Method

4.4.1.1 Participants and procedures.

In this study, subjects participated in a real-effort prosocial activity of transcribing out-of-print children's books. The study was a 2 (pay vs. no-pay) x 2 (private, low-visibility vs. public, high-visibility) between-subjects experiment design. Participants in the pay conditions were told that they would earn $0.01 for every 20 words transcribed, and those in the baseline no-pay conditions did not receive any additional instructions. Participants in the public conditions were also informed that the number of words they transcribed (including the amount earned, in the pay condition), along with their first name and city of residence would be shown to all participants at the end of the study, and would be included with the digitized book to be placed online. The motivation behind this design was to compare participants' performance on a task when financial incentives are offered.

The public/private conditions were included to explore the potential affect of image motivation. Recent research has shown that publicizing the amount of financial rewards earned for a prosocial task may reduce task effort because of the crowding-out of image motivation – people work less hard when paid to work for good causes because they do not want to be perceived as selfish and greedy (Ariely *et al*. 2009; Benabou & Tirole, 2006). I did not find this interaction to be significant in my study, so I will not present the analyses in the results section.

The study was conducted through Amazon's crowdsourcing marketplace, Mechanical Turk (MTurk). On MTurk, anyone with valid means of payment (*e.g.* a credit card) can offer to pay to have their tasks done (*e.g.*, surveys, transcription, image labeling, summary-writing) by MTurk workers. Anyone over the age of 18 can log onto MTurk as workers and earn money by working on these tasks. This site is unique in that it provides a test-bed to study micro-level rewards. Through MTurk, we could offer to compensate participants for as low as 1 cent per task.

Figure 4.2 Phases of study

One of the problems with Mechanical Turk is that the quality of workers as study participants may not be very high. These workers may not read the instructions carefully or may try to complete the tasks as

quickly as possible. To ensure high-quality workers for the experiment, dummy surveys with duplicate questions were posted. Those who responded consistently were invited to participate in the main task.

Mechanical Turk does not allow posting tasks that offer no pay. Therefore, in order to create the no-pay conditions, we made the transcribing task an opt-in task, after participants completed another dummy survey on education and social networks that offered $0.35. A pre-study showed that digitizing children's books is perceived to be an interesting task for a good cause. Participants were told that they did not need to participate in this optional task to be compensated for the survey they had just completed. This was meant to ensure a disassociation between the $0.35 financial compensation and the digitizing task. At this point, participants were also asked to provide their first names and their cities of residence.

> *One of the main activities of our non-profit organization (Digital Education) is to digitally transcribe out of print children's books. The digitized versions will allow children from all over the world to read these wonderful books. You can make a difference by contributing just 5 minutes to help us digitize a portion of a book.*
>
> *You may also choose to quit at any time by clicking on the "Exit HIT Now" button. Even if you choose not to contribute to this project, you will still get paid $0.35 for answering the education survey.*
>
> *To help, we ask that you enter just your first name and your location of residence. This will allow us to keep track of our volunteer contributors and to collect the geographic demographics of our contributors.*

If participants chose to help to digitize the books they were then shown the cover of the book they were asked to digitize — *Doctor Dolittle's Puddleby Adventures*, by Hugh Lofting, published in 1952. For a practice task, they were asked to type the title and author of the book into the transcribing area. At this point, participants did not know whether or how they would be compensated for contributing their time and effort to digitizing. Only after the participants completed the practice task were they randomly assigned their treatments.

To measure people's social orientation post the pay/no-pay treatments, a hypothetical allocation question was posed. In this question, participants were asked to divide up money that was jointly earned with a stranger. Participants were told that they had completed more work than their partners (the participant was told that s/he had transcribed 5 pages compared to 3 pages transcribed by his/her work partner, out of a total of 8 pages that needed to be completed). Furthermore, they were asked to decide how to allocate the joint earnings of $8. The expectation was that people who perceived their relationship with the stranger as

an exchange relationship would distribute the shared-earnings based on equity or individual input, resulting in giving $3 to the partner. On the other hand, the product of labor is treated as a collective resource in communal relationships and equality is the default mode of distribution, which means giving $4 to partner (Pataki *et al.*, 1994). In the setup for this experiment, participants were given 9 choices — the 9 exhaustive options of how to divide the payment at the $1 level.

