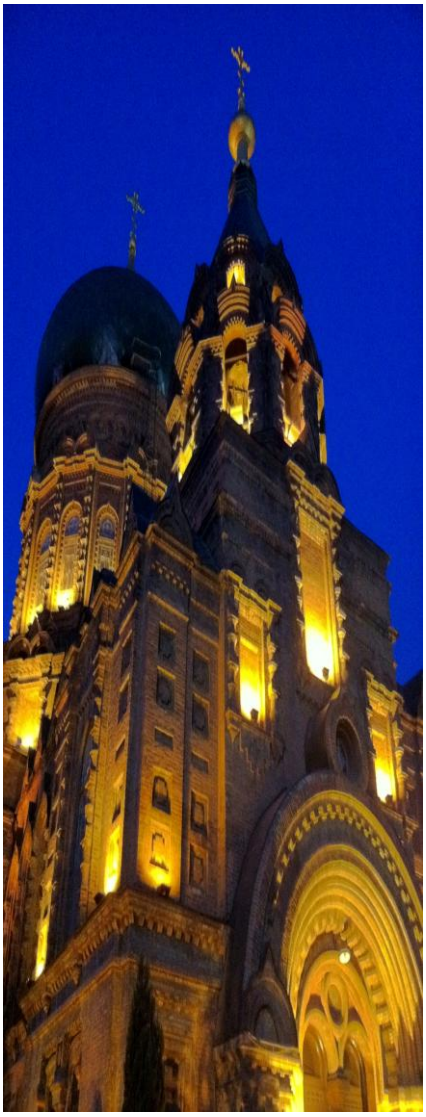
PROCEEDINGS OF

The Fifth China Summer Workshop on Information Management (CSWIM 2011)



June 24-25, 2011, Harbin, China

Edited by
Qiang Ye, Harbin Institute of Technology
Michael Zhang, HKUST
Zhongju (John) Zhang, University of Connecticut

FOREWORD

The China Summer Workshop on Information Management (CSWIM) entered its fifth year in Harbin, China on June 24-25, 2011. The purpose of CSWIM is to create a bridge to promote lively exchanges and collaborations in the area of information systems and management between scholars in China and other countries. In particular, CSWIM focuses on creating a unique experience for information systems (IS) researchers around the world who would like to communicate and collaborate with China-based scholars and study how information systems and technologies affect individuals, businesses, organizations, and societies. In the past four workshops (Shanghai, 2007; Kunming, 2008; Guangzhou, 2009; Wuhan, 2010), each received approximately 100 participants, representing most of the top IS programs in North America, China, and the rest of Asia.

The call-for-papers solicited original research papers addressing issues concerning the theory, design, development, evaluation, and application of information systems and management. As a research workshop, CSWIM 2011 encouraged submissions of research-in-progress that were innovative and thought-provoking. Research articles particularly sought after were driven by business problems and validated with proper research methodologies.

In total, 30 papers were presented at CSWIM 2011. Among them, approximately 2/5 comes from the US, 2/5 from China, and 1/5 from other parts of the world. CSWIM 2011 featured (i) two keynote speeches: one by Dr. Robert Kauffman on "*Who Will 'Bell the Cat'? IT, Channel Conflicts, Transparency and the Theory of Strategic Decommoditization*" and the other by Dr. Varghese Jacob on "*MIS Research over the Years – Rolling Stone or Leading Edge*", and (ii) two panels on issues related to Success, Collaboration, Opportunities, Risks, and Enterprise (SCORE) of Information Systems: one in English (Panelists: Han Zhang (Chair), Ming Fan, Ram Gopal, Ting-Peng Liang, Ping Zhang, and Leon Zhao) and the other in Chinese (Panelists: Qiang Ye (Chair), Guoqing Chen, Lihua Huang, Yijun Li, Zhangxi Lin, and Kanliang Wang)

We thank all the members of the Advisory Committee, who offered us advice and encouragement throughout the preparation stages of the workshop. We are grateful to the PC members for their quality review and diligent work during the short review cycle. The importance of the Best Paper Award Committee (Han Zhang (Chair), Ram Gopal, Yong Tan, Ming Fan) cannot be overemphasized; its members' collective insight, experience, and fairness enabled CSWIM 2011 to nominate and select the best candidates and final winners of the Best Paper Award.

Special thanks are owed to the sponsors of CSWIM 2011, including National Natural Science Foundation of China, University of Connecticut, Hong Kong University of Science and Technology, Harbin Institute of Technology, and City University of

Hong Kong. We specifically would like to acknowledge the superb services provided by the entire local team lead by Xitong Guo at Harbin Institute of Technology. We thank all of them (faculty, staff, and students) who are involved for their hospitality, dedication, and tireless work throughout the workshop. Without their extraordinary help, this workshop could not have been possible. Additionally, we would like to thank Han Zhang (CSWIM president) and Leon Zhao (CSWIM advisory board chair) for their guidance and inputs on many of the details and logistics of running a successful workshop. Our thanks also go to Harry Jiannan Wang, who helped us on the design of the conference system and setting up the online registration system.

Finally, we would like to acknowledge the contribution and strong support of the Honorary Chair Dr. Bo Yu, Dean of the School of Management at Harbin Institute of Technology. Dr. Bo Yu and his school provided tremendous financial support for CSWIM 2011. Without the support, CSWIM 2011 would not have been a success!

We hope that you enjoyed CSWIM 2011, and that you will remain involved in future CSWIM conferences. More information about CSWIM 2011 is available at: http://www.business.uconn.edu/cswim2011.

CSWIM'11 Co-Chairs:

Qiang Ye, Harbin Institute of Technology
Michael Zhang, HKUST
Zhongju (John) Zhang, University of Connecticut

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Content

Session 1A: Data Mining 7

Improving the Effectiveness of Opinion Orientation Identification in Sentiment Analysis of Consumer Reviews: A Gloss-based Approach 7

Segmentation with Link Structure and Expert Information (Best Paper Nominee).....13

Automatically Assessing Information Usefulness in Online Knowledge Communities: A Text Classification Framework 18

Session 1B: E-Commerce 24

Imagination or Reality — The Direction of Price Dispersion in the E-commerce Era.....24

How Can Mobile Coupons Become Contagious? A Psychological Distance Perspective……..…...…28

Two-sided Benefits or Double-edged Sword? Competition in Mobile Device and App Markets (Best Paper Nominee)…….…...…33

Session 2A: Social Networks 38

Social Loafing or Not: An Exploration of Virtual Collaboration 38

On Collaboration Productivity Model Based on Social Capital Theory(Best Paper Nominee).....43

Winning Crowdsourcing Contests: A Micro-Structural Analysis of Multi-Relational Networks (Best Paper Nominee).....48

Session 2B: IT Usage 53

Enhancing Organization's Operational Efficiency through Environmental Performance Improvement: An IT Resource-Based Vie 53

Teleconsultation: Understanding Continued Use 59

Users' Motivations and Intentions to Pay for Cybercafés in Mainland China.....64

Session 3A: Economics of IS 69

Who Welcomes Behavioral Targeting: An Economic Analysis……..……69

The Role of Certifiers in Strategic Communication.....74

Online Competition on Brick-and-Mortar Businesses: Evidence from the Banking Industry.....……80

Session 3B: IT Adoption.....104

Research on the relation between users' adoption behaviors and their teaching ability in an online education community…….....104

Technostress of IT professionals: diverse for different personality type and related to different career orientations…….....109

Perceived Affordances of Web Advertisements: Implications for Information Artifacts Design.....115

Session 4A: IT Security and Risk.....120

Decision Right of IT Unit and Risk Taking in IT Adoption.....120

Victimized by Phishing: A Dual-Process Information Processing Perspective.....125

Improving Emergency Management through Organizational Capabilities.....131

Session 4B: Electronic Marketplace.....136

Patterns and Driving Factors of C2C Seller Growth (Best Paper Nominee).....136

Effects of Friendship Links on Online Sellers' Performance: An Empirical Study.....141

Evaluating the Impacts of Auction Bidding Restrictions on Consumer Surplus and Behaviors — An Empirical Study of Penny Auctions……..…..148

Session 5A: Organizational Impact of IT.....153

Best Buy's Exit from China's Market – Anachronistic Strategy to Blame?.....153

Human Capital and Information Technology Capital Investments for Firm Innovation: Curvilinear Explanations.....158

The Motivations and Impacts of Innovation in Open Source Software.....167

Session 5B: IT Learning and Skills.....173

Introducing Basic Project Management Skills in an Introductory Information Systems Course: a Constructivist Approach to Teach and Learn High-Order Business Skills.....173

Effects of Outsourcing on IT Professionals.....178

Improving the Effectiveness of Opinion Orientation Identification in Sentiment Analysis of Consumer Reviews: A Gloss-based Approach

Chin-Sheng Yang, Cheng-Hsiung Chen, and Pei-Chann Chang
Department of Information Management, Yuan Ze University, Chung-Li, Taiwan, R.O.C.
E-MAIL: csyang@saturn.yzu.edu.tw, cjs@mail.vnu.edu.tw, iepchang@saturn.yzu.edu.tw

Abstract

With the popularity of online retail stores, consumers are not only shopping and comparing products on the Web but also providing their product reviews on the Internet platform. The Web has become the largest repository of consumer reviews which are beneficial to merchants, manufacturers, and consumers. The large volume of consumer reviews makes it difficult for any individual to obtain a comprehensive view of consumer opinions. Consequently, effective techniques for automatic consumer review analysis are desirable and essential. We concentrate on opinion orientation identification of sentiment analysis in consumer reviews. Specifically, we propose a gloss-based opinion orientation identification (G-OOI) technique capable of determining the semantic orientation of review sentences effectively. According to our empirical evaluation results, the G-OOI technique outperforms its benchmark technique.

Keywords: Sentiment Analysis, Opinion Mining, Opinion Orientation Identification, Gloss, Consumer Reviews

1. Introduction

With the rapid expansion of e-commerce innovations, shopping online becomes so popular that consumers not only purchase products through e-stores but also compare product specifications and prices on the Web. Consequently, the Web has become an excellent source for gathering consumer opinions or, more specifically, consumer reviews (Dave et al., 2003; Hu & Liu, 2004a; Hu & Liu, 2004b; Wei et al., 2010; Yang et al., 2009). Such online consumer reviews are essential for merchants or product manufacturers to understand general responses of consumers on their products. From the perspective of consumers, consumer reviews provide valuable information to facilitate their purchase decisions. However, as the number of consumer reviews expands, it becomes difficult for any individual to obtain a comprehensive view of consumer opinions pertaining to the products of interest through a manual analysis. Consequently, an effective sentiment analysis technique capable of summarizing the sentiments of consumer reviews pertaining to specific product features automatically becomes desirable and essential.

Sentiment analysis generally involve two main tasks: 1) product feature extraction and 2) opinion orientation identification (Hu & Liu, 2004a; Hu & Liu, 2004b; Popescu & Etzioni, 2005; Wei et al., 2010; Yang et al., 2009; Liu 2010). Product feature extraction focuses on automatically extracting all product features mentioned in the consumer reviews. Those review sentences contain one or more product features are considered as opinion sentences. Several product feature extraction techniques have been proposed in the literature (Hu & Liu, 2004a; Hu & Liu, 2004b; Popescu & Etzioni, 2005; Wei et al., 2010; Yang et al., 2009) and promising results have been obtained. On the other hand, opinion orientation identification concentrates on determining the sentiments (i.e., positive or negative semantic orientations) of consumers for

these opinion sentences. We concentrate on the opinion orientation identification task in this study.

Opinion orientation identification can be considered as sentiment classification (Pang et al. 2002; Turney & Littman 2003; Dave et al. 2003). However, review sentences are generally short in length and may not contain sufficient information for effective sentiment classification. Pang et al. (2002) and Dave et al. (2003) investigated several learning algorithms for sentiment classification and reported that the sentiment classifiers performed well on the document level but not on the sentence level. An alternative approach that employs a set of opinion words (Hu & Liu, 2004a; Hu & Liu, 2004b) or opinion phrases (Popescu & Etzioni, 2005) was proposed. Opinion words are adjectives used to express subjective opinions on product features. If an opinion sentence contains more positive opinion words (e.g., good, excellent) than negative ones (e.g., bad, poor), its sentiment is considered as positive (Hu & Liu, 2004a; Hu & Liu, 2004b). In contrast, if there are more negative opinion words than positive ones, a negative sentiment category is inferred. Such approach is simple and effective if representative opinion words indeed occur in opinion sentences. However, it is common that an opinion sentence may not contain any opinion words or the numbers of positive and negative opinion words may be equal. In this case, sentiment of an opinion sentence can only be determined by guess and by gosh.

In response, we propose a gloss-based approach that takes advantages but avoids limitations of both sentiment classification and opinion-word-based approaches for opinion orientation identification. Taking the idea of Esuli & Sebastiani's (2005) study, the gloss-based opinion orientation identification (G-OOI) technique is supervised in nature and learns a sentiment classifier using the glosses of a set of opinion words. Subsequently, the glosses of opinion sentences are submitted to the learned sentiment classifier for opinion orientation identification.

2. Design of the G-OOI Technique

The G-OOI technique focuses on learning a supervised classifier for opinion orientation identification. However, unlike traditional supervised classifier learning approaches that require a set of pre-classified examples (i.e., opinion sentences annotated as positive or negative sentiment categories) as training data, the G-OOI technique only requires a few positive and negative opinion words served as seeds. It then employs a lexical dictionary to perform a semantic expansion process that expands the set of positive and negative seed opinion words by including their synonyms and antonyms. The expanded set of positive and negative opinion words is then adopted as positive and negative training examples respectively for the sentiment classifier learning. However, opinion words do not contain sufficient information to learn the desired sentiment classifier. Consequently, on the basis on a lexical dictionary, we extract the glosses of each opinion word as its content and then apply for classifier induction. The induced sentiment classifier is subsequently applied to determine the orientation of opinion sentences in consumer reviews. The G-OOI technique consists of two main subsystems: 1) sentiment classifier learning and 2) opinion orientation identification.

2.1 Sentiment Classifier Learning

Given a set of positive and negative opinion words and a lexical dictionary, this part aims at inducing a sentiment classifier capable of identifying the orientations of opinion sentences. It consists of three phases: 1) semantic expansion, 2) gloss extraction, and 3) classifier induction.

Semantic Expansion: The acquisition of a comprehensive set of positive and negative opinion words is difficult, if not impossible. The G-OOI technique takes an alternative approach for opinion word acquisition. Given a few positive and negative opinion words, the semantic expansion phase derives a relatively comprehensive set of opinion words through the use of a lexical dictionary (i.e., WordNet (Fellbaum 1998) in this study). According to prior studies, the initial set of positive and negative opinion words are restricted to adjectives due to the following reason: Nouns in a document are likely to be the subjects that consumers comment on, while adjectives are often used to express opinions and feelings on subjects (Hu & Liu, 2004a). Hence, only the lexical information of adjectives in WordNet is employed.

WordNet organizes adjectives in a bipolar structure (Fellbaum 1998). Two basic semantic relations between adjectives in WordNet are synonym and antonym. Two words, such as 'fast' and 'rapid', are synonyms if they express the same or highly similar meaning. On the contrary, two words (e.g., 'fast' and 'slow') are said to be antonyms if they express opposite meanings. Using the bipolar structure of adjectives in WordNet, the semantic expansion proceeds as follows: Assume that OW_p, OW_n, EOW_p, and EOW_n be the sets of positive seeds, negative seeds, expanded positive opinion words, and expanded negative opinion words, respectively. For each positive seed $f \in OW_p$, we first search its synonyms SYN_f and antonyms ANT_f in WordNet, then expand the opinion words by adding SYN_f and ANT_f into EOW_p, and EOW_n respectively. Likewise, for each negative seed $g \in OW_n$, we incorporate its synonyms SYN_g and antonyms ANT_g into EOW_n and EOW_p, respectively. This expansion process may be performed iteratively. Currently, single iteration is executed.

Gloss Extraction: After the semantic expansion phase, we have a relatively comprehensive set of positive and negative opinion words. However, they are only words that do not contain sufficient information for sentiment classifier learning. We have to enrich the content of each opinion word to make it appropriate for sentiment classifier learning. Similar to Esuli & Sebastiani's (2005) study, the gloss of each opinion word is adopted as its content. Given an opinion word w, we obtain its gloss G_w from the WordNet. For example, assume the opinion word w is 'good', its gloss of sense 1 is "having desirable or positive qualities especially those suitable for a thing specified." We conjoin the glosses across all senses as the final gloss G_w for w. Consequently, an opinion word w can be represented as a pair $<G_w, c_w>$, where G_w is the gloss (i.e., content) and c_w is the sentiment category (i.e., positive or negative) of w.

Classifier Induction: Given the expanded set of opinion words and the corresponding glosses and sentiment categories, we can perform an induction learning process to obtain a sentiment classifier. A pre-processing is executed first to convert the glosses of opinion words to feature vectors. We filter out stopwords from the glosses of an opinion word, then represent it as a feature vector using the bag-of-word model. Subsequently, an induction learning algorithm, specifically support vector machine (Vapnik, 1995), is adopted to learn the sentiment classifier.

2.2 Opinion Orientation Identification

The sentiment classifier learned previously can be adopted to determine the sentiments (i.e., positive or negative) of new opinion sentences with unknown sentiment categories. Each new opinion sentence is represented based on the union of glosses of appeared adjectives, then its

sentiment category is predicted accordingly. The opinion orientation identification subsystem consists of two phases: 1) gloss extraction and 2) orientation identification.

Gloss Extraction: This phase is identical to that in the sentiment classifier learning subsystem. The gloss of each adjective in a new opinion sentence is searched based on the adopted lexical dictionary. The union of glosses of all adjectives occur in the opinion sentence is employed as the content of this opinion sentence and applied for opinion orientation identification.

Orientation Identification: A pre-processing process, identical to that in the classifier induction phase in the sentiment classifier learning subsystem, is performed first to transform the opinion sentences to be predicted into feature vectors on the basis of their glosses. The feature vector of each new opinion sentence is presented to the sentiment classifier and a predicted sentiment category (either positive or negative) is returned as the orientation of this opinion sentence.

3. Empirical Evaluation

We report our empirical evaluation of the G-OOI technique in this section. The approach proposed by Hu and Liu (2004a; 2004b) are employed as our performance benchmark. Moreover, the datasets of five electronic products used in Hu and Liu's studies are also adopted. Since the focus of this study is the performance of opinion orientation identification, only opinion sentences (i.e., review sentences contain one or more product features) are retained.

The G-OOI technique needs a set of opinion words served as seeds. Hu and Liu's approach also includes a mechanism similar to our semantic expansion to expand a set of seed opinion words. The 7 positive words and 7 negative words in Turney & Littman's (2003) study are adopted as seed opinion words of both the G-OOI technique and Hu and Liu's approach. The comparative evaluation results are shown in Table 1. The average accuracy, F_1 of positive category, and F_1 of negative category of the G-OOI technique are 66.71%, 76.31%, and 40.00% respectively, which are 4.52%, 1.58%, and 23.5% higher than those of Hu and Liu's approach.

Table 1: Comparative Evaluation Results

Product	Hu & Liu			G-OOI		
	Accuracy	**F_1 of Pos.**	**F_1 of Neg.**	**Accuracy**	**F_1 of Pos.**	**F_1 of Neg.**
DC1	69.87%	81.73%	14.29%	**77.41%**	**85.41%**	**50.00%**
DC2	64.38%	77.65%	12.41%	**75.00%**	**84.13%**	**41.18%**
CP	**72.93%**	**84.00%**	12.20%	62.78%	74.94%	**27.74%**
MP3	58.11%	70.68%	26.70%	**63.11%**	**73.56%**	**38.99%**
DVD	45.64%	59.61%	16.89%	**55.23%**	**63.51%**	**42.11%**
Average	62.19%	74.73%	16.50%	**66.71%**	**76.31%**	**40.00%**

As mentioned, Hu & Liu's approach has difficulty in determining the sentiment of an opinion sentence when it does not contain any opinion words or the numbers of positive and negative opinion words are equal. Among the 1,730 opinion sentences employed, 783 sentences (i.e., 45.26%) fit with this situation. We conduct another analysis to investigate this phenomenon. As shown in Table 2, the effectiveness of opinion orientation identification for the opinion sentences with zero opinion word or equal numbers of positive and negative opinion words is inferior to those with unequal numbers of positive and negative opinion words. The G-OOI technique still consistently surpasses its benchmark technique in terms of accuracy and F_1 of negative category.

Table 2: In-depth Analysis of the Evaluation Results

	Hu & Liu			G-OOI		
	Accuracy	**F_1 of Pos.**	**F_1 of Neg.**	**Accuracy**	**F_1 of Pos.**	**F_1 of Neg.**
POW ≠ NOW*	68.31%	79.76%	18.97%	**72.86%**	**81.30%**	**37.45%**
POW = NOW	56.18%	**69.25%**	13.89%	**61.32%**	67.58%	**49.50%**

*: *POW* ≠ *NOW*: numbers of positive and negative opinion words are unequal; *POW* = *NOW*: numbers of positive and negative opinions words are equal, including *POW* = *NOW* = 0.

4. Conclusion

We propose a gloss-based opinion orientation identification (G-OOI) technique to support effective sentiment analysis. According to our empirical evaluation results, the G-OOI technique outperforms its benchmark technique. Moreover, even no opinion words or equal numbers of positive and negative opinion words occur in the opinion sentences, the G-OOI technique still consistently surpasses its benchmark technique. Some ongoing and future research directions are discussed. First, empirical evaluation using additional consumer review datasets of diverse product categories would provide further insight. Second, word sense disambiguation is essential in our gloss extraction phase. Last, applying our gloss-based approach to other sentiment classification problems should be interesting.

Acknowledgements: This work was supported by the National Science Council of the Republic of China under the grant NSC 99-2410-H-155-057.

References

1. Dave, K., Lawrence, S., and Pennock, D.M., "Mining the Peanut Gallery: Opinion Extraction and Semantic Classification of Product Re-view," *Proceedings of the WWW'03*, 2003.
2. Esuli, A. and Sebastiani, F., "Determining the Semantic Orientation of Terms through Gloss Classification," *Proceedings of the CIKM'05*, 2005, pp. 617-624.
3. Fellbaum, C. (ed.), *WordNet: An Electronic Lexical Database*, MIT Press, 1998.
4. Hu, M. and Liu, B., "Mining and Summarizing Customer Reviews," *Proceedings of the ACM SIGKDD'04*, 2004a, pp. 168-177.
5. Hu, M. and Liu, B., "Mining Opinion Features in Customer Reviews," *Proceedings of AAAI*, 2004b.
6. Liu, B., "Sentiment Analysis and Subjectivity," In *Handbook of Natural Language Processing*, N. Indurkhya and F.J. Damerau (Eds.), NY: Chapman and Hall/CRC, 2010.
7. Pang, B., Lee, L., and Vaithyanathan, S., "Thumbs Up? Sentiment Classification Using Machine Learning Techniques," *Proceedings of the EMNLP 2002*, 2002.
8. Popescu, A. and Etzioni, O., "Extracting Product Features and Opinions from Reviews," *Proceedings of the HLT'05*, 2005, pp. 339-346.
9. Turney, P.D. and Littman, M.L., "Measuring Praise and Criticism: Inference of Semantic Orientation from Association," *ACM TOIS* (21:4), 2003, pp. 315-346.
10. Vapnik, V., *The Nature of Statistical Learning Theory*, Springer-Verlag, 1995.
11. Wei, C., Chen, Y.M., Yang, C.S., and Yang, C.C., "Understanding What Consumers Concern: A Semantic Approach for Product Feature Extraction from Consumer Reviews," *Information Systems and E-Business Management* (8:2), 2010, pp. 149-167.
12. Yang, C.S., Wei, C.P., and Yang, C.C., "Extracting Customer Knowledge from Online Consumer Reviews: A Collaborative-Filtering-based Opinion Sentence Identification Approach," *Proceedings of the 11th ICEC*, 2009, pp. 64-71.

Segmentation with Link Structure and Expert Information

Abstract

In many segmentation applications, data objects are often clustered based purely on attribute-level similarities. This practice has neglected the useful information that resides in the link structure among data objects and the valuable expert domain knowledge about the desirable cluster assignment. In this paper, we investigate the segmentation problem combining these three sources of information, which has not been addressed in the existing literature. We propose a segmentation method for directed graphs that incorporates the attribute values, link structure and expert domain information. The proposed method combines these three types of information to achieve good quality segmentation on data which can be represented as a directed graph. Experiments conducted on several real-world data sets demonstrate that our method can achieve segmentation with higher accuracy and satisfy constraints expressed in expert domain information. This method can be applied to a wide variety of applications such as social network and customer segmentation.

Keywords: Data Mining, Directed Graph, Graph Segmentation, Clustering

1. Introduction

Segmentation is to divide data objects (e.g. customers, products, news articles, etc.) into groups such that objects inside the same group are similar and objects in different groups are unalike. Data objects are often described by attribute values. For example, customers are described by attributes such as gender, age, income, education level, etc. When determining whether two data points are similar, a distance function is often used to calculate the similarity between data points based on their attribute values. While it is convenient to cluster solely based on attribute values, omitting other available information could lead to suboptimal clustering results when information other than attribute values is available. In this paper, we take into consideration information on link structure as well as expert domain knowledge on desirable cluster assignment while performing segmentation on data objects. In many applications, data objects are connected with each other. For example, in a social network, each person has his or her own characteristics such as gender and age which can be captured by attribute values. At the same time, people are interconnected through the network. A link between two people could mean that they share the same interests or background, giving out further information about how similar they are. It is often difficult to quantify such information into attribute values since there are no predefined values and these are often relative values instead of absolute values. News articles can be represented by a vector of words (attributes), and similarity between articles can be derived based on the frequency of the words representing the articles. Aside from the attribute-level information, news articles can provide links to other related news articles which could be a much stronger indicator for similarity.

Aside from information about link structure, another valuable source of information which can significantly affect segmentation quality comes from the experts. Expert domain knowledge carries information about the preferred results (i.e. which data points should be groups together). For example, in the social network setting, experts might prefer to have two members of the social network grouped together because they are both very active users. This can be expressed as a constraint to the segmentation method so that we can guarantee these two users will be put into the same cluster.

In this paper, we design a segmentation procedure that incorporates attribute information, link structure and domain information into the clustering process. In the first stage, we combine the attribute information and link structure into a directed graph whose edge weights carry both attribute similarity and link strength (i.e. link weight which measures how strong the link is). In the second stage, we transform the directed graph generated in the first stage to a compressed graph so that the constraints expressed in domain information can be fully captured. Then, we perform graph partition on the compressed graph, and finally we transform the clusters on the compressed graph to the clusters on the original graph. Using graph theory, we prove that the best partition that optimizes the clustering objective function on the compressed graph is equivalent to the best partition in the original graph with constraints incorporated. In addition, we propose further constraint propagation procedure to generate extra constraints to enhance the segmentation quality when experts cannot provide adequate number of constraints.

2. Constrained Clustering on Directed Graphs

Many data sets have both attribute and link information such as web pages with hyperlinks and documents with citations. The intrinsic link structure forms a directed graph while the similarities between the objects derived from their attribute values can be integrated into the same directed graph. Aside from the link structure and attributes, the domain information supplied by the experts can guide the algorithm to converge to a more desirable solution. For instance, if the experts specify that certain objects should belong to the same cluster, we can cluster in a way that these constraints are fulfilled generating results that align with domain information.

Given a directed graph, the goal of our work is to find a partition/clustering which divides the graph into k disjoint subgraphs such that these subgraphs are unrelated with weak links between them while the nodes inside the same subgraph are similar with strong links. When we measure the strength of the links between subgraphs and similarity within the same subgraph, we consider both the link information and the attribute information. Meanwhile, all the constraints are satisfied in the clustering results.

2.1. Partition Directed Graphs with Link Structure and Node Attributes

We consider a directed graph $G = (V, E_L)$ with a node set $V = \{v_i\}_{i=1}^{n}$ and a link set E_L. The edge set E is constructed to capture both the link information and the attribute information (Note, we use link to refer to the link structure between nodes in the original graph, and use edge to refer to the connection between nodes incorporating both the link information and the attribute information). We use E_L to represent the link set and E to represent the edge set. For a pair of nodes u and v, there are three weights we can measure. (a) Link weight $w_L(\,)$, which measures the strength of the link between these two nodes. Note that in a directed graph, $w_L(u,v) \neq w_L(v,u)$. If there is no link going from u to v, then $w_L(u,v) = 0$. (b) Similarity weight $w_S(\,)$, which measures the similarity between two nodes calculated based on the attribute values of these two nodes. $w_S(u,v) \geq 0$ and $w_S(u,v) = w_S(v,u)$. (c) Edge weight $w(\,)$, which is a measurement combining both the link weight and the similarity weight. The combination function we use to generate edge weight based on link weight and similarity weight is presented in Eq. (1).

$$w(u,v) = \begin{cases} \alpha w_L(u,v) + (1-\alpha) w_S(u,v), & \text{if } E_L(u,v) \text{exists} \\ \beta w_S(u,v). & \text{otherwise} \end{cases} \quad (1)$$

In Eq. (1), α ($0 \leq \alpha \leq 1$) controls the importance we assign to the link weight and similarity weight. The higher α is, the more important the link weight is. When there is no link between the two nodes (i.e. $E_L(u,v)$ does not exist), we only use the similarity weight. After the transformation, the initial graph with sparse links becomes a fully connected graph, and any pair of nodes (u,v) will have two weights, $w(u,v)$ and $w(v,u)$ ($w(u,v) \geq 0$; $w(v,u) \geq$

0; $w(u,v) \neq w(v,u)$). It is possible that some edges have zero weight. In this case, the graph is not fully connected. The method we propose in this paper apply to both the fully connected graphs and the not fully connected graphs.

In the rest of the paper, we will only use the edge weight $w(u,v)$, and we will simply use "weight" to refer to the edge weight. Let W denote the affinity matrix where the entry at position (i,j) is $w(v_i,v_j)$. The degree of node u is the sum of the weights of the edges which start from u, $d_u = \sum_{i=1}^{n} w(u,v_i)$. Let the degree matrix D be a diagonal matrix where $D_{ii} = d_i = \sum_j W_{ij}$. For a directed graph with non-negative weights $w(u,v) \geq 0$, we can normalize the weights so that sum of the weights from a node u to its out-neighbors sum up to 1. The normalized weight $p(u,v)$ on edge (u,v) is defined in Eq. (2). The normalized weights can be interpreted as transition probabilities of a random walk and $\sum_{i=1}^{n} p(u,v_i) = 1$. Let $P = D^{-1}W$ denote the transition matrix.

$$p(u,v) = \frac{w(u,v)}{d_u} \quad (2)$$

If the graph is strongly connected (which is the case in our problem) and aperiodic, there exists a unique row vector ϕ such that $\phi P = \phi$ and $\sum_{i=1}^{n} \phi(i) = 1$. This vector is called stationary distribution vector in random walk theory (Norris 1999). No matter which node the random walk starts from, the probability that the random walk converges to node v_i after infinite jumps is $\phi(i)$. We define a diagonal matrix Φ where $\Phi_{ii} = \phi(i)$.

In the graph partition problem on a directed graph, we aim to divide all the nodes into k disjoint sets $C_1,\ldots,C_k$, such that the random walk process seldom jumps between different clusters. Take $k = 2$ as an example, the directed graph $G = (V,E)$ can be partitioned into two disjoint sets A and B ($A \cap B = \emptyset, A \cup B = V$). The transition probability $p(X_1 \in B | X_0 \in A)$ from A to B represents the probability of jumping from a node in A to a node in B (X_0 represents the node where the random walk is currently located and X_1 represents the node that the random walk jumps to next). We assume that the probability the random walk is at X_0 is specified in the stationary distribution (i.e. $p(X_0 = v_i) = \phi(i)$). The objective function of the clustering can be written in Eq. (3), which is also termed as normalized cut in graph theory (Shi and Malik 2000, Maila and Shi 2001).

$$Ncut(A,B) = p(X_1 \in B | X_0 \in A) + p(X_1 \in A | X_0 \in B). \quad (3)$$

By minimizing Eq. (3), we can minimize the probability of jumping between cluster A to cluster B. The spectral clustering algorithm (Ng et al. 2001) can be used to generate clusters A and B to minimize Eq. (3). (Note: Spectral clustering algorithm also applies when $k > 2$.)

2.2 General Framework

The problem that we address in this paper is to find a good partition on a directed graph with link structure and node attributes such that the given constraints are satisfied. Figure 1 describes the main steps in our framework.

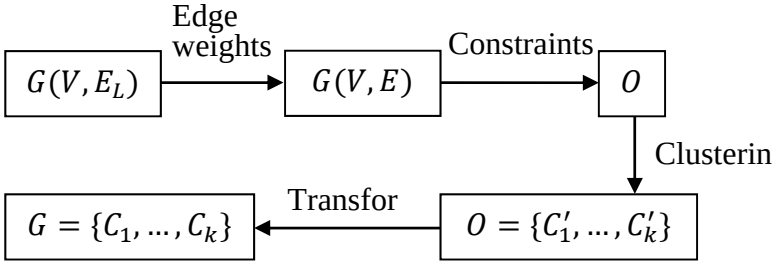


Figure 1: General Framework

In the first step, we transform $G = (V, E_L)$ to $G = (V, E)$ by gererating the edge weights based on both the link weights and similarity weights (in Section 2.1). In the second step, we encode the constraint set $Cons$ into $G = (V, E)$ to form a compressed directed graph O (discussed in Section 2.3). In the third step, we run the spectral clustering algorithm on O to partition the data on O. Finally, we transform the clusters on O to the clusters on $G = (V, E)$. We will describe the details in the following sections.

2.3 Incorporating Domain Information into a Directed Graph

Domain information about whether certain data objects should belong to the same cluster is expressed into a set of singular constraints $Cons$. A constraint is between a pair of nodes (v_i, v_j). The type of constraints we consider in this paper is must-link constraint (Wagstaff and Cardie, 2000), $ML(v_i, v_j)$, which indicates that v_i and v_j must belong to the same cluster.

If there exists a must-link constraint $ML(v_i, v_j)$ between v_i and v_j, these two nodes will be merged into one group, which is termed as a connected component. After going through all the must-link constraints in the constraint set $Cons$, we get a set of connected components which fully represent all the constraints, $M = \{M_t\}_{t=1}^{p}$ where p is the number of connected components. If a node v_i has no corresponding constraint, it will form its own connected component M_t where $M_t = \{v_i\}$ and $|M_t| = 1$. For example, for a node set $V = \{v_1, v_2, v_3, v_4\}$ and a constraint set $Cons = \{ML(v_1, v_2), ML(v_1, v_3)\}$, there will be two connect components $M_1 = \{v_1, v_2, v_3\}$ and $M_2 = \{v_4\}$. We denote the mapping from the node set $V(G)$ to the connected component set M as $\pi: V(G) \to M$. The nodes within the same connected component are merged to form a node in the compressed directed graph O. The weight from a node $\tilde{v}_a$ to another node $\tilde{v}_b$ in O is defined as $\tilde{w}(\tilde{v}_a, \tilde{v}_b) = \sum_{v_i \in M_a; v_j \in M_b} w(v_i, v_j)$, which is the sum of the weights from every node in M_a to every node in M_b. For the compressed directed graph O, its affinity matrix $\widetilde{W}_{p \times p}$ can be written as $\widetilde{W} = Y^T W Y$, where $Y_{n \times p}$ is a subspace projection matrix defined in Eq.(4).

$$Y_{ij} = \begin{cases} 1 & if\ v_i \in M_j (1 \le j \le p), \\ 0 & otherwise. \end{cases} \quad (4)$$

2.4 Finding the Clusters

We apply spectral clustering on the compressed directed graph O to generate k clusters $\{C'_1, C'_2, \ldots, C'_k\}$. Finally, we transform the clusters $\{C'_1, C'_2, \ldots, C'_k\}$ on O to clusters $\{C_1, C_2, \ldots, C_k\}$ on G according to the mapping π. For example, if C'_1 contains two connected components, then the nodes in these two connected components form the cluster C_1 in the original space. Suppose the clustering in O is denoted by a $p \times 1$ vector r' where r'_i indicates the cluster number for node x_i, then we can retrieve the clustering r in the original space by using $r = Yr'$, where Y is defined in Eq. (4). Figure 2 illustrates the complete algorithm.

Input: A data set V with attributes, the link set E_L, number of clusters - k, a constraint set $Cons$.
Output: Clusters $C_1, \ldots, C_k$.
• Derive a directed graph $G = \{V, E\}$ and its affinity matrix W in Eq. (1).
• Formulate the constraint matrix Y in Eq. (4)
• Embed the constraint set into G to derive a compressed directed graph O, where the affinity matrix is $\widetilde{W} = Y^T W Y$.
• Find the clustering in O using spectral clustering algorithm and use a vector r' to represent the cluster assignment.
• Derive the clustering in G by using $r = Yr'$.

Figure 2: Algorithm for Clustering Directed Graphs with Constraints

Our algorithm is designed to find k clusters on a directed graph which also satisfy the given constraints. First, we combine both attribute and link information to derive a directed graph $G = \{V, E\}$ (see Eq.(1)). Second, the given constraint set $Cons$ is described in a constraint matrix Y. The original graph G is then compressed into a graph O through matrix Y (see Section 2.3). We then find k clusters on O, which are represented by a vector r' (i.e. r'_i denotes which cluster $\tilde{v}_i$ belongs to). Finally, the clusters in G are retrieved by using $r = Yr'$.

We also explored the connection between the compressed directed graph O and the original graph $G(V, E)$ after we merge the constraints to generate O. We show that the best partition that optimizes the objective function on O is equivalent to the best partition in the original graph with constraints incorporated. Due to space limit, we do not provide the proof here.

In addition, manually collecting a large number of constraints can be expensive and unrealistic. Under the situation where a few manually collected constraints are available, we can generate more constraints based on the manually collected constraints to make the best use of the existing expert information. Intuitively, if nodes v_i and v_j should be grouped together according to expert information, then the nodes strongly connected to both v_i and v_j are more likely to belong to the same cluster with v_i and v_j. Due to space constraint, we do not discuss the details of constraint propagation.

3. Experiments

We conducted experiments on six data sets, all of which contain both attribute information and link structure. These data sets are labeled (i.e. we know the cluster assignment of the data objects), because we need to randomly select constraints which need to come from labeled data. We compare three different methods on all these data sets. The first method is the method to cluster directed graph with both link structure and domain information (CDL) as illustrated in Figure 2. The second method is CDL with constraint propagation (CP_CDL). The third method is CDL on data without link structure (i.e. edge weights are only calculated based on similarity weights, and link weights are ignored) (CUL). The comparison between CDL and CP_CDL will help us investigate the effectiveness of propagated constraints. The comparison between CDL and CUL will evaluate the usefulness of combining link weights and similarity weights. The effectiveness of the entire framework is demonstrated by the performance of CP_CDL.

The quality of clustering is measured by the accuracy rate because all the data sets have labeled clusters. The method with constraint propagation (CP_CDL) consistently performs the best among all the three methods indicating the effectiveness of our overall framework. The method without link information performs the worst.

References

1. Maila, M., J. Shi. 2001. A random walks view of spectral segmentation. In AI and STATISTICS (AISTATS).
2. Ng, A., M. Jordan, Y. Weiss. 2001. On spectral clustering: Analysis and an algorithm, Advances in Neural Information Processing Systems 14.
3. Norris, J. R. 1999. Markov Chains. Cambridge University Press.
4. Shi, J., J. Malik. 2000. Normalized Cuts and Image Segmentation, IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI).
5. Wagstaff, K., C. Cardie. 2000. Clustering with instance-level constraints. In Proceedings of the Seventeenth International Conference on Machine Learning, pages 1103–1110.

Automatically Assessing Information Usefulness in Online Knowledge Communities: A Text Classification Framework

Xiaomo Liu, G. Alan Wang, Weiguo Fan
Virginia Tech
{xiaomliu, alanwang, wfan}@vt.edu

Abstract

A major challenge to the success of online knowledge communities is information overload when users try to search through and interpret a large amount of unstructured text data. Traditional information retrieval techniques fail to consider users' perception of usefulness on retrieved information. In this study, we develop a text classification framework for finding useful documents in online communities. Guided by the Knowledge Adoption Model, we identify 7 feature sets to measure the argument quality and source credibility of text messages. Our experiments using data extracted from a real online community show that all feature sets improve the text classification performance.

Keywords: Online communities, information usefulness, text classification

1. Introduction

With the rapid development of Web technologies, online knowledge communities have become an important knowledge-sharing platform where people seek and share knowledge across space and time. However, due to the voluntary nature of the participations in most online communities, knowledge sharing in online communities faces a number of challenges. First, their knowledge repositories usually have low information quality (David & Pinch, 2006). It has been found that information quality at an online community is often inversely related to the size of its membership (Gu & Konana, 2007). Moreover, the knowledge repositories in online communities have accumulated a large amount of unstructured text messages over time. Community members are subject to information overload when interpreting those unstructured data.

Many online communities (e.g., Amazon) allow their members to provide information usefulness judgments that can be used to guide other users to useful contents quickly. However, it is a serious challenge to solicit enough user participation in providing feedback in online communities (Rashid & Ling, 2006). Thus, there is a strong need to develop a method that automatically assesses information usefulness for the text messages in large-scale communities.

This paper is organized as follows. Section 2 reviews literature related to information usefulness. Section 3 introduces our research goal. Section 4 describes our text classification experiments and results. We conclude our paper in Section 5.

2. Related Work

2.1. Knowledge Seeking in Knowledge-Based Communities

An online knowledge-based community is defined as an online community that primarily supports knowledge seeking and learning activities based on common interests (Hinds & Lee, 2008; Lin, 2007). Most knowledge-based communities provide search functions that users can use to seek knowledge pertinent to their interests. They often implement their search functions using traditional information retrieval (IR) techniques. However, the use of hyperlinks in online

communities may not be as effective as that on the Internet because many documents in online communities do not contain hyperlinks. The retrieval of those documents is again determined solely by keyword-based relevance matching. The most serious problem with traditional techniques is that the search results may not exactly represent the true relevance that the searchers would expect. Bade (2007) found that there was a discrepancy between the artificial relevance ranking by statistical methods and the true relevance judgments as determined by the searcher. He further suggested that the design of search techniques would benefit from incorporating relevance indications from the user's perspective. In other words, the design of knowledge seeking techniques should consider the knowledge seeker's usefulness perception on retrieved information.

2.2. Assessing Information Usefulness in Online Communities

The users of online knowledge-based communities often seek solutions that can be applied to their own cases. Therefore, we consider the knowledge seeking behavior in a knowledge-based community as a knowledge adoption process. According to the Knowledge Adoption Model (KAM), a knowledge seeker is interested in not only information relevant to a search query, but information that the seeker is able to comprehend and has confidence in the credibility and authority of the source (Sussman & Siegal, 2003). In particular, KAM suggests that the perception of information usefulness is affected by two factors, namely argument quality and source credibility. Argument quality refers to the quality of the information content such as relevance, accuracy, and timeliness, while source credibility indicates the credibility and authority of the information source reflecting nothing about the information content. Based on existing literature, we have identified 5 feature sets that can be used to measure content-based argument quality and 2 feature sets that can be used to measure source credibility. Table 1 summarizes those information usefulness feature sets that we have identified.

Table 1. Information usefulness feature sets

Category	Feature Set	Description/Example
Argument Quality	**F0: Lexical** (Joachims, 1998)	A vector of words for each document
	F1: Syntactic (79 features) (Abbasi et al., 2008)	Number of words, unique words, and wh-type words Number of sentences, word to sentence ratios Number of question marks, quotations, and web links Number of source code lines (for programming communities only) Ratio of nouns, adjectives, comparatives, verbs, adverbs, punctuation symbols
	F2: Semantic (17 features) (Abbasi et al., 2008)	Number of words overlapping between a question and its answers Cosine similarity between a question and its answers Perplexity of an answer to all other answers in a thread Topic divergence of an answer to all other answers in a thread Centroid of an answer to all other answers in a thread
	F3: Sentiment (23 features) (Stone et al., 1962)	Ratio of positive and negative sentiment words Presence of appreciative phrases such as "thank you", "thanks a lot" etc.
	F4: Topical (18 features) (Chiu et al., 2006)	Cosine similarity between a thread and threads of current month/current year/all Topic divergence between a thread and threads of current month/current year/all Topic strength against the topic models of current month/current year/all
Source Credibility	**F5: Historical** (32 features) (Wasko & Faraj, 2005)	User's tenure in the community User's number of questions and answers User's ratio of questions received solved, helpful, non-helpful answers User's ratio of answers marked as solved, helpful, non-helpful
	F6: Social (32 features) (Wasko & Faraj, 2005)	User's in-degree, out-degree, betweenness, closeness, cluster coefficient, PageRank, and HITS scores of community social network

3. Research Goals

In this study we propose a text classification framework for finding useful documents in online knowledge communities. According to KAM, a user's information usefulness perception depends on the argument quality and source credibility of the received message. Information quality literature suggests 5 types of text-based features for measuring information quality. Online communities contain rich social media where source credibility can be derived from. We consider historical and social features as our source credibility indicators. Using the 7 information usefulness feature sets, our study aims to answer the following questions:

Q1: Which types of features are effective when predicting information usefulness in online knowledge communities?

Q2: Which classification algorithm is effective when predicting information usefulness in online knowledge communities?

4. Experiments

4.1. Data Collection

We collected real discussion threads from the *Sun Forums*, which is a popular online community for finding solutions to technological problems. We crawled 70,488 discussion threads published in its largest sub-forum, *Java Programming,* as of June 6, 2009. Some data characteristics are reported in Table 2.

Table 2. Data characteristics

# of Threads	# of Posts	Members	Avg. # of replies per thread	Avg. # of respondents per thread	Vocabulary size
70,488	440,708	36,687	4.1723	2.5137	125,114

The forum allows its members to provide information usefulness judgments to each thread discussion with two tags: "helpful" and "solved". Our data set has 5,777 threads that contain solutions to the corresponding questions and 1,226 threads that contain helpful answers, but no solutions. Excluding 7,013 threads without any reply, there are 56,472 threads with replies where the users did not provide any feedback. In order to obtain "not-helpful" labels, we randomly selected 2,200 threads from the threads without users' feedback and asked two Computer Science graduate students to manually examine them. They found 1,008 threads that have replies not helpful at all in finding the solution to the corresponding question.

4.2. Experimental Design

Our experiment consisted of two binary classification tasks. In the first task, we tested if our classifier could predict at least helpful discussion threads. The "solved" and "helpful" threads were considered as belonging to the same class. In the second task, we used our classifier to detect the threads that contained solutions (i.e., the threads labeled by the users as "solved"). The "helpful" and "not-helpful" threads were considered as belonging to the same class in this task. We randomly selected 500 "solved", 500 "helpful", and 1,000 "not-helpful" threads from our data set for the first task. 1000 "solved" with 500 "helpful" and 500 "not-helpful" threads were sampled for the second task. We used four classification algorithms that are commonly used in text classifications: Naïve Bayes, Decision Tree using C4.5 algorithm, Ada Boosting using decision stumps as the base learning algorithm, and Platt's SMO algorithm for Support Vector Machine (SVM) with a linear kernel. Five-fold cross validation was carried out to evaluate the performance of the classification algorithms.

4.3. Evaluation Metrics

We use precision, recall, f-measure that are commonly used in information retrieval literatures:

$$precision = \frac{\text{\# of correctly predicted positive threads}}{\text{\# of predicted positive threads}} \qquad recall = \frac{\text{\# of correctly predicted positive threads}}{\text{\# of acutal positive threads}}$$

$$f-measure = \frac{2 \cdot precision \cdot recall}{(precision + recall)}$$

4.4. Experimental Results

To evaluate the effectiveness of each feature set on predicting useful discussion threads, we used the lexical feature set (F0) as our baseline because it is commonly used in traditional IR techniques. We then evaluated the performance improvement when each of the other 6 feature sets was considered in addition to F0. Table 4 summarizes the f-measures of the 4 classification algorithms in the two classification tasks. The results show that all 6 feature sets significantly improved the classification performance over our baseline where only lexical features were considered. The significance *p*-values indicate that syntactic and historical features had more significant impacts on the performance improvement than other feature sets when predicting helpful discussion threads (*p*-value<0.01). Similarly, historical and social features had higher impact to the performance improvement than other feature sets when predicting discussion threads with solutions.

Table 3. The f-measure performance of the 4 classification algorithms

Feature Set	Naïve Bayes	Decision Tree	Ada Boosting	SVM (SMO)
Task 1: Helpful+Solved vs. Not-Helpful				
F0 (Baseline)	0.6735	0.6307	0.6513	0.6895
F0+F1	0.6910	0.7645**	0.7666**	0.7960**
F0+F2	0.7083*	0.6652*	0.6973*	0.7395*
F0+F3	0.7076*	0.6609	0.7142*	0.7280*
F0+F4	0.6962	0.6641*	0.6897*	0.7320*
F0+F5	0.7550**	0.7911**	0.8090**	0.8010**
F0+F6	0.7188*	0.6677*	0.7205*	0.7415*
Task 2: Solved vs. Not-Helpful+Helpful				
F0 (Baseline)	0.6276	0.6079	0.6392	0.6391
F0+F1	0.6620*	0.7012**	0.6755*	0.6539
F0+F2	0.6432	0.6339	0.6384*	0.6645
F0+F3	0.6660*	0.6208	0.6504	0.6750*
F0+F4	0.6646*	0.6289	0.6692*	0.6591
F0+F5	0.7105**	0.7165**	0.7496**	0.7286**
F0+F6	0.7087**	0.7129**	0.6776*	0.7215**

*: *p*-value < 0.05, **: *p*-value<0.01

We also compared the performance of the 4 classification algorithms combining all 7 feature sets. Table 4 shows the results. Ada Boosting achieved the best performance across the 4 algorithms.

Table 4. Classification algorithm performance comparison

Classification Algorithms	*Task 1: Helpful+Solved vs. Not-helpful*			*Task 2: Solved vs. Helpful+Not-Helpful*		
	Precision	**Recall**	**F-Measure**	**Precision**	**Recall**	**F-Measure**
Naïve Bayes	0.7755	0.7290	0.7515	0.6995	0.7450	0.7215
Decision Tree	0.8561	0.8150	0.8350	0.7609	**0.8590**	0.8070
Ada Boosting	**0.8972**	**0.8470**	**0.8714**	**0.8012**	0.8180	**0.8095**
SVM (SMO)	0.8723	0.8060	0.8378	0.7657	0.7910	0.7782

6. Conclusions

A major challenge to the success of online knowledge communities is information overload when users try to search through and interpret a large amount of unstructured text data. Traditional information retrieval techniques fail to consider users' perception of usefulness on retrieved information. In this study, we develop a text classification framework for finding useful documents in online communities. Guided by the Knowledge Adoption Model, we identify 7 feature sets to measure the argument quality and source credibility of text messages. Our experiments using data extracted from a real online community show that all feature sets improve the text classification performance. Among the 4 commonly used text classification algorithms, Ada boosting achieved the best performance in predicting useful discussions in online knowledge communities.

Acknowledgement

This work is funded in part by NSF grant DUE-0840719.

References

1. Abbasi, A., Chen, H., & Nunamaker, J. F. (2008). Stylometric Identification in Electronic Markets: Scalability and Robustness. *Journal of Management Information Systems*, *25*(1), 49–78.
2. Bade, D. (2007). Relevance Ranking Is Not Relevance Ranking Or, When the User Is Not the User, the Search Results Are Not Search Results. *Online Information Review*, *31*(6), 831-844.
3. Chiu, C.-M., Hsu, M.-H., & Wang, E. (2006). Understanding Knowledge Sharing in Virtual Communities: An Integration of Social Capital and Social Cognitive Theories. *Decision Support Systems*, *42*(3), 1872-1888.
4. David, S., & Pinch, T. (2006). Six Degrees of Reputation: The Use and Abuse of Online Review and Recommendation Systems. *First Monday*, *11*(3), 1–29.
5. Gu, B., & Konana, P. (2007). Competition among Virtual Communities and User Valuation: The Case of Investing-Related Communities. *Information Systems Research*, *18*(1), 68-85.
6. Hinds, D., & Lee, R. M. (2008). Social Network Structure as a Critical Success Condition for Virtual Communities. *Proceedings of the 41st Annual Hawaii International Conference on System Sciences* (p. 323--332). Big Island, Hawaii.
7. Joachims, T. (1998). Text Categorization with Support Vector Machines: Learning with Many Relevant Features. *European Conference on Machine Learning* (pp. 137-142).
8. Lin, H. F. (2007). Effects of Extrinsic and Intrinsic Motivation on Employee Knowledge Sharing Intentions. *Journal of Information Science*, *33*(2), 135-149.
9. Rashid, A., & Ling, K. (2006). Motivating Participation by Displaying the Value of Contribution. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (p. 955--958). Montréal, Canada.
10. Stone, P. J., Bales, R. F., Namenwirth, J. Z., & Ogilvie, D. M. (1962). The General Inquirer: A Computer System for Content Analysis and Retrieval Based on the Sentence as A Unit of Information. *Behavioral Science*, *7*(4), 484–498.
11. Sussman, S. W., & Siegal, W. S. (2003). Informational Influence in Organizations: An Integrated Approach to Knowledge Adoption. *Information Systems Research*, *14*(1), 47-65.
12. Wasko, M. M., & Faraj, S. (2005). Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice. *MIS Quarterly*, *29*(1), 35--57.

Imagination or Reality — The Direction of Price Dispersion in the E-commerce Era

BINJIE LUO JIAXIAN QIU
Southwestern University of Finance and Economics, Sichuan, China
luobinjie@gmail.com

ZHANGXI LIN
Texas Tech University, Lubbock, TX 79409-2101, USA
zhangxi.lin@ttu.edu

Abstract

In the e-commerce era, the mechanism of price dispersion in the electronic market remains unclear with inconsistent research outcomes from different angles. In this paper, our empirical evidence regarding determinants of price dispersion is presented through the path analysis on the data collected from Taobao, a leading consumer-oriented online auction market rooted in China. We found that, the online reputation and buyer's search cost have positive effects on the price dispersion across 47 types of digit cameras, the number of buyers has positive direct and negative indirect effects on price dispersion, and the number of sellers plays a dominant role in affecting price dispersion but with a nonlinear and negative effect.

Keywords: Electronic market, Price dispersion, Market efficiency, Online reputation, China

1. Introduction

While the electronic market has been constantly growing, how the application of ICT (Information Communication Technology) creates a more efficient market than the traditional one has been an active research topic for years. In economics, price dispersion is one of the observable indicators used to measure how efficient a market is. However, so far, whether the price becomes more or less dispersed in the electronic market is not consistently agreed between theoretical and empirical perspectives. Electronic market is assumed to be more efficient due to several reasons. Firstly, electronic market is often regarded as a market with low barrier to entry. A large number of sellers rush into the same market is likely to happen in the electronic market context. In economics, the number of sellers reflects the competitiveness of a market, and a ''more competitive'' market is often characterized by less price dispersion. Secondly, from the perspective of buyer's search cost, conventional wisdoms often assume the electronic market could reduce buyer's search cost and thus create a more competitive market where smaller price dispersion should be observed. Will the price dispersion in the electronic market behave like what we have assumed? What is the formation mechanism of price dispersion in the electronic market? In this paper, we will use the data collected from Taobao.com, a leading consumer-oriented online auction market at China, to provide some stylized facts with respect to those questions.

2. Relevant Work and Model Development

Number of sellers and buyers are two of many important factors used to describe the structure of a market (Waldman and Jensen 2006). The number of competitors in a market reflects the degree of market competition and its effect on price dispersion has been examined in models for offline market. In Carlson and McAfee (1983), the variance of price would increase as the number of seller increases. Dahlby and West (1986) empirically applied Carlson and McAfee's model in the car insurance market and found an inconsistent result that more players in a market are associated with decreased price dispersion. Besides the contrasting views between empirical and theoretical angles, many literatures also postulate that, there should be a bound for the effect of the number of sellers on price dispersion (Carlson and McAfee, 1983; Chamberlin 1933). Thus, we suggest using a logarithm functional form of the number of seller in empirical analysis. This is also in accordance

with the statement that “a nonlinear relationship between number of players and price dispersion could exist,” Pan et al. (2001). At here, we would propose hypothesis 1 as follows.

Hypothesis 1 (H1): In the electronic market, the number of seller would affect price dispersion negatively with a logarithm functional form.

In our data set, we define the number of people who purchased a product as the number of buyers. And the increasing number of buyers, we conceive, at least, has two effects on price dispersion. One is indirect that more demand would lead to more supply due to low barriers to entry, and the increasing number of sellers will affect price dispersion in the way described by hypothesis 1. Thus, the indirect effect of increasing number of buyers on price dispersion is positive. The other effect is direct. Since, the increasing number of buyers would exhibit more diversified preferences, which would give sellers more incentives to differentiate themselves in dimensions like price, reputation, service and shipping cost, etc., even the product is homogeneous. Based on that, we propose following two hypotheses.

Hypothesis 2 (H2): The number of buyer would affect price dispersion negatively and indirectly through its impact on the number of seller.

Hypothesis 3 (H3): The number of buyer would affect price dispersion positively by giving sellers more space to differentiate themselves in dimensions like price, reputation.

The effect of buyer’s search cost on price dispersion has been emphasized by many theoretical models (Salop and Stiglitz 1977). Due to its invisibility, not too many empirical studies have investigated it in offline market except Dahlby and West (1986) and Sorensen (2000). Meanwhile, there seems no literature using any proxy to measure buyer’s search cost in electronic market (Bailey 1998). Due to the advantage of our data, we intend to measure buyers’ search cost by the click times received by a type of camera in a period of time. Therefore, we propose hypothesis 4.

Hypothesis 4 (H4): Lower search cost would result in less price dispersion.

The effect of reputation on price level has been proved by many authors (Ba and Pavlou, 2002; Melnik and Alm, 2002). Ba and Pavlou (2002) indentified that a seller's reputation plays a very important role in buyers' willingness to pay premium prices. Melnik and Alm (2002) found that seller's reputation has a positive, statistically significant, but small impact on the price. Based on those findings, we postulate that the price range (difference between maximum and minimum price of sellers selling the same type camera) would expand as the maximum reputation increases. As a result of expanded price range, price dispersion will increase. Hence, our assumption is like follow:

Hypothesis 5 (H5): Price dispersion would increase as the maximum reputation increase.

3. Data and Analysis

3.1 Data Collection

We investigated price dispersion at the product level. Firstly, 47 types of point-and-shoot digit cameras were randomly selected from the Taobao market on 10/4/2010, using a web crawler program. The collected items for each offer contain product price, seller’s reputation score, seller

type (B2C or C2C), number of product click times, and sales volume in a period of 30 days as shown in Table 1.

Table 1. Item Description

Item	Description
Price	Price listed in search result for an given product at the sample time point
SellerType	B2C (Business to Customer) or C2C (Customer to Customer)
Reputation Score	The accumulated reputation score for one seller since he/she has registered
Sales Volume In30Days	The volume of an given product sold by one seller in the past 30 days
Click Times	Received clicking times since this offer has been posted by seller

The reputation score of B2C (Business to Customer) sellers is not provided by Taobao market. Hence, B2C sellers will not be taken into account in our following analysis.

3.2 Path Analysis

From a statistic perspective, the dispersion of a set of prices should be measured by its standard deviation. However, due to different research demands, methods used in empirical studies to measure the price variation are diversified. We use "Price Index Standard Deviation" (Pan and Brain 2002) to measure the price dispersion. The estimated coefficients are marked in Figure 1.

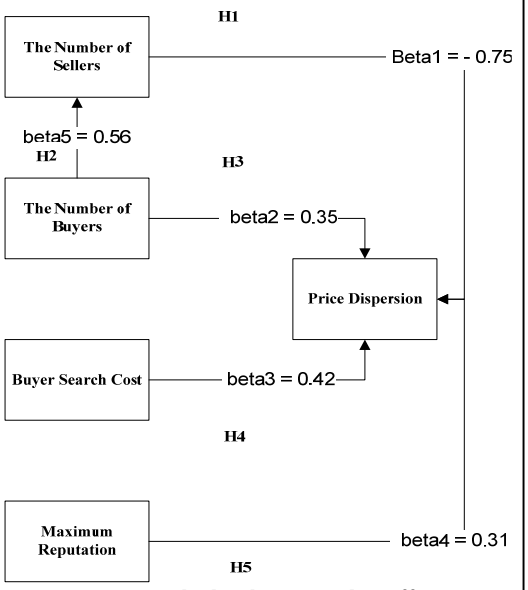


Figure 1. Standardized Estimated Coefficients

Table 2. Estimated Coefficients for Figure 1

Coefficient	*Estimate*	*t Value*	*P value*
Beta1	-0.75	-8.10094	<.0001
Beta2	0.35	2.78830	0.0053
Beta3	0.42	4.21041	<.0001
Beta4	0.31	11.99966	<.0001
Beta5	0.56	5.96071	<.0001

Table 3. Effects of the Number of Buyers

Effect	*Estimate*	*t Value*	*P value*
Direct	0.35	2.7883	0.0053
Indirect	-0.42	-4.2142	<.0001

From Table 2, we can conclude that those factors included in the path analysis affect price dispersion significantly, because p-values of all coefficients are less than 0.05.

The Goodness of Fit Index (GFI) is 0.9225 and the Chi-square is 20.55 with p-value equal to 0.61. Both statistics indicate an acceptable degree of fit between data and hypothesized model. In Figure 1, the coefficient of the number of sellers (we use the logarithm functional form of number of sellers in estimation process) is – 0.75. First, it means, in our dataset, the effect of number of sellers on price dispersion indicates similar results with Baye et al. (2004), Pan et al. (2001) and Dahlby and West (1986) that increasing in the number of sellers would decrease price dispersion. This effect also performed in consistent with finding of Pan et al. (2001) that an

increase in number of competitors reduces price dispersion but with a diminishing rate. However, according to Cohen's understanding (2000), there are two effects, positive and negative, imposed by the increasing number of sellers on price dispersion. Why our results indicate a negative effect? We intend to explain it as that, in the electronic market, the effect of "DIF-ness" that causes consumers to be poorly informed due to an increase in the number of sellers can be alleviated by using search engine. Thus, the other effect that price dispersion would decrease with a greater number of alternatives, should play a dominant role in determining price dispersion.

From the estimate of beta 4, we confirm that maximum reputation imposes positive effect on price dispersion as hypothesis 5 assumed. This might be explained as its increasing expands the range of price through increasing the level of maximum price on average. This is in line with finding that reputation could affect price level (Ba and Pavlou, 2002). In those estimates, the coefficient of search cost is 0.42 indicating positive effect on price dispersion. To our knowledge, this is the first time using proxy for buyer's search cost and measuring its impact on price dispersion in the field of electronic market research. Hypothesis 4 has been proved to be true and can be explained by Stigler (1961) that, lower search cost would induce greater amount of search, and then lead to less price dispersion. As hypotheses 2 and 3 stated, the increasing number of buyers has two effects on price dispersion. One is that, more demand would lead to more supply due to low barrier to entry and affect price dispersion negatively and indirectly. The other is the number of buyers would affect price dispersion positively and directly by giving sellers more space to differentiate themselves. As Table 3 shown, the direct effect of the number of buyers on price dispersion is 0.35 and the indirect effect is -0.42. Both of them are significant at 5% level. Thereby, hypotheses 2 and 3 have been proved.

In order to compare the weight of each effect on price dispersion, all of the estimates in Table 2 and 3 are standardized. Standardized estimates are the parameter estimates when all variables are standardized to a mean of 0 and a variance of 1. While comparing the standardized estimates of each variable, we find that, the number of sellers plays a dominant role in affecting price dispersion. Its standardized estimate is -0.75 which indicates that the degree of competition is still the first important factor in determining price dispersion in electronic market. 0.42 is the standardized estimate for buyer's search cost. It's the secondary important factor in determining price dispersion.

4. Discussions and Conclusions

In this paper, the effects of several potential factors on price dispersion have been examined. This paper contributes to the understanding of price dispersion in electronic market from several aspects. First, this work provides useful findings for both managerial and market perspectives. People often assume electronic market could reduce buyer's search cost and thus create a more competitive market where smaller price dispersion should be observed (Pan and Brian, 2002). However, in our findings, the number of competitors, one element of market structure, plays a dominant role in determining price dispersion. Another element of market structure, the number of buyers, also contribute to the formation of price dispersion but less important than buyer's search cost. Obviously, in our dataset, the force coming from market structure is the most important one in determining price dispersion. Thus, we conclude that, in the electronic market, buyer's search cost is neither the only nor the first important factor affecting price dispersion. Price dispersion is

determined by the mutual effects of many attributes of a market. It is hard to assume that a reduction in buyers' search cost must lead to less dispersion without considering other factors. Based on our findings, it might be easy to explain previous argumentation. Pan et al. (2004) pointed out that Bailey's empirical finding (1998) may be due to the lack of competition. Since only a few competitors are operating at that time, even with very low value of search cost in online market, it is still possible to have very high price dispersion. Second, in our framework, we propose using click times of products as proxy for buyer's search cost in electronic market. Even though we have got desire results, it still needs to be applied and identified in a border range.

5. References

1. Baye, M. R., Morgan, J. and Scholten, P. Price Dispersion in the Small and in the Large: Evidence from an Internet Price Comparison Site. *Journal of Industrial Economics*, Vol.52, No.4, 2004, pp.463-496.
2. Ba, S. and Pavlou, P. A. Evidence of the Effect of Trust Building Technology in Electronic Markets: Price Premiums and Buyer Behavior. *MIS Quarterly*, 2002, Vol. 26, No. 3, pp. 243-268.
3. Bailey, J. Intermediation and Electronic Markets: Aggregation and Pricing in Internet Commerce. 1998. MIT: Ph.D. Thesis.
4. Carlson, J.A. and McAfee, R.P. Discrete Equilibrium Price Dispersion. *The Journal of Political Economy*, 1983, volume 91, Issue 3, pp.480-493.
5. Cohen, M. The Impact of Brand Selection on Price Competition - a Double-Edged Sword. *Applied Economics*, 32, 2000, pp. 601-609.
6. Dahlby, B. and West, D.S. Price Dispersion in an Automobile Insurance Market. *The Journal of Political Economy*, Vol. 94, No. 2, 1986, pp. 418-438.
7. Pan, X. and Brian, T. R. Can Price Dispersion in Online Markets be Explained by Differences in e-Tailer Service Quality? *Journal of the Academy of Marketing Science*, Volume 30, Number 4, 2002, pp.433-445.
8. Pan, X., Ratchford, B. T. and Shankar, V. Why Aren't the Prices of the Same Item the Same at Me.com and You.com? Drivers of Price Dispersion Among E-Tailers. Working Paper, University of Maryland, College Park, MD 20742. 2001.
9. Pan, X., Brian T. R., and Venkatesh S. Price Dispersion on the Internet: A Review and Directions for Future Research. *Journal of Interactive Marketing*, 2004, Volume 18, pp. 116-135.
10. Salop, S. and Stiglitz, J. Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion. The Review of Economic Studies, Vol. 44, No. 3, 1977, pp. 493-510.
11. Stigler, G.J. The Economics of Information. *The Journal of Political Economy*, Volume 69, Issue 3, 1961, pp.213-225.
12. Sorensen, A. Equilibrium Price Dispersion in Retail Markets for Prescription Drugs. *Journal of Political Economy*, 108 (4), 2000, pp. 833-850.
13. Waldman, D. E. and Jensen, E.J. Industrial Organization: Theory and Practice. Addison Wesley Longman, 2006.

How Can Mobile Coupons Become Contagious? A Psychological Distance Perspective

Yuhao Li
School of Management, Xi'an Jiaotong University
lxiaoy18@stu.xjtu.edu.c

Lih-Bin Oh
School of Management, Xi'an Jiaotong University
ohlb@stu.xjtu.edu.cn

Kanliang Wang
School of Business, Renmin University of China
klwang@ruc.edu.cn

Abstract

Despite the growing attention on mobile marketing, we know little about the effects of contextual factors such as space and social factors on consumer perceptions and behaviors. These factors can influence consumers' intention to use and forward the mobile coupon to others. Viewing mobile coupon as a form of experiential computing, we draw upon the Construal Level Theory to examine the effects of spatial distance and social distance on consumer' perceptions in a simulated mobile coupon marketing environment.

Keywords: Mobile consumer behavior, Mobile Coupons, Construal Level Theory, psychological distance

1. Introduction

Mobile network technologies have changed the delivery mechanism for discount coupons. Merchants have a wide range of opportunities to be more creative in sending coupons to consumers on their mobile devices. Coupons users in mobile internet environment are very different from traditional coupons users (Kang et al, 2006). This is especially so for consumers in a multichannel retail environment who value the improved information quality and service convenience to shop in a channel based on their preference (Oh and Teo 2010). Hence, mobile coupons can become a useful marketing tool for merchants to integrate the physical channel with electronic channel effectively.

The rapid development of mobile network technologies has presented merchants with a platform with increasingly reduced costs and increased personalization to create value for consumers. Compared to traditional coupon, consumers can easily forward the mobile coupons they have received to others. This is a great news to merchants as it involves zero costs from them. It was also found that consumers are more likely to use coupons received from a peer as compared to coupons received from a merchant (Gsaimov et al. 2009). However, what are the factors that influence consumers' intention to use and forward mobile coupons so that they can become contagious? In this study, we draw upon the concept of psychological distance from the Construal Level Theory to examine the effects of spatial distance and social distance have on the perceived value of mobile coupon and consumers' intention to use and forward them.

2. Theoretical Development

2.1 Experiential Computing and Mobile Coupons

Yoo (2010) suggests that experiential computing can involve four dimensions, namely time, space, actors, and artifacts. Space is a structure that enables objects to be connected as people experience them, which is actively and materially constructed through people's actions. Likewise,

time can also influence social actors and their interactions with the artifacts similarly to the influence by the space dimension. Collectively, factors such as space, time and membership can affect the formation of psychological distance. Yoo (2010) has further called for a need to better understand how digitally mediated consumer behaviors are shaped and evolve over psychological distance.

"Generation Mobile" may be enticed by receiving electronic coupons on their cell phones, or be annoyed (Sultan and Rohm 2008), but with the right execution, the mobile channel could benefit both advertisers and consumers (Barwise and Strong 2002). It has been found that for coupons redeemed with the purchase of a product, there is no significant difference in terms of coupons usage rate between e-coupons and m-coupons (Lu and Moorthy 2007). However, it is entirely different for discount coupons' forwarding rate. The forwarding rate of discount coupons via cellphone is higher than via e-mail (Gsaimov et al. 2009). In fact, since multimedia enhances the informativeness and entertainment value of location-based advertising (Xu et al. 2009), we can expect that multimedia-based m-coupon will be more likely to be forwarded by consumers.

2.2 Construal Level Theory

Construal Level Theory (CLT) is a purely cognitive orientation social cognitive theory (Dhar and Kim 2007). Construal level determines individuals' cognition, either abstract or concrete, "lower-level construals enable people to be immersed in the rich details of the immediate situation, whereas higher-level construals enable appraisal of the general meaning that might apply across a wide range of alternatives (Liberman and Trope 2009)." Objects are psychologically distant from human, and they can be remote in time or in space. In fact increasing distance from objects affect the way human respond to these objects (Liberman and Trope 2009). Consumer consideration set is change through the time such that consumers consider more abstract attributes such as functions (higher-level factors) at the beginning, but practical choice may be more affected by advertising, promotion, and consumption situations (lower-level factors). Factors that consumer pay attention to will vary according to time (Dhar and Kim 2007; Lynch and Zaubennan 2007). Since mobile discount coupons are tightlty linked to price, and price being a relatively lower-level factor, it is expected that in such context, consumer behavior should be more affected by low psychological distance.

2.4 Research Model and Hypotheses

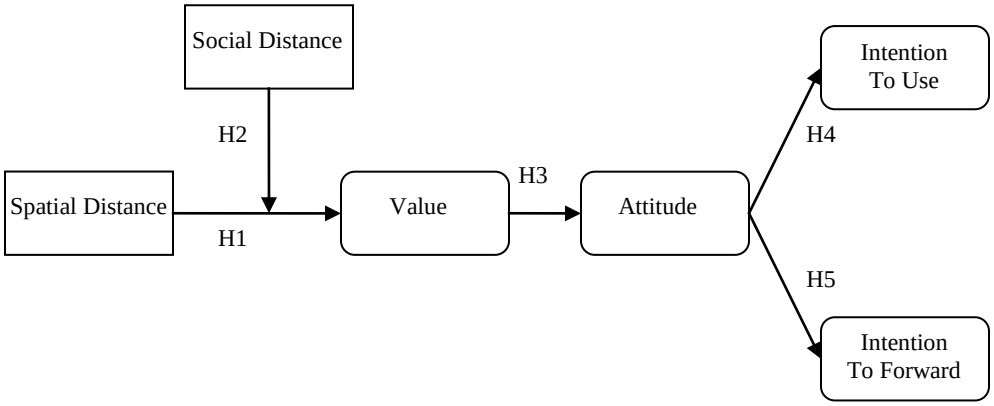


Figure 1 Research model

Location-based mobile coupons involve time and space dimensions, memberships involve actors, and consumers' interaction with the device and the activity data generated concern the artifacts dimensions. Hence, we think believe that viewing mobile coupons as a form of experiential computing is appropriate. Furthermore, the time and space dimensions are theoretically linked to the idea of psychological distance in Construal Level Theory. In this study we focus on permission-based approach of push-based multimedia messaging service (MMS) mobile coupons because it is timely (Xu et al. 2009).

Figure 1 presents the model of this research. When merchants send a mobile coupon to consumers, the spatial distance is the distance between the location that consumers received the coupon and the location that consumers can use the coupon in the store. Social distance indicates whether the consumer is familiar with the merchant or not, social distance is low when the consumer has high familiarity with the merchant. Value is the overall assessment of the utility of a service, it is based on perceptions of cost and benefits (Zeithaml 1988), and it is a critical factor for consumer when developing and maintaining attitude. Discount (price related) is regarded as a lower-Level construal factor and spatial distance is a dimension of psychological distance. When consumers are far from the purchase location(i.e., high spatial distance), lower-level construal factors such as advertising, promotion and consumption situation will have less influence on consumer decision-making. However, these lower-level construal factors will have more influence when consumers are nearer to the purchase location (i.e., low spatial distance). Therefore, we hypothesized that:

H1: Spatial distance is negatively related to perceived value of mobile coupon.

It has been demonstrated that consumers would generally ignored advertising messages sent without permission (Tsang et al, 2004). In high spatial distance condition, coupons could not fully display their function for their lower-level construal property of price, and in low spatial distance condition, coupons could fully display their function for their lower-level construal property of price. Hence, we expect that social distance will negatively moderate that effect of spatial distance on perceived value:

H2: The negative impact of spatial distance on perceived value is reduced when the social distance is high while the negative impact of spatial distance on perceived value is strengthened when the social distance is low. .

Value has been widely verified as a key determinant of attitude, such as web advertising studies (Ducoffe 1996). Hence, we expect a similar relationship between value and attitude in mobile coupons context.

H3: Higher level of perceived value will result in more favorable attitude toward mobile coupon.

Previous research has pointed out that attitude is an indicator of advertising effectiveness (Xu et al. 2009), thus we expect the relationship between attitude and intention to use and forward mobile coupons to hold in our research context.

H4: Attitude toward mobile coupon is positively related to intention to use coupons.

H5: Attitude toward mobile coupon is positively related to intention to forward coupons.

2.5 Control variables

In order to control for confounding influence, we controlled for the factors on intention to use and forward:

MMS cost

Presently, the sender would need to pay for forwarding MMS messages. However, we will control of the effect of this factor on intentions.

Merchant

Consumers' prior purchase experience would impact factors such as trust level (Marko 2005), credibility (Haghirian et al. 2005). Therefore, we will use a trustworthy merchant in the experiment and measure consumers' prior experience with the merchant.

3. Method

An experiment will be designed to investigate how psychological distance influence individuals' value perception, attitude, and intentions towards mobile coupons. The study will employ a 2*2 factorial design where social distance (familiar vs. unfamiliar) and spatial distance (0 mins journey to store, 30 mins journey to store,) will be used as treatments. We plan to recruit about 240 undergraduate students to participate in the study.

4. Discussion and Potential Contributions

With the continued development of mobile network technologies, the cost of forwarding MMS messages will become cheaper. This is a great chance for merchants to make good use of this marketing tool. Mobile coupons have the potential to be transmitted more widely among consumers, and encounter less consumer resistance. Merchant cost of advertising will be reduced sharply if consumers are willing to share coupons with friends.

There are several potential contributions of our research. Theoretically, as a fairly new theory in consumer research, Construal Level Theory offers insights to understand the influence of consumer perceptions in certain situations. It has been suggested that the interrelations among psychological distance dimensions are unclear (Liberman, N and Trope 2009). Hence, our research by applying CLT to an emerging area of IS research can offers some understanding to evaluate the interacting effects of spatial dimension and social dimension upon mobile advertising. Managerially, our study examines a mobile consumer behavior in terms of forwarding coupon. We expect our results can guide merchants to better design their mobile marketing initiatives so that they can make mobile coupons more infectious.

References

1. Barwise, P., and Strong C. "Permission-based Mobile Advertising," *Journal of Interactive Marketing* (16:1), 2002, pp. 14-24.
2. Culnan, M. J. "Consumer awareness of name removal procedures: implication for direct marketing," *Journal of Interactive Marketing* (9: 2), 1995, pp. 10-19.
3. Dhar, R., and Kim, E. Y. "Seeing the forest or the trees: implications of construal level theory for consumer choice," *Journal of Consumer Psychology* (17: 2), 2007, pp. 96-100.
4. Ducoffe, R. H. "Advertising value and advertising on the web," *Journal of Advertising Research* (36), 1996, pp. 21-35.
5. Fishbein, M., and Ajzen, I. Belief, Attitude, Intention, and Behavior: An introduction to Theory and Research. Reading, MA: Addison-wesley, 1975.
6. Goersch, D. "Multi-channel integration and its implications for retail web sites," Proceedings of the 10th European Conference on Information Systems (ECIS 2002), 2002, pp. 748-758.
7. Gasimov, A., Sutanto, J., Phang, C., and Tan, C. "An Exploratory Field Experiment on Actual Usage of Discount Coupons," Special Interest Group on Human-Computer Interaction 2009 Proceedings (SIGHCI 2009), Paper 9.

8. Haghirian, P., and Madlberger, M. “Consumer Attitude Toward Advertising via Mobile Devices - An Empirical Investigation Among Austrian Users,” ECIS 2005 Proceedings, pp. 44.
9. Kang, H., Hahn, M., Fortin, D. R., Hyun, Y. J., and Eom, Y. “Effects of perceived behavioral control on the consumer usage intention of e-coupons,” Psychology and Marketing (23: 10), 2006, pp. 841-864.
10. Lu, Q., Moorthy, S. “Coupons Versus Rebates,” Marketing Science (26:1), 2007, pp. 67-82.
11. Liberman, N., and Trope, Y. “The Psychology of Transcending the Here and Now,” Science (322: 21), 2009, pp.1201-1205.
12. Lynch, J. G. J., and Zaubennan, G. “Construing consumer decision making,” Journal of Consumer Psychology (17:2), 2007, pp. 107-112.
13. Merisavo, M., Kajalo, S., Karjaluoto, H., Virtanen, V., Salmenkivi, S., Raulas, M., and Leppäniemi, M. “An Empirical Study of the Drivers of Consumer Acceptance of Mobile Advertising,” Journal of Interactive Advertising (7: 2), 2007, pp. 1525-2019.
14. Oskamp, S. Attitudes and Oponions (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall. 1991.
15. Sultan, F., and Rohm, A. J. “How to Market to Generation M(obile),” MIT Sloan Management Review (49: 4), 2008, pp. 35-41.
16. Tolman, E. C. “A psychological model,” in T. Parsons and E. A. Shils (Eds), Toward a General Theory of Action. Cambrige, MA: Harvard University Press, 1951, pp: 279-361.
17. Tsang, M. M., Ho, S-Ch., and Liang, T-P. “Consumer Attitudes Toward Mobile Advertising: An Empirical Study,” International Journal of Electronic Commerce (8: 3), 2004, pp: 65-78.
18. Xu, H., Oh, L-B., and Teo, H-H. “Perceived effectiveness of text vs. multimedia Location-Based Advertising messaging,” Int. J. Mobile Communications (7: 2), 2009, pp.154-177.
19. Yoo, Y. “Computing in everyday life: a call for research on experiential computing,” MIS Quarterly (34: 2), 2010, pp. 213-231.
20. Zeithaml, V. A. “Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence,” Journal of Marketing (52: July), 1988, pp. 2-22.

Two-sided Benefits or Double-edged Sword? Competition in Mobile Device and App Markets

Raymond G. Sin
Hong Kong University of Science and Technology
rsin@ust.hk

Jia Jia
Hong Kong University of Science and Technology
jiajia@ust.hk

Abstract

This work builds on extant literature on two-sided market and network effects, and aims to investigate how the platform firm uses pricing or non-pricing strategies to influence the complementary goods markets and better positions itself in systems competition.

Keywords: Two-sided Markets, Network Effects, Incentives, Platform Competition

1. Motivation

Since the introduction of the first iPhone in 2007, Apple has begun its quest to dominate the smartphone market and redefined what "digital lifestyle" means to millions of consumers. Despite being a relatively new entrant, the iPhone has already claimed 27 percent of the global smartphone market (The Nielsen Company 2011).

Apple's success in the smartphone market is not exclusively driven by its fascinating devices (e.g., revolutionary HCI). iTunes App Store, an e-commerce ecosystem tailored for its "i-branded" devices, plays a definitive role in enhancing its competitive advantage. As of June 2010, a total of over 235,000 apps were available (with a growth rate of 10% to 20% month-by-month) and 5 billion cumulative downloads from the iTunes App Store was recorded, bringing $1.78 billion worth of app sales for Apple (IHS 2011). This booming app economy also presents growing business opportunities to third-party developers; by making revenue-sharing transparent for third-party developers in paid downloads (a 7-to-3 cut), Apple offers motivation for these developers to contribute to the app development for Apple's devices. In comparison with its primary competitors (there are approximately 61,000 Android apps and 8,000 Blackberry apps), proliferation of apps has created an unmatched level of customer loyalty to the Apple platform, subsequently translating into sustainable differentiation, stickiness and profitability for Apple.

The ongoing phenomenon that we observe in the smartphone market provides a vivid demonstration of competition around platforms. Although numerous decision makers are involved in these complicated interactions, platform owners generally play key roles in determining competition outcomes, and exclusive power to coordinate participants in their ecosystems. Such coordination can foster indirect network effects and two-sided market complementarity, bringing platform owners competitive advantage over their competitors. In the Apple's example, the two-sidedness of market can be understood through the following feedback cycle: the more apps that are available for Apple's devices, the more attractive these devices will become to prospective purchasers; a broadened user base in turn provides sufficient incentives for third-party developers to develop apps. Other examples of two-sided markets include online

transaction intermediary, PC operating systems/hardware, and game consoles (Economides and Katsamakas 2006; Parker and Van Alstyne 2005; Caillaud and Jullien 2003).

In contrast to the prominence of two-sided competition in today's economy, the ability of the platform owner to use price or non-price mechanisms to influence the provision of complementary goods and better position itself in competition has not been sufficiently analyzed in academia (Economides and Katsamakas 2006). Particularly, existing literature usually underplays the incentives of third-party entities in providing complementary products and treats the variety of complementary goods available on a platform as given (Hagiu 2009). As a result, it remains unclear as to what factors would influence the allocation of third-party entities' efforts across competing platforms, which in turn is manifested through cross-platform differences in application variety and eventually the value of the platform to end users. By endogenizing third-party entities' platform choices, we attempt to provide an explicit answer to this question.

In this paper, we present an analytical model based on extant literature on network economics and two-sided markets. By forgoing the simple assumption on the natural existence of complementarities between the platform and applications, this framework unveils a particular source of such complementarities. The complete model will characterize the duopolistic competition between two platform owners, and explicitly examine incentives underlying third-party developers' homing decisions and provisions of the complementary products.

2. Literature Review

There is a large body of literature that examines the competition among systems (Katz and Shapiro 1994). Systems are products made up of multiple components, among which those elements used in common or reused across implementations comprise platforms. Serving as a stable foundation, a platform also serves as a "technological bottleneck" (Armstrong 2006). The entity holding property rights over a platform possesses a right to exclude outsiders from the entire system, therefore having privilege to place or remove restrictions on the use, development, and commercialization of the platform and system (Boudreau 2010). Platform owners can exploit these privileges to develop tools, such as common ownership of various components suppliers, long-term contracts, and industry-wide standard-setting bodies, so as to achieve coordination among firms that is extensively required by systems competition (Katz and Shapiro 1994).

Required coordination sometimes goes beyond the supply side, and includes consumers as well (Katz and Shapiro 1994). Aside from coordinating consumers to enlarge the network of consumers and increase the value of membership of the network to each user (i.e., create direct network externalities), coordination could also involve both sides of the market and facilitate the interaction between consumers and producers of complementary components. Such cross-side coordination impacts the two sides' willingness to trade on the platform and, thereby, their net surpluses from potential interactions (Rochet and Tirole 2006).

Theories of two-sided markets specifically investigate how a platform can employ pricing strategies to accomplish such cross-side coordination, and, in turn, enhance and extract the surpluses from both sides of the market. As price is no longer the only extraction device, standard pricing rules cannot be applied to each side separately (Economides and Katsamakas 2006); further, competition between platforms does not necessarily lead to an efficient pricing structure, either. Previous studies show that factors influencing equilibrium platform prices include the magnitude of the cross-side externalities, the formats of fees (e.g., levied on a lump-sum or per-transaction basis), and the chance that agents multihome if several platforms coexist (Armstrong 2006; Hagiu 2006). In addition to pricing strategies, the effects of various non-price

instruments (e.g., employing screening procedures or raising application development costs for the platform) are, however, seldom examined in extant literature, even for the exclusivity clauses a platform can introduce to deal with an otherwise multihoming agent.

Another aspect that has been overlooked in extant literature of two-sided markets is consumer demand for product variety (Hagiu 2009). The widely employed assumption of homogeneous populations (Armstrong 2006; Caillaud and Jullien 2003) somewhat contradicts the reality in that a variety of contents from numerous independent parties are available in almost all prominent examples of two-sided markets. This artificial assumption may also lead to a distorted conclusion on the intraplatform competition among providers of complementary components. Moreover, under the assumption on homogeneity, product vendors are indistinguishable and thus unanimous in their actions; it may be one of reasons why extant literature has largely omitted the consideration of product vendors' incentives of allocating efforts across multiple platforms.

3. Theoretical Framework

This section develops the baseline model that analyses a monopolistic platform with complementary applications. Consider a market that consists of one firm selling a platform product, and multiple developers developing and selling applications on the platform. The platform itself is differentially valued by consumers. Consumer valuation is captured by a parameter $\gamma \sim U[0,\overline{\gamma}]$, where consumers closer to $\overline{\gamma}$ have larger reservation value for the platform.

Consumers have different preferences for applications. To model horizontal differentiation for applications, we assume that consumers are uniformly distributed along a unit circle, and incur a fit cost t per unit of distance between their locations on the circle and the location of the developer offering they purchase. A perfect fit brings consumers a utility b in addition to γ.

Assuming that there exists an infinite number of identical potential application developers. They can freely enter the application market by incurring a development cost c, and then decide where to locate their offerings and how to set their prices. Because of the circular model, no location is a priori better than others to any developer. In order to sell their applications through the platform, application developers are required to agree on a revenue-sharing arrangement proposed by the platform owner, which allows the platform owner to claim a predetermined proportion (denoted by α) of the retail price for any application sold through the platform.

We consider the platform owner's problem, the strategic variables of which include platform pricing and the revenue sharing rule with developers.

The game consists of the following stages:

- The platform owner decide the revenue-sharing portion, α, and the price for its device, p.
- Upon observing α and p, developer i chooses the location and set the price, κ, for its offering.
- Consumers observe the number of active developers, and decide whether to buy the platform or not at p. Upon acquiring the platform, consumers can frictionally observe the locations and prices of offerings provided by all active developers. The consumers choose to buy the most ideal application from all offerings available on the platform.

The arrival of developers precedes the arrival of consumers. This order is reasonable since platform owners need to get application developers involved prior to putting the platform on the market in order to ensure that there are enough applications to support its launch.

Given that consumers can frictionally observe the locations and prices of all active developers after buying the platform, the n developers locate equidistantly from one another in equilibrium.

The equilibrium price of application i, κ_i, is derived by applying techniques for the standard horizontal differentiation problem. $\kappa_i = \frac{t}{n}$, which is, however, independent of α.

The expected revenue earned by a developer is $\alpha \frac{t}{n^2} D(n, p)$ in which $D(n, p)$ denotes the demand for the platform. Specifically, $D(n,p) = \left(\bar{\gamma} + \int_0^{\frac{1}{2n}} \left(b - xt - \frac{t}{n} \right) dx - p \right) / \bar{\gamma}$, as the marginal type of consumers, i.e. γ, who buy the platform after observing n active applications fulfill $\gamma + \int_0^{\frac{1}{2n}} \left(b - xt - \frac{t}{n} \right) dx - p = 0$. Because of the free entry of developers, $\alpha \frac{t}{n^2} D(n, p) = c$ in equilibrium. As a result, n is a function of both p and α. The platform owner's problem is represented by

$$\max_{p,\alpha} \left(\bar{\gamma} + \int_0^{\frac{1}{2n(p,\alpha)}} \left(b - xt - \frac{t}{n(p,\alpha)} \right) dx - p \right) \left(p + (1-\alpha)t \right)$$

Lemma. $\frac{\partial n}{\partial \alpha} > 0$ and $\frac{\partial n}{\partial p} < 0$ in the equilibrium.

This lemma states that the higher the revenue shared with developers, the larger number of developers are active in the application market; on the other hand, the higher the price of applications, the smaller the number of developers participating in the market.

4. The Competitive Setup

In this section, we describe how to extend the basic setup to incorporate competition and consumer choice across two platforms. The duopolistic setup departs from the previous one in as follows: first, the two platforms, indexed by h and l, are distinguished by parameter $\bar{\gamma}$, where a higher $\bar{\gamma}$ represents a higher-quality platform with a higher maximum standalone value; second, consumer preferences are captured by two parameters (γ_h, γ_l) which are uniformly distributed on $[0, \bar{\gamma}_h] \times [0, \bar{\gamma}_l]$. All consumers either not buy at all or buy exactly one of the two platforms.