> *Assume that you and a stranger (someone you have never met) are offered $8 to help transcribe 8 short chapters of a book. You both started on the task at the same time, but because you are the faster typer, you finished 5 chapters and the other person finished 3 chapters.*
>
> *You are then asked to determine how the $8 should be divided between the two of you. What would you do?*

Finally, participants in the public conditions were shown all participants' performances. A few days later, participants were compensated.

In all, 174 MTurk workers participated in the transcription study. Each of the conditions had more than 38 participants, though due to random assignment, some conditions had more participants than others.

4.4.1.2 Measures

The number of words transcribed and the responses to the allocation decision were recorded. The length of the transcription was used for our measure of task performance.

4.4.2 Results and Discussion

On average, 136.5 words per participant were digitized, which equated to average earnings of 6.8 cents when the participant was paid.

Results support the hypothesis at the trend level that paying increases task effort (estimated mean: 144.4 to 123.7, $F(1,169)=2.93$, $p=0.09$). This analysis was done with an ANOVA model using pay/no-pay and private/public as the binary independent variables and the number of words digitized as the dependent variable. Two outliers were removed after preliminary analysis. The model only explains 2% of the variance, which may be due to the high variability in typing speed across participants.

	Pay	No-Pay
Public	**65%**	**44%**
Private	**74%**	**55%**

Table 4.2 Equity decisions across conditions

To study the effects of financial incentives on shared-resource allocation decisions, I examined the allocation decision. In my setup, sharing $4 was the equality decision, whereas sharing $3 was the equity decision. The resulting decision distributions were non-normal (most centered on giving $4 and $3), so I coded up the dependent variable as greater than or equal to $4 (communal-oriented), or less than $4 (exchange-oriented). The logistic-regression model using incentive (pay/no-pay) and image (public/private) as independent variables shows that getting paid has a significant effect on the allocation decision ($p=0.03$). Specifically, the estimates suggest that getting paid resulted in a 2.3 times increase in likelihood to allocate based on equity (Table 4.2). There was no 2-way or 3-way interaction effect and the image effect was also not significant.

These results are important findings in two ways. First, these results offer concrete proof that financial incentives change social orientation into more exchange-based orientations. Second, these results offer proof that the social norms' change due to money is different from the self-sufficiency change due to money. Here, participants only earned 6.8 cents for their 5 minutes of work, which is well below minimum wage and low for even MTurk standards. The low rewards offered, according to Vohs *et al.*, should not have resulted in a sense of self-sufficiency. Yet, a significant effect was found here.

4.5 Experiment 3

Experiment 3 extends experiment 2 by examining whether existing friendship interacts with financial incentives to affect allocation decisions. The hypothesis is that friends should be less susceptible to adopting an exchange-based norm of interaction when money is offered because they have already converged on communal-based norms as the desired norms of interaction.

4.5.1 Method

4.5.1.1 Participants and procedures

Participants were recruited through flyers posted around Pittsburgh and through online postings at the Center for Behavioral Decision Research at Carnegie Mellon University. Participants were told that they would help to transcribe out-of-print children's books for a few good causes. First, the transcribed text would be used for testing education technologies. Second, participants would be studied to improve existing transcribing interfaces. And finally, these out of print books would be made available online for kids from all over the world to read. Participants were told that they would be paid $10 for the thirty-minute long session.

Participants were each asked to invite a friend for this "transcribe campaign." We explained that this would provide a more diverse pool of participants, as well as contributions from and study participants who do not typically participate in these studies. Prior to coming into the study, participants and their friends were asked to fill out a pre-survey. They were asked how long they have known their friend, and about their communal orientation with their friend (using a scale developed by Mills *et al.*, 2004) and their personality (using the Big Five Inventory, John *et al.*, 2008). Participants were not screened based on their responses to the pre-study survey; instead, all of them were invited to participate in the study and their responses were used to facilitate analyses.

The study was a 2 (friends vs. strangers) by 2 (no-pay vs. pay) between-subjects design. Participants were scheduled in a manner such that 4 or 6 persons (2 or 3 pairs of friends) arrived at the lab at the same time. Within each session, participants were seated either in front of their friends or in front of strangers (*i.e.*, another participant's friend). They were told that pairs seated across from each other would be working together on transcribing a chapter. They were told that this was to ensure complete coverage on the chapters. Dividers were used so that participants could not see each other after they were seated.

Participants were given instructions on how to transcribe and what the transcribing interface looked like. After the instructions, participants were given 60 seconds to practice transcribing. Then, participants were told which chapter they would be transcribing with their partner. In the study, all participants transcribed the same material, Chapter 2 of the aforementioned *Doctor Dolittle's Puddleby Adventures*. Those in the pay condition were also told that they would earn an additional 1 cent for every 10 characters transcribed.

<In the pay condition>

In addition to the money you will receive for showing up to the study, to thank you for your help, we will also pay you 1 cent for every 10 characters you transcribe.

<In all conditions>

The book you are asked to transcribe is Dr. Dolittle's Puddleby Adventures by Hugh Lofting, published in 1952.

*You have been assigned to transcribe **Chapter 2** with the person across from you. What you two are able to transcribe will be merged together later.*

Participants were given 10 minutes to transcribe. The transcribing interface provided feedback on how much time was left, how many characters had been transcribed, and, in the pay condition, how much participants had earned (Figure 4.3). Immediately after the 10 minutes, participants were asked to make the allocation decision. They were all told that the amount they had transcribed with their partners qualified them for a shared bonus of $2.00 and that, since they transcribed more, they should decide how to split up the bonus. They were shown how many characters they transcribed and were deceived into believing that their partners transcribed about 3/5 of that amount. In other words, they themselves transcribed 62% of the total, and their partner transcribed 38% of the total. With this set-up, participants who used an equity decision rule should keep $1.25 while participants who used an equality rule should keep $1.00. After the allocation question, participants were asked to fill out a background survey, answer some open-ended questions about their experiences, and also the manipulation checks questions.