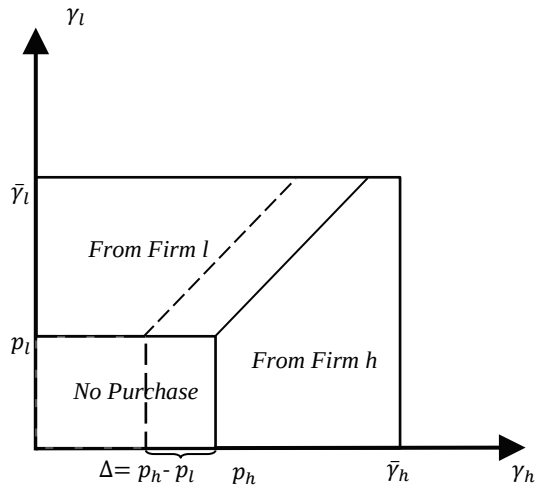


Fig 1. The pattern of consumer demand for the standalone platforms

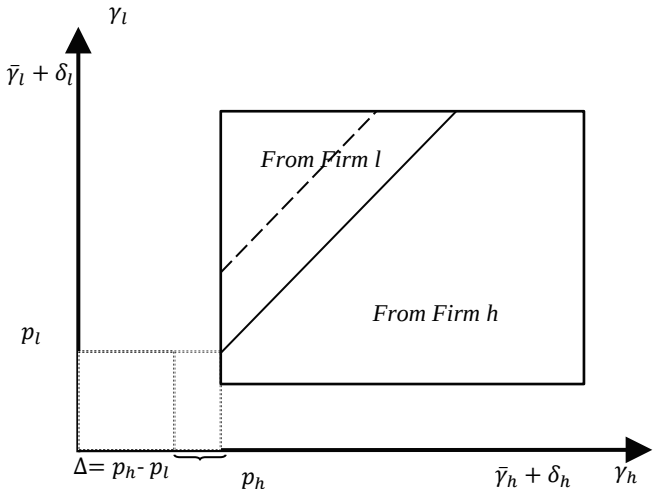


Fig 2. The pattern of consumer demand for the platforms with add-on values

In a scenario where there are no complementary goods, the demand patterns for the two platforms are shown in Figure 1. p_h and p_l are the prices charged by the two platform owners.

The dashed lines indicate the demand pattern when $p_h = p_l$, whereas the solid lines indicate the demand pattern when $p_h \neq p_l$. The market is partitioned into three segments, and there always exists a portion of consumers who do not buy either of the platforms.

The impact of including complementary goods on end users' utility function is to shift the supports of the two preference parameters in a disproportionate manner. The new lower bounds of consumer valuation are δ_h for the high-quality platform and δ_l for the low-quality platform, both of which depend on p_h and p_l and α_h and α_l as shown in the monopoly case. These additional parameters may induce a full-purchase scenario as described in Figure 2. With the characterization of the demand functions, we can then formulate the two firms' objective functions, and calculate the equilibrium platform prices and revenue sharing proportions.

5. Research in Progress

Ongoing research focuses on relaxing several key assumptions. Particularly, the assumption of an infinite number of application developers, though approximately describing end users' realistic perception, excludes the possibility of investigating the impact of asymmetry of any sort among developers. Also, the restrictive assumption of one-stop application shopping rules out multiple application purchases that are practically common among end users. We are considering a setting where there are finite application developers with more than one application category (e.g., the number of application categories can be modeled as the number of unit circles, between which consumption is not exclusive). This allows us to gain more insights on how platform developers can optimally allocate their efforts. It further allows for discussions on developers' multihoming decisions if a developer can transplant the applications it has developed for one platform on the other platform at negligible cost. We expect to report findings at the workshop so as to solicit timely and constructive feedback from participants.

References

1. Armstrong, M. "Competition in Two-Sided Markets." *RAND Journal of Economics* (37:3), 2006, pp.668-691.
2. Boudreau, K. "Open Platform Strategies and Innovation: Granting Access vs. Devolving Control." *Management Science* (56:10), 2010, pp.1849-1872.
3. Caillaud, B., and Jullien, B. "Chicken & Egg: Competition among Intermediation Service Providers." *RAND Journal of Economics* (34:2), 2003, pp.309-328.
4. Economides, N., and Katsamakas, E. "Two-Sided Competition of Proprietary vs. Open Source Technology Platforms and the Implications for the Software Industry." *Management Science* (52:7), 2006, pp.1057-1071.
5. Hagiu, A. "Pricing and Commitment by Two-Sided Platforms." *RAND Journal of Economics* (37:3), 2006, pp.720-737.
6. Hagiu, A. "Two-Sided Platforms: Product Variety and Pricing Structures." *Journal of Economics & Management Strategy* (18:4), 2009, pp.1011-1043.
7. Katz, M. L., and Shapiro, C. "Systems Competition and Network Effects." *Journal of Economic Perspectives* (8:2), 1994, pp.93-115.
8. Parker, G. G., and Van Alstyne, M. W. "Two-Sided Network Effects: A Theory of Information Product Design." *Management Science* (51:10), 2005, pp.1494-1504.
9. Rochet, J., and Tirole, J. "Two-Sided Markets: A Progress Report." *RAND Journal of Economics* (37:3), 2006, pp.645-667.

Social Loafing or Not: An Exploration of Virtual Collaboration

Abstract

This paper reports an experiment design that investigates three research questions: (1) whether social loafing exists in asynchronous virtual collaboration; (2) how the perceived co-worker's performance influences social loafing; (3) how the perceived co-worker's performance influences social comparison and social compensation, which are two group processes that are related to social loafing.

Keywords: Virtual teamwork, Social comparison, Social compensation, Social loafing, Electronic brainstorming

1. Introduction

With globalization of business and advancement of information technology, virtual collaboration has become pervasive organization phenomenon. Virtual collaboration refers to group collaboration that is conducted via computer-mediated communication (CMC) in synchronous or asynchronous setting (Cohen and Gibson, 2003; Connaughton and Shuffler, 2007; Martins, Gilson et al., 2004; Powell, Piccoli et al., 2004). The benefits of virtual collaboration include reduced travelling cost, flexibility of working time and location, and "tapping into a world of talents" Fuller, Hardin et al., Winter 2006-2007).

However, one critical issue of virtual collaboration is that it may provide more opportunities for individuals to engage in social loafing than in a face-to-face (FtF) collaboration due to the dynamics of the virtual setting (Blaskovich, 2008). The effects of social loafing on group performance have been extensively studied in prior research (for review, see Karau and Williams, 1993). However, previous studies on social loafing were mainly conducted in FtF collaboration. Driskell, Radtke et al.(2003) pointed out that little research has investigated social loafing in virtual collaboration. Chidambaram et al. (2005) echoed the statement by stating that "social loafing has not been studied systematically in the context of technology-supported teams".

Despite the call for more thorough study of social loafing in virtual collaboration, only a handful of studies (see, for example, Chidambaram and Tung, 2005; Blaskovich, 2008; Suleiman and Watson, 2008) have been published in this area. The investigation seems to be still in the early stage, since one of the research questions addressed in these studies is to find out whether there is social loafing in virtual collaboration. The findings are not consistent. The study by Chidambaram et al. (2005) did not find social loafing effects for the distributed groups, whereas the study by Blaskovich (2008) found that "virtual collaboration negatively affects group performance and that social loafing behavior may partially explain this result". The study by Suleiman and Watson (2008) also found social loafing in technology-driven teams.

These studies are conducted in teams that engaged in synchronous collaboration (i.e., synchronous virtual collaboration). No study has been conducted to investigate social loafing in asynchronous collaboration (i.e., asynchronous virtual collaboration). We believe that it is important to examine social loafing in asynchronous collaboration since the group dynamics of asynchronous collaboration are different from that of synchronous collaboration. The

convenience and flexibility of asynchronous collaboration provides even more opportunities for social loafing than synchronous collaboration does. In synchronous collaboration, each member is committed to a task in a fixed period of time, while in an asynchronous collaboration, a member can freely choose how much time to be spent on a task and when. Moreover, without the time immediacy and with even less visibility of their team members, individuals may not regard the tasks conducted asynchronously as important as the ones conducted synchronously. In addition, they may feel less obligated to make contributions to group work. As a result, individuals may spend less effort in asynchronous collaboration and are more prone to take free ride than in synchronous or FtF collaboration.

In this study, we investigate social loafing in asynchronous collaboration. However, instead of just investigating social loafing alone, we investigate the effect of social loafing along with social comparison and social compensation upon group performance. The theory of social loafing predicts that people usually extend less effort for group task than for individual task. The theory of social comparison suggests that people match their performance with people around them. If other people's performance is superior, they would increase their performance to match. On the other hand, if other people's performance is inferior, they would decrease their performance. However, social compensation works just the opposite, it predicts that when a team member perceives that his team members have low motivation or low ability for the group task, he would increase his effort to compensate for the expected poor performance from his team members. The effects of these three group processes are entangled, and no research has investigated how all these group processes affect group performance at the same time. We believe our research will shed lights in our understanding of social loafing in virtual collaboration.

2. Research Background and Hypotheses

Social loafing is "*the tendency for individuals to expend less effort when working collectively than when working individually*" (Karau and Williams 1993). According to previous studies, social loafing existed in face-to-face group collaboration (Karau and Williams 1993) and in synchronous group collaboration (Blaskovich, 2008; Suleiman and Watson, 2008). We speculate that social loafing exists in asynchronous group collaboration as well:

H1: Social loafing exists in asynchronous virtual collaboration.

One way to reduce social loafing is to invoke social comparison. The theory of social comparison proposed by Festinger (1954) postulates that when opinions and abilities are evaluated, social pressure toward uniformity is present, and this pressure may result in performance matching or competition. There were a number of studies that investigate the effects of social comparison on performance in face-to-face and synchronous group work (e.g., Rijsman, 1974; Seta, 1982; Seta, Seta et al., 1991; Shepherd, Briggs et al., 1996; Roy, Gauvin et al., 1996; Paulus and Dzindolet, 1993; Paulus, Larey et al., 1996; Munkes and Diehl, 2003; Michinov and Primois, 2005; Suleiman and Watson, 2008). These studies illustrated that providing feedback about co-workers' performance induced social comparison, which was manifested as the upward performance matching or competition. Upward matching refers to matching with the superior performance of co-workers, while competition is the upward pressure to do a better job. No evidence found for the downward matching (matching with the inferior performance of

co-worker). In other words, providing information about co-worker's performance increased group performance. We speculate the same effect will display in asynchronous collaboration.

H2: In asynchronous virtual collaboration, participants who receive information about their co-workers' performance will perform better than those who do not.

However, previous studies did not investigate how the perceived performance level affects group performance. We argue that receiving information on co-workers' performance level may induce social compensation as well. Research about social compensation (e.g., Hart, Bridgett et al., 2001; Todd, Seok et al., 2006) indicated that individuals may actually work harder collectively than individually in order to compensate for the expected poor performance of their co-workers under two conditions: the task is meaningful, and the expected co-worker's ability or motivation is low.

When participants feel that their co-workers contribute a little, they may choose to work harder to compensate for the co-workers' poor performance. Hence the hypothesis:

H3: In asynchronous virtual collaboration, participants who perceive that their co-workers contribute a little will experience more social compensation than those who perceive that their co-workers contribute a lot.

When participants perceive that their co-workers contribute a lot, there may be a tendency for upward social comparison or social loafing. Therefore, we investigate the following research question:

RQ: Who will perform better: participants who perceive that their co-workers contribute a little towards the group task or those who perceive that their co-workers contribute a lot?

If participants working with high performers achieve worse performance than participants working with low performers, then it is evident that people tend to engage in social compensation and social loafing when feedback information is available. On the other hand, if participants working with high performers achieve better performance than participants working with low performers, then people tend to engage in social comparison when feedback information is available.

3. Research Methodology

We conducted an experiment to evaluate the effects of feedback on virtual collaboration. The task required participants to generate ideas about how social media such as Facebook can be used to complement traditional classroom teaching and learning. There are four experimental conditions as illustrated by table 1. The participants were required to use a Web-based electronic meeting system to post ideas that they generated for the task during the period of five days.

Condition	Condition description
1	Individual work
2	Group work (no feedback)
3	Group work (low level of co-worker effort)
4	Group work (high level of co-worker effort)

Table 1: Study Design

Students from five introductory MIS classes in a U.S. University participated in the study voluntarily. The experiment adopted a research design that uses simulated group interaction instead of real group interaction in order to avoid confounding effect of real group interaction Valacich, Jung et al. (2006). The participants in condition 1 were told that they would complete the task individually. The participants in condition 2, 3, and 4 were told that each of them was randomly assigned to work with a student from another university and the grade would be assigned at the group level. In fact, each participant collaborated with a fictitious group member on the group task. By the end of each day, an experimenter manually logged into each participant's experiment session to post the number of ideas generated by his/her fictitious partner on that day for condition 2, 3, and 4. The average number of ideas for low level of effort is 2 (conditions 3), and the average number of ideas for high level of effort is 6 (condition 4). In order to ensure that the participants were blind of the experimental conditions, we varied the number of ideas for each day to make the average number of postings to be 2 or 6. A post-test survey was conducted for subjective measures and manipulation check. For the survey, we used 7-likert scale, with 1 indicating strongly disagree and 7 indicating strongly agree.

4. Next Step of Research

We have already collected the data, the next step that we need to do is to analyze data. If we complete data analysis by the conference date, we will be able to present our result at the conference.

References

1. Blaskovich, J. L. "Exploring the Effect of Distance: An Experimental Investigation of Virtual Collaboration, Social Loafing, and Group Decisions," *Journal of Information Systems* (22:1), 2008, pp. 27-46.
2. Chidambaram, L. and L. L. Tung "Is Out of Sight, Out of Mind? An Empirical Study of Social Loafing in Technology-Supported Groups," *Information Systems Research* (16:2), 2005, pp. 149-168.
3. Cohen, S. G. and C. B. Gibson. Chapter 1, In the beginning: Introduction and framework. . *Virtual Teams that Work: Creating Conditions for Virtual Team Effectiveness* S. G. C. a. C. B. Gibson. Jossey-Bass, San Francisco.2003.
4. Connaughton, S. L. and M. Shuffler "Multinational and Multicultural Distributed Teams: A Review and Future Agenda," *Small Group Research* (38:3), 2007, pp. 387-412.
5. Driskell, J. E., P. H. Radtke and E. Salas "Virtual teams: Effects of technological mediation on team performance," *Group dDynamics: Theory, Research, and Practice* (7:4), 2003, pp. 297-323.
6. Festinger, L. "A theory of social comparison processes," *Human Relations* (7:2), 1954, pp. 117-140.
7. Fuller, M. A., A. M. Hardin and R. M. Davison "Efficacy in Technology-Mediated Distributed Teams," *Journal of Management Information Systems* (23:3), Winter 2006-2007, pp. 209-235.
8. Hart, J. W., D. J. Bridgett and S. J. Karau "Coworker ability and effort as determinants of individual effort on a collective task," *Group Dynamics Theory, Research, and Practice* (5:3), 2001, pp. 181-190.

9. Karau, S. J. and K. D. Williams "Social loafing: A meta-analytic review and theoretical integration," *Journal of Personality and Social Psychology* (65, 1993, pp. 681-706.
10. Martins, L. L., L. L. Gilson and M. T. Maynard "Virtual Teams: What do we know and where do we go from here?," *Journal of Management* (30:6), 2004, pp. 805-835.
11. Michinov, N. and C. Primois "Improving productivity and creativity in on-line groups through social comparison process: new evidence for asynchronous electronic brainstorming," *Computers in Human Behavior* (21:1), 2005, pp. 11–28.
12. Munkes, J. and M. Diehl "Matching or competition? Performance comparison processes in an idea generation task," *Group Processes and Intergroup Relations* (6, 2003, pp.305–320.
13. Paulus, P. and M. Dzindolet "Social Influence Processes in Group Brainstorming," *Personality and Social Psychology* (64:4), 1993, pp. 575-586.
14. Paulus, P. B., T. S. Larey, V. L. Putman, K. L. Leggett and E. J. Roland "Social influence processes in computer brainstorming," *Basic and Applied Social Psychology* (18:1), 1996, pp. 3-14.
15. Powell, A., G. Piccoli and B. Ives "Virtual Teams: A Review of Current Literature and Directions for Future Research," *Database for Advances in Information Systems* (35:1), 2004, pp. 6-36.
16. Rijsman, J. B. "Factors in social comparison of performance influencing actual performance," *European Journal of Social Psychology* (4, 1974, pp. 279–311.
17. Roy, M. C., S. Gauvin and M. Limayem "Electronic Group Brainstorming: The role of feedback on productivity," *Small Group Research* (27:2), 1996, pp. 215-247.
18. Seta, J. J. "The impact of comparison processes on coactors' task performance," *Journal of Personality and Social Psychology* (42), 1982, pp. 281–291.
19. Seta, J. J., C. E. Seta and S. Donaldson "The impact of comparison processes on coactors' frustration and willingness to expend effort," *Personality and Social Psychology Bulletin* (17), 1991, pp. 560–568.
20. Shepherd, M. M., R. O. Briggs, B. A. Reinig, J. Yen and J. F. J. Nunamaker " Invoking Social Comparison to Improve Electronic Brainstorming: Beyond Anonimity," *Journal of Management Information Systems* (12:3), 1996, pp. 155-170.
21. Suleiman, J. and R. T. Watson "Social Loafing in Technology-Supported Teams," Computer *Supported Cooperative Work* (17, 2008, pp. 291-309.
22. Todd, A. R., D. H. Seok, N. L. Kerr and L. A. Messe "Social compensation: Fact or Social-Comparison Artfact?," *Group Processes Intergroup Relations* (9, 2006, pp. 431.
23. Valacich, J. S., J. H. Jung and C. A. Looney "The Effects of Individual Cognitive Ability and Idea Stimulation on Individual Idea Generation Performance," *Group Dynamics* (10:1), 2006, pp. 1-15.

On Collaboration Productivity Model Based on Social Capital Theory

Abstract

Shaokun Fan
The University of Arizona
fsk@email.arizona.edu

J. Leon Zhao
City University of Hong Kong
jlzhao@cityu.edu.hk

In a networked society, collaboration and collaboration technology is commonplace in business as well as in social networks. However, theoretical research in collaboration technology is relatively scant in the literature; as a result, there is no consolidated, general theory of collaboration. To support our explorative study of team building in social networks, we envision a collaboration productivity model based on social capital theory as we report in this short paper. Our goal is to present the basic concepts and principles as part of our ongoing research in collaboration management and technology. Our core effort is to model collaboration productivity with the Cobb-Douglas production function and social capital theory. We find that the value of additional social capital to a team depends on the cost of social capital, output elasticity, and team size. We further analyze strategies for team building based on the collaboration productivity model.

Keywords: Social capital, Collaboration productivity, Cobb-Douglas production function

1. Introduction

The recent years have witnessed the explosion of collaborative communities such as open source, group buying, and social networks. However, there is a lack of general theory of collaboration, which will provide a framework for businesses to better understand and apply collaborative efforts in any given field of human endeavor (www.wikipedia.org). In our recent research, we become strongly interested in filling this research gap in order to study collaboration management and technology.

Specifically, we would like to study team building and performance by developing a collaboration productivity model based on social capital theory situated in the literature of economics. Generally, social capital has a significant impact on collaboration performance; however, the relationship between social capital and team performance is not very clear in the literature. This paper stands out by providing a combined view for costs and benefits of social capital in collaboration teams. We analyze the factors that influence the relationship between social capital and collaboration performance from an economic perspective and use Cobb-Douglas production function to model collaboration processes.

The research questions addressed in this paper are (1) “what is the relationship between social capital and collaboration productivity” and (2) “how to build up efficient collaborative teams based on social capital theory”. Our contributions are three folds: First, we use Cobb-Douglas production function to model collaboration processes and indentify factors that influence collaboration productivity. Second, we define the collaboration value of individual participant based on the collaboration productivity model. Third, we propose strategies for collaboration team building.

2. Literature Review

Social capital is typically defined as "resources embedded in a social structure that are accessed and/or mobilized in purposive actions" (Lin 2001). Social capital resides in the relationships among individuals. In recent years, the concept of social capital has been identified as an important

factor for explaining social achievements that the concept of individual based capital (such as human or financial capital) is unable to explain (Guimerà et al. 2005). Social networks create substantial value for the individuals who participate in them, the organizations that sponsor them, and the larger society in many ways (Agarwal et al. 2008). For example, Wasko and Faraj (2005) demonstrated that knowledge sharing in electronic networks of practice is facilitated by social capital. Chang et al. (2011) found that various types of social capital are significantly associated with group contribution quantity or quality in OSS communities.

Although some researchers have argued that social capital is a valued team resource that affects collaboration productivity positivity, others increasingly consider this view as too one sided (Alder and Kwon, 2002). Too much social capital may bring some side effects to team collaboration (Portes and Landolt, 1996). As pointed out by Lin et al. (2001), "Forms of social capital that are valuable in one environment may be useless or even harmful in another."

Several studies have already compared social capital with other forms of capital (e.g. physical, human, culture capitals). The key difference between social capital and other forms of capital is that social capital is embedded in the social realm (Wasko and Faraj, 2005). Social capital is also studied by economists and modeled as a productive factor to predict economic growth in the literature (Dinda 2008).

3. The Collaboration Productivity Model

In this section we draw on microeconomic theory to discuss the theory of production as it applies to the relationship between social capital and collaboration productivity. In its analysis of production, economics has always included two factors: labor and capital. Many production processes have been successfully modeled by the Cobb-Douglas production function (Hildebrand and Liu 1965). By incorporating social capital into the Cobb-Douglas production function, the production process of a collaborative team is modeled by the following function:

$$Y = AK^{\alpha}L^{1-\alpha} \quad \text{where } 0 \le \alpha \le 1 \quad (1)$$

1. Y is the total team production. It can be measured by the quantity of the output produced by a team.
2. K is the amount of social capital possessed by the team.
3. L represents available labor hours and can be measured by available man-hours.
4. α and $1-\alpha$ are output elasticities of social capital and labor, respectively.
5. We combine all other factors that affect team production into the coefficient A.

Many collaboration processes are production processes in nature, thus it is reasonable to use production function to model collaboration. Although there is no unified scale to measure social capital in the literature, researchers generally agree that social capital consists of cognitive, structural and relational dimensions (Wasko and Faraj 2005). In this paper, we represent the amount of social capital by units. Each unit of social capital can be operationalized as a communication tie, trust relationship or common cognitive ability between individuals. For different collaboration contexts (e.g., local collaboration vs. online collaboration), we may operationize social capital differently. We defer this issue of social capital operationlization to our future research. The model developed in this paper can be applied to different operationlization mechanisms of social capital with little adjustment.

Definition 1. *Collaboration productivity* of a team is defined as production per unit of time (e.g., hour or day). For a team with T time units of collaboration, productivity is represented as $P = Y/T = AK^{\alpha}L^{1-\alpha}/T$.

Social capital is costly to create and maintain. Researchers such as Narayan and Cassidy (2001), emphasize that social capital exists only when it is shared. In order to create and maintain

social capital one must invest time and resources to sustain social interactions (Dinda 2008). In this paper, we represent the time spent on one unit of social capital as βKT. Here, β is the coefficient that captures time cost of maintaining and creating one unit of social capital in collaboration time T. Therefore, total labor hours for a team with n members and K units of social capital can be represented by $L=(n-\beta K)T$.

Replacing L with $(n-\beta K)T$ in Equation (1), we get $P = AK^{\alpha}(n-\beta K)^{1-\alpha}T^{-\alpha}$, which describes the trade-off between cost and benefit of social capital because increasing social capital K will decrease labor hours. If a collaboration team has too much social capital, team members need to spend a lot of time to deal with interruptions caused by social communications and inter-personal relationships. The extreme case is that when team members are overwhelmed by communication interruptions and have no labor time ($K=n/\beta$), the collaboration productivity is equal to 0. Another extreme case is that when team members has no relationship with other members and they work on the task separately ($K=0$), the collaboration productivity is also equal to 0 because collaboration tasks are usually hard to be handled by individual workers. Therefore, optimal collaboration productivity requires a balance between social capital and labor hours.

Lemma 1. For a team to achieve optimal collaboration productivity, the amount of social capital is determined by $K=\frac{\alpha n}{\beta}$.

Proof. To maximize the collaboration productivity P, the first order condition should be satisfied.

$$\frac{dP}{dK} = \frac{A\alpha K^{\alpha-1}(n-\beta K)^{1-\alpha} - A(1-\alpha)\beta K^{\alpha}(n-\beta K)^{-\alpha}}{T^{\alpha}} = 0$$

We get $K=\frac{\alpha n}{\beta}$.

Based on Lemma 1, the following four propositions are intuitive:

Proposition 1. *The amount of social capital K for optimal collaboration productivity is increasing in its output elasticity α.*

Output elasticity α is defined as the percentage change in output per one percent change in all the inputs. The coefficient of output elasticity can be used to estimate returns to scale. It represents the relative importance of social capital. For different types of tasks, their social capital elasticities could vary dramatically. For example, football teams may have higher social capital elasticities than relay race teams because team relationships and communications are more important in football teams. If social capital has high output elasticity, it means much of the collaboration task relies on social relationships and more social capital is needed for optimal collaboration productivity.

Propostion 2. *The amount of social capital K for optimal collaboration productivity is increasing in the number of team members n.*

Based on Lemma 1, when n increases, we need to increase social capital K to enhance collaboration productivity. Therefore, for large collaboration teams more social capital is required.

Proposition 3. *The amount of social capital K for optimal collaboration productivity is decreasing in the social capital cost coefficient β.*

If communication can be efficiently handled by team members, time cost of each unit of social capital will be reduced. The team can build up more social capital without reducing too many labor hours.

The relationship between social capital and collaboration productivity can be described by Figure 1. There is a reversed "U" shape relationship between social capital and collaboration

productivity. In order to improve collaboration performance, collaborative teams need to find an optimal way to manage the social capital and labor hours.

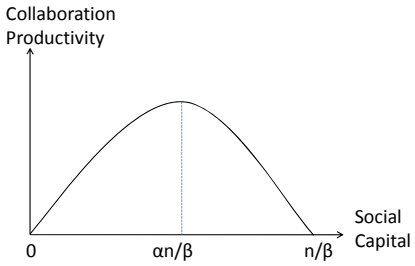


Figure 1. The Collaboration Productivity Model

4. The Collaboration Value of an Individual Participant

Suppose that we have a collaboration team with n members and K units of social capital. And the collaboration time is T hours. Then we have another available individual i who can join the existing team. Assume that we already know additional social capital (K_i) that will be provided by this individual *i*. The value of individual i to a team is defined next.

Definition 2. The collaboration value of individual i to a team is defined as the extra productivity that this individual can add to the team. It can be represented by

$$V_i = \Delta P = \frac{A(K+K_i)^{\alpha}((n+1)-\beta(K_i+K))^{1-\alpha} - AK^{\alpha}(n-\beta K)^{1-\alpha}}{T^{\alpha}}$$

Depending on how much social capital and labor hours provided by the individual, the collaboration value can be either positive or negative. Note that the collaboration value of an individual also depends on the status of the whole team. Based on Definition 2, the following proportions are proposed.

Proposition 4. *Whether adding individual i to a team could potentially increase the team productivity is determined by* $A(K+K_i)^{\alpha}((n+1)-\beta(K_i+K))^{1-\alpha} - AK^{\alpha}(n-\beta K)^{1-\alpha} > 0$.

(1) *If the additional labor hour CAN outweigh the extra time spent on additional social capital ($\beta K_i \le 1$), adding individual i can increase the collaboration productivity.*

(2) *If the additional labor hours CANNOT outweigh the extra time spent on additional social capital ($\beta K_i > 1$), the value of this individual to a team depends on the cost coefficient of social capital β , output elasticity α ,team social capital K, individual social capital K_i, and team size n.*

We assume that any individual would not bring negative social capital to the team ($K_i>0$). If $1-\beta K_i \ge 0$, then $V_i>0$ holds. The rationale behind the first half of Proposition 4 is that if individual i can increase both social capital and labor hours for a team, it guarantees that the collaboration productivity will increase if the team adds individual i.

For the second half of Proposition 4, if $\beta K_i > 1$ holds, both positive and negative collaboration values are possible. For the special case of $\alpha = 0.5$, $K_i \le \frac{(n+1)+\sqrt{(n+1)^2 - 4\beta K(n-\beta K)}}{2\beta} - K$.

Due to space limitation, all proofs are limited and are available upon request.

Next, we use an example to illustrate collaboration value and productivity. An OSS development team has 5 members. The scheduled time for the software development project is eighteen days (18days*8hours/day=144 hours). The cost coefficient for one unit of social capital

in this team is 0.25. Suppose social capital's output elasticity is 0.5. According to Lemma 1, when social capital *K=10*, the team can collaborate the most efficiently. The team productivity is given as

$$\mathrm{P}= A\times 10^{0.5}\times(5-10\times 0.25)^{1-0.5}/144^{0.5}=5A/12\,.$$

If the team has 10 units of social capital, a new member wants to join the team. Suppose the new member will add 10 units of social capital to the team. The collaboration value of the new member can be calculated according to Definition 2.

$$V_i=\Delta P=\frac{A\times(10+10)^{0.5}((5+1)-0.25\times(10+10))^{1-0.5}-A\times 10^{0.5}\times(5-10\times 0.25))^{1-0.5}}{144^{0.5}}\approx -0.044A$$

This new member will bring negative value to the team. Therefore, adding this member to the team would not be a smart choice in terms of collaboration efficiency. If this member only added 5 units of social capital to the team, s/he could have a positive value to the collaboration team.

5. Conclusions

In this paper, we use Cobb-Douglas function to model collaboration production and show that there is a reversed U shape relationship between social capital and collaboration productivity. We also define the individual collaboration value as the productivity increment by a new team member. Strategies for collaboration team building based on the collaboration productivity model are also proposed. Our future research will study the difference in costs of creating, consuming and maintaining social capital, how to operationalize social capital in different contexts, and empirical evaluation of the collaboration productivity model.

Acknowledgement:

This research was supported by the project of "PPR 9056003: Enhancing Hong Kong SMEs' Competitiveness via Open Information Services".

References

1. Adler P.and Kwon S. Social Capital: Prospects for a New Concept. *The Academy of Management Review* (27:1), 2002, pp. 17-40.
2. Agarwal, R., Gupta, A.K., and Kraut, R. "Editorial Overview: The Interplay Between Digital and Social Networks," *Information Systems Research* (19:3) 2008, pp 243-25
3. Chang R. M., Yang S., Moon J., Oh W., Pinsonneault A., "A Social Capital Perspective of Participant Contribution in Open Source Communities," *HICSS'11*, pp. 1-10.
4. Dinda, S., Social Capital in the creation of Human Capital and Economic Growth: A Productive Consumption Approach. *Journal of Socio-Economics* (37:5), 2008, 2020-2033.
5. Guimerà R., Uzzi B., Spiro J., and Amaral L. , Team Assembly Mechanisms Determine Collaboration Network Structure and Team Performance. *Science*, 2005, pp. 697–702.
6. Hildebrand, H., and Liu C., *Manufacturing Production Functions in the United States,* Cornell University Press, 1965.
7. Lin, N. *Social Capital*, Cambridge University Press, Cambridge, UK, 2001.
8. Nahapiet, J., and Ghoshal, S. "Social capital, intellectual capital, and the organizational advantage," *Academy of Management Review* (23:2), 1998, pp 242-266.
9. Portes A., Landolt P. The downside of social capital. *American Prospect* (26:18-2), 1996.
10. Wasko M. and Faraj S. Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice, *MIS Quarterly* (29:1), 2005, pp. 35-57.

Winning Crowdsourcing Contests: A Micro-Structural Analysis of Multi-Relational Networks

Jiahui Mo
The University of Texas at Dallas
jxm083020@utdallas.edu

Zhiqiang Zheng
The University of Texas at Dallas
ericz@utdallas.edu

Xianjun Geng
The University of Texas at Dallas
geng@utdallas.edu

Abstract

This research investigates the impact of two fundamental types of social interactions in crowdsourcing contests - rivalry and friendship - on a solver's chance of winning. We propose triadic embeddedness as a novel conceptual framework for our analysis, in which we highlight multi-relational social interactions within a triplet of neighboring solvers. Our analysis shows that the triadic structures a focal solver is embedded in have significant effects on her winning chance. The effects not only depend on the relationship between the neighbors in a triad, but also depend on whether the focal solver has a relationship with these neighbors and what kind of relationship it is.

Keywords: Crowdsourcing contest, multi-relational social network, triadic embeddedness

1. Introduction

Crowdsourcing contests refer to an increasingly popular form of contests in which a firm (seeker) outsources a business task to an open crowd of competing solvers. The majority of crowdsourcing contests are facilitated by online marketplaces, among which InnoCentive.com, taskcn.com and zhubajie.com are notable ones. A signature characteristic of crowdsourcing contests is the high-intensity of competition and the resulting (often very) low chance of winning for an average solver -- less than 5% in the case of zhubajie.com. How to increase the chance of winning is thus a question of paramount importance to solvers in practice.

While the literature on auctions offers abundant explanations on the economic factors (e.g. prize) that affect bidder's chances of winning, there is limited understanding on whether and how social factors within a crowdsourcing marketplace affect a solver's chance of winning. Furthermore, social interactions within crowdsourcing are distinctive from these in other popular social networks (such as facebook.com or youtube.com) in that the former are often characterized by both friendship and intense rivalry. We thus conduct a longitudinal study to understand the linkage between a solver's chance of winning and her multi-relational social ties.

An empirical challenge in this research is that rivalry, as a persistent relationship among solvers, is not directly observable. Instead, we can only observe a history of solvers who competed in the same contests. We conjecture that repeated competitions between any pair of solvers cultivate a lasting (yet hidden) rivalry relationship between this pair. If this rivalry emerges between a pair, we could then capture this relationship when this pair co-participate in any future contest and explain each one's chance of winning not explained by any mere individual-level factors.

In this research we conduct a longitudinal study using data from zhubajie.com (a leading crowdsourcing marketplace in China) spanning a 3-year period, and seek answers to the following two broad sets of research questions:

- what are and how to model the distinctive social interactions in crowdsourcing contests?
- what is the relationship between social interactions and solver winning in crowdsourcing?

2. Modeling Micro-Structural Social Interactions Using Triad Embeddedness

For a given crowdsourcing contest, only a tiny proportion (<0.1%) of all potential solvers in a marketplace participate; obviously, these participating solvers have much more impact on each other's chance of winning in this particular contest. Consequently, another distinctive feature of crowdsourcing is that the micro-structural interactions among solvers, rather than the macro-structural ones that focus on the network of all solvers, play a bigger role in affecting a focal solver's chance of winning. We thus propose triadic embeddedness (TE) as a central term to capture micro-structural interactions among a focal solver and her immediate ties. We define TE as a solver being embedded in a three-actor neighborhood, social interactions among which are multi-relational. Figure 1 illustrates three types of TE with respect to the friend network. In each triad, the left node stands for the focal solver. We refer to any tie between the focal solver and any neighbor a direct tie, and any tie between the two neighbors a diagonal tie.

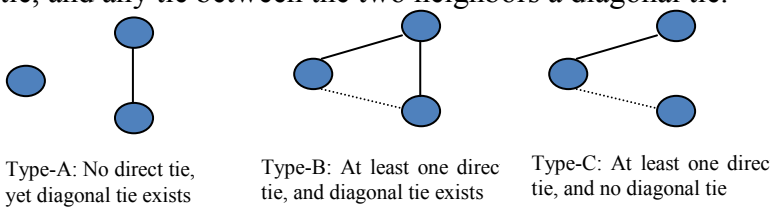


Figure 1: Three types of triadic embeddedness in the friend network

For any give contest, each type of TE has a clear practical meaning. For example, the existence of a type B triad in a contest means that the focal solver is befriending a pair of competitors who themselves are also friends. In the rival network there are three similar types of TE as well. Furthermore, TE also applies to multi-relational networks. For example, we are particularly interested in type-B triads in which direct ties are friendship and diagonal ties are rivalry (or vice versa).

3. Hypotheses

In this section we develop hypotheses that link a solver's micro-structural and multi-relational ties to her chance of winning a crowdsourcing contest. Based on the TE framework, we organize our hypotheses into four groups: those on direct ties (of a focal solver), those on type-A triads, those on single-relational type-B triads and those on multi-relational type-B triads.

3.1 The effects of Direct Ties

Friend network is among an individual's most important social capital. Friendship ties are found to have higher interaction frequency than other types of ties (Granovetter 1973). Learning, for example, frequently occurs within a friend network (Burt 1995). Kehler (2010) asserts that direct ties generally offer individuals the opportunity to share and learn skills that will improve their personal lives. Having more friends enables a solver to share more valuable information, access

more resources and have a better chance to enhance her skills through mutual learning and ultimately lead to higher chance of winning. Therefore, we postulate that:

Hypothesis 1: *The more friends a solver has in a current contest, the higher the winning chance for the solver.*

Direct and enduring rivalry ties between a focal solver and her neighbors, on the other hand, affect the focal solver's winning chance in a different manner. The focal solver may closely observe what the rivals do and indirectly learn from them. For example, after a contest, the solver can download the winners' solution (which is public information in zhubajie.com) and observe the color, the style and other knowledge from the rivals. Enduring rivalry may also lead to enhanced competition intensity. Evidence in political science and sports documents that enduring rivals compete more intensively with each other than with other rivals (Wiggins and Rodgers 2010). Ceteris paribus, such augmented efforts by the enduring rivals could raise their winning chances relative to the rest solvers. As such, we postulate that

Hypothesis 2: *The more past rivals a solver competed with in a current contest, the higher the winning chance for the solver in future tasks.*

3.2 The Effects of Type-A Triads

In a type-A triad, the focal solver is not tied to either neighbor, yet there is a friend (or rival) tie between the two neighbors. According to our discussion on direct ties, such a tie between the two neighbors increases these two neighbors' chance of winning. Because a crowdsourcing contest is a zero-sum game – one solver's win is another solver's loss – the focal solver's winning chance would then suffer. We thus propose that:

Hypothesis 3*: The more type-A friend triads a solver is embedded in, the lower the winning chance for the solver.*

Hypothesis 4*: The more type-A rival triads a solver is embedded in, the lower the winning chance for the solver.*

3.3 The Effects of Single-Relational Type-B Triads

Georg Simmel in his 1917 seminal work observes that three actors in a triad may allow qualitatively different social dynamics that cannot be reduced to individuals or dyads. According to Gulati (1998), an actor in a social network can derive control advantages by being the tertius gaudens, that is, one who is situated between two other actors (also known as structural hole or brokerage.) This can occur when two or more actors are after the same relationship with a focal actor, as is the case when multiple firms want to form an alliance with a certain firm; or when an actor is the tertius in separate relationships with two actors having conflicting demands. In both instances, firms in the tertius role can gain advantages by playing one off against the other and brokering tension between the other players. Therefore, we propose that

Hypothesis 5*: The more type-B friend triads a solver is embedded in, the higher the winning chance for the solver.*

Hypothesis 6*: The more type-B rival triads a solver is embedded in, the lower the winning chance for the solver.*

3.4 The Effects of Multi-Relational Type-B Triads

We are interested in two forms of multi-relational type-B triads. The first one is the type-B rival-friend triad, in which the focal solver is an enduring rival with both neighbors, and these neighbors befriends each other. In such a triad, the focal solver may be in a serious disadvantage

due to the collaboration and trust between the two rivals. Similar phenomenon is observed in the case of firm competition where the firms usually adopt alliance strategy to gain the advantage to compete with other firms (Kanter 1994). We propose that

Hypothesis 7*: The more type-B rival-friend triads a solver is embedded in, the lower the winning chance for the solver.*

Second is type-B friend-rival triad, in which the focal solver is friend of every neighbor, and these neighbors are enduring rivals. In such a triad, the focal solver benefits from both friendship ties. In addition, the focal solver can gain advantages by playing one neighbor against the other and brokering tension between the other players (Gulati 1998). We thus propose that

Hypothesis 8*: The more type-B friend-rival triads a solver is embedded in, the higher the winning chance for the solver.*

4. Data and Method

Our data from zhubajie.com includes 10,891 single-winner logo-design tasks (involving 66,859 unique solvers) spanning from March 2007 to March 2010. Upon entering each task, we identify the relationships among all participants as follows: friendship is obvious as it is explicitly designated by solvers; we then construct the rivalry network for each month, and derived 36 month by month networks. For each solver in each task, we infer enduring rivalry by checking whether any pair of participating solvers are connected in the whole network, and thus get the micro-structure network.

The dependent variable, an indicator of solvers' winning, was measured using the binary variable. To measure the micro structure embeddedness, we measure each type of triad in Figure 1 for each solver in the micro structure network. What is more, we consider many control variables. First, we control the solver's level variables, including solver's capability measured by the Pagerank and the efforts of a solver measured by her number of submission. Second, we control for the competitor's level variables, including the competitor's capability as well as efforts. Lastly we control the task-specific effects, such as the prize and the duration of the task.We adopt a fixed effects probit model, which is appropriate for binary dependent variables.

$$Prob(Win_{ij} = 1) = \Phi(Directties_{ij}, Triadic_{ij}, Rival_j, Solver_{ij}, Task_j + \epsilon_{ij})$$

Win_{ij} indicates whether solver *i* wins task *j*. Φ is the normal link for the probit model. $Directties_{ij}$ includes the degree of the friend and rival sub-networks for solver *i* in task *j*. $Triadic_{ij}$ includes type-A and type-B triads in friend and rival sub-networks. We also include other solver-specific and task-specific controls in $Rival_j$, $\mathbf{Task_j}$.

5. Results

We estimate three models (see Table 1) hierarchically. Model1 comprises of only the control variables; Model2 consists of the control variables plus the two commonly used degree variables in social network; and Model3 uses all the variables, including our proposed triadic measures.

Model 2 shows that direct ties have significant impact on solver winning, supporting H1 and H2. A comparison of Models 2 and 3 shows that the inclusion of TE variables significantly enhances the overall fitness of the model. Interestingly, by contrasting H3 and H5, we find that from a given focal solver's perspective, the impact of the friendship among any pair of competitors in the same task depends on whether or not she also befriends that pair: if yes, her chance increases

(0.0841, p<.001); if not, it decreases (-.0261, p<.001). One possible explanation of these two findings is collusion: friendship leads to mutual benefits that improves the winning chances of all friends at the cost of the rest solvers' loss. We do not observe a similar pattern regarding rivalry relationships. Our results regarding H7 and H8 are mixed: when a focal solver is befriending a pair of foes, such TE improved the focal solver's chance of winning; nevertheless, we do not observe any significant impact of TE when the focal solver is a rival to a pair of friends.

Table 1: Results

Independent variables		Dependent variable (Probability(win=1))		
Variable type	Variable name	Model1	Model2	Model3
	Intercept	-0.7624	-0.7583	-1.2862
Direct ties	Friend-Degree		0.0786***	0.0942***
	Rival-Degree		0.0388***	0.0564***
Friend triads	type-A triad			-0.0261***
	type-B triad			0.0841***
Rival triads	type-A triad			-0.00021***
	type-B triad			-0.00015***
Multi-relation Triads	type-B rival triad			0.0445
	type-B friend triad			0.00935***
Task-specific	Prize	-0.2173***	-0.2453***	-0.1351***
	Duration	0.0690***	0.0769***	0.0624***
Solver- specific	Solver's efforts	0.1674***	0.1695***	0.1768***
	Solver's capability	65.9654***	59.0829***	54.8972***
Competitor-specific	Competitors' average efforts	-0.2976***	-0.2628***	-0.2255***
	Competitiors'average capability	-122.0***	-134.4***	-159.0***
sample size		456485	456485	456485
log-likelihood (LL)		-47010.469	-46877.534	-46132.4155
-2 ($LL_{i-1} - LL_i$), for column i .		265.87	1490.237	
$\chi^2(DF_i\text{-}DF_{i-1},0.05)$		5.99	12.59	

Our research is the first that studies the impact of multi-relational and micro-structural dynamics on solver performance in crowdsourcing. Our results indicate that TE is a strong driver in determining solver winning. The practical implications of this research for solvers are that, when choosing tasks, solvers should not only consider competitive factors such as prize, but also consider the micro-structural social environment she is embedded in.

References

1. Archak, N., Sundararajan, A. "Optimal design of crowdsourcing contests," *Proceedings of the 13th International Conference on Information Systems*. 2009.
2. Archak, N., M. Glory. "Cheap Talk: Analyzing Strategic Behavior of Contestants in Simultaneous Crowdsourcing Contests on TopCoder.com," *2010 International World Wide Web Conference Committee (IW3C2)*.
3. Baum, J. A. C., A. V. Shipilov, T. J. Rowley. 2003. *Where do small worlds come from?* Indust. Corporate Change. 12 697–725.
4. Borgatti, S. P., R. Cross. 2003. "A relational view of information seeking and learning in social networks." *Management Science*. 49(4) 432–445.
5. Brabham, D. C. "Crowdsourcing as a model for problem solving: an introduction and cases," *The International Journal of Research into New Media Technologies.*2008. 14(1) 75–90.
6. Brabham, D.C. "Moving the crowd at Threadless: Motivations for participation in a crowdsourcing application," *Forthcoming in Information, Communication & Society.*2010.