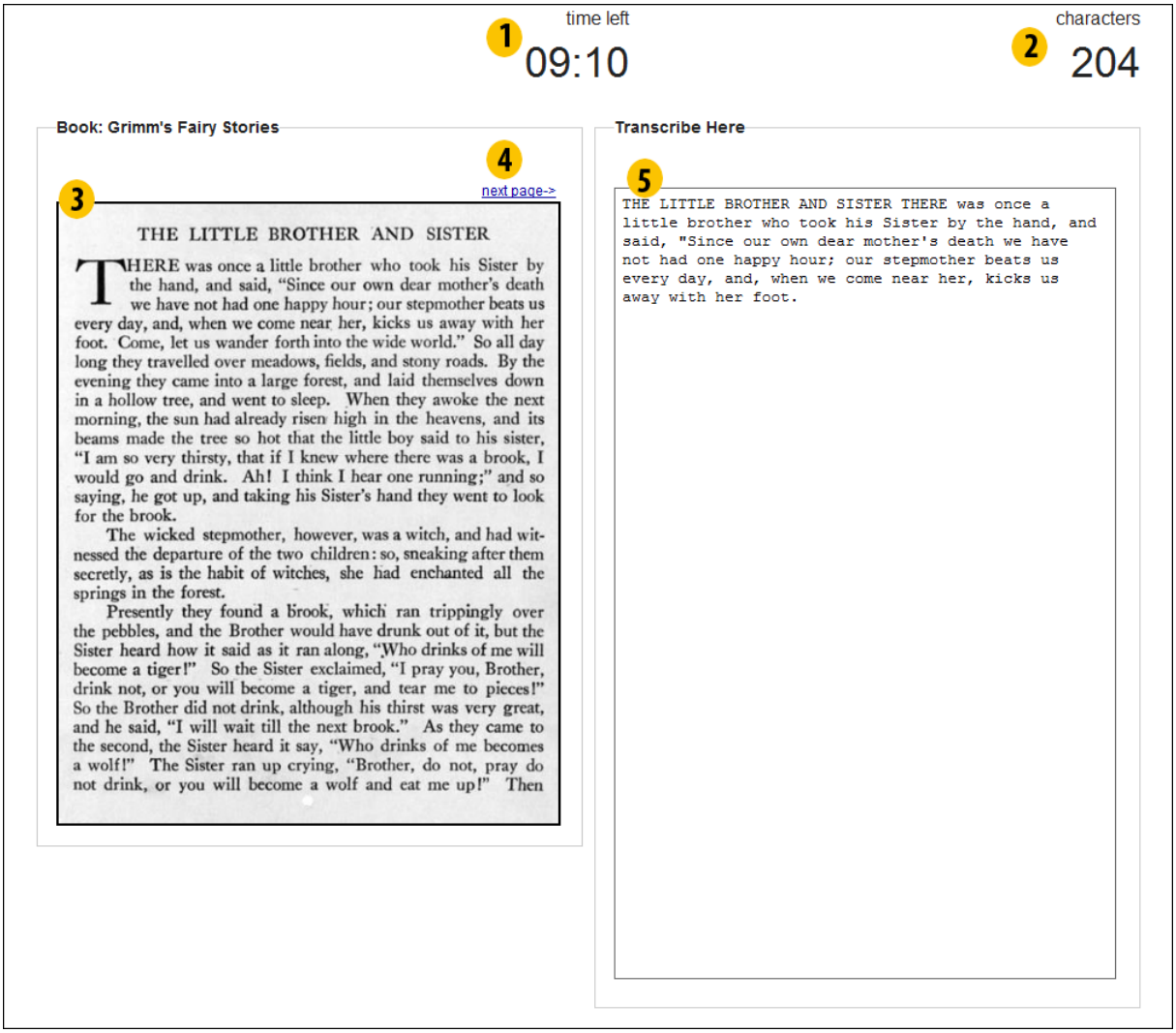


Figure 4.3 Screenshot of transcribe interface: 1) amount of time left, 2)number of characters transcribed, 3) scanned page from a book, 4) button to advance to the next page, 5) input text area

In all, 114 participants participated in the study (all conditions had 28 participants, except for the no-pay, friends condition which had 30). One participant did not complete the study due to a computer malfunction, so her partner was also excluded from the final analysis. In addition, two other participants were also excluded because they thought that they had been partnered with their friends, despite having been specifically informed that they were partnered with the person sitting across from them. In the manipulation checks, participants reported not knowing anyone else in the study session other than their friend. Excluding these four participants left 110 participants in the analyses.

It should be noted that the deceptions were not perfect. Some participants expressed doubts that they had transcribed more than their partners in the post-study questionnaire. This was especially true between friends who perhaps know more about each other's typing skills (8 participants in the friend condition and 2 in the stranger condition expressed doubt about their transcription performance having outstripped that of their partners). Analyses were conducted both with and without these participants, and there were no differences between the models so the models are presented with them included.

4.5.1.2 Measures

The number of characters participants transcribed and their response to the allocation question were recorded. The length of the transcription is used for the measure of task performance.

4.5.2 Results and Discussion

On average, participants transcribed 1781 characters in 10 minutes, which equated to an average additional earning of $1.78 in the pay conditions.

To examine the effect of paying on task effort, an ANOVA model was built using pay/no-pay as the binary independent variable, the number of characters transcribed in the trial session as a control variable, and the number of characters digitized as the dependent variable. One outlier was removed. Unlike the previous experiment, the results showed no difference between the pay and no-pay conditions ($F(2,106)=0.83$, $p=0.37$).

Like experiment 2, the allocation decision was coded into binary outcomes. Deciding to keep more than or equal to $1.25 was coded as the exchange-oriented decision, and less than or equal to $1 as the communal-oriented decision. The logistic-regression analysis shows that the interaction of pay and friendship was not significant, so the model is presented without the interaction term. As expected, the model shows that friendship has a significant effect on the allocation decision ($p<0.001$); strangers are 14 times more likely to choose the equity decision. Confirming results from experiment 2, the model also shows that paying results in a higher likelihood of equity-based decision ($p=0.02$). People who were in the pay conditions were 3.1 times more likely to allocate the joint-earnings based on equity. Testing was conducted to see whether the number of characters transcribed had an impact on the allocation decision; the effect was not significant.

Since participants were not screened based on the pre-study survey, there is a concern for construct validity. Participants in the friend condition may have been people with weak ties who decided to participate in this study together. Therefore, to ensure that the friend condition actually reflected pairs of people with existing communal relationships, participants across all conditions who had known their

"friend" for less than a month and had a pair-wise communal rating lower than 6 out of 10 (24 participants) were removed. With these participants removed, the mean communal score was 7.75 out of 10. Interestingly, removing these participants actually increased the effect size and significance of both binary predictor variables in the model (pay: b=3.1, p<0.001; friend: b=1.6, p=0.01).

	Pay	No-Pay
Friends	**18%**	**4%**
Strangers	**70%**	**48%**

Table 4.3 Equity decisions across conditions

Results from this experiment reinforce findings from experiment 2 and show that paying increases the likelihood of subsequent exchange-norms of interaction (supporting H3). In some ways, results from this experiment are even more convincing than those from experiment 2 because in experiment 2 participants were asked participants to make a hypothetical decision, and this experiment actually asked participants to make an allocation decision that had real financial consequences.

However, results from this experiment do not support the hypothesis on the interaction between financial incentives and existing communal relationship (H4). I had hypothesized that the undermining effects of payment would more strongly affect interactions between strangers than friends. What I found is that the suggestive nature of financial incentives for exchange-based interaction is just as powerful between friends as it is between strangers (Table 4.3).

One possible explanation for why I did not find the interaction effect is because people learn to apply different norms with different situations, even with the same person (Mills & Jordan, 2002). Participants were essentially put into an artificial environment where they worked on a task that they most likely had not encountered before. From that perspective, friends may also have needed to figure out what norms to apply just like strangers, and the offered financial incentives were just as suggestive to them as they were to strangers. Additional research is needed to explore this.

4.6 General Discussion

Despite the amount of prior research on how financial incentives affect individual motivations and task performances, relatively little is known about how these rewards can affect social relationships. In the studies presented herein, results support the idea that offering financial incentives result in a desire for

more exchange-oriented interactions, and that being offered financial incentives for help can change the subsequent norms of interaction to more exchange-transactional and less social-communal.

The results suggest that there are symbolic meanings behind offering financial incentives that affect our decisions on whether or when to offer these incentives. As pointed out by a growing body of literature, and in fairly stark contrast to the traditional western view of cash as cold and meaningless, there are embedded meanings when offering financial rewards (Zelizer, 1994). Money, then, is not much different from other goods we select and give to one another – they have certain existing social and cultural meanings embedded. Also, because financial incentives are often associated with a desire for an exchange-oriented transaction, we are less likely to offer such incentives when seeking social interactions. In Study 1, when comparing the questions asked in a system supported by financial incentives to questions asked in a system without a payment system, the questions from the market versus the no-market system were less social in nature. This finding is consistent with research on relationship norms and incentives, where financial transfers are perceived to be violations when used in communal relationships but not when deployed in exchange relationships (Clark & Mills, 1979; Aggarwal, 2004).