Enhancing Organization's Operational Efficiency through Environmental Performance Improvement: An IT Resource-Based View

Lele Kang
Department of Electronic Business
Nanjing University
lelekangnju@gmail.com

Xiang Wang
Department of Electronic Business
Nanjing University
xiangwang@vip.163.com

Xue Yang
Department of Electronic Business
Nanjing University
yangxue@nju.edu.cn

Chuan-Hoo Tan
Department of Information Systems
City University of Hong Kong
ch.tan@cityu.edu.hk

Abstract

This study's overarching thesis is that in an increasingly environment-conscious society, an organization's operation could be further enhanced through appropriate investment of IT resources on environmental performance improvement. Specifically, building on the resource-based view, we focus on three forms of IT resources, namely IT infrastructure, human-IT resources and IT-enabled intangibles, and posit that the investment of these three forms of IT resources affect an organization's operational efficiency through two environmental performance indicators, namely eco-efficiency ("doing things right") and eco-effectiveness ("doing the right things"), moderated by cost and advantage differentiation. Case study and survey methods will be used to collect data and verify our research model.

Keywords: IT resource investment, corporate environmental performance, operational performance, resource-based view

1. Introduction

The widespread and rapid industrialization around the globe, without paying due attention to the impacts on the environment, has resulted in damaging environmental pollution (Shrivastava, 1995). The consequential damages on the environment include the global warming, resource depletion and environmental degradation, to name a few. In recent years, important new economies face an enormous pressure externally and internally to be more conscious in the industrialization and consumption of the natural resources (Fu, et al., 2010). An important avenue where a country could better address the environmental issue is through organizational practices (Brooks and Wang 2010). For instance, there is an increased attention and call for organizations to have their operations and operating habits to be more ecologically friendly, such as the reduction of carbon emissions (Hart, 1995).

Information technology (IT), as one of the most energy consuming equipment within an organization becomes one of the focal points (Chen et al. 2008). According to a research by Gartner (2007), the IT industry produces about 2-percents of global carbon emissions through the IT equipments, such as servers, desktops and phones. In addition, a report made by the United States Department of Energy (2007) shows that data centers accounted for 1.5-percents of all

electricity in US in 2006, and the growth rate is expected to be 12-percents per year from 2011. Thus, more and more IT corporations consider investing resources in minimizing the environmental impact of IT. For these IT corporations, information technology (IT) itself is believed to contribute to the environmental protection campaigns (Chen et al. 2008), such as applying IT to improve energy efficiency or change organizational processes and practices that are environmentally ineffective (Brooks and Wang 2010).

However, the main concern of IT corporations' environmental practices is whether resource commitments on improving environmental performance may cannibalize their regular operational performance at the same time (Rugman & Verbeke, 1998). Though previous research (Hart 1995) suggested that these two objectives may not be contradictory, many IT corporations still hesitate in their environmental practice investments because of its uncertainties (Rugman and Verbeke, 1998). Therefore, in order to better understand the phenomenon and provide helpful guidance to IT corporations, we raise this particular research question: how would IT research investment impact IT corporations' environmental performance and in which scenario it could further enhance rather than impair the operational performance?

Adopting the resource-based view (Bharadwaj 2000; Rugman and Verbeke 1998; Hart 1995), this study ascertains three forms of IT resources, namely IT infrastructure, human-IT resources and IT-enabled intangibles, within an IT organizational context. We posit that an IT organization's environmental performance, indicated by eco-efficiency ("doing things right") and eco-effectiveness ("doing the right things"), could be enhanced through the investment of these three forms of IT resources, and further influence the operational efficiency based on the moderating effects of cost and differentiation advantage. The resource-based view perspective emphasizes that a critical driver for an organization's performance is the gains deriving from leveraging IT resource investment on environmental improvements (Rugman & Verbeke, 1998).

2. Research Framework

Figure 1 depicts the conceptual framework of this research. This study's overarching thesis is that in an increasingly environmental-conscious operating environment, an organization's operation could be further enhanced through appropriate deployment of IT resources on environmental performance improvement.

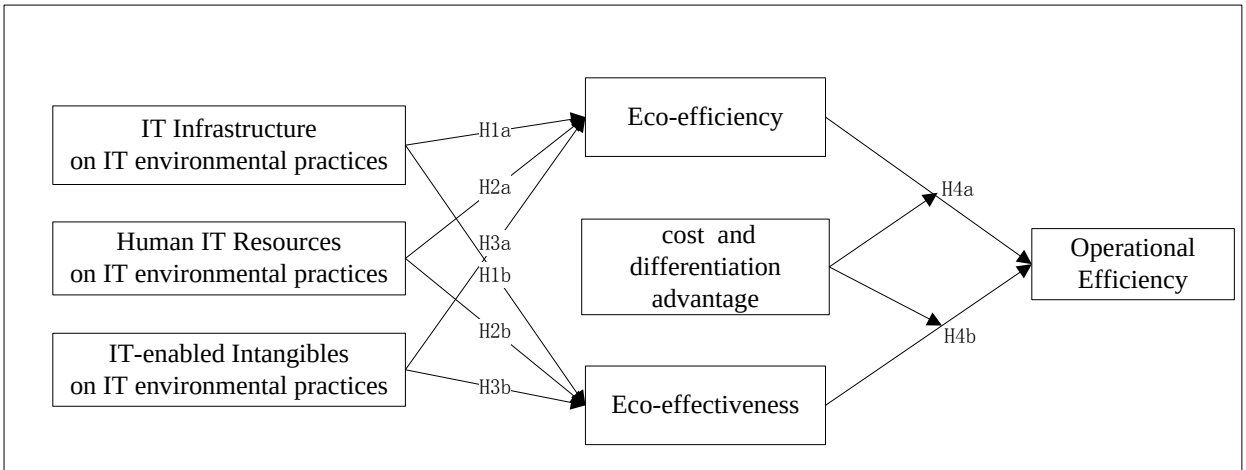


Figure 1: Research Framework

The resource-based view of organizations emphasizes heterogeneous organizational resource endowments as a basis for competitive advantage (Melville et al. 2004). If resources are valuable (i.e., they reduce the energy consumption), rare (i.e., few firms can have them), inimitable (i.e., there are high barriers to imitation) and non-substituent, they can help organizations gain sustainable competitive advantages (Barney 1986, 1991; Bharadwaj 2000; Brynjolfsson and Hitt 1996; Mata et al. 1995; Melville et al., 2004). A subset of resources can also help an organization to attain a competitive advantage, eventually leading to increased organizational performance (Barney 1991). In the context of IT corporate environmental practices, we focus on how the organizational performance is influenced by the IT resource investments which are committed to enhancing environmental performance.

Environmental performance, the mediator of the relationship between IT resource investments and organization's operational efficiency, is manifested by eco-efficiency and eco-effectiveness. Eco-efficiency means "doing things right" (Waston et al. 2010), which indicates cost reduction and productivity improvement. It focuses on internal perspective. Eco-efficiency requires a business to reduce waste, energy consumption (at a minimum) and ecological impact (Hart and Ahuja 1996). For example, IT corporations could invest in IT resources to reduce carbon emission and energy consumption. Eco-effectiveness refers to "working on the right things on the right products and services and systems instead of making the wrong things less bad" (McDonough and Braungart 2002; Waston et al. 2010). In order to achieve eco-effectiveness, organizations need not only to reduce ecological destruction, but also to redesign the way their business is conducted.

Bharadwaj (2000) classified organization's specific IT resources into three categories: IT infrastructure, human-IT resources, and IT-enabled intangibles.

IT Infrastructure mainly refers to physical IT assets, including servers, computers, communication technologies, platforms and databases. IT infrastructure serves as the platform on which it facilitates continuous improvement and innovation (Huang et al. 2006). These resources can contribute to eco-efficiency and eco-effectiveness and the extent to which IT corporations invest on the IT infrastructure may lead to different levels of environmental performance. Especially, eco-efficiency and eco-effectiveness can be achieved, when IT infrastructure investment is allocated to IT environmental practices, which is the strategic IT role played in the environmental practices (Chen et al. 2008). For instance, contemporary Internet data centers (IDCs) are capable of improving their efficiency by using new energy-efficient equipments, deploying energy management systems, and improving airflow management (Murugesan 2008). In addition, IDCs which invest on redesigning their data center infrastructures may help improve IDCs' eco-effectiveness. Thus, we propose the following hypotheses:

Hypothesis 1a: IT infrastructure investment on IT environmental practices is positively associated with eco-efficiency;

Hypothesis 1b: IT infrastructure investment on IT environmental practices is positively associated with eco-effectiveness;

Human IT resources include both technical and managerial IT skills. Technical IT skills mainly include systems development skills and technology innovation abilities. Managerial IT skills contain system management skills as well as project management and leadership abilities (Bharadwaj 2000). Employees equipped with higher IT proficiency are able to explore opportunities to participate in the ecological process, leading to more eco-efficiency and eco-effectiveness. For instance, managing IT infrastructure to achieve corporate environmental performance requires senior IT management abilities, which need a long time to form through

experience accumulation (Katz 1974). In this sense, the human IT resource investment could influence IT corporations' environmental practices and performance when it is assigned to IT environmental practices. Thus, we propose the following hypotheses:
Hypothesis 2a: Human IT resource investment on IT environmental practices is positively associated with eco-efficiency;
Hypothesis 2b: Human IT resource investment on IT environmental practices is positively associated with eco-effectiveness;

IT-enabled intangibles are IT resources which can change or improve the other resources and capability of an organization such as know-how, corporate culture, corporate reputation and environmental orientation (Bharadwaj 2000; Russo and Fouts 1997). The intangible advantages of IT include better service, improved quality, customer orientation, synergy operation enabled, policy sensitiveness, and knowledge assets (Brynjolfsson and Hitt 1996). For instance, IT as an efficient instrument can help an organization gathering and forming knowledge. With the knowledge management systems, the methods of adopting energy management system can be shared widely in the organization, which makes IT organization easier to achieve the corporate environmental performance. Organizational reputation is another important motivation of IT corporate environmental practices. Specifically, safeguarding an organization's reputation could compel an organization to pay attention to environmental performance. Therefore, investment on IT-enabled intangibles can be considered as key drivers to IT corporations' environmental performance. Hence, we propose the following hypotheses:
Hypothesis 3a: IT-enabled intangible investment on IT environmental practices is positively associated with eco-efficiency;
Hypothesis 3b: IT-enabled intangible investment on IT environmental practices is positively associated with eco-effectiveness;

We further focus on operational efficiency as the most direct organizational performance that may be related to the environmental practices. In the context of IT organizations' environmental practices, we propose that eco-efficiency and eco-effectiveness are not contradictory to corporations' operational efficiency. Eco-efficiency can enhance operational performance by reducing their energy consumption. For instance, some data centers use infrastructure management software is used to monitor energy consumption of all equipments. The analysis data to enable efficient resource utilization and workload placement, which makes data centers more efficient (Mingay et.al. 2010). Eco-effectiveness impacts operational efficiency by totally redesigning the business process. For example, some strategies are used to build eco-friendly data centers, such as using solar or wind power to operate the facility, recycling the obsolete machines, or using recycled or low-emission materials, etc (Martinez 2008).
However, such win-win outcomes can only happen when the corporations can gain cost competitive advantage and differentiation advantage through the IT environmental practices (López-Gamero et al. 2009). Cost advantage is gained from reducing input and waste disposal costs by improving the operational efficiency (Hart 1995; Shrivastava 1995); differentiation advantages can be obtained when customers hold the opinion that the service or product is more valuable (Lankoski 2008). In contrast, if the environmental practices require significant resource investment that is not contributed to the cost advantage and differentiation advantage, the environmental performance achievement will in turn cannibalize operational performance at least in the short term. Thus, we propose the following hypotheses:

Hypothesis 4a: Eco-efficiency is positively associated with operational efficiency, only when the IT resource investment contributes to cost advantage and differentiation advantage;
Hypothesis 4b: Eco-effectiveness is positively associated with operational efficiency, only when the IT resource investment contributes to cost advantage and differentiation advantage;

3. Research Methodology

In order to test our hypothesis, we will apply case study and survey research methods. The research context will be among IT corporations in mainland China. Due to the fast economic growth, China, as the one of the most important economies in the world, is facing fundamental dilemmas between environmental protection and economic boom (Fu, et al., 2010). For example, we have interviewed several big IDCs in mainland China. Most of them are engaged in energy conservation, eco-friendly design or virtualization practices. Some of them develop energy management systems to control the energy consumption. Some of them redesign their data centers by using the eco-friendly materials; others provide virtualization service for their customers. In these initiatives, they place investment on IT infrastructure, human-IT resources and IT-enabled intangibles. These IDCs are important to support our preliminary exploration. We will further conduct more interviews with other types of IT corporations and try to figure out how resource investment could influence the corporate environmental practices and whether the practices help them to improve operational efficiency or on the contrary, cannibalize the organizational performance. The in-depth interviews can help us find out underlying facts of the above mentioned questions. The case study method will be employed during this period. The information about their IT environmental practices can be gathered and analyzed. After that, survey method is our best choice to test the model empirically. Self-reported questionnaire and some objective indicator are helpful to test our hypothesis of multiple industries through large scale survey.

4. References

1. Barney, J. "Strategic factor markets: Expectations, luck, and business strategy," Management Science, (32:10), 1986, pp. 1231-1241.
2. Barney, J. "Firm resources and sustained competitive advantage," Journal of Management (17:1), 1991, pp. 99–120.
3. Bharadwaj, A.S. "A resource-based perspective on information technology capability and firm performance: an empirical investigation," MIS quarterly (24:1), 2000, pp. 169–196.
4. Brooks, S., and Wang, X. "Unpacking Green IT: A Review of the Existing Literature," AMCIS 2010 Proceedings, 2010, Paper 398.
5. Brynjolfsson, E., and Hitt, L. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," Management Science (42:4), 1996, pp. 541-558.
6. Chen, Adela J W, Boudreau, Claude, M. , and Richard T Watson. "Information systems and ecological sustainability," Journal of Systems and Information Technology (10:3), 2008, pp. 186-201.
7. Department of Energy, "Partnering with Computer Data Centers", 2007, http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html
8. Fu, B. J., Zhuang, X. L., Jiang, G. B., Shi, J. B., and Lü, Y. H. "Environmental Problems and Challenges in CHINA," Environmental science & technology (41-22), 2010, pp. 7597-7602.
9. Gartner, "Gartner: Data Centres Account for 23% of Global ICT C02 Emissions," 2007, http://www.gartner.com/it.

10. Hart, S. L. “A Natural-Resource-Based View of the Firm,” The Academy of Management Review (20:4), 1995, pp. 986-1014.
11. Hart, S. L, and Ahuja, G. “Does It Pay to Be Green? An Empirical Examination of the Relationship between Emission Reduction and Firm Performance,” Business Strategy and the Environment (5:1), 1996, pp. 30-37.
12. Huang, S., Ou, C., Chen, C., and Lin, B. “An empirical study of relationship between IT investment and firm performance: A resource-based perspective,” European Journal of Operational Research (173:3), 2006, pp. 984-999.
13. Katz, R. L. “Skills of an Effective Administrator,” Harvard Business Review (52:5), 1974, pp. 90-102.
14. Lankoski, L. “Corporate responsibility activities and economic performance: a theory of why and how they are connected,” Business Strategy and the Environment (17:8), 2008, pp. 536–547.
15. López-Gamero, M. D., Molina-Azorín, J. F., and Claver-Cortés, E. “The whole relationship between environmental variables and firm performance: competitive advantage and firm resources as mediator variables,” Journal of environmental management (90:10), 2009, pp. 3110-3121.
16. Martinez, N., and Bahloul, K. “Green IT Barometer European Organisations and the Business Imperatives of Deploying a Green and Sustainable IT Strategy,” White Paper, 2008
17. Mata, Fj, and Wl Fuerst. “Information technology and sustained competitive advantage: A resource-based analysis,” Mis Quarterly (19:4), 1995, pp. 487-505.
18. McDonough, W., and Braungart, M. “Cradle to Cradle: Remaking the Way We Make Things,” North Point Press, 2002, New York
19. Melville, Nigel, and Kenneth Kraemer. “Review: Information technology and organizational performance: An integrative model of IT business value,” MIS quarterly (28:2), 2004, pp. 283-322.
20. Mingay, S., Tratz-ryan, B., and Stokes, S. “Hype Cycle for Sustainability and Green IT,” 2010, Gartner, 2010
21. Murray, J. “Public sector bosses fear they will miss green IT goals,” 2009, http://www.businessgreen.com
22. Murugesan, San. “Harnessing Green IT: Principles and Practices,” IT Professional (10:1), 2008, pp. 24-33.
23. Rugman, Alan M, and Alain Verbeke. “Corporate strategies and environmental regulations: an organizing framework,” Strategic Management Journal (19:4), 1998, pp. 363-375.
24. Russo, Michael V, and Paul A Fouts. “A Resource-Based Perspective on Corporate Environmental Performance and Profitability,” The Academy of Management Journal (40:3), 1997, pp. 534-559.
25. Sarkar, Pradipta, and Leslie Young. “Managerial Attitudes Towards Green IT: An Explorative Study of Policy,” Pacific Asia Conference on Information Systems, 2009, Paper 95.

Teleconsultation: Understanding Continued Use

Abstract

Teleconsultation, one of the new telemedicine solutions, has been increasingly important in healthcare. However, the adoption and diffusion are slow and portion of them end up with failure. The underlying reasons for discontinued use of teleconsultation projects and methods to accommodate the teleconsultation to continued use have yet received little attention, especially in China. We aim to understand continue use of teleconsultation. We propose a multi-layer conceptual framework as an overall umbrella aligning theoretical lens in cognitive perspective as attitudinal and normative determinants of individual participant and collaborative interactive engagement. Intensive case studies are designed to explore the underlying reasons for discontinued use phenomenon in teleconsultation projects and potential solutions are provided.

Keywords: Teleconsultation, Continued use, Resource dependence theory

1. Introduction

With the increasing healthcare need while scare resources, it becomes increasingly imperative to allocate the healthcare resources in an effective and efficient way. Particularly, medical resources, in many developing countries such as China, are in an extremely uneven distribution. Most of specialists work in big hospitals which locate in big cities such as Beijing and Shanghai whereas large parts of population in rural areas have scare resource. (Zhang et al. 2010). Teleconsultation provides a solution for this problem.

Teleconsultation is "a particular type of telemedicine typically involving one healthcare provider—usually a primary care provider seeking advice from another—usually a specialist or sub-specialist—who has specialized expertise regarding the health problem at hand " (David 2010). Specialists can sit in his hospital and give consulting advice to a remote area through teleconsulatation. Literately, teleconsultation could solve the unbalanced distribution of medical resource in a cost-effective way. Although implementation has widely covered in prosperous and rural hospitals, the actual utility is remaining at a disappointingly low level.

Teleconsultation gains more and more attention from world wide scope and knowledge has been accumulated in this domain, however, inconsistent findings in terms of efficiency of teleconsultation service are shown in prior studies. Existing literature find that some cases are effective such as psychological intervention, some remote monitoring for chronic disease, etc, while others are not effective or even not useful such as self-monitoring (Ekeland et al. 2010). The study doesn't further explain the disequilibrium phenomenon. In addition, the review doesn't cover the cases in China and therefore cannot reflect the situation of teleconsultation in China. Admittedly, teleconsultation have been promoted and widely implemented in China, lots of discontinue use problems or disinterested reaction after first attempt have been found. Potential problems are brought up from teleological, political, managerial, professional issues and so on, however, no academic study has been done to comprehensively explain underlying reasons for discontinue use phenomenon in teleconsultation projects.

Driven by this practical issue and literature gap, our research questions are brought up as: 1.What are reasons for discontinued use of teleconsultation projects? 2. How to accommodate teleconsultation into practice for continued use? The paper proceeds as follows. The multi-layer conceptual framework is proposed to guide the following case study design and analysis. We categorized the identified problems into the proposed conceptual framework for preliminary findings and conducted the comparison between the prevalent service mode in our case and the new service mode in teleconsultation domain. This study is exploratory by nature with implications for future research.

2. Theoretical framework

Antecedences of Discontinue Usage

Different from pre-adoption of Information systems (IS), the post-adoption of IS draw attention to continuing use of IS and further investigate the long-term effect which ultimately reflect the success of IS. Accumulated knowledge has been developed within post-adoption area: the IS continue use from the technological perspective(Datta et al. 2010), and the cognitive factors explaining the human behavior related to continuing use.(Bhattacherjee 2001; Karahanna et al. 1999; Rogers and M 1962). Subjective norm, the other component derived from Theory of Reason of Action (TRA) (Fishbein and Ajzen 1975), is another dimension of influence on the intention.

We adopt the argument that assumption for continuing use does not covary with the acceptance of initial adoption. Based on the previous research, we accommodate our research context to structure the boundaries of antecedences of continue usage. The antecedence on attitudinal dimension includes perceived usefulness, image determinant and on subjective norm dimension includes management support, local technological support, and peers influence. Specifically, we assess the attitude of healthcare works in teleconsultation service, and ask them if they feel the service is useful and why. We also assess the image determinant by asking them whether the resolution of the picture in video conference is clear enough for their purpose, etc. On the other hand, we ask the situation about managerial support, peer's influence and technical support such as training programs to assess the social normative dimension.

The attitudinal and normative determinants serve as our theoretical lens to explore the underlying reason for discontinues use of teleconsultation projects. However, it is only on an individual level of analysis. In order to get a comprehensive understanding of the discontinue use phenomenon, it is necessary to conduct an in depth profiling of teleconsultation structure as a foundation to further explore the underlying logical linkage for continue use attention. We identify two separate end users: the specialist in big hospital and generalist in rural hospitals. Collaboration needs to be formed to complete the teleconsultation. Therefore, we adopt Resource dependency theory (RDT) (Pfeffer and Salancik 1978; Ulrich and Barney 1984)as our theoretical lens to investigate the interaction between the two parties.

Resource Dependency theory

Resource dependency theory (RDT) (Pfeffer and Salancik 1978; Ulrich and Barney 1984) is a fundamental theory of the adaption of organization to exogenous environmental change. It investigates the collaboration from the inter-organizational relationship and argues that firms should be able to cope with interdependency issues from external environment on managing and

controlling resources. Therefore, we adapt RDT theory to investigate the collaboration in teleconultation throughout the case studies and analysis.

The resource in RDT is "anything perceived as valuable by an actor(i.e. an organization), such as information, material, capital, or access to markets, and dependency is a state in which one actor relies on the actions of another to achieve particular outcomes" (Pfeffer and Salancik 1978; Tillquist et al. 2002). In order to fully assess interaction among participants, the key is to identify the comprehensive and precise scope of the recourse in teleconsultation domain. Addition to previous literature, we interview the specialists in healthcare, executive manager and project manager of IT service provider and government officer involving to further refine the scope of teleconsultation resource in our research context.

Coordination is through management of dependency of two parties to achieve stable consensus via terms and conditions(Van de Ven and Walker 1984). Accordingly, we design our interview questionnaires to acquaint all related terms and conditions such as regulations, policies and standardized work flow and based on that information to assess the coordination. Furthermore, we provide practical improvement suggestions for organizations to adapt to changing dependent relationship by leveraging resource dependency in a long-term perspective; the theory reveals that the successful collaboration is build on the mutual assumption that the outcome of a relationship is greater than that achieved by individual party. Thus, our interview questions seek to find benefit of each party in teleconsultation collaboration and compare among the supply and demand to find the gap and give our suggestions for achieving mutual benefit.

3. Research Method

The objective of our research is to explore underlying reasons for discontinued use of teleconsultation projects and provide practical solution for continued use. Qualitative research method is suitable for exploring underlying reasons in a dynamic natural context(Benbasat et al. 1987; Yin 2008). As an exploratory study with future implication, we adopt case studies with intensive interviews to answer the proposed research questions. In order to generate the validated case sample frame, it is imperative to have an overall understanding for our research context.

In China, teleconsultation service can be classified into two types in terms of its structure: point-to-point mode (P2P) and client/service mode. (Zhu et al. 2003). P2P mode is an independent service between a big hospital and a rural hospital. The distant video conference serves as the communication media between the two. The description of patient's condition is input to the computer with a text document form and share by two sides of doctors. CT, CR scanning pictures can be scanned to computers and transfer through internet or intranet by two sides. Both sides of doctors are sitting in front of computers with the web camera to discuss cases.

Client/service mode is a network structure composed by a center-based service provider and clients connecting to the server. The service provider is a third-party supplier and the hospitals are clients side connected to this network. The service provider is responsible for building the infrastructure to support the teleconsultation network. The web server and database is located at the center and responsible for processing the data coming from clients sides. In this case, each hospital which has subscribed the service owns a client account. Hospitals install the client side software and can be connected to the network. All activities, including applying for

teleconsultation, accepting requests, receiving patient's record before teleconsultation, reporting consulting results, etc, are done through their client account by logging in.

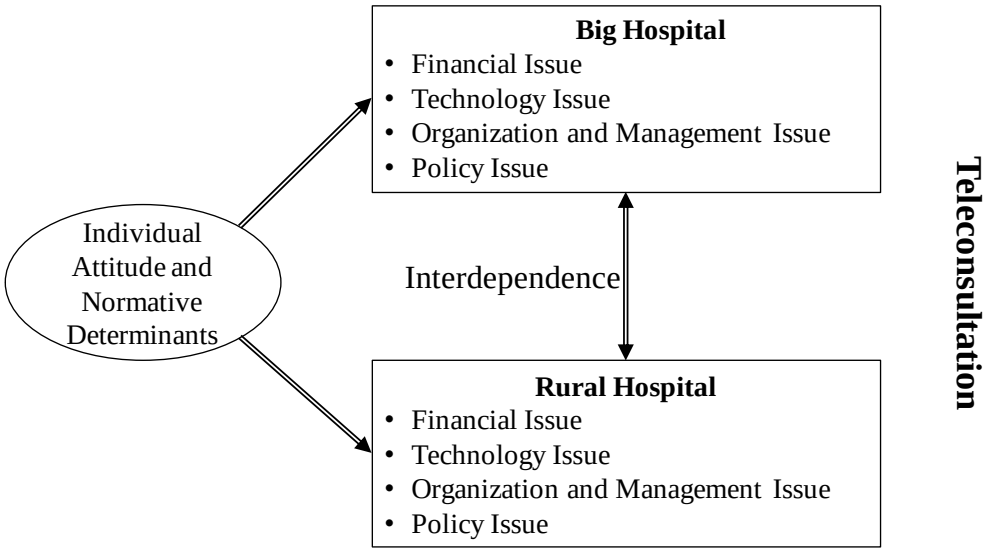


Figure 1: Conceptual Framework

4. Preliminary findings and Discussion

In our case, the resource includes three main stakeholders: Hospitals, Ministry of Health as representative for government department, IT service provider. Resources are summarized as follows respectively: In hospitals, administrative management, medical specialist, and technological infrastructure for digital health and their business model are included ; In Ministry of Health, the relevant policy and regulations and government funding are included; In IT service provider, IT hardware infrastructure and software service, and its business model are included. The ideal dependency of two parities in teleconsutlation is to achieve the reciprocal dependency. Therefore, the key is to govern dependency through coordination of activities between two organizations and to sustain motivation determinants of collaboration. (Cheon et al. 1995; Thompson 1967). Although discontinued use phenomenon happened in both cases, degree of the situation and reasons are varied. We summarized findings from two case studies and categorized into our conceptual framework (Figure 1) respectively.

4.1 P2P mode

1) Technological asymmetry

Although rural hospitals self-equipped the infrastructure for telecommunication, it cannot support smooth and clear video conference for teleconsultation. The revolution is too low because of limited bandwidth of internet.

Surgical department director in big hospital: "We cannot see clearly about tumor's location from the video conference"

2) Time-intensive

Specialists in big hospitals are very busy and have no extra time on planning and negotiating for teleconsultation service

Specialist in orthopedics department: "Rural hospitals are not well prepared before the teleconsultation which usually lead to low efficient diagnosing process, time-consuming and lack of useful medical information to give a diagnose result."
Surgical department director in big hospital: "There is no clear procedure to guide the teleconsultation. Instead, the communicating ways in teleconsultation are not uniformed, so that we have to spend to reach a mutual understanding on whole procedure to complete the teleconsultation for each time…"

3) Inappropriate expense
Every year, government generates funding to support the development of healthcare for public hospitals. Instead of investigating on teleconsultation, large amount of money is used for organize trip for training and learning among big and rural hospitals. In the training and learning conducted among different level of hospitals, doctors need to pay a visit to the distant hospitals during the session. One administrative person said:
"When I went to the county hospital for training and teaching, there were not many cases at hand. Instead of training rural doctors with case of illness they are dealing with, I had to use my prior cases as examples and material. I think the effectiveness of training could be improved a lot if I could teach them through the real cases they are dealing with. However, I may not have time to pay visit when they have patient cases. So it is very difficult to schedule an ideal time for both sides."

4.2 Client/Service mode
Different from P2P mode, this new model of service has improvement for the identified issues. Standard hardware packages will be equipped for hospitals and consultation management center and can support different requirement respectively. The consultation management center is responsible for collecting requests and distributing them and also provides standardized procedure to match the two-sides.

4.3 Comparison of P2P mode and Client/Service mode
Although Client/Service mode can provide a more effective and efficient teleconsutlation service, it is too hesitate to draw the conclusion that this new mode of service can be the solution for continued use of teleconsultation. From the resource dependency theory in the overall conceptual framework, the all stakeholders should reach the mutual benefit assumption. However, in teleconsultaion service, three stakeholders, hospitals, government department, and IT service provider, are varied by nature.

5. Concluding Remarks
This paper proposes a multi-layer conceptual framework to understand continued use in teleconsultation. There are, of course, a hot of limitations in the current study given the explorative nature. Generalizability could be a concern given that we only investigate a couple of hospitals. We plan to collect data from other collaborative hospitals. In order to leverage resources from the four identified issues in our conceptual framework, further research will examine how to accommodate Client/Service mode of teleconsultation to continued use in a long term.

(References are available upon request)

Users' Motivations and Intentions to Pay for Cybercafés in Mainland China

Wei SHANG
Academy of Mathematics and Systems Science, Chinese Academy of Sciences, China
shangwei@amss.ac.cn

Guoxin LI
School of Management
Harbin Institute of Technology, China
liguoxin@hit.edu.cn

Abstract

This research focuses on understanding cybercafé users' behavior to promote effective cybercafé marketing strategies and proper government regulations in mainland China. Both users' motivations of using a cybercafé and their intentions of paying for cybercafé services are investigated based on an integrative framework of Theory of Planned Behavior and the Self Determination Theory. Structural Equation Modeling is employed to empirically test the proposed framework. The result suggests: 1) users' attitude, subjective norms and perceived behavioral control influence their willingness to pay through their intention; 2) Users' need for autonomy motives predicts their intention through attitude and users need for competence motives predicts their intentions through perceived behavioral control. Users' income, past experiences has significant influence on their willingness to pay through their intention.

Keywords: Willingness to pay, Perceived behavioral control, Autonomy, Competence, Relatedness

1. Introduction

According to the Chinese Internet Statistical Report published by China Internet Network Information Center (CNNIC, 2011), the total number of Chinese Internet users has increased to 457 million. The Internet penetration rate, however, is only 34.3%, which is the 12th in Asia. Public venues for Internet access enable more people to access information and communication technologies (ICT) and the Internet with lower cost, by sharing limited ICT facilities and infrastructures. Cybercafés (or net bars) are major public Internet access venues in China, especially for rural people and low-income people (CNNIC, 2010).

Cybercafés have become prosperous in China since the late 90's. However, cybercafés recently suffered a general reputation among Chinese media and culture as venues where individuals, particularly young people, indulge in computer gaming and other online pursuits that are considered not to be constructive or appropriate. Chinese government promulgates new cybercafé management policies, which include minimum hardware and software requirements, business scope limitations and also a control on the growth of number of cybercafés. Chinese Cybercafé Industry Survey Report (by Chinese Cyber Café Association, 2009.3) reported that 47.3% of cybercafés suffer profit decrease. And a most recently cybercafé industry survey (TXWM, 2011) shows that 42% of cybercafés claim that newly launched cybercafé regulations are major reason for their sluggish business.

One way for cybercafé operators to maintain profit is to understand the customers' willingness to pay in different segmentations and adjust cybercafés' business strategies to meet various

customers' needs. From the government perspective, understanding of different categories of users' willingness to pay with different intentions of ICT access will offer meaningful regulation implications on how to exert the positive side of cybercafés to contribute more for national's ICT penetration especially for those rural and low income group. This study is designed to examine factors influencing people's intentions to use and willingness to pay for cybercafés services.

2. Literature Review

The Theory of planned behavior (TPB) posits that an individual's intention, a motivational construct, is the most proximal influence on social behavior and mediates the effect of three sets of belief-based perceptions on behavior: attitudes, subjective norm, and perceived behavioral control (Ajzen, 1991). Attitudes (A) are a person's overall positive or negative evaluation of the target behavior. Subjective norms (SN) summarize a person's expectation that significant others want them to engage in the target behavior. Perceived behavioral control (PBC) comprises a person's overall judgment whether they have the ability and resources available to engage in the target behaviour. According to TPB, a person's actual behavior in performing certain actions is directly influenced by his or her behavioral intention and, in turn, is jointly determined by his or her attitude, subjective norms and perceived behavioral controls toward performing the behavior. Behavioral intention is a measure of the strength of one's willingness to exert effort while performing certain behaviors.

The Self-determination theory (SDT) takes a different approach to understanding social behaviour. SDT focuses on the quality of an individual's motivation in a given context and the environmental factors that affect motivation in that context (Deci & Ryan, 1985; Ryan & Connell, 1989). Central to the theory is the distinction between self-determined versus controlled types of motivation (Deci & Ryan, 2000). SDT research has shown that self-determined motives positively affect behavioural engagement (Chatzisarantis et al., 2003) and that self-determined motivation can be supported or thwarted by environmental contingencies, such as the support offered by salient others, often evaluated by perceived autonomy support (Hagger et al., 2007; Reeve, Bolt, & Cai, 1999). According to the theory, individuals strive to satisfy three basic psychological needs: autonomy, competence, and relatedness. The need for autonomy reflects an individual's desire to be a causal agent in their world, and if a behaviour satisfies the need for autonomy, the individual feels a sense of personal choice, free-will, and 'ownership' over their actions. The need for competence is satisfied through the pursuit of autonomously motivated behaviours that lead to perceptions of success and control over outcomes. The need for relatedness reflects innate desires to be supported by others and be supportive of others when engaging in behaviours. SDT states that these needs are complementary.

While both TPB and SDT have been shown to be effective in accounting for variation in social behaviour (e.g., Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003; Hagger, Chatzisarantis, & Biddle, 2002), they have shortcomings in terms of their predictive utility. SDT does not chart the exact process by which motivational orientations are converted into intentions and behaviour and the TPB has provided an adequate basis for the explanation of variance in intentions and social behaviours without identifying the origins of the antecedents of the behaviours (Chatzisarantis, Hagger, & Smith, 2007).

For the current study on cybercafé use, we have adopted an integrated approach. Specifically, we propose that both theories can serve to assist in overcoming these shortcomings by integrating constructs from these two prominent social psychological theories in a unified model of motivation to explain behaviour. The integrated model is advantageous as it will identify the important belief-based factors and psychological need-based factors that influence intentions to use cybercafés and willingness to pay for cybercafé use. The basis for integration is offered by Deci and Ryan (1985) and Vallerand (1997) who state that motivational theories can offer explanations for the origins of social cognitive beliefs and expectations outlined in models of intention. Specifically, the role of self-determined motivation in influencing intentions to use cybercafés and a behavioral indicator, in this case, willingness to pay for cybercafé use, will be proposed our an integrated model.

3. Methodology

3.1 Survey Design

Subjects of this research are cybercafé users in mainland China. Sampling is conducted using multi-staged cluster sampling method. Finally, 20 cybercafés are randomly selected from 10 cities and their nearby counties. The questionnaire was designed and validate within pilot research before the main survey. According to theory framework construction and exploratory user survey, a questionnaire is designed to explore users' behavior and their willingness to pay for cybercafé services. The questionnaire contains users' demographic information, attitudes (2 items), subjective norms (3 items), perceived behavioral control (2 item), intention (2 items), and willingness to pay (2 items), and past experiences.

3.2Data Collection

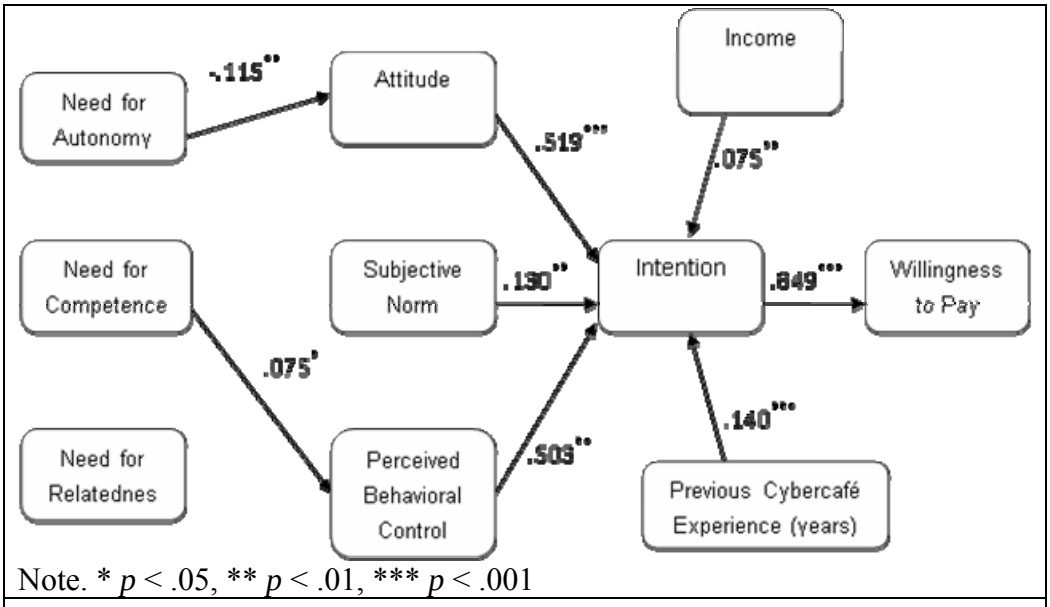
To avoid commonly criticized self-selection bias in online surveys and reach the exact cybercafé users, we adopted on site survey. The questionnaires are printed and filled in at selected cybercafés. The survey was during the summer vacation of 2010. The investigators are sent out to the field after one face-to-face survey training and one virtual meeting through the Internet. Questionnaire answers are input into a software program and then imported to our survey database. Unreasonable answers and missing values are deleted. 976 effective answers are collected.

4. Results

The percentage of male cybercafé users in our sample is 72.8%, which is similar with reports from CNNIC. We find that people between ages 18 and 24 constitute the largest part of the cybercafés users. Most of the cybercafés users live in the urban areas. They are mostly high school students, followed by college graduates and junior college.

Data were analyzed using the structural equation modelling (SEM) approach using the AMOS program (version 7.0). Confirmatory factor analysis (CFA) was applied to assess the validity of latent constructs with AMOS 7.0. Items of attitude, subjective norms, perceived behavioral control, intention to come, and willingness to pay were modeled as a reflective indicator of latent constructs respectively. These five constructs were allowed to co-vary freely in the CFA model. This result suggested adequate model fit ($\chi 2/df=10.088$, $p < .001$, CFI = .907, GFI=0.944, NNFI = .898, RMSEA = .097). Given the robust fit of the measurement CFA model, the hypothesized relations among the psychological need satisfaction and the TPB constructs were tested in an

SEM. The income and past cybercafé use experience (years) were included as predictors of the antecedents of intention and willingness to pay in accordance with the project proposal. For the research model, goodness-of-fit statistics revealed a satisfactory model ($\chi 2/df=8.678$, $p < .001$, CFI = .944, GFI=0.925, NNFI = .829, RMSEA = .089).



Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1. Estimated integrative model predicting intentions to engage in Internet use and willingness to pay from all psychological needs satisfaction, TPB, income and previous Cybercafé experience

5. Conclusions and Discussions

5.1 Improved Understanding of Cybercafé Users Behaviors

The results show that psychological need satisfaction significantly predicted attitudes and perceived behavioral control, but had no effect on intentions and willingness to pay. The resulting model demonstrated that satisfaction of the need for autonomy significantly predicted attitudes which, in turn predicted intentions. Intention was the only predictor of willingness to pay. The satisfaction of the need for competence also significantly predicted perceived behavioral controls, and then predicted intention to come. The integration of the theories provided a comprehensive explanation of the processes by which global psychological need satisfaction influenced decisions to engage in specific cybercafé use behaviors.

Findings from these integrated models indicate that satisfaction of the psychological need for autonomy is an important influence on intentions to use cybercafés in this cultural context and also had a significant influence on the behavioral indicator, willingness to pay. This means that the extent to which users believe their autonomous goals are satisfied motivates them to positively evaluate their behavior and make plans (intentions) to repeat the behavior in the future. The prediction of the extent to which users are willing to make a financial outlay to pursue Internet usage in the future is also highly salient. These findings indicate that encouraging and promoting Internet users to identify autonomous reasons for engaging in cybercafé use is important.

Findings also indicate that satisfaction of the psychological need for competence is another important factor which has effect on intention to come to cybercafé. This implies that how uses believe their competence abilities can be satisfied with using cybercafé will improve their perceived level of control and make them more intend to come to cybercafé. Such reasons include people can learning new skills, improving computer and Internet literacy, completing work and job, and increasing one's self-confidence.

5.2 Public Policy Implications

The present research has a number of implications for public policy and practice. First, it seems that promoting and encouraging the satisfaction of autonomous goals and motives is a key to facilitating adaptive Internet use among users in China. This means that autonomy supportive interventions using persuasive communications (e.g., on the Internet, using leaflets, through schools and teachers) will be effective in promoting intentions to use cybercafés and the Internet. Strategies that promote autonomous engagement in behaviors through 'autonomy support' include providing choice, giving a rationale for the action, and acknowledging conflict.

References

1. Ajzen, I. "The Theory of Planned Behavior". *Organizational Behavior and Human Decision Processes*, 1991, 50, 179-211.
2. CNNIC. 2011. *The 27th Statistical Report on Internet Development in China*, China Internet Network Information Center. 24.
3. CNNIC, 2010. *Cybercafe User and Internet Application Report 2009*. China Internet Network Information Center.
4. Deci, E. L., Ryan, R. M. *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press. 1985.
5. Deci, E. L., Ryan, R. M. "The "What" and "Why" of goal pursuits: Human needs and the self-determination of behavior". *Psychological Inquiry*, 2000, (11), pp. 227-268.
6. Hagger, M. S., Chatzisarantis, N. L. D., and Biddle, S. J. H. "A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables". *Journal of Sport and Exercise Psychology*, 2002, (24), pp. 3-32.
7. Hu, L., & Bentler, P. M. 1999. "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives". *Structural Equation Modeling*, (6), pp. 1-55.
8. Liebe, U., P. Preisendorfer, et al. 2011. "To Pay or Not to Pay: Competing Theories to Explain Individuals' Willingness to Pay for Public Environmental Goods." *Environment and Behavior* 43(1): 106-130.
9. McLachlan, S., Hagger, M. S. 2010. "Effects of an autonomy-supportive intervention on tutor behaviors in a higher education context". *Teaching and Teacher Education* (26), pp. 1205-1211.
10. Pouta, E., Rekola M. 2001. "The theory of planned behavior in predicting willingness to pay for abatement of forest regeneration." *Society & Natural Resources (*14:2), pp.93-106.
11. Reeve, J., Bolt, E., and Cai, Y. 1999. "Autonomy-supportive teachers: How they teach and motivate students". *Journal of Educational Psychology* (91), pp. 537-548.

Who Welcomes Behavioral Targeting: An Economic Analysis

Abstract

Behavioral targeting, under which users are presented with advertisements based on their past browsing and search behavior and other available information (e.g., hobbies registered on a website), has been hailed as the new "Holy Grail" in online advertising. In this paper, we study the economic implications when an online publisher engages in behavioral targeting. We show that revenue for the online publisher in some circumstances can double when using behavioral targeting. On the other hand, increased revenue for the publisher is not guaranteed: in some cases the prices of advertising and hence the publisher's revenue can be lower, depending on the degree of competition and the advertisers' valuations. We also demonstrate that although social welfare is increased and small advertisers are better off under behavioral targeting, the dominant advertiser might be worse off and reluctant to switch from traditional advertising.

Keywords: analytical modeling, economic modeling, pricing, targeted advertising, auctions

1. Introduction

Advances in information technology have radically changed online advertising. One radical and recent innovation in online advertising is behavioral targeting—a technology that aims to increase the effectiveness of advertising by online publishers. Behavioral targeting uses information collected from an individual's web-browsing behavior (e.g., the pages that they have visited or the searches they have conducted) in the selection of advertisements to display. A recent study by the Wall Street Journal found that the nation's top 50 web sites install, on average, 64 pieces of tracking technology, usually without warning. This paper aims to understand how behavioral targeting affects publishers' revenues, advertisers' payoffs, and social welfare.