The results also show that the use of financial incentives can affect helpers' subsequent norms of interaction. This is an important contribution that helps to elucidate the intricate relationship between financial incentives and social relationships. One set of prior work assumes that money changes social norms, without offering any proofs that social relationships or social norms were indeed changed (Gneezy & Rusticini, 2000b; Heyman & Ariely, 2004). Other studies did find that priming people with money reduced their interaction and increased physical distance to others; however, these researchers relied upon the concept of self-sufficiency to explain their findings, *i.e.*, that money encourages people to be free of dependency on and dependent-free from others (Vohs *et al.*, 2006). The study presented herein provides evidence in support of the social norm hypothesis. It demonstrates two specific ways in which social norms were altered by the offer of financial incentives. First, people in financial-based systems were less likely to provide responses that were social in nature. If this were due to an increase in self-sufficiency, then we should have observed fewer overall interactions between participants, and not only fewer socially-oriented interactions. Second, people who are offered financial incentives for their help subsequently allocate shared resources differently from those who are not offered financial incentives. They are more likely to base their decisions on individual inputs (equity) instead of sharing it evenly with their partners (equality). In the study setup, the amount rewarded was minimal, much less than the hourly minimum wage (less than $1 an hour when extrapolated). With such a small amount of money offered, it is, therefore, unlikely that the results are caused by self-sufficiency.

In addition, results from the third experiment advance prior work by improving our understanding of the connection between financial incentives and existing relationships. As expected, people with existing communal orientations are more likely to share equally with each other. However, what was surprising was that friends are just as likely to change their norms of interaction as strangers when money was introduced. In other words, existing communal relationships do not render people immune to the undermining effects of financial incentives. It could still be possible that certain types of relationships are impervious to the effect of financial incentives, however, that would only constitute a small number of people that with whom we interact.

It is important to note that in the allocation decisions, while the incentives were awarded by the experimenters, the allocation decision is actually between the participant and another party (not with the experimenters). Hence the results do not necessarily reflect how people would respond to allocation decisions when it is the requester who is offering the financial rewards. However, I believe that the effects of financial incentives have an overall framing effect that changes the payee's subsequent mindset and their interaction norms not only with the person or people who paid them, but with third parties as well.

Lastly, re-examining the impact of financial incentives on intrinsic motivation and task performance is not the primary focus of this work, the results offered no evidence to support crowding-out, either at small or fairly average payment levels (about $0.25-$0.50 per question and 6.8 cents for 5 minutes of transcription, or $1.78 for 10 minutes).

4.6.1 Practical Contributions

The most direct application of this study concerns the use of financial incentives in interpersonal exchanges. Advances in electronic payment services have reduced the overhead costs of financial exchanges in everyday interactions. PayPal, one of the most popular e-commerce businesses that supports payments and money transfers online, has 73 million active accounts as of 2009 and boasts a healthy $16 billion total value of transaction in the first quarter of 2009 alone (eBay shareholders' report). Users of services such as PayPal can now promise and transfer financial rewards for goods or assistance from afar. Even though we are empowered with the option of offering financial incentives for help, we must carefully consider what we want to get out of the interaction and what type of relationship we plan on establishing with the helper. As the studies presented herein have shown, what is offered may not only have an impact on the quality of help, but may also alter the relationship.

In addition, findings also have implications for encouraging contributions in online communities, where under-contribution is a prevalent problem (*e.g.*, Butler, 1999). A growing number of online communities are experimenting with the use of financial incentives to attract participation and contribution (*e.g.*,

Mahalo, Squidoo, stickK). However, the tradeoff between immediate participation and long-term relationship building needs to be considered. If financial incentives affect the relational framing between community members and are changing the nature of the conversations, then these incentives may have an adverse effect on the creation of social bonds. Much existing work has shown that these types of socializing between community members are vital for task performance, satisfaction, and the long-term success of these communities (Barge & Schlueter, 2004; Bauer *et al.*, 2007; Saks, Uggerslev, & Fassina, 2007). Furthermore, the findings presented herein also suggest that financial incentives may corrupt existing relationships. This implies that existing sites are also susceptible to relationship changes if an economic system is introduced.

Outside of interpersonal relationships, the findings also have practical implications for branding and marketing. Research has shown that consumers relate to brands in the same way they do with people in social contexts (Fournier, 1998; Muniz Jr. & O'Guinn, 2001). Social relationship theory may then be extended to person-brand relationships. People may adhere to exchange-based norms when interacting with certain brands and communal-based norms when interacting with other brands. Aggrawal tested this idea and showed that brand satisfaction is dependent on the company's ability to behave according to the expected social norms, just like satisfaction with people is dependent on their ability to behave according to the norms. My results suggest that brands' use of financial rewards, perhaps through marketing ploys or loyalty programs, can affect costumers' relationship orientations with the brand. Companies that use financial rewards may alter their customer's perceived relationship with the brand, from a more communal-social relationship, to a more exchange-transactional relationship.