Behavioral targeting has been used for different advertising formats on the Internet. For instance, any banner advertisement associated with a text webpage (e.g., from Dictionary.com or MSN) may be chosen in a way to reflect a user's interest. The "Pre-roll" (i.e., a video advertisement that appears before a requested video starts) or "Overlay Ad" (i.e., an advertisement that appears near the bottom of a video window) with online videos (e.g., from YouTube or ESPN3) may be tailored based on a user's interest.

Advertising using behavioral targeting is becoming a sizable industry: eMarketer estimates that online advertisers will spend more than $1.3 billion in targeted advertising in 2011, rising to over $2.6 billion in 2014. Different studies also show the promise of behavioral targeting from different perspectives. For example, experiments have shown that click-through rates can be increased by as much as 670% using behavioral targeting.

2. Baseline Model

We consider n advertisers competing for an advertising slot offered by a publisher in a specific context. A group of online users with a measure of one unit may view the advertising slot. The advertisers fit each user's interest or need to different degrees, and the users have different preferences across the advertisers and have different probabilities of clicking on the

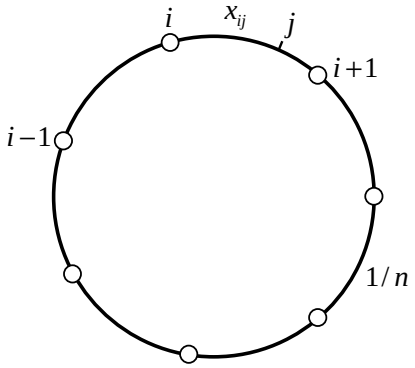


Figure 1: Circular Model of Preferences

advertisements from different advertisers. In particular, we use a circular model to represent users' preferences or probabilities of clicking on advertisements from different advertisers.

We assume that the advertisers, indexed by $i = 1, ..., n$, are symmetrically distributed along a circle, clockwise in the order of 1, 2, ..., and n. The perimeter of the circle is 1, and thus the shortest distance between any two adjacent advertisers along the circle is $1/n$. Each user is represented by a point on the circle, and users are uniformly distributed along the circle. The distance between a user and an advertiser reflects the degree of matching or *mis-fit* between the user and the advertiser: the longer the distance is, the lower the degree of the matching. Therefore, the *most favorable* user for an advertiser is the user that is located at the same spot as the advertiser. For advertiser i, we denote p_i as the probability that the most favorable user clicks on the advertisement when it is displayed. The probabilities attached to other users' clicking on the advertisement decay to different degrees, depending on their distances to the advertiser. If the distance between advertiser i and user j is x_{ij}, we model the decay q_{ij} as

$$q_{ij} = 1 - \gamma x_{ij}$$

such that the probability that user j clicks on advertiser i is $p_i q_{ij}$, where $x_{ij} \in [0, 1/2]$ and γ is the *decay* factor ($0 < \gamma \leq 2$). Notice that γ also measures the heterogeneity of users' preferences, and a high γ means that users have very different probabilities of clicking on an advertisement. We also call the probability $p_i q_{ij}$ advertiser i's click-through rate for user j. Figure 1 illustrates the basic elements of the model, with each small circle representing an advertiser (e.g., advertiser i) and any point on the big circle representing a user (e.g., user j).

The publisher knows the advertisers' types, characterized by the locations on the circle. The publisher can learn a user's preference (e.g., by monitoring her browsing history and the registered information) if the user opts in to the behavioral targeting; in this case the publisher is able to determine the location of each user on the circle. In the baseline model, we assume that all users opt in. We can show that the main results continue to hold when some users may opt out of behavioral targeting.

Following common practice in online advertising, we assume that the publisher uses unit-price auctions to sell the advertising slot. Advertisers bid on a per-click unit price, or cost-per-click, b for the slot, and the winner is chosen based on weighted unit prices, that is, the product of their cost-per-click bids and the (expected) click-through rates measured

by $p_i q_{ij}$. Under behavioral targeting, the publisher identifies each user's preference/click-through rate across advertisers and uses this information to choose the advertiser being displayed to a specific user. Because the users differ in their preferences/click-through rates, different advertisements may be presented to different users. Under traditional advertising, the publisher does not learn or does not use users' preference information, and one auction is used for the whole group of users. The winner is chosen based on his bid and the expected click-through rate across all users, and the same advertisement is displayed to all users. Notice that the cost-per-click bid times the (expected) click-through rate is the expected payment that an advertiser proposes. Therefore, the winner of an auction is essentially determined by advertisers' expected payments for the user(s). The advertiser with the highest proposed expected payment wins the auction, and pays the unit price that matches the second highest proposed expected payment. Because the winning cost-per-click price times its click-through rate is the winner's expected payment, the winner is equivalently paying the second highest proposed expected payment for the user(s).

We denote the unit value that advertiser i derives from each click by v_i, and thus the value of user j to advertiser i is $v_i p_i q_{ij}$. We let $z_i \equiv v_i p_i$ and call z_i advertiser i's *reference value*, which is the value that advertiser i derives from his most favorable user. Then the value of user j to advertiser i is advertiser i's reference value z_i discounted by the decay q_{ij}. Notice that we can always rank z_i in non-increasing order and denote the i-th highest value as $z_{(i)}$, such that $z_{(1)}$ is the highest value among all z_i's, and $z_{(2)}$ is the second highest, and so on. For ease of exposition, we here assume that $z_{(n)} \geq z_{(1)}(1 - \frac{\gamma}{n})$; that is, even if the advertiser with the lowest reference value happens to be adjacent to the one with the highest reference value, it is still socially efficient to present the lowest-value advertiser to his most favorable user. In other words, the existence of any advertiser, even the advertiser with the lowest value, brings in additional social welfare (which can also be seen as a situation where there are no strictly dominated advertisers).

3. Equilibrium Analysis

Facing the two advertising technologies, the publisher may choose the one generating higher revenue. We derive conditions under which one advertising technology is superior to the other for the publisher.

Proposition 1. *(a) If and only if the number of advertisers is small ($n = 2$), the publisher is (weakly) better off by using traditional advertising, regardless of the advertisers' value structure; (b) When the number of advertisers is intermediate ($2 < n < 6$), which advertising technology yields the higher revenue depends on the value structure and the heterogeneity of users' preference; (c) If and only if the number of advertisers is large enough ($n \geq 6$), the publisher is better off by using behavioral targeting, regardless of the advertisers' value structure.*

Under behavioral targeting, each advertiser has his own favorable users and thus, compared to traditional advertising, the competition among advertisers is less fierce (in a sense similar to the product differentiation setting). This *relaxed competition* has a negative effect on the publisher's revenue. On the other hand, each individual user is checked case by case and assigned to an advertiser with the highest proposed payment for the user, which improves the advertising resource allocation. In contrast, misallocation is inherent in the allocation

under traditional advertising. When the advertiser with the highest reference value wins the auction under traditional advertising, he wins all the users and pays the second-highest advertiser's expected value of the users. However, when there are multiple advertisers, assigning these users who are distant from the winner or who have a low probability of clicking on the winner's advertisement might not be desirable in a sense that other advertisers might value those users more and be willing to pay more. We call this the *propensity effect*, and it positively affects the publisher's revenue under behavioral targeting.

Whether behavioral targeting can generate more revenue depends on the balance between the competition effect and the propensity effect. When the number of advertisers is low, the auction under traditional advertising can leverage the competition effect (by letting the advertisers compete for one single "bundled" user group), but at the cost of efficiency because of the lower propensity of users to click on the advertisement. When the number of advertisers becomes considerably large, the propensity effect becomes intense, because, for some of the users, many of the other advertisers have a much better fit and propose higher expected payments than the winner under traditional advertising does. As a result, the propensity effect dominates the competition effect, and the publisher is better off using behavioral targeting.

We next explore the maximum gain that the publisher could obtain by switching from traditional advertising to behavioral targeting. We here use $(\pi_B - \pi_T)/\pi_T$ as the measure of the gain from behavioral targeting.

Proposition 2. *When the number of bidders is greater than two, the maximum gain is* $\frac{\gamma}{4-\gamma}[\frac{(n-2)(n-1)}{n^2} + (\frac{n-\gamma}{(2n-\gamma)n})^2]$*, which is increasing in the number of advertisers* n *and user heterogeneity* γ*.*

It is worth pointing out that the gain from behavioral targeting can be very significant. For example, if there is a high degree of heterogeneity among user preferences (i.e., $\gamma \to 2$), then the gain can be one hundred percent when the number of advertisers becomes large.

Next, we examine advertisers' payoffs under different advertising technologies. Under traditional advertising, all advertisers except the advertiser with the highest reference value earn zero payoff because they have zero market share. Under behavioral targeting, in contrast, all advertisers might have make positive payoffs. Therefore, all advertisers except the one with the highest reference value are always (weakly) better off under behavioral advertising.

In general, whether the highest value advertiser can be better off depends on the parameters, such as the values of its neighbors and the number of advertisers. For example, if the highest-value advertiser has a comparable competitor (e.g., $z_{(1)} = z_{(2)}$), the advertiser earns zero payoff under traditional advertising but has positive payoff under behavioral targeting, and thus is better off under behavioral targeting. In the following example, we show that the highest-value advertiser could be worse off under behavioral targeting.

Example 1. *Consider a case in which one dominant advertiser has a significant competitive advantage in the market place, while the other advertisers are of similar competitive advantage. In particular, we let* $z_1 > z_2 = z_3 = ... = z_n = 1$*. The dominant advertiser (with the highest value) is (weakly) better off under behavioral advertising when there are only two*

advertisers, regardless of its per-click value or γ. When $n \geq 3$, if

$$z_1 \leq \frac{(1-\frac{\gamma}{n}) - \sqrt{\gamma(1-\frac{\gamma}{4})[(1-\frac{\gamma}{n})^2 - (1-\frac{\gamma}{2})^2]}}{(1-\frac{\gamma}{2})^2}$$

the advertiser is better off under behavioral targeting; otherwise, the advertiser is worse off.

When the dominant advertiser has a low valuation (close to that of the other advertisers), the face-to-face competition under traditional advertising leaves the dominant advertiser little profit margin. In contrast, under behavioral targeting, with the relaxed competition, the dominant advertiser can reap benefits from its favorable users. Therefore, the dominant advertiser is better off under behavioral targeting. With a high valuation, the dominant advertiser can grab the whole group of users under traditional advertising while maintaining a considerable profit margin. Under behavioral targeting, the dominant advertiser wins significantly less users as other advertisers have advantage over their favorable users. Therefore, the dominant advertiser is worse off under behavioral targeting.

Proposition 3. *(a) All advertisers are always (weakly) better off under behavioral targeting except the advertiser with the highest reference value. (b) The advertiser with the highest reference value could be better off or worse off depending on the competitive situation.*

We next compare the social welfare created under the two different advertising technologies. Social welfare is defined as the sum of the publisher's payoff and advertisers' payoffs, or the value created by users through advertising.

Recall that in equilibrium advertisers bid their true value and that each user is allocated to the advertiser with the highest value under behavioral targeting. The realized highest value of each user is also the realized social welfare from each user, which is divided between the advertiser and the publisher by the auction rule. Therefore, the equilibrium allocation under behavioral advertising creates the maximum social welfare. In contrast, the equilibrium allocation under traditional advertising cannot generate the maximum social welfare. This is because when the advertiser with the highest reference value wins the auction under traditional advertising, he wins all the users, including the users who are distant from the winner or who have a low probability of clicking on the winner's advertisement (for which other advertisers might value more). So, the social welfare created under behavioral targeting is higher than that created under traditional advertising.

Proposition 4. *The social welfare is maximized under behavioral targeting. The allocation under behavioral targeting generates more social welfare than the allocation under under traditional advertising.*

Notice that the social welfare created by displaying the advertisement(s) to the users is partitioned by the publisher and advertiser(s) via the auction. Behavioral targeting creates a larger "pie" than traditional advertising, and thus engenders the possibility that both the publisher and the advertisers are better off (i.e., a possible "win-win" result). This win-win result under behavioral targeting indeed occurs in many cases. For example, all advertisers are better off under behavioral targeting in many cases such as in the one with symmetric advertisers, and the publisher is certainly better off under behavioral targeting when the number of advertisers is large. Therefore, in the case with both conditions satisfied, behavioral targeting leads to a win-win equilibrium.

The Role of Certifiers in Strategic Communication[1]

Hong Xu, Maxwell B. Stinchcombe, and Andrew B. Whinston

hxu@ust.hk, maxwell@eco.utexas.edu, and abw@uts.cc.utexas.edu

1 Introduction

The essential problem in strategic communication is how to guarantee that the information conveyed is actuate and relevant. Certifiers has been employed to fulfill this purpose in various contexts. Issuers of debt or securities, be they operating firms raising capital, financial institutions selling securitized debts, or governments issuing bonds, are interested in obtaining capital at a lower cost. Realizing this, investors are not willing to believe the information provided unless verified by an external certifier, such as an auditing firm or a credit rating agency. However, recent events have cast doubt on the credibility of certifiers. Following the collapse of the Enron Corp., their auditor, Arthur Anderson LLP surrendered its CPA licenses and its right to practice in 2002. Ernst & Young, as the auditor of the Lehman Brothers, has faced inquiry by the U.K. government after the US bankruptcy court examiner revealed evidence that the Lehman Brothers has prepared misleading financial statement using an accounting gimmick called "repo 105" (Baer and Thomas, 2010). Meanwhile, the Senate subcommittee has launched an investigation of Moody's and Standard & Poor's, which confirmed their act of skewing their assessments to please their clients (Krugman, 2010).

The previous literature on auditing and credit rating agencies mainly investigated how to motivate certifiers to exert appropriately high effort in gathering evidence and evaluating clients under the assumption that the certifiers always truthfully reveal their evaluation. We explicitly consider the strategic reporting decisions by certifiers and identify two questions as key to determinants of certifiers' reliability: Who buys the certification, the firms or the investors; and what is the balance of power between firms and certifiers? There is an extensive literature studying how to optimally motivate a single certifier hired by the investors to evaluate the actions of an operating firm. By contrast, we focus on the potential conflicts of interest that arise when the operating firm hires a certifier in a competitive market to evaluate its actions. We also examine the balance of power by analyzing the possibility that certifiers may strategically misreport their findings in the direction favored by the operating firms. This possibility is limited by the observation that investors ignore "fluff." More formally, if misreporting is too large, the information value of certification does not induce investment.

[1]We acknowledge helpful comments received from Andrew Bailey, Paul Newman, Dain Donelson and Volker Laux. We also thank the Accounting Department workshop participants at the University of Texas at Austin.

We have two main conclusions from our analysis: (1) Certifier liability, in a competitive setting with power for operating firms, has negative effect on the information quality. Expected liability is passed through auditors to operating firms, and the latter will deteriorate the quality of audit to increase investment through slant. (2) When the economy consists of a small proportion of well performing firms, loosening audit standards is counter productive; contingent fee is necessary to induce quality reporting; even well-performing operating firms have to provide a contingent payment contract.

2 Review of Literature

This paper is related to the literature in several areas. The fundamental question we are addressing is how to turn a cheap talk scenario into effective communication between firms and investors. Without certifiers such as auditors or rating agencies, low-type firms have little incentive to reveal their performance, and investors simply ignores firms' announcement (Crawford and Sobel, 1982). When the relative proportion of low-type firms' is large enough, investors' confidence in the market becomes low and do not invest. Even high-type firms have difficulty in getting financing and are driven out of the capital market, which leads to a market for "Lemons" (Akerlof, 1970). Certifiers, as an intermediary between firms and investors, provide their third-party opinion to facilitate more efficient investment decisions from investors.

Certification industries are usually concentrated with a few oligopolies (Furchtgott-Roth et al. (2006), Coskun (2008)). One important topic in the certification literature is the market for certification, or in other words, who induces the certification market, the buyer or the seller? Certification is a costly inspection device when demanded by the buyer, but a signaling device when demanded by the seller. The audit process can be divided into three stages: setting the scope, gathering and evaluating evidence, and reporting (O'Reilly et al., 1998). Our paper focuses on the third stage and examines auditors' reporting strategies and how litigation and payment impact their report. We differ from the previous literature in auditing that has provided extensive analysis on auditors' incentive to exert effort in the second stage of gathering information and performing evaluation(Dye (1993), Carcello and Palmrose (1994)). Credit rating agencies are in a very similar position to auditing firms. Rating agencies often argue that they have their reputation at stake for offering reliable ratings, the fundamental conflict of interest generated by their business model has drawn increasing attention.

Our paper differs from the literature in several aspects. First of all, we emphasize the misalignment of interests between firms and investors. When investors are users of certifications, and their inefficient decision may favor some firms, who are buyers of certifications, the strategic decision of certifiers becomes crucial. Secondly, our paper reveals a distinctive impact of audit fee, that is to serve as a risk premium to auditors for issuing favorable report, but not necessarily increase the audit quality or the level of investment. Also, we have explicitly analyzed the impact of auditor competition, and provided insight on the current

industry structure in auditing (Bar-Yosef and Sarath, 2005).

3 The Model

We analyze a game with three risk-neutral entities: firms, certifiers, and investors. A firm can be of two types, denoted H and L, and two types of certifiers A and B. Firms seek to raise capital from outside investors. The proportion of H-firms is μ and the proportion of L-firms is $1-\mu$. The type of a firm is private information to the firm itself, while μ is public information. The return of investment depends on the type of the firm. H-firms can generate more cash flow than L-firms. Given the market price, the firm is overpriced if the type is L and underpriced if H. Since firms' types are unobservable, the investors need to learn from the certifiers' report and the firms' behaviors. Certifier A can provide more accurate opinions than certifier B, and their types are public information. Certifiers express their opinion by issuing a certification, which can be of two types, h and l, referring to the their assessment of the two types of firms respectively. Certifiers' accuracy is described in below.

Certifier A	H-Firms	L-Firms	Certifier B	H-Firms	L-Firms
h	s_A	$1-t_A$	h	s_B	$1-t_B$
l	$1-s_A$	t_A	l	$1-s_B$	t_B

We frame the certification process with 5 stages. In the first stage, both types of firms discover their true types. Then they choose between two certifiers for a certification about their type. Meanwhile, they make a take-it-or-leave-it offer to the certifier which specifies the payment scheme. In the third stage, the certifier investigate their patron and issue an certification. The investors observe the announcement and the certification, as well as certifiers' types, and decide whether to invest in the firms. The investors have an outside option that gives a market rate of return, r. We present the payoff structure for both firms and investors in below.

Firms' payoff	H-Firms	L-Firms	Investors' payoff	H-Firms	L-Firms
Investment	1	a	Investment	1	0
No Investment	b	0	No Investment	r	r

We impose the following assumption to ensure that certification is necessary for any investment to occur. Without certifiers, investors act on their initial belief, μ. When H-firms predominate, i.e. $\mu > r$, all investors invest since the expected payoff is higher than the outside option, the market rate of return, which yields r.

Assumption 1. *Information is needed for investment to occur, $\mu < r$.*

Our second assumption guarantees that the cost of certification does not exclude firms from choosing a certain type of certifier.

Assumption 2. $c_A < a(1-t_A)$.

We describe three different models based on the above setup.

Non-strategic Certifiers We first analyze firms' certifier choice and reporting strategy when the certifiers are non-strategic. Certifiers are created to provide their independent and unbiased third-party opinions. They are often required to disclose any conflict-of-interest with the firms or the investors. For instance, rating agencies and analysts, after offering their stock or bond recommendations, have to state whether they own the stock that they recommend. The auditing industry has also put in force several standards to reduce the potential conflicts of interest, including required rotation of engaged partners and limiting the non-audit service that auditors can perform for the same client firm. We study non-strategic certifiers as a benchmark model.

Strategic Certifiers without Litigation We then relax the assumption of non-strategic certifiers and consider certifiers as a rational economic agent who determine issuance of certification to maximize their profit. Firms, who seek to maximize their own payoff, offer payment contracts to induce a preferable certification. The strategic aspect of certifiers is reflected in the impact of payment contract on certifiers' certification issuance.

We impose a new assumption in our equilibrium analysis.

Assumption 3. *If the auditors are indifferent, they will choose actions according to the distribution making the equilibrium as profitable as possible for the operating firms.*

There are two observations to be made about the above assumption. First of all, we are treating the choice of contract as a mechanism design problem. Also, we are assuming that the investors know the equilibrium reliability of auditor reports in choosing their best responses. In situations of changing standards/behavior, the equilibrium assumption may be less compelling. However, it forces the operating firms to pay attention to the long run implications of lowering the quality of information available to the investors.

To focus on the strategic property of certifiers, we leave out potential litigation for now, meaning $\xi = 0$. For example, rating agencies including Moody's, Standard & Poor, and Fitch, are protected by the SEC from litigation. They also frequently use First Amendment Right to escape from lawsuits.

Strategic Certifiers with Litigation We also take into account potential regulation and litigation on certifiers. When investment failure occurs, investors can sue the certifier. If the court judges the certifier to be liable for misleading investors, the certifier will be penalized to compensate for investors' loss. Let ξ denote the expected level of liability and ψ denote the proportion of penalty allocated to investors. We will consider three different contexts where the litigation environment differs.

Auditors' importance has been greatly enhanced since the prosperity of the financial market. The SEC has required publicly traded firms to have their annual statement audited. However, since the Enron scandal, among many others, litigation has been enforced to regulate auditors' behaviors and to align their incentive towards interests of the investors. Empirical studies have provided contrary evidence as to the role of litigation. This model provides a theoretical analysis on the conditions under which litigation is useful in aligning incentives.

4 Discussion and Conclusions

We have investigated the communication between firms and investors with the facilitation of two different types of certifiers. We focus on situation where communication turns into cheap talk when there is no intermediaries. We consider three different models to examine separately the impact of payment contract and litigation on certifiers' report and investors' decisions. We also investigate the reputation effects on communication.

This paper builds a framework for further investigation of certifiers' reporting strategies. Certifiers' reporting option is often a continuous set of opinions that are often vague in meanings. A firm's financial statement, which is prepared and certified by auditors, can contain critical information in footnotes that most investors pay little attention to comprehend. When investors have different interpretations of a vague certification, their investment decisions differ. Vagueness can also be used as a defense of certifiers in case of lawsuits. Certifiers may take into account of different vague opinions and the associated liability cost when issue their certification.

References

Akerlof, George A. 1970. The market for "lemons": Quality uncertainty and the market mehchanism. *The Quarterly Journal of Economics* **84**(3) 488–500.

Baer, Justin, Helen Thomas. 2010. Valukas smoothes way to legal action. *Financial Times* .

Bar-Yosef, Sasson, Bharat Sarath. 2005. Auditor size, market segmentation and litigation patterns: A theoretical analysis. *Review of Accounting Studies* **10** 59–92.

Carcello, Joseph V., Zoe-Vonna Palmrose. 1994. Auditor litigation and modified reporting on bankrupt clients. *Journal of Accounting Research* **32** 1–30.

Coskun, Deniz. 2008. Credit rating agencies in a post-enron world: Congress revisits the nrsro concept. *Journal of Banking Regulation* **9**(4) 264–283.

Crawford, Vincent P., Joel Sobel. 1982. Strategic information transmission. *Econometrica* **50**(6) 1431–1451.

Dye, Ronald A. 1993. Auditing standards, legal liability, and auditor wealth. *The Journal of Political Economy* **101**(5) 887–914.

Furchtgott-Roth, Harold, Robert W. Hahn, Anne Layne-Farrar. 2006. The law and economics of regulating ratings firms. *Journal of Competition Law and Economics* **3**(1) 49–96.

Krugman, Paul. 2010. Berating the raters. *The New York Times* .

O'Reilly, Vincent M, Patrick J. McDonnell, Barry N. Winograd, James S. Gerson, Henry R. Jaenicke. 1998. *Montgomery's Auditing*. 12th ed. Wiley.

Online Competition on Brick-and-Mortar Businesses: Evidence from the Banking Industry

Mei Xue

Boston College

140 Commonwealth Avenue

Chestnut Hill, MA 02467

Bin Gu

University of Texas at Austin

2100 Speedway, B6500

Austin, TX 78712

Preliminary: Please Do Not Circulate Without Authors' Consent

Online Competition on Brick-and-Mortar Firms: Evidence from the Banking Industry

Abstract

The growth of electronic commerce broadens consumers' choice of merchants and service providers. Brick-and-mortar businesses face not only competition from local competitors but also competition from their online counterparts. However, little systematic study has been conducted to assess the nature and significance of the influence of online competitors on brick-and-mortar businesses and the effectiveness of business strategies to mitigate such competitive influence. We address the research question using a panel data on individual customer depository balance from a major US bank. Our analysis reveals that competition from online banks presents a significant threat to the brick-and-mortar bank, while local competition has little influence. Moreover, the competitive influence from online banks is moderated by the availability of brick-and-mortar services such as ATMs and local branches and the provision of online services by the local bank. In particular, we find that local services, especially accesses to ATMs, mitigate the competition from online banks. On the other hand, online services such as eBanking significantly intensify the competition. We also find that some commonly used business strategies have little influence on the competition between online vendors and brick-and-mortar vendors. These business strategies include establishing local branches, providing single-sign-ons, and offering multiple products.

Introduction

The growth of online commerce has significantly increased competition among vendors and service providers. Earlier studies analyze the level of competition among online vendors and strategies adopted by online vendors to mitigate such competition. These studies find that, while there is a significant level of competition among online vendors due to price transparency, differentiation in product selection and service quality allows vendors to avoid Bertrand competition (Bryjolffson and Smith 2000; Clay et al. 2002; Goolsbee and Chevalier 2003; Hann et al. 2002). In addition, studies find that firms actively use obfuscation strategy to reduce price transparency (Ellen and Ellen 2008)

The increased competition is not limited to online markets. With the wide spread adoption of the internet, the price and service offerings from online vendors increasingly affect brick-and-mortar vendors. The objective this study is to assess the competitive influence of online vendors on brick-and-mortar businesses and the effectiveness of retailer strategies to mitigate such competitive influence.

We conduct the analysis in the context of US retail banking industry. The choice of online banking industry has a number of unique advantages. First, US retail banking industry plays a critical role in the US economy. By the end of 2007, US retail banks held close to 7 trillion in deposit and had 1.8 million employees (Carney 2008). The competition from Internet banks and the response from brick-and-mortar banks could have a significant implication on the structure of this important industry sector. Second, the US retail banking industry is one of the largest consumers of information technology. Total IT spending reached 48 billion in 2006 (Census Bureau 2008), second only to IT spending in the information technology sector. Understanding the competition between online and offline banks could provide new insights into the driver of

IT investments in the sector. Third, prior studies on online and retail competition have largely focused on physical products instead of service products. The competition, however, could be significantly different service products. These products require significant and frequent interactions between the vendor and its customers, which present a new set of opportunities and challenges for both online and offline service providers.

To address the question, we obtain a proprietary dataset on individual customer depository balance from a major US bank. The data track depository balance of over 30,000 bank customers between June 2002 and June 2003. We supplement the customer level depository data with competitive pricing on saving products from Bankrate.com that provides information on both local and online competitors for the bank. We use the data to estimate cross price elasticity of competitive pricing on non-interest bearing account balance using a panel data approach. Our analysis reveals that an individual's non-interest bearing account balance is influence by competitive offering from both online and local competitors as well as the bank's own saving offerings. Across all customers, the bank's own saving products has the largest influence. For each 0.1% increase in interest rate, we observe a 5.4% decrease in non-interest bearing account balance. Offerings from online competitors have the second largest influence with each 0.1% increase in interest rate leading to a 4.9% decrease in individual's non-interest bearing account balance. Local competitors also have a significant negative influence. However, the magnitude is much lower. Each 0.1% increase in interest rate is associated with a 0.9% decrease in individual's account balance. Our analysis also reveals that the cross price elasticities vary significantly across bank customers, depending on the availability of local services such as ATMs and the provision of online services by the bank. We show that brick-and-mortar service such as access to ATM machines can mitigate the competition from Internet banks. On the other

hand, we find that consumers using eBanking services are more price sensitive towards offerings from Internet banks. Our results suggest that brick-and-mortar firms can counter Internet competition by providing better local services to differentiate product offerings and to increase switching costs. The results also explain the substantial build-up of ATM services in recent years by major brick-and-mortar retail banks in the face of growing threat from Internet banks.

Our study is related to a number of prior research that examines competition between online and offline retailers and service providers. In one of the earliest studies that examine the competition across the two channels, Goolsbee (2001) find that the cross price elasticity between online and retail vendors is about 1.5 using individual PC purchase data between 1996 and 1998, indicating a significant level of competition between the two types of vendors. Brown and Goolsbee (2002) consider the influence of Internet comparison shopping sites on the life insurance industry in 1990s. Their results indicate that the Internet reduces term life insurance price by 8 to 15 percent. Ellen and Ellen (2006) also find significant competition between online and offline channels using data on memory modules sales. Their studies find that consumers are not only concerned about price in making online and offline choices, but also concerned about convenience and reputation in making purchase decisions. Prince (2007) further analyzes the PC purchase data used in Goolsbee (2001) and find that that cross-price elasticity changes significantly between 1996 and 1998. The cross price elasticity is statistically zero in 1996-1997, but jumps to 3.0 in 1998. His analysis reveals that the change in the level of competition is not due to demand side changes, but due to supply side changes undertaken by physical and online retailers that make their products more substitutable to each other. In a study that is closest to ours, Forman et al. (2007) consider the influence of local bookstore opening on online book sales at Amazon. They find that the opening of local bookstores reduces online book sales and consumer price

sensitivity to online discounts. The results indicate that convenience at offline channels play an important role in consumer purchase decisions.

Complementary to these studies, we study the influence of internet competitors on the sales of brick-and-mortar businesses and factors that moderate the competitive influence. A unique contribution of the study is that we have proprietary micro customer data from a brick-and-mortar business and data on both Internet and local competition. The data enable us to identify the influence of online competition on individual brick-and-mortar business while control for local competition that could correlate with online competition. In addition, we have detailed information on service offerings by the brick-and-mortar businesses and customers' usage of these service offerings. This allows us to assess the effectiveness of the offerings in mitigating the online competition.

The remaining of the paper is organized as follows. We discuss the US retail banking industry and propose hypotheses in Section 2. Section 3 presents the data and variables used in the analysis. Section 4 discusses the empirical results and their implications. We conclude in Section 5.

Internet and the US Retail Banking Industry

The influence of the Internet on the retail banking industry has long been the subject of significant discussion among both researchers and business practitioners (DeYong 2001). The Internet has two effects on brick-and-mortar businesses. First, the Internet significantly reduces the operational costs of retail banking operations. Studies show that online transaction costs are much lower than transaction costs incurred through local branches or telephone banking services. Internet transactions cost about $0.01 per transaction for the bank as compared the cost of more

than $1.00 for financial transactions conducted at local branches transactions (Economist 2000). Internet transaction costs are also much lower than telephone banking and ATM, which are estimated to be $0.50 and $0.27 per transaction respectively. The significant reduction in transaction costs leads to one of the early predictions for the industry that suggests banks will be able to "shed much of their investment in expensive brick-and-mortar branches" (DeYong 2001). The development of the retail banking industry in the past decade, however, reveals a different picture. Based on data from Federal Deposit Insurance Corporation (FDIC), Spieker (2004) shows that number of bank branches actually increased 15% between 1994 and 2003. The surprising increase in number of bank branches indicates the second effect of the Internet on the retail banking industry: it increases competition in the banking industry. The growth of the Internet and the improvement of online security allow banks to reach consumers over long distance and break into previously localized banking markets. As a result of the competition, brick-and-mortar banks could be motivated to either differentiate from the online competition by build up more branches or compete with online competition by providing similar online services. We analyze the competitive implications of the two types of strategies.

We start with an overall assessment of the competitive forces on brick-and-mortar banks. We focus on non-interest bearing accounts as they mainly consist of checking accounts, a type of bank products that provide the highest liquidity. Unlike saving or CD accounts, money in checking accounts can be easily transferred to other banks or other products from the same bank through checks, electronic fund transfers, or wire transfers. The high liquidity of non-interest bearing accounts makes them more sensitive to competitive influence and a natural candidate for the study.

A brick-and-mortar bank faces competition from two main forces. First, competing local banks operating in the same regions could attract the bank's customers by offering higher interest rates on saving, money market and CD products. Second, competing Internet-only banks could attract the bank's customers by offering products through the Internet. Internet-only banks typically offer the highest interesting rates on saving products to compensate for the lack of local presence. Moreover, a bank's non-interest bearing products also face competition from other products offered by the same bank. We therefore hypothesize:

Hypothesis 1a: A customer's non-interesting bearing account balance decreases with the annual percentage yield of saving products offered by Internet-only banks.

Hypothesis 1b: A customer's non-interesting bearing account balance decreases with the annual percentage yield of saving products offered by local competing banks.

Hypothesis 1c: A customer's non-interesting bearing account balance decreases with the annual percentage yield of saving products offered by his or her own bank.

A variety of competitive strategies have been used by brick-and-mortar banks to counter the competitive influence of banking products offered by online banks. The strategies can be categorized into two groups: imitation strategies and differentiation strategies. Imitation strategies are used by brick-and-mortar to match the services provided by online competitors. The strategies have been used by a variety of firms in different industries. Prince (2007) finds that competition from online PC vendors such Dell and Gateway motivates local PC retailers to match their product offering by providing customized services similar to those offered by Dell and Gateway. In the context of the retailing banking industry, brick-and-mortar banks quickly

match Internet banks' product offerings by establishing their own online banking services that provide the same level of convenience and 24-hour access. Two online services are provided by the bank in our study. One is called eBanking service that provides basic online access to its customers. The other is a more advanced online service called single-sign-on service that allows the bank's customers to access information on multiple products through a single log-in process. The use of imitation strategy, however, could increase competition between online banks and brick-and-mortar banks because it reduces product differentiation (Prince 2007). We therefore propose:

Hypothesis 2a: eBanking customers are more sensitive to the annual percentage yield of saving products offered by Internet-only banks than customers without eBanking services.

Hypothesis 2b: Single-sign-on customers are more sensitive to the annual percentage yield of saving products offered by Internet-only banks than customers without single-sign-on services.

Besides the imitation strategy, a brick-and-mortar business can also pursue differentiation strategy by providing features and services that are difficult for online competitors to match. In the context of retail banking industry, a natural advantage of brick-and-mortar banks is to leverage its branch and ATM networks. One important benefit of the differentiation strategy is that it increases product differentiation among products, thus mitigating the competition between online and offline channels. We therefore propose:

Hypothesis 3a: Customers with local ATM access are less sensitive to annual percentage yield of saving products offered by Internet-only banks than customers without ATM access.

Hypothesis 3b: Customers with local branch access are less sensitive to annual percentage yield of saving products offered by Internet-only banks than customers without branch access.

Finally, a brick-and-mortar business can reduce competition by developing customer loyalty and increasing customer switching costs. While customer loyalty is not directly observable in the dataset, it can be inferred from the number of products a customer holds with the bank. We therefore propose:

Hypothesis 4a: Customers with other saving products with the bank are less sensitive to annual percentage yield of saving products offered by Internet-only banks than customers without ATM access.

Hypothesis 4b: Customers with multiple accounts with the bank are less sensitive to annual percentage yield of saving products offered by Internet-only banks than customers without branch access.

Data

We obtain the data from two sources. First, we obtain a proprietary data on individual depositary accounts from a large US retail bank. The data track depository balance of 30,388 bank customers between June 2002 and June 2003. For each customer, the data provides

monthly ending balance for each of the depository accounts held by the customer with the bank. The data also reports the availability and use of local and online services by each customer. In particular, the data contains detailed information on ATM and local branch availability and customers' use of eBanking and single-sign-on services each month. Besides customer banking activities, the data from the bank also include demographic information such as income and education level for a majority of bank customers. We supplement the customer level depository data with competitive pricing on saving products from Bankrate.com. Bankrate.com collects weekly information on APYs of local and online banking saving products. For online banks, it tracks the top 25 "Highest Yields" from Internet-only banks and online operations of brick-and-mortar banks. The list of 25 "Highest Yields" covers money market products and term depositary products from six months to two years. Since many Internet-only banks offer only money market products, we use the average APYs on money market products to represent the online competition. For local competing banks, Bankrate.com tracks the APY of the ten largest banks in twenty metropolitan markets for money market and term saving products. We again calculate the average APYs on money market products offered by the local banks. The calculation excludes offerings from the brick-and-mortar bank. Since the competition data from Bankrate.com is on a weekly basis while the customer data from the bank is on a monthly basis, we reconcile the difference by aggregate Bankrate.com to a monthly basis.

Table 1 and 2 report the summary statistics and the correlation table for the data used in this study. The statistics show that, on average, each customer has $3,220 in non-interest bearing accounts. It is also evident from Table 1 that online competition offers significantly higher APY on saving products than the brick-and-mortar bank. The average APY for online offerings during the study period is 2.55%, while the average APYs for local competitors and the brick-

and-mortar bank are 1.91% and 0.61% respectively. The summary statistics also show that 35% of the bank customers use eBanking services and 22% using the more advanced single-sign-on services to access multiple accounts with the bank. Local ATMs and local branches are available to 65% and 56% of the bank customers respectively. It is useful to note that customers with access to local branches always have access to local ATMs because all branches of the bank provide ATM services. The reverse is not true. The bank provides ATM services in many areas where it does not have a branch. The table also reveals that, on average, each customer has 1.9 accounts with the bank and 13% of them have saving or CD accounts with the bank. Interestingly, 31% of the bank's customers live in states where the bank does not have a banking license and therefore has no operation. These customers are of two categories: customers who sign up through the online operations of the bank; and customers who used to live in states serviced by the bank but later moved to other states. We also find 31% of the bank customers have bachelor's degree or higher and the average household income is close to 4, which corresponds to an income range of $50,000 - $75,000. The average income is slightly above the US average household income of $43,527.

Results and Analysis

We use a log linear fixed effect regression to identify the influence of online and local competitions and the effectiveness of business strategies to mitigate the influence. In a log linear model, the coefficients on independent variables can be explained as percentage change in the dependent variable for each unit change in the independent variables. Table 3 presents the result of the analysis. Column 1 and 2 compares two base models without and with fixed effects. The results show that control for fixed effect is critical to ensure unbiased analysis of the true

competitive influence. Without control for fixed effects, the analysis indicates that consumers are most sensitive to saving offerings from the same bank, and less sensitive to saving offerings from local competitors and the least sensitive to offering from online competitors. While the results seem reasonable on the surface, the results from the fixed effect model in Column 2 indicate that the results from pooled regression are biased. Once individual heterogeneity is controlled for, the analysis reveals that bank customers are much more sensitive to offerings from online competitors than offerings from local competitors. For each 0.1 percent increase in online APY, a bank customer reduces his non-interest bearing account balance by 4.3 percent. For the same 0.1 percent increase in local competitors, a bank customer only reduces his non-interest bearing account balance by 0.9 percent. The results confirm that brick-and-mortar banks face competition from both online and local competitors (H1 and H2). In addition, there is significant internal competition between different products offered by the same bank (H3). The results also indicate that online competition presents a serious threat to brick-and-mortar banks. The competition is five times more severe than the competition in local markets. The results provide evidences that the impact of Internet is not incremental to brick-and-mortar banks. Rather, it represents a revolutionary change to its competitive environment.

Column 3 presents the full model to assess the influence of two commonly used strategies on online and local competition. The model also allows a customer's cross price sensitivity to differ based on demographic differences. The analysis reveals two important results. First, customers with eBanking are significantly more sensitive to online offerings and no longer sensitive to saving product offerings from the brick-and-mortar bank. For each 0.1 percent increase in online APY, a bank customer reduces his non-interest bearing account balance by 7.4%[1]. On the other

[1] The cross price sensitivity to online competition for eBanking customers equals to the sum of the coefficient on online APY (-0.50) and the coefficient on the interaction between online APY and eBanking (-0.24).

hand, for each 0.1 percent increase in the APY of the bank's own saving product, a bank customer reduces his non-interest bearing account balance by 0.1%, a change that is no longer statistically significant[2]. This results confirms H2a, indicating that imitation strategy leads to higher substitution between online saving products and a bank's own saving products and results in intense competition. Besides eBanking, the brick-and-mortar bank also offers Single-sign-on (SSO) service to its customers. SSO is a more advanced online offering that allows a customer to manage multiple accounts using a single log-in process. By design, all SSO customers are also eBanking customers. The only difference is that SSO customers face a more convenient log-in process. The coefficients on the interaction between the APYs of competing products and SSO measure the incremental influence on competition of having SSO services in addition to having eBanking services. All the coefficients are not statistically significant, indicating that customers with SSO services behave the same way as customers with eBanking services with regard to how they response to competitive offerings from online and local competitors. This suggests that SSO customers are also highly sensitive to online competition but not to local competition or product offerings from the brick-and-mortar bank, in support of H2b.

We next consider the influence of two differentiation strategies on online and local competition. Brick-and-mortar banks have increasingly resort to build up local branches and local ATM services to differentiate their products from online competition. Column 3 reveals that provision of local ATM services mitigate the influence of online competition. For each 0.1 percent increase in online APY, a bank customer with access to local ATM services only reduces his non-interest bearing account balance by 3.2% as compared to 5% when he has no access to local ATM services. The analysis also reveals that local ATM services significantly increase bank

[2] The cross price sensitivity to the bank's own saving product for eBanking customers equals to the sum of the coefficient on Bank APY (-0.54) and the coefficient on the interaction between Bank APY and eBanking (0.44). The standard deviation of the cross price sensitivity is calculated from the covariance matrix of the regression.

customers' response to saving product offering from their own bank. For each 0.1 percent increase in the APY of the bank's own saving products, a customer with access to local ATM services reduces his non-interest bearing account balance by 10.4% as compared to 5.4% when he has no access to local ATM services. This result is potentially caused by a significant reduction of transaction of making internal transfers. Instead of having to go to local branches to make transfer between a customer's non-interest bearing account and his saving and money market accounts, the customer can now easily complete the transfer on ATM machines. The results confirm H3a, suggesting that differentiation strategy mitigates online competition for brick-and-mortar banks. Column 3 also reveals the influence of local branch services on online competition. We note that all bank branches offer ATM services. The coefficients on the interaction between the APYs of competing products and the availability of local branch services, therefore, measure the incremental influence on competition of having local branch services in addition to having local ATM services. The analysis shows that the coefficients on local competition and online competition are not statistically significant, indicating that customers with local branch services behave the same way as customers with local ATM services with regard to how they response to competitive offerings from online and local competitors. This suggests that customers with local branch services are also less sensitive to online competition, in support of H3b.

We also assess the effectiveness of providing multiple products to customers in mitigating online and local competition. The analysis show that all the coefficients are insignificant, suggesting that providing multiple products have little impact in reducing online or local competition for the brick-and-mortar bank. Our results reject H4a and H4b. The results are consistent with the

finding of Forman et al. (2007) that suggests providing multiple product lines has little impact on online competition for online retailers.

Finally, we consider the competitive implication of having remote customers. Large brick-and-mortar banks often have a significant number of customers who have moved to areas and states where the bank does not provide local services. These customers still have access to the bank's telephone banking services and online banking services. Remote customers account for 31% of all bank customers in our data. This indicates that remote customers could be an important revenue source for the brick-and-mortar bank. Our analysis reveals that remote customers of the bank are significantly different from its local customers. These customers are highly sensitive to local competition. For each 0.1 percent increase in the APY of the bank's own saving products, a remote customer reduces his non-interest bearing account balance by 10% as compared to 0% when he was a local customer. This is not surprising as the bank does not offer local services to these customers. As a result, they are more sensitive to product offerings from local competing banks that provide local services. The analysis also reveals that remote customers are much less sensitive to online competition as indicated by the significant positive coefficient on the interaction term between online APY and remote customer status. This is potential due to unobserved customer characteristics that make these remote customers to stay with the bank in the first place.

The analysis of Column 3 also reveals that customer demographics have little impact on their sensitivity to online and local competition. The only significant result is that high income customers are more sensitive to local competition. The result is potentially driven by the high switching costs between local banks. A customer must physically go to a local competing bank to open a new account to take advantage of their saving products. The relative high switching

costs suggest that high income customers are more likely to make the switch than low income customers. This is because the potential benefits of switching are higher for high income customers as they have more financial assets at stake.

Conclusions and Limitations

In this study, we consider how the Internet influences a major brick-and-mortar bank. We find that online competition presents a dramatic change to the bank's competitive environment. The intensity of online competition is five times as much as the intensity of local competition that the brick-and-mortar bank used to face. We also consider the competition influence of three groups of business strategies. We show that imitation strategies significantly increase competition between the brick-and-mortar bank and its online competition. This result echoes the finding of Prince (2007) in the PC industry indicating that increase in competition of the PC industry is largely due to supply-side dynamics as PC retailers provide similar services as their online competition. The action reduces product differentiation and increase competition. Our results show that the same phenomenon exists in the banking industry and highlight the business risk of matching product and service offerings from online competitors. It is important to note that we are not suggesting that the brick-and-mortar bank makes a wrong decision in providing online access and other online services to its customers to counters the influence of online competition. The provision of such services may well increase customer retention and boost customer depository balance. Our results indicate a side-effect of such behavior, i.e. it increases the competition between the brick-and-mortar bank and could lead to more intense competition in equilibrium. We also show that differentiation strategies such as providing local ATM services can mitigate online competition. But we find little value of providing local branch services in

addition to local ATM services. Our results suggest convenience is an important consideration of bank customers and a key differentiation point for brick-and-mortar banks. However, the need for convenience can be largely met by local ATM services. Build-up of retail branches provides little additional value. Finally, we show that, while offering multiple products to customers have been considered one of the key strategies to increase customer loyalty, there is little empirical support for this conjecture in the banking industry.

Our study provides one of the first comprehensive analyses of the impact of the Internet on a brick-and-mortar business and how product and service offerings provided by the business moderates the competitive influence. Our unique dataset also allows us to separate the influence of the Internet from the influence of local competition that could be correlated with the online competition, thus providing an unbiased view on the competitive influences. Our analysis also identifies the influence of online competition on individual customers and shows the importance of control of consumer heterogeneity that could lead to spurious correlation between online competition and customer behavior. Finally, we are one of the first studies on the competitive influence of the Internet on a service industry and show that service industry is not immune from online competition. The severity and magnitude of the competitive influence is striking.

Our study has a number of limitations. First, we only have customer data from side of the brick-and-mortar bank. We do not observe customers' complete financial portfolio and their usage of online and local competitors. As a result, our analysis is limited to estimation of cross price sensitivity and we assume that the symmetric changes in customers' non-interest bearing account balance are mainly driven by competition influences. For the same reason, we can only estimate the influence of online and local competition on the brick-and-mortar bank, but not the influence of brick-and-mortar bank on its online and local competitors. In the regard, our analysis does not

provide only a partial picture of the competition among the brick-and-mortar bank, its local competitors and its online competitors. Second, our results are limited to the retail banking industry. Retail banking industry has a number of unique characteristics as compared to other service industries. In particular, saving products share the nature of commodity products as their prices are easily comparable and their security is guaranteed by FDIC. The increase use of electronic fund transfer also significantly reduces switching costs to online competitors. These characteristics are likely to make the competition in the retail banking industry more severe than other service industries where quality and service differentiations may play a more important role. As such, further studies are needed to assess the generalizability of our results to other industries.

References

Brown, J. A. Goolsbee. 2002. "Does the Internet Make Markets More Competitive? Evidence from the Life Insurance Industry." Journal of Political Economy 110 481-507.

Brynjolfsson, Erik, Michael Smith. 2000. "Frictionless Commerce? A Comparison of Internet and Conventional Retailers." Management Science 46(4) 563-585.

Carney, E. 2008. "Industry Essential: The US Retail Banking Market." Forrester Research Report.

Census Bureau, 2008. "Total Noncapitalized and Capitalized Expenditures and Percent Change for Companies with Employees by Major Industry Sector." in 2006 Information and Communication Technology Survey. Census Bureau. Washington D.C.

Clay, K., R. Krishnan, E. Wolff, D. Fernandes. 2002. "Retail Strategies on the Web: Price and Non-price competition in the Online Book Industry." Journal of Industrial Economics. 50 pp. 351-367.

Clemons, E., I. Hann, L. Hitt. 2002. "Price Dispersion and Differentiation in Online Travel: An Empirical Investigation." Management Science. 48(4)

DeYoung, R. 2001. "Internet's Place in the Banking Industry." Chicago Feb Letter.

Economist. 2000. "Branching Out – Many Financiers Expect Online Banking to Grow as Fast as Online Broking". The Economist. May 20, 2000.

Ellen G. and S. Ellen. 2006. "Internet Retail Demand: Taxes, Geography, and Online-Offline Competiton". MIT Department of Economics Working Paper No. 06-14. Available at: SSRN: http://ssrn.com/abstract=901852

Ellen G. and S. Ellen. 2008. "Search, Obfuscation, and Price Elasticities on the Internet." Econometrica. forthcoming.

Forman, C., A. Ghose, A. Goldfarb. 2007. "Competition between Local and Electronic Markets: How the Benefits of Buying Online Depends on Where You Live." NET Institute Working Paper No. 06-15.

Goolsbee, A. 2001. "Competition in the Computer Industry: Online vs. Retail." Journal of Industrial Economics 49, 487-499

Goolsbee, A. J. Chevalier. 2003. "Price Competition Online: Amazon versus Barnes And Noble." Quantitative Marketing and Economics 1(2) 203-222

Prince J. 2007. "The Beginning of Online / Retail Competition and Its Origin: An Application to Personal Computers." International Journal of Industrial Organization. 25(1) 139-156

Spieker, R. L. 2004. “Bank Branch Growth Has Been Steady – Will It Continue?”, FDIC Future of Bank Study, FOB-2004-08.1

Sullivan, R. Z. Wang. 2005. “Internet Banking: An Exploration in Technology Diffusion and Impact” Federal Reserve Bank of Kansas City Working Paper 05-05.

Table 1: Summary Statistics

Variables	Variable Name	Number of Observations	Mean	Standard Deviation
Non-interest Bearing Account Balance	NonInt_Bal	154,908	3,220.66	2431.80
Brick-and-Mortar Bank Saving APY (in %)	Bank_APY	343,273	0.61	0.08
Local Competitive Saving APY (in %)	Comp_APY	343,273	1.91	0.19
Online Saving APY	Online_APY	343,273	2.55	0.22
eBanking Account (dummy)	eBanking	343,273	0.35	0.48
Single-sign-on Account (dummy)	SSO	343,273	0.22	0.41
Local ATM Access (dummy)	ATM	343,273	0.65	0.48
Branch Access (dummy)	Branch	343,273	0.56	0.49
Remote Customers (dummy)	Remote	343,273	0.31	0.46
Own CD products (dummy)	CD	304,884	0.13	0.34
Number of Accounts	#Accounts	343,273	1.91	1.20
Income Class (0-9)	Income	343,273	3.96	3.15
College Education (dummy)	Education	343,273	0.21	0.67

Table 2: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1. Bank_APY	1.00											
2. Comp_APY	0.61	1.00										
3. Online_APY	0.84	0.79	1.00									
4. eBanking	-0.02	-0.02	-0.02	1.00								
5. SSO	-0.01	-0.01	-0.01	0.72	1.00							
6. ATM	0.00	0.06	0.00	0.02	0.01	1.00						
7. Branch	0.00	0.09	0.00	0.02	0.02	-0.17	1.00					
8. Remote	0.02	-0.01	0.03	0.04	0.08	-0.03	0.15	1.00				
9. CD	-0.01	-0.01	0.00	-0.09	-0.07	-0.01	0.01	0.04	1.00			
10. #Accounts	0.00	0.02	0.00	0.07	0.07	0.03	0.03	0.04	0.05	1.00		
11. income	0.02	-0.01	0.03	0.04	0.08	-0.03	0.03	0.05	0.45	0.15	1.00	
12. Education	0.05	-0.00	0.01	0.03	0.06	-0.02	0.01	0.06	0.02	0.06	0.19	1.00

Table 3: Online and Local Competition

Independent Variables	Model 1	Model 2	Model 3
Bank_APY	-0.42*** (0.17)	-0.48*** (0.09)	-0.54*** (0.19)
Comp_APY	-0.34*** (0.04)	-0.09*** (0.03)	0.00 (0.07)
Online_APY	-0.28*** (0.10)	-0.43*** (0.06)	-0.50*** (0.11)
Bank_APY * eBanking			0.44** (0.19)
Comp_APY * eBanking			0.05 (0.07)
Online_APY * eBanking			-0.24** (0.11)
Bank_APY * SSO			-0.18 (0.23)
Comp_APY * SSO			0.02 (0.08)
Online_APY * SSO			0.07 (0.13)
Bank_APY * ATM			-0.50*** (0.19)
Comp_APY * ATM			0.08 (0.08)
Online_APY * ATM			0.18* (0.11)
Bank_APY * Branch			0.33* (0.19)
Comp_APY * Branch			-0.04 (0.08)
Online_APY * Branch			-0.13 (0.11)
Bank_APY * CD			-0.06 (0.31)
Comp_APY * CD			-0.03 (0.18)
Online_APY * CD			-0.16 (0.11)
Bank_APY * #Accounts			-0.06 (0.31)
Comp_APY * #Accounts			-0.03 (0.18)
Online_APY * Accounts			-0.16 (0.11)
Bank_APY * Remote			1.17 (0.74)
Comp_APY * Remote			-1.00*** (0.24)

Online_APY * Remote			1.04*** (0.32)
Bank_APY * Income			-0.08 (0.28)
Comp_APY * Income			-0.04*** (0.08)
Online_APY * Income			0.02 (0.02)
Bank_APY * Education			-0.08 (0.28)
Comp_APY * Education			-0.01 (0.10)
Online_APY * Education			-0.10 (0.16)
Time	0.20*** (0.04)	0.00 (0.04)	-0.03 (0.04)
Time (squared)	-0.00*** (0.00)	-0.00 (0.00)	-0.00 (0.00)
Individual fixed effects	No	Yes	Yes
Number of Observations	105,288	105,288	91,535
R-Square	0.1%	75.7%	76.0%

Research on the relations between the teacher's adoption behavior and their teaching ability in an online education community

Liangjuan Qin
Institue of E-Business, University of International Business and Economics
ljqin@uibe.edu.cn

Bin Li
School of information & Managment, University of International Business and Economics
Levin001@sohu.com

Wei Wu
School of information & Managment, University of International Business and Economics
2010wuwei@gmail.com

Abstract

In this paper, we mainly focus on the teacher of compulsory education; analyze the teacher's adoption behavior in an online education community. Finally it concludes that the adoption of educational community has a positive impact on the users' teaching ability; the usage time has mediating affects their teaching ability via adoption behavior, though there's no direct impact.

Keywords: online education community, adoption intention, adoption behavior, teaching ability

1.Introduction

As is in every country of the world, compulsory education and related tasks, including constant improvement of teaching ability and skills of elementary school teacher through continuous training, are very concerned by the Chinese government. SNS network communities which are based on Web2.0 technologies, are playing a significant role of promoting communication and quick sharing of the information. These communities all have the attributes of personalized, decentralized, formed by grassroots, scattered distribution of information, strong information sharing, group and timely feedback. There are some online education communities in China, such as *Teacherclub.com*, they were built for the primary and secondary school teacher in China to support their exchanging of teaching experience, and discussion on research of teaching methods. The website has built a multi-dimensional environment for online work, discussion, study and information sharing of the teacher.

In this paper, we will research the teacher's adoption behavior, and its effect on the teaching ability improvement, through observations and surveys of the teacher on the teacherclub.com.

2. Literature review and hypotheses

2.1 Influence of adoption behavior on users' learning of knowledge in the online community

There are many studies on the users' behavior in an online community in literature.. Wangbin Fan (2006) concluded that online community not only plays a significant role of inspires communication, but also promoting quick sharing of information. Through interviews of the online community users and observations of their behavior, Alon Hasgall and Snunith Shoham(2007) found that users' behavior could be affected by effect of adopting the community. By studying the individual network model within an SNS community, combined with analyze of the questionnaires, Eoin Whelan，David G.Collings and Brian Donnellan(2010) concluded that individuals in a SNS community could acquired more external knowledge. Weidong Guo(2009) analyzed the promoting effect on individual and group knowledge learning by adopting Internet, and concluded that the behavior of the users had group characteristics. Through these studies, we can learn that socialized online community could influence the behavior of its users. It not only

provide easier communication and abounds the study and living resources of the users, but also reduce the time cost of sharing.

Comparing with the users of regular online communities, teacher may have more intention to learn knowledge and share their teaching experience rather than entertainment and common friends making. So we will give a further research on whether the teacher's adoption behavior can improve the teaching ability through promoting the teacher's knowledge learning and experience sharing, and hypothesis 1 was proposed:

H1: The Adoption behavior of teacher in the *online education community* has a positive impact on the teaching ability;

2.2 Usages time of users of an online community

In the study of online community, the adoption frequency and their consistent usage time are two important factors to be investigated (Mohd Safar Hasim and Ali Salman,2010). In the research of audiences' media using situations among SNS users in the campuses in China, Xun Zhan and Yuli Gu (2005) designed the questionnaires including investigation of purposes of the users (information acquiring, interpersonal relationships, self-identify), user's characteristics, frequency of use, continuous time of use, using preferences and satisfaction, and researched the gap between online communities and returning of interpersonal communication reality.

In this research, we will discuss the relationship between usage time(including using hours per week or using hours everyday and the continuous time of use) and teaching ability, adoption behavior on an education network community——Teacherclub.com,and following hypotheses are proposed, In the online educational community:

H2: The teacher's usage time has a positive impact on the teacher's teaching ability;

H3: The teacher's usage time has a positive impact on the teacher's adoption behavior;

H4: The teacher's adoption behavior has a positive impact on users' usage time;

H5: The teaching ability has a positive impact on their usage time;.

2.3 Research of teaching ability evaluation of the teacher

Teaching ability is the competence of the teacher represented in their teaching activates, and as the core competency of teaching expertise of the teacher, it has a direct influence on the effectiveness of the courses as well as knowledge management and ability development of the students (Xuemin Zhang, 2002). Evaluation of teaching ability could be implemented from several aspects, including curriculum design, which is emphasized by many domestic and foreign researchers in their studies (Taqi N.Al-Faraj 2007，Carole Edmonds 2007，Zhanguo Gao 2011，Xiaoqiu Luo, etc.). F.Enns(1965) from Canada also concludes that basic teaching skills, adaptability, flexibility, communication and other aspects of the teacher also represent their teaching ability. Other factors including teaching cases, teaching management, differentiated guidance for the students, the application of new teaching methods are also taken into consideration of teaching ability evaluation by foreign scholars (Carole Edmonds, 2007).

There is no unified evaluation standard on teacher's teaching ability from the research and practical status. The course design is chosen as the important part of the teaching process in this research, in order to explore whether the teacher's course design ability and finally the teaching ability can be improved through the adoption of the online community's resources. In the measurement scale part, we choose subjective measure variables, because the subject perceived usefulness has a direct effect on the user's continues adoption behavior.

3. Research model and the development of concept measurement

According to the existing studies of the effects of network community on knowledge learning, we proposed and hope to verified the relations of three constructs, which are teacher's

adoption behavior, such as the type of resource they like to use, usage time of the online educational community, and their teaching ability. and reveal whether the teaching ability will be improved through adopt the recourses on the education community and communicate with other colleagues online.

Considering the characteristic of teacher online, and based on the literature review, we use using hours per week and continuous time of use of the community as the observable variables of the usage time.

We use the ability of teaching content design, the ability of teaching methods, the ability of teaching process design and the ability of reviews and examination design as the observable variables of teaching ability. It is needed to mention that the teaching ability are measured by self-description instead of objective measurements, but from their subjective indicators, we can evaluation the perceived usefulness of the teacher through the comparison of ability between the beginning and now.

The adoption behavior can be measured by the several variables, including watching teaching videos, teaching materials finding, participate activities, reading news and notices, share experience and learning teaching theories The constructs and their relations hypotheses as Figure 1.

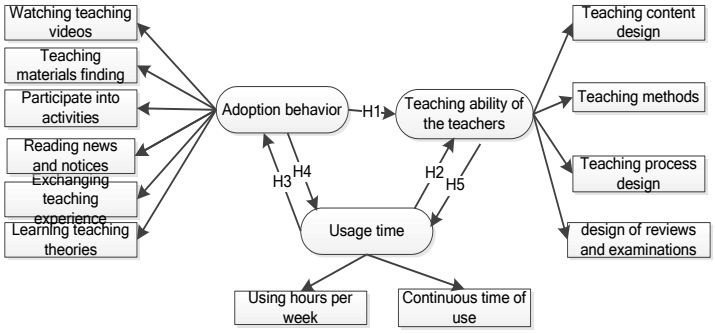


Figure 1. The constructs and the relationships hypotheses

4. Scale design and sampling investigation

The objects measured in this study include both subjective and objective data, so Likert five scales will be mainly used, mixed with several rating scales. Other information, such as the user's personal basic information and network usage, will also be included.

A multi-stage stratified sampling investigation was implemented in national wide through *Teacherclub.com*. 158 questionnaires were collected anonymously from the users of Teacherclub platform with the method of internet investigation The feedback come from different regional, the survey data is considered to be comprehensive, complete and reliable, and valid rate is 100%.

Table 1. Scale design

Usage time UT	continuous time of use of the online educational community	UI1
	using hours per week of the online educational community	UT2
Adoption behavior AC	I often watch various teaching videos on *Teacherclub*	AC1
	I often study teaching theories on *Teacherclub*	AC2
	I often read education policies, news and notices on *Teacherclub*	AC3
	I often find many useful course PPT, teaching programs, etc.	AC4
	I often share my teaching and management experience with other teacher	AC5
	I am very willing to participate in activities in a variety of topics	AC6
Teaching Ability TA	*Teacherclub* provided me with great help on teaching content design	TA1
	Teacherclub provided me with great help on teaching process design	TA2
	Teacherclub provided me with great help on my teaching method design	TA3
	It provided me with great help on my examinations design	TA4

5.Data Analysis

5.1.Model fitting evaluation, reliability testing and Validity analyze

We use Structural Equations Model (SEM) to analyze the relation of adoption content, usage time and teaching ability in an online community, and the result is as shown in Figure 2,

and the model's tested indicators is shown in Table 2, we can judge the model fits the data very well.

Component reliability (CR)of the latent variables involved in this study are all between 0.70 and 0.98, the latent variables passed the reliability test, and are with high stability and consistency. After KMO and Bartleet sphere test of the sample data, the KMO coefficient is 0.882; Bartlett sphere test significance probability is 0.000, and the test result is significant. According to the standard of factor analysis, the sample is suitable for factor analysis.

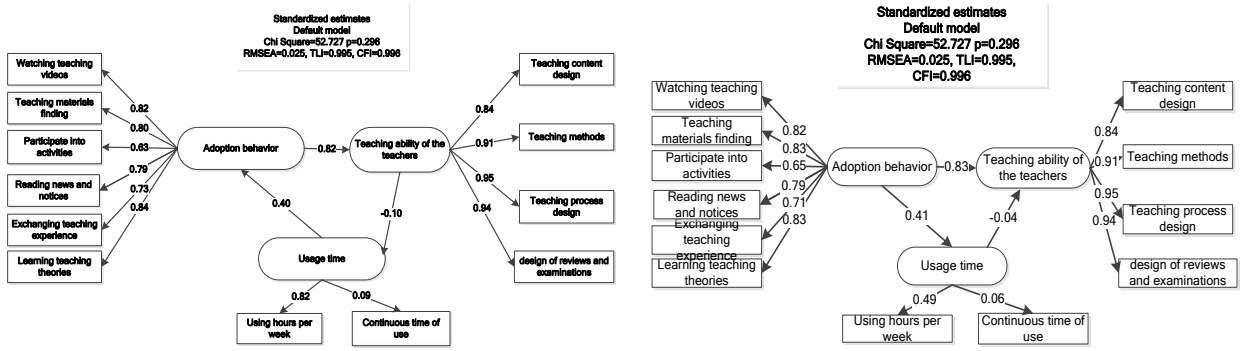


Figure 2 Model fitting results

Table 2 The model's indicators' value

Indicators	P	RMSEA	TLI	CFI
Valid value	>0.05	<0.08	>0.95	>0.95
Test Value	0.296	0.025	0.995	0.996

5.2 Statistical results and conclusions

After the analysis of route regression weights and effectiveness, we can conclude:

(1) There is a significant relation between adoption behavior and teacher's teaching ability (route value: 0.82), and its probability P<0.001, it means adoption behavior have an significant direct positive impact on teaching ability, hypothesis H1 is supported

(2) Usage time does not have significant positive impact on teacher's teaching ability (route value:-0.04), so hypothes H2 is not supported. But usage time has an indirect influence on the teaching ability through adoption behavior, which serve as a mediating variable. The usage time's indirect effects on teacher's teaching ability is 0.331.

(3) Usage time of the users could promote their adoption behavior (route value: 0.40), its probability P<0.001, which represents the positive impact of usage time on adoption behavior, and supports hypothesis H3.

(4) Route coefficient of adoption behavior to usage time is 0.45, and its probability P<0.001,. The hypothesis H4 is supported.

(5) There is No significant impact of teacher's teaching ability on usage time (route value: -0.08). It means that the perceived usefulness on the improvement of teaching ability can not encourage the teacher to spend more time on the education community. So H5 is not supported.

6. Research summary

Facing the teachers who are actived in the online educational community, we researched the relations among the usage time, adoption behavior and the teaching ability. After an in-depth summarize of the related literatures, we proposed the constructs and the model, and performed imperial study. The result includes:

Adoption behavior directly affects the teacher's teaching ability, and is very important to improve teaching ability, and it is proved that service provided by the online educational

community can significantly improve the teacher's teaching ability; though usage time does not affect the teaching ability directly, it affects the adoption behavior which contributes to the teaching ability. And it is proved that users, who have adopted the online community for a long time but without making full use of the resources, are hard to elevate their teaching ability. On the other hand, as special users of the online community who are limited by their working nature and time constrains, some teacher, though perceived the strengthening of their ability by adoption this educational community, cannot constantly increase their weekly online time.

This research's result could help the educational administrations to realized the important role of online educational communities in improving teaching ability, and issue more incentives measures of adoption the teaching resources and activities rather than a single measure of usage time, when making promotions of the teacher adoption the online community. However, as the usage time has a positive influence on adoption behavior, the minimum online time strategy is on some level reasonable.

References

1. Wangbin Fan, Zhengjie Liu. "The research on the user's behavioral of Blog service system," *The second academic conference on man-machine harmonious environment*, 2006,10
2. Alon Hasgall, Snunith Shoham. "Digital social network technology and the complex organizational systems," *The journal of information and knowledge management systems*, 2007(37),pp.180-191
3. Eoin Whelan,David G.Collings,Brian Donnellan. "Managing talent in knowledge-intensive settings," *JOURNAL OF KNOWLEDGE MANAGEMENT*, 2010(14),p486-504
4. Weidong Guo. "Research on Innovation Ecosystem in IT Industry," *Proceedings of CCDC*
5. Xun Zhan,Yuli Gu. "The investigation on the campus SNS media," *The Press*, 2008,(3)
6. Mohd Safar Hasim, Ali Salman. "Factors affecting sustainability of internet usage among youth,"*The Electronic Library*, 2010(28), pp 300-313
7. Xueming Zhan,Jiliang Shen. "The research on the elementary school's teaching ability," *Psychological development and education*, 2002,(3)
8. Taqi N.Al-Faraj,Abdulaziz S. "Alidi.Evaluating Teaching Staff: Data Envelopment Analysis," *International Journal of Educational Management*, 2007(5),pp.25-29
9. Zhanguo Gao. "Modification Recommendation on the elementary school teacher education teaching ability test scores standard in heilongjiang province ," *http://jcjykc.cersp.com/Post/ShowArticle.asp?ArticleID=11057.2011*
10. Carole Edmonds. "Continuous quality improvement:integrating best practice into teacher education," *International Journal of Educational Management*.2007(21), pp.232-237
11. Xiaoqiu Luo,Chuanyi Gu. "Develope higher vocational teacher professional competence standard and construct teacher team management system," *Chinese vocational and technical education*, 2007(21)
12. F.Enns. "Rating Teacher Effectiveness: The Function of the Principal," *The journal of educational administration*, 1965(3),pp.82
13. Ursula Paola Torres Maldonado,Gohar Feroz Khan, Junghoon Moon, Jae Jeung Rho. "E-learning motivation and educational portal acceptance in developing countries," *Online Information Review*, 2011(35), pp 66-85
14. Ursula Paola Torres Maldonado,Gohar Feroz Khan. "E-learning motivation and educational portal acceptance in developing countries," *Online Information Review*, 2011(35), pp 66-85

Technostress of IT professionals: diverse for different personality type and related to different career orientations

Yuwen Liu
Xi'an Jiaotong University
lywemma@gmail.com

Kanliang Wang
Renmin University of China
kanliang.wang@gmail.com

Abstract

With the widespread of Information and Communication Technologies (ICTs), the issue of technostress becomes increasingly pervasive. Based on regulatory focus theory, this study tested the relationship between personality and technostress among IT professionals, as well as the influence of technostress on their career orientations. Results show that: (1) Higher promotion orientation leads to lower perception of work overload, role ambiguity, job insecurity, and higher perception of invasion of privacy; (2) Higher prevention orientation leads to higher perception of work overload, role ambiguity, job insecurity, and invasion of privacy;(3) For both types of people, role ambiguity facilitates managerial orientation, and invasion of privacy is positively related to technical orientation; (4) job insecurity facilitates technical orientation for promotion orientated employees, while facilitates managerial orientation for prevention orientated.

Keywords: technostress, personality type, regulatory focus theory, career orientation

1. Introduction

Driven by the emergence and development of ICTs, employees, especially IT professionals nowadays have to work a lot more efficiently and have to continuously familiarize themselves with new skills. These problems result in negative effect on human attitudes, thoughts, behavior, and psychology, which has been defined as technostress (Tarafdar et al. 2005).

Existing studies have investigated some factors that affect technostress, and have found the influence of technostress on individual productivity, as well as organizational outcomes (Ragu-Nathan et al. 2008; Tarafdar et al. 2007). However, few paid attention to the relationship between technostress and personality, even though personality has significant effects on stress perception. In this article we categorized subjects into promotion oriented and prevention oriented according to the Regulatory Focus Theory, and examined the difference in their perceptions of technostress. Furthermore, we investigated whether the 5 dimensions of technostress experienced by IT professionals would affect their career anchors, as job stress is closely related to turnover intentions and can result in loss of talents(De Villiers 2009).

2. Theoretical Background

2.1 Regulatory Focus Theory and Technostress due to ICTs

Ayyagari (2007)extended the definitions of technostress to the technostress specifically caused by ICTs, namely work overload, role ambiguity, job insecurity, work-home conflict and invasion of privacy. The five stressors in Ayyagari's definition, which are what we opted for in this paper, could be classified into two groups: work overload, role ambiguity, and job insecurity could be

overcome through effort and self-motivation; while work-home conflict and invasion of privacy are inevitable.

According to the Regulatory Focus Theory(Higgins 1997), for promotion orientated person in terms of goal pursuit, the main focus is on satisfying the individual's own ideals and wishes. Growth and self-actualization needs are strongly developed. They tend to actively pursue their goals and choose approach as their strategic means. So when faced with problems that can be solved through effort, they will improve themselves and try to deal with the stress; however, they would still experience the inevitable stresses. Hence we proposed Hypothesis 1(see Table 1).

On the other hand, for prevention orientated person in terms of goal pursuit, satisfying others' expectations and fulfilling one's obligations are relevant, and security needs are strongly developed. Their strategies are defensive and passive by trying to avoid mistakes. Hence we proposed Hypothesis 2 (see Table 1).

2.2 Technostress and Career Orientation

Schein's defines career anchors as a pattern of "self-perceived talents, motives and values which guide, constrain, stabilize, and integrate the individual's career." These career anchors are self-perceptions which influence career choices and career decisions(Schein et al. 1978). Technostress has an influence on intention to leave, satisfaction, as well as changes in career orientation. Schein (1990) defined eight categories of career orientations. However, the most prevalent career orientations of MIS employees were found to be technical and managerial (Igbaria et al. 1991). Technical orientation means one is primarily excited by the content of the work itself, and prefers advancement only in his/her technical or functional area of competence; Managerial orientation means that one is primarily excited by the opportunity to analyze and solve problems under conditions of incomplete information and uncertainty, and likes harnessing people together to achieve common goals (Schein 1990).

Among the five dimensions of technostress, work overload, role ambiguity, and work-home conflict will increase the managerial orientation for IT professionals. Job insecurity places challenges and motivations for promotion orientated employees, driving them to learn and master new technologies; however, it is instead a threat to prevention orientated professionals and may cause them to become managerial oriented. Invasion of privacy is inevitable for both IT professionals and managers, it would not change their original technical orientation. Hence we proposed Hypothesis 3 and 4 (see Table 1).

Table 1. Hypotheses
Hypothesis 1a: higher promotion orientation will lead to lower perception of the stress taken by work overload.
Hypothesis 1b: higher promotion orientation will lead to lower perception of the stress taken by role ambiguity.
Hypothesis 1c: higher promotion orientation will lead to lower perception of the stress taken by job insecurity.
Hypothesis 1d: higher promotion orientation will lead to higher perception of the stress taken by work-home conflict.
Hypothesis 1e: higher promotion orientation will lead to higher perception of the stress taken by invasion of privacy.
Hypothesis 2a: higher prevention orientation will lead to higher perception of the stress taken by work overload.
Hypothesis 2b: higher prevention orientation will lead to higher perception of the stress taken by role ambiguity.

Hypothesis 2c: higher prevention orientation will lead to higher perception of the stress taken by job insecurity.
Hypothesis 2d: higher prevention orientation will lead to higher perception of the stress taken by work-home conflict.
Hypothesis 2e: higher prevention orientation will lead to higher perception of the stress taken by invasion of privacy.
Hypothesis 3a: For promotion orientated IT professionals, work overload will be positively related to one's managerial orientation.
Hypothesis 3b: For promotion orientated IT professionals, role ambiguity will be positively related to one's managerial orientation.
Hypothesis 3c: For promotion orientated IT professionals, job insecurity will be positively related to one's technical orientation.
Hypothesis 3d: For promotion orientated IT professionals, work-home conflict will be positively related to one's managerial orientation.
Hypothesis 3e: For promotion orientated IT professionals, invasion of privacy will be positively related to one's technical orientation.
Hypothesis 4a: For prevention orientated IT professionals, work overload will be positively related to one's managerial orientation.
Hypothesis 4b: For prevention orientated IT professionals, role ambiguity will be positively related to one's managerial orientation.
Hypothesis 4c: For prevention orientated IT professionals, job insecurity will be positively related to one's managerial orientation.
Hypothesis 4d: For prevention orientated IT professionals, work-home conflict will be positively related to one's managerial orientation.
Hypothesis 4e: For prevention orientated IT professionals, invasion of privacy will be positively related to one's technical orientation.

We follow the structural model proposed by Barkhi et al.(2007) , which also brings in the personality constructs, and build our model as shown in Figure 1.

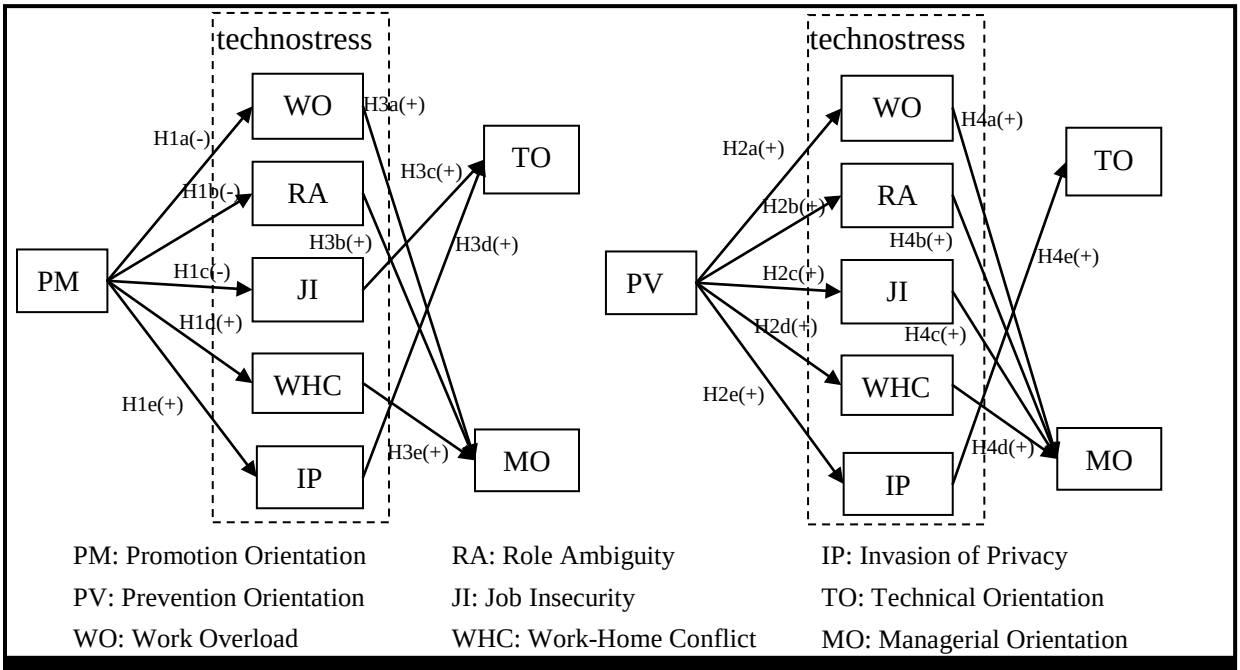


Figure 1. Research Model

3. Methodology

3.1 The Measures

The variables were measured by Regulatory Focus Scale (Fellner et al. 2007), Career anchors Scale (Schein 1990). Technostress was measured by the questionnaire used by Ayyagari (2007). All these questionnaire items ware organized in 5-point Likert-type scales. Some items were deleted or modified through Q-sort method.

3.2 Samples

We did this pilot study in Xi'an, where 3 companies with different sizes were selected. We handed out a total of 82 questionnaires to IT professionals and got 66 valid responses. 35 subjects were in the promotion orientated group and 31 were in the prevention orientated group.

4. Data Analysis and Results

4.1 Assessment of Measurement Validation

We conducted validation checks for the two groups in Smart PLS. All constructs exceeded 0.7 for Cronbach's alpha (construct validity), 0.7 for composite reliabilities, and 0.6 for Average Variances Extracted (convergent validity). Also, the squared root of AVE for each construct was larger than all other cross-correlation values (discriminate validity). In addition, the loadings and cross-loadings of PLS both satisfy the requirement that indicators load more on their theoretical construct than on the other constructs and the loadings of the indicators are above 0.7. Due to page constraints, descriptive statistics was not presented in here.

4.2 Structural Model Testing

The results of the model estimation for promotion orientated type and prevention orientated type, including standardized path coefficients, significance of the paths based on atwo-tailed t-test, and the amount of variances explained(R^2) ,are presented in Figure 2 and Figure 3 respectively.Most of the 20 hypotheses were supported and significant. However, the results for Hypothesis1d (t=0.477, p>0.05),Hypothesis2d (t=1.629, p>0.05), Hypothesis3a (t=1.013, p>0.05), and Hypothesis3d(t=1.328, p>0.05) were not significant. In Hypothesis4a, result is oppositeof the original hypothesis and work overload is significantly negatively relatedto managerial orientation.

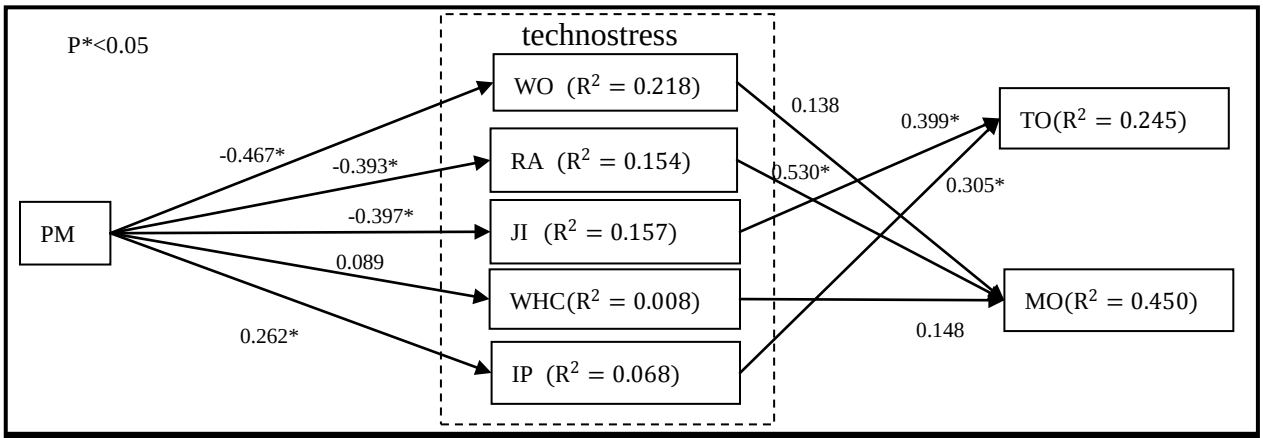


Figure 2. The Results of the Structural Model Testing for Promotion Orientated IT Professionals

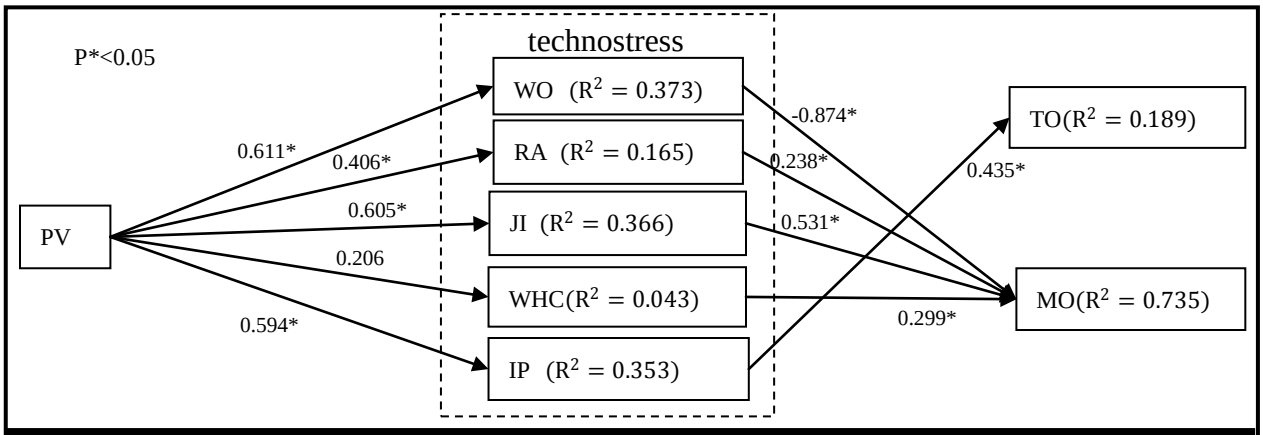


Figure 3. The Results of the Structural Model Testing for Prevention Orientated IT Professionals

5. Discussion and Implication

The majority of our hypotheses were confirmed, and there were several interesting findings that are worth further studies. The hypothesized positive relationship between work overload and managerial orientation was not significant for promotion orientated IT professionals and it was even negative for prevention orientated IT professionals. A possible explanation for this diversion could be that the technical oriented employees initially enjoyed technology related work which was why they chose their job in the first place, and would not be easily pushed into managerial positions. Furthermore, a promotion orientated person enjoys challenge and would not turn over to another occupation because of overload; a prevention orientated person values responsibilities and tries to avoid any loss, thus work overload would bring out more effort. The hypothesized effects of work-home conflict on career anchors were not supported in either types of people and require further investigation.

This study makes some theoretical contributions for IS research. It validated stressors of technostress due to ICTs, discovered the relationship between personality type and technostress, and examined the influence of technostress on the career orientations of IT professionals. Since technostress is to some extent a psychological concept, it's important and necessary to take personality into consideration. Also, our investigation on the impact of technostress on career orientations could be regarded as a complement of technotress research.

This study also has practical implications. Since personality determines the type of stressors a person experiences, employees could adopt corresponding coping strategies for the specific stressors that affect them the most. Implication for the employers is that companies should try to tackle technostress to lower the turnover of the employees, as technostress has an influence on their career anchors.

Acknowledgement

This research was supported by National Natural Science Foundation of China (grant 70971107).

References

1. Ayyagari, R. "What and why of technostress: Technology antecedents and implications," *A*

Dissertation Presented to the Graduate School of Clemson University, 2007.
2. Barkhi, R., and Wallace, L. "The impact of personality type on purchasing decisions in virtual stores," *Information Technology and Management* (8:4) 2007, pp 313-330.
3. De Villiers, M. "The relationship between employee wellness and career anchors,") 2009.
4. Fellner, B., Holler, M., Kirchler, E., and Schabmann, A. "Regulatory Focus Scale (RFS): Development of a scale to record dispositional regulatory focus," *Swiss Journal of Psychology* (66:2) 2007, pp 109-116.
5. Higgins, E.T. "Beyond pleasure and pain," *American Psychologist* (52) 1997, pp 1280-1300.
6. Igbaria, M., Greenhaus, J.H., and Parasuraman, S. "Career orientations of MIS employees: an empirical analysis," *MIS Quarterly*) 1991, pp 151-169.
7. Ragu-Nathan, T., Tarafdar, M., Ragu-Nathan, B.S., and Tu, Q. "The consequences of technostress for end users in organizations: Conceptual development and empirical validation," *Information Systems Research* (19:4) 2008, p 417.
8. Tarafdar, M., Ragu-Nathan, B., Ragu-Nathan, T., and Tu, Q. "Exploring the impact of technostress on productivity," Decision Sciences Institute, 2005.
9. Tarafdar, M., Tu, Q., Ragu-Nathan, B.S., and Ragu-Nathan, T. "The impact of technostress on role stress and productivity," *Journal of Management Information Systems* (24:1) 2007, pp 301-328.

Perceived Affordances of Web Advertisements: Implications for Information Artifacts Design

Jian Tang
Syracuse University
jtang04@syr.edu

Yuxiang Zhao
Nanjing University
yxzhao@smail.nju.edu.cn

Ping Zhang
Syracuse University
pzhang@syr.edu

Abstract

Perceived affordance is utilized as a theoretical lens to explore factors influencing consumers' positive or negative perceptions of Web advertisements, which is one type of information artifacts. Content and form are two main attributes shared by information artifacts. Based on the literature review and content analysis, a conceptual framework is proposed to shed light on perceived affordance of information artifacts for the IS researchers and designers.

Keywords: Information artifacts, Web ads, Perceived affordances, Design

1. Introduction

The Internet has transformed consumers' lives and how they experience information, work, entertainment, and brands. According to a recent report from the Interactive Advertising Bureau (IAB) and PricewaterhouseCoopers (PwC), U.S. Internet advertising revenues hit $6.4 billion in the third quarter of 2010, representing the highest quarterly result ever for the online advertising industry and a 17% increase from the same period in 2009 (IAB 2010). Web advertisements or Web ads are those advertisements that are presented to the targeted consumers through the World Wide Web. With the increase of Web ads on the Internet, many researchers from various disciplines have been paying attention to the effectiveness of Web ads, i.e. how consumers react to Web ads and how Web ads affect consumers. Zhang and Kim (2008) conducted a qualitative meta-analysis to provide a comprehensive view of the state of empirical research on various factors that influence consumers' reactions to Web ads and factors that influence Web ads' impacts on consumers. The findings reflected that three kinds of interactions (View-Ad, View-Host, and View-Product/Service) play an important role in terms of the consumers' perceptions towards Web ads. The Viewer-Ad interaction is about consumers' reactions to the features or characteristics of Web ads. The Viewer-Host interaction represents consumers' perceptions of the hosting entities (normally websites). The Viewer-Product/Service interaction concerns about consumers' perceptions and attitudes to the products or services being advertised. The last two interactions may be more related with the marketers, policy makers, and managers who are behind the Web ads, while the Viewer-Ad interaction may attract more interest from the designer's perspective.

Design science is one of the most important research paradigms in Information Systems (IS) field (Henver et al. 2004. Previous studies investigate the design principles of IT artifacts from different angles (Ponte et al 2009; Hanseth and Lyytinen 2010; Tilson et al 2010). As a large portion of consumers don't have direct interaction with the technical layer of the IT artifacts, and technologies are often transparent to those consumers, they may value more about the applications and information that are exposed to them. In that case, it is meaningful to explore the IT artifacts in a dualistic way, i.e. we divide the IT artifacts into the 'hard' and 'soft'

components. The former focuses on technology dimension, such as the emergent technology innovation, convergent technology mashup, technology evolution, change, and adaption, while the latter highlights the information dimension of IT artifacts, which has more relations with social purposes that address the information lifecycle, such as information being acquired or created, processed, disseminated, and used (Zhang and Benjamin 2007), thus we name it *Information Artifacts*. The concept of information artifact covers a wide range of information technology products, such as blog, twitter, wiki, and user-generated media, to name just a few. Web ads are one kind of information artifacts. So far few researchers from IS discipline have examined the Web ads as an information artifact from the design perspective, hence, in this paper we attempt to use the "Perceived Affordance" as a theoretical lens to study the design related issues of Web ads. Affordance is a perceptual psychological concept defined by Gibson (1979) as the actionable properties between the environment and the animals, and then it was introduced to the interaction design research by Norman (1999), who clarified the differences between real affordance and perceived affordance. Perceived affordance is users' perception of actionable properties of the artifact, and it can result from the mental interpretation of environments based on consumers' past knowledge, experiences and memories (Norman 2002). The idea of affordance has gained increasing attention from researchers who share the interests of design research, and many previous studies emphasized on the real affordances (Maier and Fadel 2009; Sadler and Given 2007; Zhang 2008). The paper aims to explore various types of the perceived affordances of Web ads, and the representations of those perceived affordances on the main attributes of Web ads as an information artifact. Our study may help the Web ads designers better understand users' perceptions, and shed light on perceived affordances of information artifacts for the IS researchers.

2. Related Concepts

In this paper, two groups of related concepts will be clarified. One group of concepts is relevant to the information artifacts design. Based on our observation, information artifacts share two primary categories of embedded attributes, i.e. content and form. Another group of concepts is relevant to people's perceptions in terms of various kinds of affordances, i.e. perceived affordances.