4.7 Conclusion

This work provides an important glimpse into the potential social cost of financial incentives. Evidence presented indicates that financial incentives are indeed more often used in exchange-oriented transactions than in social-conversational interactions, but, more importantly, offering financial incentives can affect subsequent relationship orientations. Offering financial rewards for help can lead to fewer social responses and future interactions that are based on exchanged-norms instead of communal-norms.

Hence, if you ever need help translating a paragraph of from English to Thai, you should not only consider how financial incentives can impact the likelihood and quality of the help, but also think about the social cost.

Chapter 5

CONCLUSION

The goal of this thesis was to examine the use of market mechanisms to help to allocate our resources for information exchange efficiently. I presented in this thesis a series of studies and experiments that test the feasibility and examines the strengths and weaknesses of applying market mechanisms to support information exchange. Here, I present an overview of the central findings.

5.1 Practical Contributions

From a practical standpoint, I have shown how markets can both support and undermine information exchange. I also offered guidelines on how to design these markets.

5.1.1 Why Use Markets

In theory, two-sided market solutions differ from other solutions due to their many desired properties. First, they allow for signaling and screening, which reduce the problems of information asymmetry. Second, they enable the sharing of wealth and exchange surplus, and the financial rewards help to align the asymmetrical sender and receiver motivations.

The study presented in chapter 1 is the first to demonstrate empirically that a market condition for information exchange can improve the welfare of users. This is then followed by my studies of question and answer (Q&A) services, in which I found that, to a certain extent, question askers can use market pricing to their advantage. The pricing system reduces the frivolous questions and offers a mechanism for question askers to raise the salience of the more difficult questions. Also, the addition of financial incentives can solicit higher answering effort. Furthermore, the added pricing information may be able to support knowledge search and help to organize the knowledge repository. From a functional perspective, markets can indeed help information exchange.

5.1.2 Why Not to Use Markets

Despite the potential for markets to facilitate information exchange, I also found drawbacks in employing markets to facilitate information exchange.

First, there is the problem of transaction costs. From the empirical laboratory study presented in Chapter 1, I found that using markets for information exchange can increase deliberation costs, which can undermine exchange efficiency. Instead of making a binary decision as to whether or not to engage in an exchange, like we do with our existing communication technologies, using markets for information exchange may require us first to quantify our exact exchange surplus and then select a bidding or reserve price. Not only does the increase in the number of decisions required increase opportunities for error, it also requires more cognitive resources.

Second is the problem of social costs. From the mimir study presented in Chapter 2 and the follow-up experiments presented in Chapter 3, I carefully examined how using money changes the perception of exchanges and the subsequent relationships between people. Specifically, I found that, when money is introduced, it reduces the social interaction between people; it also changes how people share joint resources — people become more focused on individual inputs. For the purpose of exchanging information, this may not be a problem. However, we are social beings and, in many cases, social interactions are desirable. Social interactions are not only vital for our health (*e.g.*, Kaplan, Cassel & Gore, 1977), but can also lead to long-run productivity benefits (Kraut *et al.*, 1990).

5.1.3 How to Best Use Markets

Given that using markets for information exchange both incurs costs and yields benefits, how and when should we leverage these markets? Through my studies on mimir and Mahalo Answers, I have presented various design guidelines to improve Q&A markets.

To reduce transaction costs, pricing support should be incorporated into these markets. An example is to present feedback on pricing. In mimir, I presented a design that provides user feedback on average reserve price in the real-time exchange interface. With more data and with the right prediction models, that can be extended to include much better feedback. For example, senders may be given the option to adjust their bid price to see how changing the bid price changes the projected number of answers, answer length, and maybe even answer quality. Alternatively, using those same models, we can simply suggest the bid prices based on senders' information needs. Even without intelligent predictions, a design recommendation based on the empirical study is to offer only a few pre-set price tiers. From the distribution of exchange in the Q&A dataset, it seems that there should be more tiers at the lower-end price points since there are

more low-valued questions (power-law distribution). For example, a four-tiered system (*e.g.*, $1.00, $2.00, $5.00 and $20.00) may provide sufficient tiers to help to differentiate the information requests while minimizing deliberation costs.