2.1 Contents and Forms

In terms of contents of Web ads, they mainly consist of types and attributes. In terms of forms of Web ads, it mainly consists of presentations and behaviors. Form presentations refer to the static elements, including place location, banner size, color scheme, and media form, etc., while form behaviors refer to some dynamic elements such as movement, flashing, pop-up, etc. (Zhang and Kim, 2008).

2.2 Perceived Affordance

When information artifacts are designed, they possess certain degree of affordance, however, due to consumers' mental transformation processes, sometimes, the real affordance of the information artifacts cannot be detected by the consumers, and the consumers' perceived affordance of the artifacts may mismatch the real affordance. Hartson (2003) expands the affordance concept and identifies four types of affordance, including physical affordance, cognitive affordance, sensory affordance, and functional affordance. In our study, the perceived physical affordance and perceived cognitive affordance are developed on the basis of Hartson

(2003). However, the perceived physical affordance in this paper is broader, covering the physical affordance and sensory affordance in Hartson's study (2003). In addition, we add two new types of perceived affordance, one of which is perceived affective affordance, related to the affective properties of the information artifacts. The other one is the perceived control affordance, considering the controllability of the information artifacts from consumer's angle. It is worth noting that these four types of perceived affordance are not considered exclusively, and some of users' perceptions or reactions may involve more than one perceived affordance.

2.2.1 Perceived Physical Affordance

Physical affordance is the attributes of the information artifact that can be sensed, acted upon, or physically manipulated by users or consumers for a particular purpose. Perceived physical affordance usually utilizes human senses to achieve certain goals of the information artifact. Perceived physical affordance is a user's perception or appraisal of the degree of Information artifact's physical affordance. For example, Web ads with well-designed figures may support human sensing. In interactive technology design, vision, audition, and touch are three physical attributes considered to lower the complexity between human-computer interaction (Te'eni et al. 2007).

2.2.2 Perceived Cognitive Affordance

Cognitive affordance is the attributes of the information artifacts that would help, aid, support, facilitate or enable a consumer's thinking, knowing, and/or cognitively/mentally processing something, which may take effect immediately or have a potential impact. Perceived Cognitive Affordance is a user's perception or appraisal of the existence or lack of information artifacts' cognitive affordance. It is not about how people learn to use the artifacts, but it is about users' perceptions of the artifacts to support conceptual, analytical, and problem-solving process. Types of examples include: provide information, such as news, reminders, reinforcement, or suggestions, etc.; influence information processing, such as affect work, jobs, learning, or performance, etc.; inspire or enlighten some ideas which may lead to some valuable behaviors.

2.2.3 Perceived Affective Affordance

Affective affordance is the attributes of the information artifacts that can trigger or stimulate users' emotional reactions. For example, Web ads with pornographic scenarios may offend some consumers. Perceived Affective Affordance is user's perception or appraisal of information artifacts' affective affordances. For example, some people may feel certain web ads make them feel positive about life, or make them feel embarrassed.

2.2.4 Perceived Control Affordance

Control affordance is the attributes of information artifacts that emphasize a consumer's power of making choices of the situation or the environment rather than of one's own behavior. For example, whether it is a consumer's own decision to enter into a Web ad reflects the degree of control affordance. It is different from physical affordance in that physical affordance does not hint whose will it is for the information artifacts to be displayed or interacted in certain way, while control affordance gives hints of who should initiate the action or interaction. Perceived Control Affordance represents the features of information artifacts that support consumers' willingness to be in control. Consumers tend to feel and behave more positively when they perceive that there is more room for control in the environment. Examples can be something that

against the consumer's will. For instance, pop-up ads block the main content without any early warning, or unwanted noises interfere with current tasks without any noticing, etc.

3. Research Method

The data used for this study was a part of a larger dataset collected through an online survey. Since it was an exploratory study, we only used the data collected through two open-ended questions in the survey instrument, which asked the respondents to list the most negative and positive web ads they ever met, and to explain the reasons. Participants were 111 Chinese users of Web ads, and the demographic showed that most of them were from universities and colleges in China. Each participant's responses to one question were treated as one unit for coding and analysis. Open coding was conducted by two coders independently. The coding scheme was developed throughout the coding process. The raw disagreements between the coders are around 70%. Disagreements were resolved by consulting with the third researcher and the final agreement was 100%.

4. Preliminary Findings

According to our statistics, 77 out of 111 respondents gave their answers about positive ads, and 107 out of 111 respondents gave their answers about negative ads. Besides comments on ads, 25.97% of the positive responses and 35.45% of the negative responses referred to the products/ services being advertised, and 22.08% of the positive responses and 3.74% of the negative responses referred to the hosts where those ads appeared. Those numbers support that the respondents' perceptions of Web ads are not only relevant to ads itself, but also relevant to the products/ services and hosts.

Among the participants who responded on the Web ads themselves, Table 1 shows the frequencies of the four types of perceived affordances, indicating that perceived affordance plays an important role in shaping consumers' perception of the Web ads. Specifically, the high frequencies of the perceived affordances in the negative ads category may indicate that the lack of those perceived affordances is more likely to result in consumers' negative perceptions. Table 1 illustrates that perceived cognitive affordances significantly affect consumers' perceptions of both positive and negative Web ads. Additionally, perceived physical affordances and perceived cognitive affordances are also frequently referred and valued by the respondents.

Table 1 Perceived Affordances of Positive/ Negative Advertisements

	Perceived Physical Affordances	***Perceived Cognitive Affordances***	***Perceived Affective Affordances***	***Perceived Control Affordances***
Positive	17	66	17	10
Negative	50	102	22	55

Table 2 shows the co-occurrences frequencies of the "Content/ Form" codes and the "Perceived Affordances" codes. The "Perceived Cognitive Affordances" and the "Content Attributes" are the pair with the highest frequency that is mentioned by respondents. For example, the respondents perceived the Web ads to be positive because those ads provide suggestive information, such as book recommendation. Another interesting finding is that the "Perceived Control Affordances" and the "Form Behavior" is also a pair of codes with high frequency,

which indicates that consumers would like to have higher level of control over the Web ads, especially the Web ads' behaviors. The data also shows that the overall co-occurrences frequencies between perceived affordances and content are much higher than that between perceived affordances and form, which indicates that regarding the designing of Web ads as an information artifact, designers should place more emphases on the content part, especially on the content attributes which may have the strongest relevance to consumers' perceptions.

Table 2 Frequencies of Co-occurrence of Wed Ads Content/ Form and Perceived Affordance

		Perceived Physical Affordances	***Perceived Cognitive Affordances***	***Perceived Affective Affordances***	***Perceived Control Affordances***
Content	Content Type	20	113	26	32
	Content Attribute	24	137	32	43
	Total	***44***	***250***	***58***	***75***
Form	Form Presentation	12	28	11	12
	Form Behavior	15	61	16	59
	Total	***27***	***89***	***27***	***71***

5. Future Work

Based on the discussion above, we propose the following conceptual framework (see Figure 1) and suggest considering the perceived affordances as a new lens from which researchers can study the design related issues of Web ads as an information artifact. We believe that the perceived affordances can largely support the positive design of information artifacts, especially act on two attributes of information artifacts: content and form. It would be interesting to explore to what extent each type of perceived affordances can influence consumers' perception of the content or form attributes of the information artifacts, and consequently, have impact on the negative or positive judgments or attitudes towards the design of information artifacts. Our future work may further explore some constructs derived from the four types of perceived affordances, and conduct some survey or lab experiment studies to examine how the perceived affordances can impact the design of information artifacts (e.g. Web ads), thus propose some design principles or guidelines.

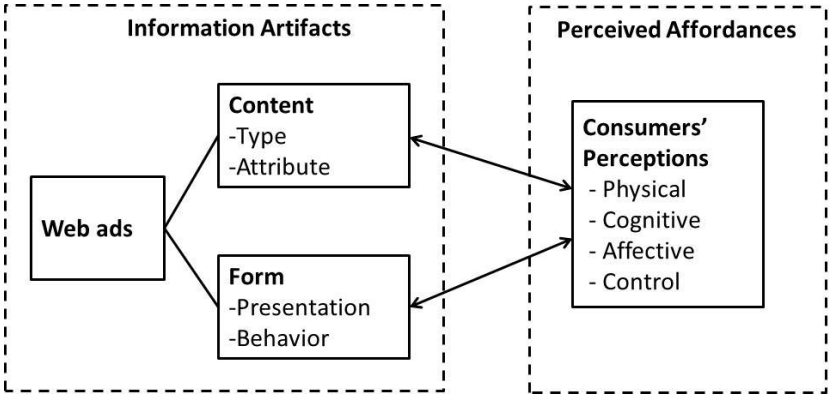


Figure 1 A Conceptual Framework of the Information Artifacts and Perceived Affordances

References may be provided upon request

Decision Right of IT Unit and Risk Taking in IT Adoption

Abstract

This study aims to understand how the company's risk-taking decisions in IT adoption are influenced by the decision right of its IT unit. Using the adoption of electronic supply chain management (e-SCM) systems as a research context, we build a theoretical framework capturing how the IT unit's decision right influences two determinants of risk taking, perceived risk and risk propensity, and their impacts on the actual adoption decisions. The framework is empirically tested using a dataset of Chinese companies. The findings suggest that the IT unit's decision right is not associated with the decrease in perceived risk, but associated with the increase in risk propensity. Moreover, the IT unit's decision right strengthens (weakens) the positive (negative) association between risk propensity (perceived risk) and e-SCM adoption. The study generates important managerial implications on how the IT unit facilitates more strategic risk-taking in IT adoption.

Keywords: Risk taking, IT Governance, IT adoption, Electronic supply chain management

1. Introduction

Extant literature on IT adoption has primarily studied risk-taking from the perspective of risk perception. The central argument is that the adoption of risky IT is driven by the mitigation of perceived risk (e.g., Nicolaou and McKnight 2006). However, this finding is insufficient to explain the strategic risk taking in the organizational context. When decision makers in companies are fully aware of the high risk of IT, they may still proactively take the risk in adopting IT. Therefore, studying what drives companies' rational and strategic risk-taking behaviors helps generate more insights on the organizational IT adoption. The Management literature has recognized that risk perception is not the only determinant of risk-taking behaviors. The interpretation of risk-taking decisions based on risk perception alone may lead to inconsistent findings (Sitkin and Pablo 1992). In order to better understand the risk-taking behaviors, decision makers' willingness to take or avoid risk, namely *risk propensity*, needs to be explicitly examined together with risk perception.

The objective of this study is to understand how risk perception and risk propensity jointly influence the decision making for risky IT adoption. More importantly, this study aims to explore how these risk-related factors and their impacts on IT adoption are influenced by a key aspect of IT governance – the IT unit's decision right. The IT unit's decision right refers to the degree of authority that the IT unit has in the decision making for IT adoption. For companies in which IT units play a more important role in the decision making, do they have less perceived risk of IT initiatives? Are they more willing to take risk in adopting IT? How does the IT unit's decision right influence the impact of risk perception and risk propensity on the actual risky initiatives of IT adoption? These are the primary research questions we explore in this study.

To examine companies' IT-related risk-taking, we focus on a specific area of IT adoption: the adoption of electronic supply chain management (e-SCM) systems. Based on the literature on strategic risk-taking and that on IT governance, we develop an integrated research framework to incorporate both the perceived risk and the risk propensity for e-SCM adoption. Our study

departs from the extant literature since we do not impose a one-way causality relationship between these two factors. Instead, we use a simultaneous equations model to endogenize both of these factors and capture the mutual influences between them. Our framework also captures the influences of the IT unit's decision right on risk perception, risk propensity, and the impacts of these two factors on the actual risk decisions on e-SCM adoption.

The theoretical framework was empirically tested using a survey dataset of e-SCM adoption by Chinese companies. The study generates the following findings. First, this study suggests that the increase of the IT unit's decision right is not necessarily associated with a decrease in the perceived risk of e-SCM. Second, the results suggest that the IT unit's decision right is positively associated with the risk propensity for e-SCM adoption. Also, the negative association between risk perception and risk propensity is weaker when the IT unit has more decision rights for e-SCM adoption. Finally, the study finds that providing the IT unit with more decision rights is likely to weaken the negative relationship between risk perception and the actual e-SCM adoption, and strengthen the positive relationship between risk propensity and the actual e-SCM adoption. These findings in general suggest that letting IT units to take more responsibility in decision making drive companies to more rationally anticipate the risk and proactively take risk in e-SCM adoption.

2. Theory and Hypothesis Development

2.1 Perceived Risk and Risk Propensity for e-SCM

In the context of IT adoption, risk perception refers to the extent to which the decision maker believes uncertainty exists about whether desirable outcomes of adopting an IT solution will occur (Nicolaou and McKnight 2006). Prior IS research has identified various types of risk associated with the adoption of inter-organizational systems (IOS) that connect organizations along the supply chain, such as implementation risk, transactional risk, and technological risk (Kumar and Dissel 1996). The perception of these types of risk has a crucial impact on the decision making regarding e-SCM adoption.

In the Management literature, risk propensity has been conceptualized as the decision maker's tendency to take or avoid risks (Sitkin and Pablo 1992). Sitkin and Pablo (1992) suggest that risk propensity is a factor correlated with risk perception and it is essentially separate from and influencing the actual risk behaviors. Existing theoretical frameworks integrating both risk perception and risk propensity tend to focus on the impact of risk propensity on risk perception. However, to better understand the relationship between these two constructs, we hypothesize a relationship with negative mutual influences between them (see H1 in Figure 1).

2.2 IT Unit's Decision Right

Decision right, which refers to decision-making authority, is a central element of the governance of IT (Sambamurthy and Zmud 1999). Decision rights of IT development and adoption are often shared to varying degrees between the IT unit and other functional departments (Sambamurthy and Zmud 1999, Weill and Ross 2004).

We hypothesize a direct effect of the IT's decision right on both the perceived risk and risk propensity (see H2 and H3 in Figure 1). Existing theories on strategic risk taking suggest that the risk perception of decision makers is often dependent on their familiarity with the problem

domain (Sitkin and Pablo 1992). Therefore, letting the IT unit involve more in the decision making helps bring more domain knowledge and experience into the decision team and thus decrease the perceived risk of e-SCM adoption. Also, extant literature suggests that past successful experience is a key determinant of risk-seeking. Compared to the decision makers from other areas, IT managers have more successful experience in handling IT-related risks and are likely to bring to the decision group more risk propensity for e-SCM when they have more rights in decision making.

We hypothesize that there is a moderating effect of the IT's decision right on the mutual influences between the perceived risk and risk propensity for e-SCM (see H4 in Figure 1). First, risk-averse decision makers often over-weigh the negative outcomes and the probability of loss. Therefore, when the IT unit has more right in decision making, it is more likely to mitigate the perceived risk and ease the concerns of more risk-averse decision makers. On the other hand, IT managers may also help prevent the overconfidence of risk-seeking decision makers by providing more professional analysis and opinions. As a result, when the IT unit has more right in decision making, the negative impact of risk propensity on risk perception can be weakened. Second, risk perception may drive decision makers to be risk averse since their attention was directed to the potential loss. This effect tends to be stronger when decision makers have little experience in the problem domain. When the IT unit plays a more important role in the decision making, IT managers can use their professional experience and knowledge to neutralize others' pessimism and enhance their willingness to rationally take risk. Therefore, the negative impact of perceived risk on risk propensity may also be weakened by the IT unit's decision right.

2.3 e-SCM Adoption

In this study, we consider e-SCM adoption as the extent to which firms adopt e-SCM systems in transacting with their suppliers and customers. Comparing to decision makers from other functional areas, the IT unit generally favors high level of IT adoption (Weill and Ross 2004). Therefore, we hypothesize that all else being equal, firms allowing their IT units to play more roles in the decision making have higher levels of e-SCM adoption (see H5 in Figure 1).

Prior IS studies have well documented the negative relationship between perceived risk and IT adoption (e.g., Nicolaou and McKnight 2006). In this regard, we hypothesize that the increase in perceived risk leads to less actual adoption of e-SCM (H6 in Figure 1). What has been underexplored in the literature is whether this negative relationship is moderated by the IT unit's decision right. Compared to managers from other functional areas, IT managers are more capable of figuring out solutions to deal with the anticipated risk of e-SCM implementation. Therefore, the negative impact of perceived risk on e-SCM adoption can be reduced when the IT unit is involved more in the decision making for e-SCM adoption. We hypothesize that the negative association between perceived risk and e-SCM adoption is stronger when the IT unit has more decision rights (H7 in Figure 1).

Since risk propensity is conceptualized as the willingness to take or avoid risk, we hypothesize a positive association between risk propensity and actual risk decision, e.g., e-SCM adoption (H8 in Figure 1). Furthermore, the theory on reasoned risk-taking (Carpenter et al. 2003) notices that decision makers may not actually convert their risk-seeking willingness into actual risky initiatives in a certain area if they lack experience in this area. In this regard, IT managers'

domain experience is likely to strengthen the positive relationship between the willing to seek risk and the actual risk-seeking actions. Therefore, we hypothesize that the positive association between risk propensity and e-SCM adoption is stronger when the IT unit has more decision rights (H9 in Figure 1). Figure 1 illustrates the theoretical framework and summarizes the hypotheses. In this framework, we also include some exogenous control variables that are potential determinants of the perceived risk and risk propensity.

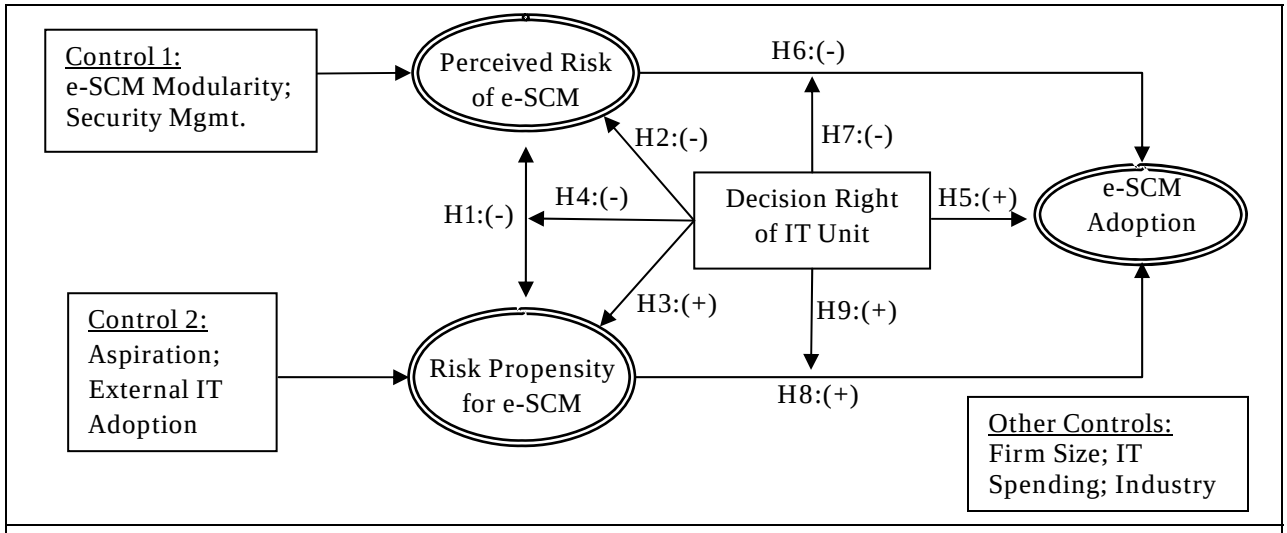


Figure 1: Research Framework

3. Data and Empirical Method

3.1 Data Collection

We empirically test the theoretical framework using a survey dataset of Chinese companies. The survey was conducted in two rounds in March and December 2010 using a Chinese consulting company. We received feedbacks from a total of 341 firms, with 17 firms providing incomplete surveys. Therefore, 324 firms were used in the analysis. The measurement items are developed based on the prior literature.

3.2 Method

The econometric approach we use to examine perceived risk and risk propensity is a simultaneous equations model (SEM) with three-stage least square (3SLS) estimation. The simultaneous equations are specified as follows,

$$PR=\alpha_0 + \alpha_1 RP + \alpha_2 ITDR + \alpha_3 RP\times ITDR + \alpha_4 Mod + \alpha_5 SM + \alpha_6 Other\ Controls + \varepsilon \quad (1)$$

$$RP=\beta_0 + \beta_1 PR + \beta_2 ITDR + \beta_3 PR\times ITDR + \beta_4 Asp + \beta_5 Ext + \beta_6 Other\ Controls + \eta \quad (2)$$

where *PR* – perceived risk, RP—risk propensity, ITDR—IT unit's decision right, Mod—the modularity between e-SCM and internal systems, SM—security management, Asp—managerial aspiration, Ext—external IT adoption of key suppliers and customers. The simultaneous equations of (1) and (2) capture how the two endogenous variables, perceived risk and risk propensity, affect each other in decision making for e-SCM adoption. The error terms ε and η are also assumed to be correlated. To examine the level of e-SCM adoption, we use the following regression model,

$$eSCM=\theta_0+\theta_1 PR+\theta_2 RP+\theta_3 ITDR+\theta_4 PR\times ITDR+\theta_5 RP\times ITDRi+ \theta_6 Exogeous\ Variables+\theta_7 Other\ Controls+\zeta \quad (3)$$

where eSCM—e-SCM adoption. *Exogeous Variables* include *Mod*, *SM*, *Asp* and *Env* that are used in the simultaneous equations of (1) and (2).

Results

As Table 1 illustrates, the results support all hypotheses except H2. The finding suggests that when the IT unit has more decision rights in e-SCM adoption, the company may not necessarily have less perceived risk about e-SCM. A plausible explanation is that the IT unit is likely to well understand the risk associated with e-SCM due to its domain knowledge. When involved in decision making, IT managers bring this knowledge to the decision team and thus help other decision makers to rationally expect the risk. Also, the results suggest that the IT unit motivates the risk taking by enhancing risk propensity, strengthening the positive impact of risk propensity on e-SCM adoption, and weakening the negative impact of risk perception on e-SCM adoption.

Table 1. Results

	Simultaneous Equations Model on Perceived Risk and Risk Propensity				**Regression Model on e-SCM Adoption**	
	Base Model		Full Model		Base Model	Full Model
	Perceived Risk	Risk Propensity	Perceived Risk	Risk Propensity	e-SCM Adoption	e-SCM Adoption
Perceived Risk (*PR*)		-0.276**		-0.570**	-0.038	-0.092†
Risk Propensity (*RP*)	-1.045**		-1.291**		0.181**	0.112*
IT Unit's Decision Right (*ITDR*)	0.504	0.451*	0.272	0.226*	0.101	0.138*
PR × *ITDR*				0.059*		0.062*
RP × *ITDR*			0.052†			0.093**
Coefficient estimation for intercepts and control variables are not reported due to space limit…						
System Weighted R^2	0.516		0.520			
Adj. R^2					0.612	0.624

References

1. Kumar, K., and van Dissel, H. G. 1996. "Sustainable Collaboration: Managing Conflict and Cooperation In Interorganizational Systems," *MIS Quarterly* (20:3), pp. 279-300.
2. Nicolaou, A. I., and D. H. McKnight. 2006. "Perceived Information Quality in Data Exchanges: Effects on Risk, Trust, and Intention to Use," *Information Systems Research* (17:4), pp. 332–351.
3. Sambamurthy, V., and Zmud, R. W. 1999. "Arrangements for Information Technology Governance: A Theory of Multiple Contingencies," *MIS Quarterly* (23:2), pp. 261 – 290.
4. Sitkin, S. B., and Pablo, A. L. 1992. "Reconceptualizing the Determinants of Risk Behavior," *Academy of Management Review* (17:1), pp. 9–38.
5. Weill, P., and Ross, J. W. *IT Governance: How Top Performers Manage IT Decision Rights for Superior Results.* Harvard Business Press, Boston, Massachusetts, 2004.

Victimized by Phishing: A Dual-Process Information Processing Perspective

Wei Zhang	Xin Luo	Zhengchuan Xu
Univ. of Massachusetts Boston	The Univ. of New Mexico	Fudan University
Wei.zhang@umb.edu	luo@mgt.unm.edu	zcxu@fudan.edu.cn

Abstract

To the extent that phishing has become a serious threat to information security, there has been rather limited theory-grounded research on this burgeoning phenomenon. In this paper, we propose a study on victimization by phishing based on the Heuristic-Systematic Model of information processing. We argue that the Heuristic-Systematic Model offers an ideal theoretical framework for investigating the psychological mechanism underlying the effectiveness of phishing attacks, and present a preliminary research model based on the theory.

Keywords: Phishing, Information Security, Heuristic-Systematic Model, Victimization

1. Introduction

The last two decades witnessed the dramatic advances in information and communication technologies that lead to easier, quicker, and more convenient access to information and, in essence, funds in an electronic form. Unfortunately, the ever expanding Internet and communication networks have facilitated reaching not only regular businesses and their consumers but also users with malicious intentions, exposing valuable digital assets to potential criminals. Consequently, information security management that can safeguard the digital information and funds is becoming increasingly important to business survival and success in today's keenly competitive environment.

Answering the calls for more effective information security management to counter various types of attacks aiming at their digital assets, businesses have invested heavily into a plethora of technologies. However, security breaches reported were seldom because of technological superiorities by offenders and/or organizations' concern about public image vis-à-vis their capabilities of harboring consumers' private information under such circumstances. In a widely reported case in China, suspects simply sent out text messages, instructing unsuspecting victims to provide their account information through a website resembling a well-known online banking portal. Referred to as phishing, such low-tech, seemingly simple deceptions can be surprisingly effective and lead to enormous financial losses for the victims.

Phishing attacks are designed to exploit human cognitive biases instead of technology loopholes. Phishing offenders often masquerade as a credible figure and broadcast manipulative messages – through emails, instant messages, or short messages – to a large population. While the validities of the messages may not be difficult to disprove on a second thought, victims are usually caught off-guard at first glance. Victimized by phishing are thus beyond the technological control and subject to human cognitive nature. As such, psychological and behavioral factors arguably play a more important role, but little research has attempted to identify, describe, and analyze them systematically. This paper is one of the early scientific initiatives endeavoring to bridge the gap and to further advance this line of research in the information systems arena.

Drawing on a dual-process theory of information processing, we propose an empirical study that investigates the human factors and psychological mechanism associated with phishing attacks based on Heuristic-Systematic Model. We begin with introducing the model and explaining why it can be applied to study victimization by phishing. We then develop a preliminary research model, followed by a brief discussion on research method. A short discussion on potential contributions concludes the paper.

2. Heuristic-Systematic Model

Heuristic-Systematic Model is a dual-process theory of information processing (Chaiken and Trope 1999) originated from persuasion research in social psychology. Persuasion research studies how received messages can change people's attitudes. The gist of the dual-process theories holds that when being persuaded, people must first establish the validity of the received message; but in addition to the information content of the messages, people also consider the factors surrounding the messages, for example, source credibility and message length.

The dual-process in HSM involves two information processing modes: *systematic processing* carefully elaborate on the information content of the received message and *heuristic processing* takes advantage of the factors surrounding the messages – called heuristic cues in HSM – and uses associated heuristics to quickly make a validity assessment. Compared with heuristic processing, systematic processing is more effortful and takes more cognitive resources such as time and energy. According to HSM, both information processing modes can lead to decisions on the validity of received messages, but neither is automatic. Systematic processing will be limited if a message recipient is not motivated to elaborate on the message, is not mentally capable of making sense of the message, or does not have enough cognitive resource to adequately process the message. Heuristic processing depends on the availability of cues and awareness of the heuristics associated with these cues. If a cue is not available to the message recipients, or if the message recipients are not aware of the implications of the cue, they cannot process the content heuristically. When conditions for both systematic and heuristic processing are met, HSM contends that both processing modes can and do occur concurrently. However, because extensive systematic processing "provides people with more judgment-relevant information" (Eagly and Chaiken 1993, p328), high levels of systematic processing can attenuate the effects of heuristic processing, so much so that the validity assessment resulted from heuristic processing can be overturned (Chaiken 1980).

The theoretical uniqueness of HSM among the dual-process theories family is in the concept of *sufficiency threshold*. Sufficiency threshold refers to the "desired judgmental confidence" that people wish to reach when making decisions under a given circumstance (Eagly and Chaiken 1993, p330). HSM argues that when message recipients engage in validity assessment, the level of their confidence in their assessment must reach or surpass sufficiency threshold for them to be comfortable with their judgment. They will continue processing the message as much as possible until the sufficiency threshold is attained. Therefore, when heuristic processing alone cannot lead the message recipients to achieve the sufficiency threshold, it is likely that they will invoke systematic processing, even though it is more effortful and demands more cognitive resource.

The nature of phishing attacks is to mislead message recipients into making a quick but incorrect assessment of the validity of false messages. Thus from HSM's perspective, the success of

phishing attack depends on whether the attacker can 1) provide a message that can stand systematic processing, 2) promote heuristic processing and/or suppressing systematic processing; and/or 3) reduce the sufficiency threshold. In this sense, HSM provides an ideal theoretical framework to understand victimization by phishing.

3. Research Model

To illustrate how HSM can be employed to investigate how phishing leads to victimization, we build a preliminary research model (Figure 1). In previous HSM research, systematic processing has been assessed by examining the effect of the argument quality – "the strength or plausibility of persuasive argumentation" (Eagly and Chaiken 1993, p325) – of the message on validity assessment. When systematic processing occurs, high quality arguments lead to favorable message assessment. In the current research context of phishing attacks, false messages are used with the intention to mislead the message recipients. High level of argument quality that can stand message recipients' systematic processing will increase the likelihood that they be victimized. Therefore, we hypothesize:

H1. Message recipients will be more likely to be victimized by phishing messages with high argument quality.

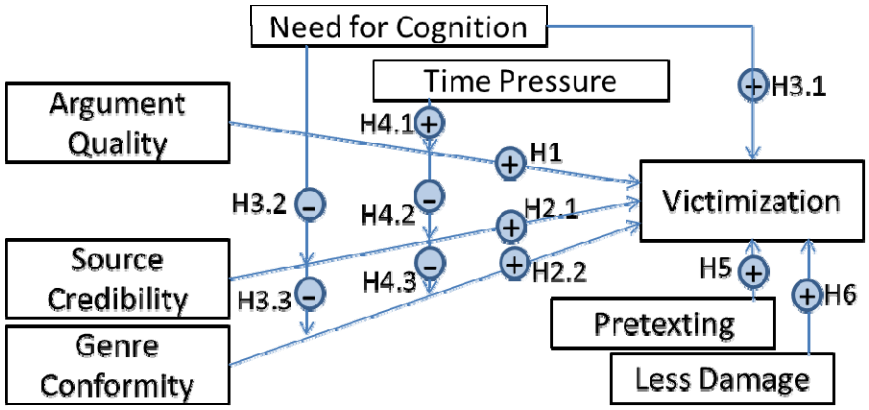


Figure 1: Proposed Research Model

Heuristic processing depends on the ready availability of heuristic cues. One heuristic cue that has been extensively studied (Sussman and Siegal 2003; Zhang and Watts 2008) and that phishing offenders particularly like to take advantage of is source credibility: Most phishing messages would assume a false source identity and pretend to be from credible sources such as friends or authoritative departments. The effectiveness of (false) source credibility has been repeatedly demonstrated in actual phishing attacks, thus:

H2.1. Message recipients will be more likely to be victimized by phishing messages pretending to be from a source with higher level of source credibility.

Another heuristic cue that we propose to study in this study is genre conformity. Genres are "socially recognized types of communicative actions that are habitually enacted by members of a community to realize particular social purposes" (Orlikowski and Yates 1994, p. 542). Serving as templates for communications (Orlikowski and Yates 1994), they represent the association between communication formats and communication purposes (Yates et al. 1999), and help to improve communication efficiency and effectiveness. As businesses communicate with their customers electronically, over time they develop certain communication genres for certain

communication purposes. Especially, the email and/or message templates frequently used by businesses when sending mass communications to customers further reinforce the development and use of such genres. Phishing offenders can abuse these genres by forging their messages to resemble legitimate messages and bias the recipients into believing the validity of the messages (Zhang and Watts 2003). In this study, we refer genre conformity to the extent to which the composition of a phishing message conforms to the relevant genre used by a legitimate message it attempts to mimic, and posit:

H2.2. Message recipients will be more likely to be victimized by phishing messages with higher level of genre conformity.

Factors that can affect the extent of systematic processing and heuristic processing are typically modeled as moderators in research using dual-process theories (e.g., Sussman and Siegal 2003; Zhang and Watts 2008). In this study, we focus on one personality variable, need for cognition, and one contextual variable, pressure for immediate action. Need for cognition refers to the intrinsic desire for a person to comprehend and structure environmental information. It captures individual differences in dispositions to engage in effortful cognitive activities (Cacioppo and Petty 1982; Petty and Cacioppo 1986). Previous suggested that people with higher level of need for cognition are more likely to engage in systematic processing and less likely to be influenced by heuristic processing. Since an increased level of systematic processing is more likely to reveal the fallacy of phishing messages, messages recipients with higher level of need of cognition are less likely to be victimized. Thus we hypothesize:

H3.1 Message recipients with higher need for cognition is less likely to be victimized.

H3.2 Effect of source credibility on victimization will be less for message recipients with higher need for cognition than for those with lower need for cognition.

H3.3 Effect of genre conformity on victimization will be less for message recipients with higher need for cognition.

Systematic processing demands cognitive resources such as time and energy. If message recipients are distracted, or are pressed for time, systematic processing will be suppressed. Some phishing attacks attempt to exaggerate the urgency of the situation and press the message recipients into actions as soon as possible, thus preventing them from engaging in an increased level of systematic processing. Under such circumstances, message recipients usually have to reply on heuristic processing to make erroneous decisions. Considering the increased reliance on heuristic processing, we hypothesize,

H4.1 Phishing messages that impose more time pressure decreases the effect of argument quality.

H4.2 Phishing messages that impose more time pressure increases the effect of source credibility.

H4.3 Phishing messages that impose more time pressure increases the effect of genre conformity.

Lastly, we explore factors that can lower the sufficiency threshold for message recipients. Pretexting is a commonly used technique in social engineering attacks, with which offenders use a pre-designed scenario to legitimize their interactions with potential victims, reduce their suspicions, and eventually mislead them to give away sensitive information or perform actions that would be deemed atypical or in violation of company policies otherwise (Mitnick and Simon

2002). In the context of phishing, pretexting may be difficult to design, but it may simply be the result of coincidences: a company may have experienced an email system failure just before their employees received phishing messages asking for their email account information. Either way, we argue that pretexting can lower the sufficiency threshold of message recipients, and hence:

H5. Phishing attacks coupled with pretexting are more likely to victimize message recipients.

We also believe that phishing messages targeting less damage will lead the message recipients to care less about the message validity and more likely to act as instructed by the message:

H6. Phishing attacks targeting less damage are more likely to victimize message recipients.

4. Proposed Research Method

The research model presented in Figure 1, of course, is merely preliminary. The constructs and hypotheses, therefore, need to be further developed, refined, and operationalized to enhance their rigor and appropriateness for further parsimonious investigations. Both qualitative and quantitative data will be collected to test the final research model and hypotheses. Qualitative data collected through field observations and interviews will allow us to gain more first-hand insights into the phishing attacks and the messages they use, and provide us with the opportunity to verify our theoretical reasoning and refine it. Quantitative data collected through scenario-based surveys and carefully-designed experiments allow us to test the hypotheses in a positivist way. Through triangulating the findings from both studies, we can gain more confidence in the validity of the findings and hope to present scientifically rigorous outcomes in the near future.

5. Discussions

In this article we propose a study of the victimization by phishing based on HSM, and call for more research attention to this serious threat to information security. Through this study, we hope to offer instrumental insights to the often neglected human aspects of information systems security management and to theoretically advance behavioral information security research. Applying HSM to victimization by phishing, we hope to test it in a completely new research context, and potentially advance this popular theory. We are also optimistic that the results can pragmatically inform business decision-makers of how employees can deal with phishing attacks and social policy-makers of how public can recognize and circumvent phishing attacks

References

1. Cacioppo, J.T., and Petty, R.E. 1982. "The Need for Cognition," *Journal of Personality and Social Psychology* (42:1), pp. 116-131.
2. Chaiken, S. 1980. "Heuristic Versus Systematic Information Processing and the Use of Source Versus Message Cues in Persuasion," *Journal of Personality and Social Psychology* (39:5), pp. 752-766.
3. Chaiken, S., and Trope, Y. (eds.). 1999. *Dual-Process Theories in Social Psychology*. New York: The Guilford Press.
4. Eagly, A.H., and Chaiken, S. 1993. *The Psychology of Attitudes*. Orlando, FL: Harcourt, Brace, & Janovich.
5. Mitnick, K.D., and Simon, W.L. 2002. *The Art of Deception: Controlling the Human Element of Security*. Indianapolis, Ind.: Wiley Publishing, Inc.
6. Orlikowski, W.J., and Yates, J. 1994. "Genre Repertoire: The Structuring of Communicative Practices in Organizations," *Administrative Science Quarterly* (39), pp. 541-574.
7. Petty, R.E., and Cacioppo, J.T. 1986. *Communication and Persuasion*. New York: Springer - Verlag.

8. Sussman, S.W., and Siegal, W.S. 2003. "Informational Influence in Organizations: An Integrated Approach to Knowledge Adoption," *Information Systems Research* (14:1), pp. 47-65.
9. Yates, J., Orlikowski, W.J., and Okamura, K. 1999. "Explicit and Implicit Structuring of Genres in Electronic Communication: Reinforcement and Change of Social Interaction," *Organization Science* (10:1), pp. 83-117.
10. Zhang, W., and Watts , S. 2003. "Knowledge Adoption in Online Communities of Practice," *ICIS 2003*, Seattle.
11. Zhang, W., and Watts, S. 2008. "Capitalizing on Content: Information Adoption in Two Online Communities," *Journal of Association of Information Systems* (9:2), pp. 73-94.

Improving Emergency Management through Organizational Capabilities

Abstract

Emergency incidents such as hurricane, flood, and tornado have greatly interrupted social and economic dynamics, causing enormous losses of human lives and property. Despite its strategic importance, emergency management is not well understood. In this research-in-progress, we explore emergency management through the lens of organizational capability literature. We identify the key human capabilities and technical capabilities in emergency response and discuss how they jointly contribute to incident mitigation that directly leads to response performance as measured by loss reduction.

Keywords: Emergency management, organizational capability, IS, human systems

1. Introduction

Emergency response is the process of gathering and deploying resources to reduce loss of life and property when an incident strikes. Emergency incidents may be natural or manmade and include traffic accidents, fire and explosion, floods, tornados, earthquakes, nuclear or biological attacks, and chemical leakage. Incident response is threatened by uncertainty; sudden and unexpected events; risks of possible mass casualty; high time pressure and urgency; large-scale impact and damage; and the disruption of infrastructure support necessary for coordination [1]. To minimize incident loss, it is imperative that response teams utilize task critical resources, technical and non-technical, to mitigate the threats and bring the community back to normal. Although there have been many successes, failures in incident response are frequently documented in large scale incidents such as the 9/11 attack and Hurricane Katrina. Understanding of past responses and informed preparation for future responses can increase efficiency and ultimately efficacy.

There is a need for theoretical frameworks of emergency management to guide response research [2]. The vast majority of prior literature in this area explores the technical designs of emergency response systems. Little is known about the theoretical underpinning of emergency response or the management factors that impact response performance. This research-in-progress investigates emergency response through the lens of capability literature. The article explores the potentials of human and technical capabilities in explaining organizational performance within extreme contexts such as emergency incidents. Wade and Hulland advocate that "information systems exert their influence on the firm through complementary relationships with other firm assets and capabilities" [7]. In the context of emergency management, we identify the major capabilities as stemming from human systems and technical systems and discuss how they jointly contribute to emergency response. We suggest that IS capabilities such as asset allocation, channel reliability, and dispatch capability cultivate incident mitigation. Meanwhile, we posit that human capabilities such as training and stress complement IS capabilities in shaping incident mitigation. Finally, we postulate that core competence such as incident mitigation directly leads to response organizational performance that is measured by reduction of human lives and properties.

2. Literature Review and Theoretical Background

2.1 Literature Review

Emergency management has been the interest of information system discipline since the 1980s [8-10]. In the wake of incidents such as 9/11 attack, more research endeavors have been observed. Existing research in emergency management falls into two major categories.

Principles of emergency response system design and evaluation. This stream of research has focused on developing general design principles for dynamic emergency response management information systems [11]. There have been several efforts each involving a unique approach. Chen et al explored system designs that support simple-single, complex-single, and multi-incident emergencies [1]. Others have proposed methods for assessing the quality of emergency information systems [12], while still others have developed and validated instruments that evaluate the efficiency of critical incident management systems [13]. Some researchers in this stream have developed architectures and a prototype of a virtual information center (VIC) [14] while others have developed palm-based mobile clinical support systems for Mobile Emergency Triage (MET) [15]. This stream also includes papers that have examined the use of data warehousing in the design of bioterrorism surveillance systems [16]. Chen et al. developed a data model to support information sharing among key stakeholders in chemical incident response [17]. In a similar vein, Fruhling designed and analyzed a public health emergency response system STATPack [18].

Strategies for emergency incident management. The study of incident coordination, proposed management frameworks, and the role of IT have been highlighted in this stream [19]. Constantinides et al for instance, studied the way in which high reliability organizations sustain a distributed coordination of expertise in incidents [20]. Mendonca analyzed the 9/11 attack response and derived rules for cognitive level decision improvisation [21]. Adrot and his colleagues have examined IT enabled improvisation with its relationship to dynamic capabilities and organizational routines [22] and summarized the set of exogenous variables that affect IT use in crisis response situation [23]. Marich et al developed a normative enterprise architecture for guiding end-to-end emergency response services [24]. Park et al studied the impacts of disaster on information system infrastructure and examined the relationship between organizational resilience and information infrastructure effectiveness [25]. Sujanto et al developed emergency management domain ontology to be shared across emergency agencies and systems [26].

Despite the knowledge gained so far, little is known about a systematic theoretical underpinning of emergency response and the management factors that contribute to response success [27]. Much of the advancement is achieved through technology oriented designs and analysis of life experience. In this subsequent section, we draw on relevant strategy literature to offer preliminary framework that helps explain the imperative sources to response success.

2.2 Theoretical Background

In this research-in-progress, we explore emergency management through capability literature. Capability literature argues that organizations create competitive performance by collecting, binding, and leveraging firm resources to create organizational capabilities [28, 29]. Organizational capability is defined as "a set of differentiated skills, complementary assets, and routines that provide the basis for a firm's competitive capacities and sustainable advantage in a particular business" [30]. Capability has been referred in prior literature as distinctive

competence[31], core or organizational competencies, firm-specific competence, and invisible assets. Capabilities subsume the notion of organizational competencies and transform inputs into outputs of greater value [32, 33]. They are repeatable patterns of actions that are effective in utilizing resources in meeting operational and strategic goals and objectives.

Leonard-Barton suggested that organizational capability is embodied in employee knowledge and skills and embedded in technical systems as well [35]. Knowledge and skills embodied in people is one that is most often associated with capabilities and one that is relevant to innovative organizational practices. These knowledge and skill encompasses organizational specific understanding in firm procedures, and policies, and operational techniques. Technical systems, on the other hand, are co-structured and created by employee, organizational routines, and the social environment over years of accumulation. These physical production or information systems represent complications of knowledge and relatively more important to organizations that have intensive demand on information processing, decision making, and coordination and collaboration. Bharadwaj et al theorized IT capabilities and identified major contributors as IT business process integration, IT infrastructure, and external IT linkage [36]. IT business process integration refers to the ability of an organization to align IT investments with organization objectives. It requires the restructuring of existing IT systems and processes to ensure that business is served and that new opportunities for process efficiency are exploited. IT infrastructure refers to the foundation for organizational applications and services and it consists of data, network, and processing architectures. External IT linkage refers to technology based connections between an organization and its key business partners such as external collaborators. Electronic distribution systems (e.g., EDI network) that span over the boundaries of firms facilitate in-depth interactions with the strategic partners and foster sharing of information and intelligence.

The key tenets of the capability literature have significant implications for the current study. First, emergency management relies heavily on human capabilities of the response organization. Among others, response knowledge of the participating agencies is vital. To offer mitigation relief in a timely manner, first responders are operating within a short time window. Task critical knowledge, for example, in risk and hazard assessment, intervention tactic planning, and progress evaluation adds vital support to responders in developing response strategies. Meanwhile, veteran responders are equipped with skills in coping with the trying conditions in emergency scenarios. Incidents response is challenged by high time pressure, unpredicted course of development, and significant risks. Adverse factors as these cultivate a highly volatile, complex, and dynamic environment which is rarely observed in normal business context. The emergency context introduces stress factors and skills in handling these stressors are essential to responders in making satisfactory performance in their duties.