I believe that the more challenging problem is the social costs that arise from the use of financial incentives. Experiments in chapter 4 show that this is a real problem that can even affect friendships. There are some interface design guidelines that I offered, one of which is to soften the financial framing for these market-based communication technologies. Instead of using words such as "money," "pay," and "cost," a different set of terms can be used that do not highlight the exchange-oriented nature of the interactions. Coupled with the aforementioned idea of a tiered pricing system, instead of a "$20.00" request, it may be referred to as a "VIP" or "urgent" request. This may help to disassociate the money framing from the interaction, but still help by preserving the signaling and screening aspects of the market system.

Specific to Q&A communities, my findings suggest that we should design interfaces for two different usages — information and social. Any information exchange service may support both information and social exchanges, but they will have different interfaces, different interactions and different incentive structures. Information exchanges will be market-based, and will have the more standard question and answer fields and affordances. On the other hand, more discussion-oriented exchanges will use more fun and social rewards (*e.g.*, badges) and will have more of a discussion-oriented interface. Users will be able to build social bonds through the more social topics, but can also easily find and respond to serious informational questions.

5.2 Theoretical Contributions

Economic markets have become such an integral part of our society that we often forget that they are man-made institutions that we have only relied for a short and recent part of human history. While research in the field of behavioral economics has significantly improved our understanding of how humans behave in market situations, our knowledge is still limited, especially when it comes to applying markets to novel domains.

In Chapter 2, I demonstrated empirically that using markets can improve communication welfare, but more importantly, findings highlight the tradeoff between the expressiveness of the market and deliberation costs. More expressive markets should allow us to provide more precise signals, but the higher precision also demands more deliberation. Even though the notion of deliberation costs in

economic decisions is not new, considering it as a factor in markets for communication is. The results presented herein can help to create more accurate models of communication decisions.

In Chapter 3, I studied how market systems can affect help-seeking and help-giving behaviors. Those studies contribute to the growing set of literature that shows that while paying solicits more effort, it may not improve the quality of work. In addition, those studies also demonstrate how social norms can impact help decisions in market systems. The decision as to whether or not to pay is dependent on the actual exchange needs and the nature of the exchange. Specifically, it shows that people are more likely to pay when seeking information than initiating conversation.

In Chapter 4, I presented experiments that elucidate the association between money and social relationships. Prior work suggests that money changes how people engage tasks, but it does not explicitly measure how. Here, I showed that money affects social orientation and reduces social interaction. In addition, money suggests equity-based allocation norms between strangers, and can undermine existing equality-based allocation norms between friends.

5.3 Closing Remarks

From the printing press to the internet, from the telegraph to the Smartphone, advancements in communication technologies have been responsible for the accelerated spread of information and knowledge throughout human history. However, while these technologies have gotten better, our brains have not changed — we have about the same cognitive prowess as we did a thousand years ago. We have arrived at a point in human history where the most pressing communication issues are not the engineering challenges of how to make these technologies faster, richer, and more flexible; instead, we are faced with the growing human-computer interaction problem of how to maximize users' benefits from using existing and future communication technologies, given our limited cognitive resources.

Economic markets offer a solution to this problem. By designing, building and studying markets for information exchange, this dissertation has demonstrated the feasibility and the benefits of using these markets. But the studies also highlight some of the drawbacks of employing these types of markets for interpersonal exchanges. I hope that the knowledge gained from this thesis will help us to design and develop computer-mediated communication technologies that are sensitive to our limited resources of attention and time. In the long run, these results will also help to pave the road for novel incentive mechanisms that are able to leverage both social and economic forces while minimizing their potential to undercut each other. They will then lead to more efficient interpersonal interactions while preserving the important social interactions.

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