Second, emergency management demands technical capabilities to mitigate the impacts of emergency events. By leveraging these resources, a response team obtains a supreme capability in utilizing the response efforts and maximizing the strength of mitigation. Consistent with the theorizing of IT capability [36], technology assisted emergency management capability is fostered by response business process integration, IT infrastructure, and external IT linkage. First, modern emergency management has increasingly aligned cutting edge technologies with the core response processes. System modules that support rapid decision making in allocating response

asset (e.g., sandbags and fire engines), for example, is a much needed integration in optimal allocation maximizes the value of the limited response assets [37]. Second, incident response teams have adopted communication systems such as wireless network, 800M Hz radio, and satellite phones. These systems enable responders attacking an incident to stay connected, share information, and foster a common understanding of the incident. Third, emergency mitigation consists of both onsite and EOC response. The onsite team mitigates the immediate threats in a reactive manner and works with the local picture stemming from the scene. An EOC is staffed with senior supervisors and it leverages external resources to help onsite response. As a consequence, the ability of an onsite team to link to an EOC is vital to sure that local responses will proceed successfully with all the support and directions.

3. Conceptual Model and Research Hypotheses

Deployment and utilization of response resources foster incident mitigation support that is of great interest to emergency practitioners [12, 44]. Support for incident mitigation is mostly concerned about the speed of response planning and the efficacy of mitigation operations. Specifically, mitigation support helps responders update situation reports, reach quick decisions, develop action plans, and coordinate onsite teams. With a high level of mitigation support, the performance of an incident response increases. We assess response performance through incident loss reduction which measures the savings of human lives and properties as a result of emergency management [38]. The response community is able to discern the differences that response efforts bring in decreasing the devastating outcome of an incident, owing to an abundant volumes of lost estimation guidelines, frameworks, and tools developed by organizations such as Federal Emergency Management Agency [52, 53]. As a consequence, responders are skillful in gauging the reduction of incident loss due to organized intervention – emergency management. We hypothesize:

Hypothesis 1: Incident mitigation will positively relate to incident loss reduction.

Response asset allocation is a key issue of emergency management and IS capability facilitating this process bears strategic importance. Asset allocation systems manage personnel and organizational contacts, training, certification, and special skills, equipment inventory for organizations, departments, and facilities, and NIMS-typed equipment description and specification. They also match available assets with requests, schedule transportation and delivery, and track the deployed asset through integrated Geographic Information Systems (GIS).. With proper support in asset allocation, emergency management leverages the limited response assets to avoid over- or under-allocation and to subsequently build a high level of incident mitigation support. As a result, we postulate:

Hypothesis 2: Asset allocation capability will positively relate to incident mitigation.

Reliable communication channels strengthen mitigation support of an emergency response system. Responders are often dispersed at the scene when attacking to an incident. Take a residential fire incident for example, the onsite response team may consist of varying groups who secure the perimeter, launch attacks from multiple entries (e.g., front door and back door), operate tanks for water supply, and stand by as backup forces. Communication channels enable real-time information sharing, establishing a “common operational picture” to keep all on the same page [50, 51]. Through information transfer, responders working on varying aspects of the

mitigation tasks are able to synchronize their visions on the focal incident, smooth out potential inconsistencies, and synthesize a complete "shared mental model" [52]. Hence we hypothesize:
Hypothesis 3: Channel reliability will positively relate to incident mitigation.

Dispatch systems are imperative sources in building technology capability in the face of high-velocity environments. A dispatch system is located offsite at EOC which is a supervisory center in incident management. Through a dispatch system, senior advisors (e.g., director of emergency service) offer assistance to onsite response teams via (1) response intelligence, (2) supportive response assets, (3) supportive arrangements (e.g., area evacuation), and (4) commands that intervene onsite operations. For local teams, a dispatch system renders a lifeline to the external assistance. Yet dispatch systems for emergency management are likely to be flooded by a high volume of requests when an incident takes place. A response dispatch system with sufficient capacity is, therefore, necessary to ensure that queries and responses flow smoothly between onsite and EOC so as to increase the mitigation support.
Hypothesis 4: Dispatch system capacity will positively relate to incident mitigation.

Incident mitigation may be hampered by the presence of psychological stress. Due to the fact that incidents are highly unexpected in nature and that they are of high social and economic impacts, emergency response introduces psychological stress which concerns the state of mental tension, preoccupation, and agitation. Responders may also experience stress out of concern for their families who may be in the affected region. This psychological stress may lead to physical and mental dysfunction and disorder, prohibiting responders from fully engaging in incident response. When a responder is skillful in stress coping, he or she is likely to perform well under the demanding environment and hence save more properties and human lives. Therefore we hypothesize:
Hypothesis 5: Responder stress coping ability will positively relate to incident mitigation.

Responder stress coping ability of a responder may be enhanced by professional training that he or she receives. Training in emergency response concerns about the standard operating procedures of incident response and it does not necessarily cover technology use. Training helps responders make informed and quick response decisions when facing complex scenarios. Consequently, training contributes to improved stress coping ability as it reduces the typical emergency stressors such as workload, time pressure, operational risk, and desire to achieve acceptable results under uncertainty. Preliminary evidence suggests that training has a causal effect upon stressors as it alleviates role ambiguity, role overload, role conflict and job future uncertainty [42]. Therefore, we hypothesize that:
Hypothesis 6: Response training will be positively related to responder stress coping ability.

Conclusion

In this paper we explore emergency management through the lens of capability literature. The research model captures the unique roles of human and technical capabilities in the context of emergency management. Future work includes data collection and empirical validation which is already underway.

References

Available upon contact with the corresponding author.

Patterns and Driving Factors of C2C Seller Growth

Weijia You	Mu Xia	Lu Liu
Beihang University	Santa Clara University	Beihang University
weijiawx@gmail.com	mxia@scu.edu	liulu@buaa.edu.cn

Abstract

In this paper, we present a method utilizing the Hidden Markov Model (HMM) and clustering of time series data to study the growth patterns of individual online sellers in a C2C market. We also apply multinomial regression to further analyze the factors driving the growth. Analysis of 1092 Taobao entrepreneurs is provided to demonstrate the feasibility of the method.

Keywords: C2C, Online sellers, Hidden Markov Model, Clustering of Time Series Data, Multinomial Regression

1. Introduction

Chinese C2C markets have seen explosive growth of entrepreneurs recently, reaching 12 million in June 2010 (Research Center of Chinese C2C market, 2010). Such business activities have increasingly contributed to a larger share of the economy in China and have been actively promoted by the government. However, there is little understanding of the growth patterns of these online entrepreneurs, or the critical factors that impact their growth.

Existing work in online entrepreneur growth is mostly exploratory and qualitative. For example, Luo et al. (2009) analyzed a Chinese C2C online auction market and found that transaction volumes follow a certain periodical pattern that negatively correlates to the sellers' tenure. Lu (2009a, 2009b), using a case-study approach, identified four phases in the growth path of individual online entrepreneurs: startup period, development period, matured period, and company operation period. She also discussed the constraints of online entrepreneur and suggested growth strategies for overcoming these constraints.

We take an empirical approach that takes advantage of a large dataset from Taobao, the largest online C2C market in China. We propose a method to model the growth pattern of netrepreneur based on HMM. Based on this model, we employ unequal length time series clustering to classify the growth patterns of entrepreneurs. Furthermore, multinomial regression is applied to analyze the influence of all the related factors.
The paper is organized as follows. We describe our method in detail in Section 2. An experiment of the analysis on 1902 Taobao entrepreneurs is provided in Section 3. We draw the conclusion in Section 4.

2. Methodology

2.1 Growth model based on HMM

Hidden Markov Model (HMM) is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobserved (hidden) states. In this study, we assume the

monthly sales are the observations, and we infer the state transitions (level of development) from these observations. As the number of products sold in one month is discrete, we assume it's a random variable following the Poisson distribution:

$P(X=k)=\frac{e^{-\alpha}\alpha^{k}}{k!}$, where the mean and variance are both equal to α .

By setting the value of α , the states can be ordered:

$$\alpha=\min+\left(\left(\max-\min\right)\Big/N\right)*i, i=0,1,\ldots N-1$$

Then the growth model of entrepreneurs can be modeled as a triple $\lambda=(A,B,\pi)$, where:

$A=\{a_{ij}, 1\le j\le N\}$, a_{ij} stands for the transition probability from state S_i to state S_j.

$B-\{b(o|S_j)\}$ stands for the probability of observing o when in state S_i.

$\pi=\{\pi_i\}$ stands for the probability of initial states.

$S=\{S_1, S_2, \ldots, S_N\}$ stands for the collection of states sellers could be in.

2.2 Clustering on the netrepreneurs

There are many methods for time series clustering, many of which only work well with time series of equal length (Liao 2005). In this study, based on the hidden Markov model we have established in Section 2.1, similarity-based clustering of sequences using Hidden Markov Models proposed by Bicego et al. (2003) is applied for clustering the entrepreneurs. The main idea of this method works as follows.

①┌ Set a sequence as the "reference" for comparison.

②┌ Train each sequence to get its HMM using the Baum-Welch algorithm

③┌ Calculate the similarity of each sequence to the "reference" set, so that each sequence is transformed to the point in high-dimension space.

④┌ Apply the regular methods, like k-means for clustering of these points.

⑤┌ Find the point closest to the center of each class and take it as the representative of each cluster.

2.3 Factor analysis

Because the clusters we obtained from the clustering in Section 2.2 are not ordered, multinomial logistic regression is adopted in this step to study the impact of factors of growth pattern:

$$P(Y_i = j)=\frac{\exp(\alpha_j' z_i)}{1+\sum_{j=1}^{4}\exp(\alpha_j' z_i)}, (j=1,2,\ldots,m); (i=1,\ldots n),$$

Where, m stands for the number of the clusters we get from section 2.2, α_j is the vector we are going to estimate, and z_i is a vector representing the factors which are hypothesized to influence the growth pattern.

3. Data Analysis

3.1 Data collection

In this study, monthly sale is adopted to approximately measure the performance of entrepreneurs. To tease out the influence of fluctuation of product life cycle on monthly sale, we chose the sellers of a product with a near-constant overall demand, diapers. We analyze 1902 sellers that have positive sales for more than 10 months.

3.2 Clustering and Growth Pattern

Through the five steps introduced in Section 2.2, we calculated the Silhouette value when N = 3,4,5,6,7. As Fig 1 shows, we should choose k =6 which means that we should separate the sellers into 6 clusters.

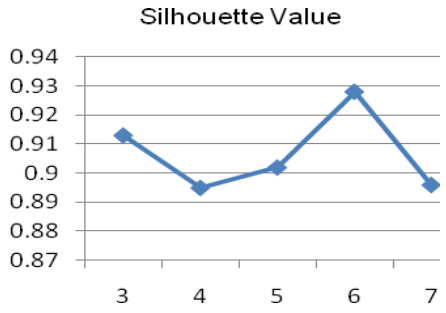
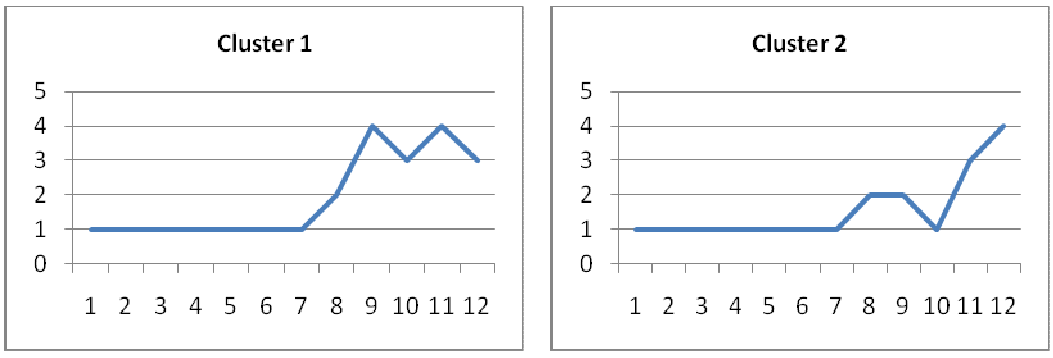


Fig 1. Silhouette Value V.S. Number of Clusters

After obtaining the labels of each seller, we find the seller at the center of each cluster, and we use them as the representative of this cluster for further analysis. By applying the Viterbi algorithm, we map the observations to the transition of states (See Fig 2).

Cluster 1 shows the sellers who stay at low level for about half a year and transition to state 3 and state 4. We deem it the "ideal" growth pattern. Sellers in cluster 1 account for 3.6% of all the 1902 sellers. Cluster 2, which accounts for 3.8% of all sellers, also shows a good growth pattern. Cluster 3 and cluster 4 have notable fluctuations in their growth. The two clusters represent about 11%. Cluster 5 account for less than 2% of all the sellers. Cluster 6 represents the majority (79.6%) which shows an annual fluctuation.



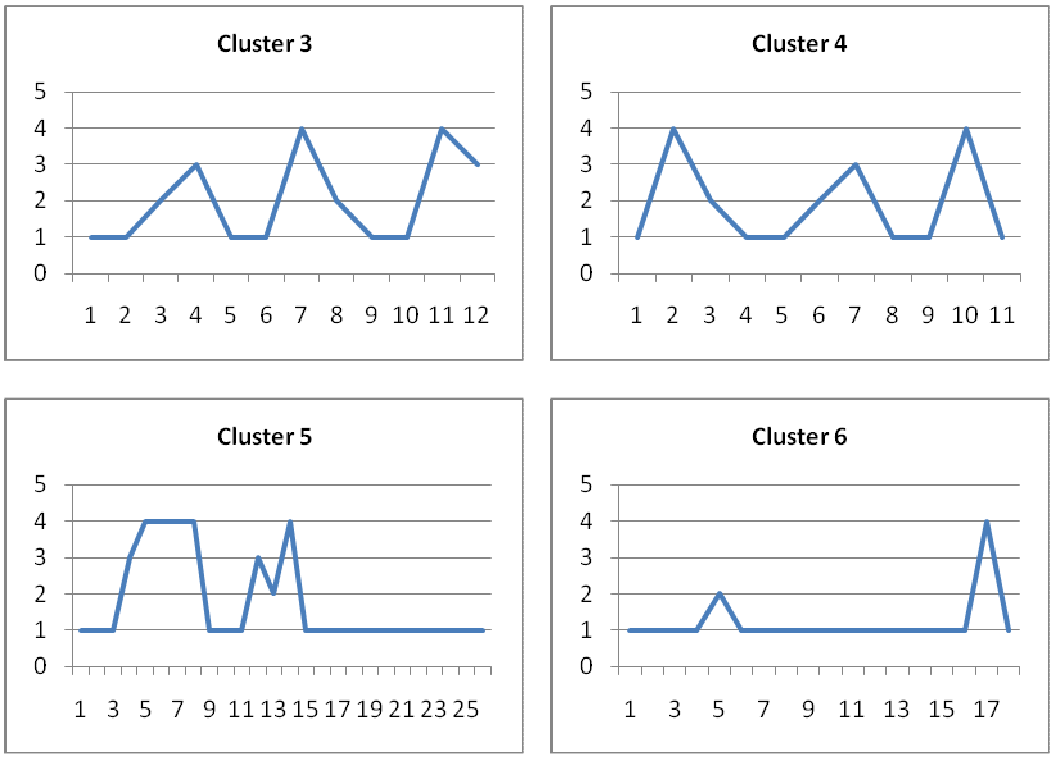


Fig 2.Six growth patterns of 1902 netrepreneurs

3.3 Factor Analysis

From Section 3.2, we can see that sellers with good growth patterns (cluster 1 and cluster 2) all have a half-year "start-up" period before taking off. Next, we intend to understand what factors actually drive such growth. We identify the factors from the perspective of resources (scale of business and diversity) and capability (operation and service). See Table 1 for the factors and related variables, as well as the descriptive statistics.

Table 1 Descriptive statistics of independent variables

Factor	Variable	Obs	Mean	Std Dev	Min	Max
Scale	Number of products	1092	317.17	340.48	11.5	2614
Diversity	Number of categories	1092	5.41	2.91	1	19.08
Service capability	whether or not the seller is in consumer assurance program	1092	0.62	0.49	0	1
	rate of good comments	1092	0.99	0	0.96	1
Operation capability	Number of being collected	1092	8.58	10.7	1	106.14
	rate of view to purchase	1092	0.05	0.04	0	0.36

As the key variables are all skewed in their distribution, log form is used in multinomial regression. We took cluster 6 as the base for comparison. The result is quite interesting and has some implications for the sellers in this industry (See Table 2). Contrary to intuition, service capability is not significant among different growth patterns. The important factors are scale and diversity of products, as well as the operation capability. The negative coefficient of the variable "number of products" shows that it is better to have fewer products, while the positive coefficient of the variable "number of category" shows that diversity is necessary for successful development. Combining above two implications, we may infer that sellers with better growth

pattern are those who are better at picking out most competitive products. Operation capability is also very important, but how to be competitive on these two indicators requires further study on these sellers.

Table 2 Estimation Result

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
# of product	-0.843**	-1.153***	-0.430	-1.021***	0.123
	(0.277)	(0.285)	(0.256)	(0.232)	(0.355)
# of category	1.050*	1.432***	0.559	1.014**	1.421**
	(0.410)	(0.424)	(0.375)	(0.329)	(0.547)
# of being collected	0.902**	1.214***	0.626*	1.530***	0.198
	(0.293)	(0.309)	(0.267)	(0.249)	(0.337)
rate of view to purchase	0.335*	0.376**	0.447***	0.346**	0.526**
	(0.136)	(0.122)	(0.114)	(0.105)	(0.161)
rate of good comments	53.28	7.670	37.14	-38.80	-29.94
	(63.83)	(52.06)	(54.98)	(31.04)	(46.16)
in/not in consumer	0.448	-0.192	0.679	-0.106	1.075
assurance program	(0.431)	(0.402)	(0.415)	(0.324)	(0.608)
constant	-1.112	-0.329	-1.664	-0.681	-6.261***
	(0.956)	(0.938)	(0.903)	(0.784)	(1.514)

Standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05

4. Conclusion

This paper proposed a method to model the growth pattern of online entrepreneurs based on HMM. By applying a method of time series clustering, we obtain the primary growth models of entrepreneur. Multinomial regression is applied to analyze the influence of related factors from both the views of resource and capability.

References

1. Bicego, M., Murino, V., & Figueiredo, M. "Similarity-based clustering of sequences using hidden Markov models". *Machine learning and data mining in Pattern Recognition*, 2003, (2734), pp 95-104.
2. Liao, T. W. "Clustering of Time Series Data—A Survey". *Pattern recognition*, 2005, 38, pp. 1857-1874.
3. Lu, X. "Research on Internet Individual Entrepreneurs' Growth and Sustainability—Evidence from Taobao.com Sellers", *Economic Management Journal*, 2009, 4, 31 (4), pp. 64-69.
4. Lu, X. "The Constraints of Individual Internet Entrepreneurs Transformation: Evidence from Taobao.com Top Sellers". *Proceeding of the second netrepreneurs and E-business Ecosystem Seminar*, Hangzhou, 2009. pp. 18-23.
5. Luo, B., Lin, Z. X., Xie, M. Z., Zhang, T. "Discovering Online Sellers Growing Patterns from the Sampling Data of C2C Auction Market", *Proceeding of the second netrepreneurs and E-business Ecosystem Seminar*, Hangzhou, 2009, pp. 8-17.
6. Rabiner, L. R. "A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition". *Proceedings of the IEEE*, 1989, 77(2), pp. 257-286.
7. Research Center of Chinese E-Business, 2010 Report on Chinese E-Business, http:// b2b.toocle.com/zt/down/2010jc.pdf

Effects of Friendship Links on Online Sellers' Performance: An Empirical Study

Abstract

Online marketplace has led to the appearance of sizeable sellers. Friendship links, which are hyperlinks generated by sellers and shown on their storefronts, functionally bridge online stores while facilitating the navigation of buyers. Few extant studies have examined the effects of this new marketing vehicle on seller performance. Based on analyses of an unique dataset involving more than 1919 Taobao sellers, we argue and empirically verified that the effects of friendship links are contingent on sellers' capability. Specifically, empirical findings are: 1) incoming friendship link has significant and positive effects on seller performance, while outgoing friendship link has no such effects; 2) incoming link and seller capability (measured by seller credentials and number of merchandises) have synergy effects. Sellers having many incoming links and strong capability enjoy extraordinary sales performance. Our empirical results highlight the advertising effects of friendship links while offer some practical suggestions for online sellers and online marketplace operators.

Keywords: Friendship Links; Online Marketplaces; Online Sellers; Internet Entrepreneurship; Social Commerce

1. Introduction

Nowadays, the low entry barrier of online marketplaces has stimulated the surge of online sellers, who are retailers and entrepreneurs falling short of financial and human resources comparing to offline retailers and public traded companies. The largest online marketplace in China, Taobao.com, for example, hosted more than 2 millions stores by the end of 2010. Attracting customers online becomes essential but difficult especially for newly established online stores (Stephen et al. 2010). A new marketing vehicle, which is named friendship link in this paper, emerged and might have important effects on sellers' sale performance. In this paper, therefore, we endeavor to empirically examine the effects and business implications of friendship links.

Friendship link is a functionality offered by online marketplaces to facilitate the navigation of buyers when they are browsing online stores. Individual seller can voluntarily add another seller's store on its shop front. The number and destinations of friendship links are also in control for seller group. Although the motivations of adding friendship links can be serendipitous (Stephen et al. 2009), the outcome of adding friendship link is clear: it benefits accessibility of sellers who are referred to by peers. By improving click-through traffics, sellers have more store visitors and some of them will patronize.

In the literature, less attention has been paid to the advertising effects of friendship links and their business implications. In a modeling paper, Katona and Sarvary (2008) studied the trading dynamics of advertising hyperlinks and found sellers with rich contents are more motivated to buy links while sellers with little contents are well motivated to sell links. Recently, Stephen and Toubia found that the online friendship links obey the power law distribution (Stephen et al. 2009). Incoming links benefit ego sellers while outgoing links hurt ego sellers. In addition,

storefronts with improved accessibility benefit more from adopting the feature, not the ones with high centrality (Stephen et al. 2010).

While findings concerning friendship links in past studies are convincing, it is questionable whether traffics generated by friendship links could be readily leveraged to advance sellers' business. Internal capability of sellers might play an important role to seize customer attentions and turn them into real profits. In other words, although one can attract buyer attentions by having many friendship links, without impressing credibility records and lots of shopping options, visitor traffics cannot readily turn into sales. Theoretically, the synergy effects of friendship links and internal capability of online sellers are evident but seldom examined before.

Drawn upon the literature, this study asks the following research questions: (1) do friendship links have impacts on online sellers' sales performance? and if so, (2) whether the effects of friendship links are contingent on endogenous capability of sellers?

2. Hypotheses Development

For an ego seller, there are two types of friendship links: incoming links and outgoing links. While outgoing links enable buyers navigate to other stores, incoming links invite buyers from alternative stores. From an accessibility point of view, incoming link benefit ego seller while outgoing link hurt ego seller. Traffic on each store is another factor accounting for the net effects of each link connecting a couple of sellers. But it doesn't change the nature of the system: having incoming link is always better than having outgoing links for ego seller. Since sellers only have control over whether and to whom to add outgoing links (rather than incoming links), one might wonder what motivate sellers to add outgoing links that are detrimental to their business. Although no concrete answers to this question (interested readers please refer to (Stephen et al. 2009)), it seems that, for reasons such as reciprocating, sellers who contribute to other's accessibility will also benefit to some degrees. As a result, seller groups in which people exchange links will enjoy better accessibility than sellers who don't. In an empirical study, Stephen and Toubia verified the asymmetric effects of incoming links and outgoing links for ego sellers (Stephen et al. 2010). This paper primarily focuses on the effects of incoming links (empirical results on outgoing links will also be reported in subsequent sections).

Hypothesis 1: The larger the number of incoming links, the better an ego seller's sales performance.

A second factor that contributes to the sales performance of a store is its internal capability. In light of the theory of resource-based view (RBV), strategic resources that neither perfectly imitable nor substitutable can help firm sustain above average returns (Barney 1991). In the online retailing context, we focus on two potentially valuable resources: credentials and products.

On online trading platforms, seller credentials are accumulated points wined by sellers after completing transactions and get positive ratings from buyers. In other words, transactions that are rated neutrally or negatively by buyers don't contribute to the credentials of sellers (although they generate revenue). On the marketplace where we collect data, stringent policies are enforced to avoid manipulations of the credential system. For example, in every calendar month, no matter

how many times a buyer shop from a seller, the maximum points the seller received from this customer could not exceed 6. Coupling with the auditing efforts through payment system (only buyers who conduct transactions with sellers could rate and contribute to seller credentials), it is hard for online stores to reach large credential levels in short run. For such reasons, seller credentials are strategic resources that are rare, valuable and in-imitable for online business. In the literature, the benefits of good ratings/credentials have been well explored. For example, positive feedbacks can induce trust in buyer-seller relationship and eventually leads to price premium (Ba et al. 2002). Zhu and Zhang (2009) showed that an increase in online reviews (both number and ratings) results in more sales in the game industry. Chevalier and Mayzlin found that an improvement in a book's reviews leads to an increase in relative sales for two major US online bookstores: Amazon.com and Barnesandnoble.com (Chevalier et al. 2006). We thus expect a positive relationship between seller credentials and their business performance.

The number of on-stock products is another indicator of seller capability. From buyers' perspective, more merchandises mean more shopping options. Thus, keeping all other factors equal, sellers with more listing products could provide better shopping experiences. It follows that buyers might shop for one of the products even if the very first product of the seller that leads the buyer to visit the online store doesn't seems that attractive. Secondly, sizeable products give potential customers the impression that it is a "big" online store. The linkage between store size and its service capability (e.g., number of service employees, physical stock size, etc.) will be aroused. Thus, number of products represents one important aspects of seller capability. Keep all other things equal, sellers with more products will have better performance.

Hypothesis 2: The higher an online seller's internal capability, the better its sales performance.

Hypothesis 2.1: The higher an online seller's credential, the better its sales performance.

Hypothesis 2.2: The more listing products, the better a seller's sales performance.

We also expect a synergy effect between incoming link and seller capability. To complete a successful transaction, a potential customer should at least: (1) be aware of an online store, (2) be convinced that this store is capable and trustworthy, and (3) one of the products hosted by the store meets her shopping objectives. As discussed earlier, more incoming links improve the awareness of a focal seller, high credentials make a store looks more capable and trustworthy, more variety of products increase the chances that buyers select one from the product portfolio. Arguably, sellers who excel in all those aspects will enjoy superior performance than those good at one aspect or another (but not all of them). In the marketing literature, the synergy effects of marketing vehicles and product quality are well documented (Dawar et al. 1994). Specifically for the new marketing tools of friendship links, however, we are not aware of any study that proposed similar interaction effects before. We hypothesize:

Hypothesis 3: There is an interaction effect between incoming link and internal capability such that capable sellers having more incoming links enjoy superior sales performance.

Hypothesis 3.1: Incoming link and online seller credential have positive interaction effects.

Hypothesis 3.2: Incoming links and variety of products have positive interaction effects.

3. Data

Our data are collected from the largest online marketplace in China, Taobao.com, which dominates the market with a lion's share of about 80%. To lift the generalizability of the findings, we collected data from multiple industries (women wear, cosmetics, cell phone, and game card). To save spaces, subsequently we only report findings concerning women wear sellers. To alleviate the concerns of endogeneity, independent variables are collected at September 1st, 2010 (T1) and dependent variables are collected at December 1st, 2010 (T2). At T1, we randomly sampled 3000 sellers from each industry. We compared the sampled sellers and that of the population (all sellers operating in each industry at the times of data collection) on two demographic variables (i.e., number of hosting products and seller credentials) to assure the representativeness of the sample. For women wear sellers, the usable sample size shrink from 3000 (at T1) to 1919 (at T2) after three month. The decreasing of sample size attributes to either stores shut down permanently or measures of some theoretical variables are missing.

The meaning of key theoretical variables, their descriptive statistics are displayed in Table 1.

Table 1. Descriptive Statistics of Variables

	Meaning	N	Min	Max	Mean	Std. Dev
TranNum	Transaction number (T1~T2)	1919	0	5853	414.347	2648.484
Revenue	Sales revenue (T1~T2)	1919	0.000	5885862.000	44313.700	265313.685
Cred	Seller credentials (T1)	1919	0	174713	1105.310	5809.292
StoreMon	Store age till T2	1919	1.567	77.167	17.936	15.863
Prod	Product number (T1)	1919	0	2 28	163.891	244.808
GdComRat	Ratio of positive ratings (T1)	1919	0.990	1	0.992	0.004
CRSP	Join in consumer rights safeguarding plan (Y/N, at T1)	1919	0	1	0.305	0.461
OutShop	Outgoing links number (T1)	1026	1	35	5.262	6.148
InShop	Incoming links number (T1)	1919	0	235	4.007	13.407

The correlation coefficients are show in Table 2.

Table 2 Correlation Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Lg(TranNum)(1)	1.0	.908	.369	.167	.276	.087	.482	.388	224	.440	.643
Lg(Revenue)(2)	.908	1.0	.337	.234	.254	.101	.469	.370	.209	.4 8	.641
Cred(3)	.369	.337	1.0	.225	.089	.022	.223	.394	.162	.301	.483
StoreMon(4)	.167	.234	.225	1.0	.085	.013	.228	.478	.235	.259	.460
Prod(5)	.276	.254	.089	.085	1.0	.011	.270	.229	.128	.620	.248

GdComRat(6)	.087	.101	.022	.013	.011	1.0	.061	.070	.049	.076	.110
CRSP(7)	.482	.469	.223	.228	.270	.061	1.0	.426	.242	.387	.524
Lg(InShop)(8)	.388	.370	.394	.478	.229	.070	.426	1.0	.527	.725	.790
Lg(OutShop)(9)	.224	.209	.162	.235	.128	.049	.242	.527	1.0	.444	.433
Prod*InShop(10)	.440	.428	.301	.259	.620	.076	.387	.725	.444	1.0	.686
Cred*InShop(11)	.643	.641	.483	.460	.248	.110	.524	.790	.433	.686	1.0

Note: correlation coefficients above .7 are highlighted.

4. Results

The model specifications are shown in two formulas below.

$$Lg(TranNum)=a0+a1Cred+a2StoreMon+a3Prod+a4GdComRat+a5CRSP+ a6lg(InShop)+ a7lg(OutShop)+ a8(Prod*InShop)+ a9(Cred*InShop)+error \quad (1)$$

$$Lg(Revenue)=b0+b1Cred+b2StoreMon+b3Prod+b4GdComRat+b5CRSP+ b6lg(InShop)+ b7lg(OutShop)+ b8(Prod*InShop)+ b9(Cred*InShop)+error \quad (2)$$

4.1 Regression Results

Linear regression results are given in Table 3. Concerning hypotheses 1 through 3, we have the following findings:

1. Incoming links have significant positive effects on sellers' performance in terms of increments of both transaction number and revenue (Model 1 and 3), leading to supports for hypothesis 1.
2. Seller credentials and number of products both have positive and significant effects on sellers' performance (Model 1 and 3), thus supporting hypothesis 2.
3. The coefficients of interaction terms for both product number and seller credential are both positive and significant (Model 2 and 4), leading supports to hypothesis 3. However, after adding interaction terms, main effects of incoming links become negative, main effects of product number are insignificant. The insignificance of product number after considering its corresponding synergy effects might be due to the lowered explanation power of product number after introducing interaction effects. This should not invoke major concerns since maximum VIF is far smaller than 10 and that introducing interaction terms didn't change significantly the signs and significance levels of the coefficients for most control variables. The change of signs for coefficients of incoming links before and after introducing interaction terms warrants more explanations. In formula (1), for example, let's assume the coefficient of the independent variable lg(InShop) to be a6 before introducing interaction terms. After adding interaction terms, the coefficient for lg(InShop) becomes a6' and coefficient for interaction term (Prod*InShop) is a8. Thus, intuitively we have a6= (a6' + a8Prod). Theoretically, it is possible for both a6 and a8 to be positive while a6' is negative (given that Prod is always positive). This also means that the net positive effects of incoming links (corresponding to a6) are primarily due to its positive interaction effects with product number (corresponding to a8), not its main effects alone. Therefore, the findings in model 2 and 4 concerning changed signs of lg(InShop) lend supports to the positive synergy effects of internal capability and incoming links, rather than refuting it.

Additional findings (for control variables) include:

4. Elder sellers grown slower in terms of both transaction number and revenue (model 1, 2, and 4), lending some supports to the arguments of "liability of adolescence" in the literature (Fertala 2008).
5. High ratio of positive ratings (model 1 and 3) is helpful in boosting transaction number and revenue. After introducing interaction terms, however, its effects become insignificant. This finding warrants further investigation.
6. Comparing to sellers don't adopting the CRSPs, the ones adopting them perform better.
7. Outgoing links has no significant effects on the sellers' performance and this finding is consistent across different model specifications. This finding is conspicuously different from that in the literature (e.g., (Stephen et al. 2010)), suggesting that adding friendship links to alters doesn't hurt ego sellers much at least in our research site.

Table 3. Regression Results

	DV=Lg(TranNum)		DV=Lg(Revenue)	
	(1)	(2)	(3)	(4)
(Intercept)	2.866***	5.567***	7.423***	10.345***
	(.206)	(.298)	(.230)	(.331)
Lg(InShop)	.371**	-1.080***	.378**	-1.157***
	(.114)	(.171)	(.127)	(.189)
Cred	<.001***	<.001***	<.001***	<.001**
	(<.001)	(<.001)	(<.001)	(<.001)
Prod	<.001¶	<.001	.001*	<.001
	(<.001)	(<.001)	(<.001)	(<.001)
Cred×InShop		.638***		.753***
		(.052)		(.057)
Prod×InShop		.239**		.150¶
		(.081)		(.090)
StoreMon	-0.012*	-.024***	.001	-.013*
	(.005)	(.005)	(.006)	(.005)
GdComRat	93.424***	4.183	96.996***	-7.022
	(17.863)	(17.477)	(19.956)	(19.380)
CRSP	1.471***	.765***	1.699***	.884***
	(.158)	(.151)	(.176)	(.168)
Lg(OutShop)	.033	0.056	-.098	-.057
	(.119)	(.107)	(.133)	(.119)
N	1919	1919	1919	1919
R^2	.348	.479	.338	.478
Max VIF	2.006	5.639	2.006	5.639

Note: 1) Non-standard regression coefficient are shown in cells. Corresponding standard errors of regression coefficient are in parentheses. 2) ***p<.001, **p<.01, *p<.05, ¶p<.10

4.2 Robustness Check

To test the robustness of our findings, we repeated the analyses for sellers in other industries (cosmetics, cell-phone, and game cards) and the results are similar. We also analyzed cross

sectional data (both independent and dependent variables are based on T2) and got similar results. Therefore, our results seem reliable.

5. Discussion and Conclusion

This paper is motivated by the emergence of a new marketing vehicle called advertisement link. Empirical findings support the argument that there is a synergy effect between incoming link and sellers' internal capability. Theoretical implication of this finding is that the effects of incoming links are contingent on seller capability. This new marketing tool of friendship link is instrumental but only for sellers with suffice capability. Consumers are judicious enough to evaluate the quality of sellers and their products. Drawing visitors' attentions by having more incoming friendship links is necessary but insufficient condition to turn them into business. Practically, the current study offered some guidance to online sellers, particularly on how to leverage this new marketing tool. Given that the average number of links per seller is not so large (see Table 1), online marketplace operators are advised to promote the link feature further, in order to help sellers trying hard to improve their visibility.

This paper has a few limitations. First, the observation period of three month is short. As a result, the effects of some factors might not show up yet. Second, we draw conclusions based on analyses of data collected from one online marketplace in China. The generalizability of the findings across marketplaces is thus questionable. Third, we controlled for factors that might contribute to seller performance but the factors are by no means exhausted. To conclude, more future studies are necessary to triangulate the findings in the current work.

References

Ba, S.L., and Pavlou, P.A. "Evidence of the effect of trust building technology in electronic markets: Price premiums and buyer behavior," *MIS Quarterly* (26:3), Sep 2002, pp 243-268.

Barney, J. "Firm resources and sustained competitive advantage," *Journal of Management* (17:1) 1991, pp 99-120.

Chevalier, J.A., and Mayzlin, D. "The Effect of Word of Mouth on Sales: Online Book Reviews," *Journal of Marketing Research* (43:3) 2006, pp 345-354.

Dawar, N., and Parker, P. "Marketing universals: Consumers' use of brand name, price, physical appearance, and retailer," *Journal of Marketing* (58:2) 1994, p 81.

Fertala, N. "The shadow of death: do regional differences matter for firm survival across native and immigrant entrepreneurs?," *Empirica* (35:1) 2008, p 59.

Katona, Z., and Sarvary, M. "Network Formation and the Structure of the Commercial World Wide Web," *MARKETING SCIENCE* (27:5), September 1, 2008 2008, pp 764-778.

Stephen, A.T., and Toubia, O. "Explaining the Power-Law Degree Distribution in a Social Commerce Network," *Social Networks* (31) 2009, pp 262-270.

Stephen, A.T., and Toubia, O. "Deriving Value from Social Commerce Networks," *Journal of Marketing Research* (47:2) 2010, pp 215-228.

Zhu, F., and Zhang, M.X. "Impact of Online Consumer Reviews on Sales: The Moderating Role of Product and Consumer Characteristics," *Journal of Marketing* (74:2) 2009, pp 133-148.

Evaluating the Impacts of Auction Bidding Restrictions on Consumer Surplus and Behaviors — An Empirical Study of Penny Auctions

Hanxiong Zheng
National Univ. of Singapore
hanxiong@comp.nus.edu.sg

Khim Yong Goh
National Univ. of Singapore
gohky@comp.nus.edu.sg

Ke-Wei Huang
National Univ. of Singapore
huangkw@comp.nus.edu.sg

Abstract

Penny auction is an innovative and booming online auction in which bidders are charged a small fee for placing each bid. A penny auction typically ends up with an extremely low final auction price. Therefore, in each auction, only one bidder can enjoy positive surplus whereas other bidders suffer from bidding costs incurred. This paper empirically investigates the dynamics of consumer surplus and bidding behaviors by conducting a field experiment. We implemented three restrictions on bidding activities on all customers. At first sight, these restrictions may hurt the auction provider's profitability. However, our results show these restrictions could enhance overall customer retention rate. The intuition is to restrict the winning probability of a small group of bidders who won most of the auctions so that more bidders can enjoy the thrill and fun of winning an auction, inducing them to bid more at the target website in the long run.

Keywords: Penny Auction, Econometrics, Consumer Surplus, E-Commerce

1. Introduction

Penny auction applies a Pay-to-Bid mechanism (Platt et al., 2010) and is considered as a special form of all-pay auction. Specifically, bidders will be charged each time they place a bid in penny auctions, while bidders do not need to pay unless they win in a traditional online auction such as eBay. In addition to bidding fee, a penny auction also differs in how the auction price is determined. A penny auction typically starts from a price that is close to zero and increases by a constant but small amount, such as USD$0.1, each time a bid is placed. In reality, the auction winner often gets the auctioned item at a very low price. For instance, in penny auctions, an iPhone 4 with retail price USD$700 can be sold for as low as USD$150. With deeply discounted final prices, penny auctions have successfully attracted the many eyeballs of online bidders, as is reported in previous studies like Augenblick (2009). Penny auction websites can collect proceeds from both the product sales and the bidding fees from all participating bidders. Many websites set the increment of auction prices at $0.01 and therefore $150 implies 15,000 bids. If the cost of each bid is USD$0.1, the penny auction can earn $1,500 from the bidding fees, which is sufficient to cover their loss in selling an iPhone 4 at $150. This example illustrates the reality that penny auction sites may make profits from the bidding fees alone.

The penny auction format and its extremely low final auction price is a double-edged sword. On one hand, low auction prices attract bidders to participate in this type of auctions. On the other hand, in each penny auction, there is only one winner who potentially earns very high surplus whereas all losing bidders suffer some loss in having incurred the bidding fees. In contrast, in conventional eBay auctions, no bidder ever suffers monetary loss. For example, in our iPhone example, a penny auction winner can gain as high as $700-$150-$0.1 of surplus if he wins the item with only one bid whereas all other bidders' expenditure of $1500 bears no returns for them. If there exist some experienced or intelligent bidders who can win most of the items, most of the

other bidders will suffer. If a novice bidder participates in several penny auctions but he cannot win any auctions in the short run, it is natural to conjecture that he may accumulate significant losses in bidding fees, becomes disenfranchised with this auction site, and thus exit from the penny auction site altogether. Over the long run, as the number of bidder decreases, the participants in each auction may decrease, and the target site's profit may deteriorate sharply. Therefore, managing the retention of customers in penny auctions is an instrumental part of achieving profits in such sites.

Motivated by this issue, we conducted a real-world field experiment with a leading penny auction provider in Asia. Before September 23rd, 2010, the auction site operators observed few bidders winning most of the auctions and they started to receive complaints from customers who incurred high bidding charges but could not win any auction items. Working with the site operator, we implemented 3 rules to equalize bidders' participation in auctions, with the intention to curb a small group of bidders' aggressive bidding strategies and to rebalance the winning probability of auctions among a larger pool of customers. The 3 rules implemented are as follows: (1) each bidder is allowed to win a maximum of 8 auctions within 28 days; (2) each bidder cannot win the same item more than once within 28 days; (3) each bidder is allowed to participate in only X concurrent auctions where X is 8 minus the number of auctions won in the past 28 days. Although focusing on different dimensions, these 3 rules share the same purpose of reducing the auction participation capacity of those frequent, aggressive bidders such that the opportunities of winning auctions are not concentrated among these bidders.

The objective of this paper is to empirically analyze how these three rules may impact bidders' retention and participation in auctions. Specifically, we answer the following research questions:

Does the implementation of bidding restriction rules in penny auctions

(1) Contribute to a more equalized distribution of bidders' surplus across an auction market?

(2) Increase the probability of a unique bidder to bid at least once in each subsequent week?

(3) Increase the average number of auctions and the number of bids by a unique bidder in each subsequent week?

The contributions of this research lie in clarifying the answers to the above three research questions which have not been studied before in the context of penny auctions. Answers to these questions will help to quantify precisely the individual bidder level and aggregate market level impacts of the bidding restriction rules implementation. These will help the penny auction industry to address and manage the crucial issue of bidder attrition and customer retention in the long run, in order to maximize customer lifetime values (Ho, et al. 2006).

Our analysis results show that a skewed or lopsided consumer surplus distribution is highly correlated to more bidder attrition on our penny auction website. The implementation of the bidding restriction rules improves the surplus distribution in a more equal manner such that the Gini coefficients for consumer surplus drop significantly by 10% after the rule changes. In addition, we find evidence that the customer retention rate of marginal, occasional bidders are higher after the rule changes, and that they increased the number of auction participations and the number of bids placed in auctions. These benefits for the marginal occasional bidders, however, are offset by the loss or reduction in the auction bidding and participation activities by the aggressive, frequent bidders.

Our research findings in this study imply that rather than emphasizing on the total amount of customer surplus at the aggregate level, penny auction operators should not ignore the distribution of consumer surplus, which may ultimately impact on customer satisfaction levels. The three bidding restriction rules designed provide a convenient and economical way to

potentially equalize the distribution of consumer surplus in penny auctions. Therefore, with this systematic analysis of the three bidding rules, we are able to offer the industry an effective and efficient solution to maximize customer retention rates and lifetime values in penny auctions.
The rest of the paper is as follows. In the next section, we provide a literature review of penny auctions and customer retention in the context of marketing and customer management. Section 3 describes the field experiment design, and Section 4 contains the data description, data field definitions and empirical methodology which specify three econometric models of interest. Section 5 discusses the empirical results. Section 6 provides implications, limitations, and future directions of this research.

2. Data Definitions

2.1 Data Source

Since we have access to the proprietary dataset from PennyLeader, we have all of the data fields needed to examine our research questions. We compiled a weekly panel dataset at the unique bidder's level. In the 16 weeks of sample period, we collected data of 271 products, 924 auctions, and 263,435 bids from 586 unique bidders. The average age of these bidders is 31 year old, and 381 out of the 586 bidders are male (65%).

2.2 Independent Variable

(1) A dummy variable that indicates before and after the rules change.

We create a dummy variable d_{rule} indicating if the three rules have been implemented across the weeks. In the weekly panel dataset, d_{rule} is 1 if the week number is larger than the 38th week of 2010 (i.e. the week when the rules were introduced), otherwise it is equal to 0.

2.3 Dependent Variables

(1) Consumer Surplus (Model 1)

We define the consumer surplus for bidder *j* as follows.

$$S_j = \begin{cases} Suggested\ Retail\ Price - Final\ AuctionPrice - Tokens\ cost, & if\ bidder\ j\ wins \\ -Tokens\ cost, & if\ bidder\ j\ loses \end{cases}$$

Here, since we do not have the willingness-to-pay of each bidder, we are forced to use the suggested retail price as a proxy. The suggested retailed price is listed on the PennyLeader website and is observable to all bidders. This measure of consumer surplus should be interpreted as the surplus for a bidder to use PennyLeader, benchmarking against buying the same product from other retailers at the suggested retail price.

(2) The Equality Measure of Consumer Surplus (for Model 1)

The most prevalent measure of inequality in the literature is Gini Coefficient, which is widely used to measure the income disparity. The standard Gini coefficient ranges from 0 to 1, and a value of 0 represents perfect equality (Christian and Weiner, 2000). Similarly, a value of 1 expresses a status of extreme inequality, in which one person earns all income while the others earn nothing. We need to adopt a modified Gini coefficient in this study because many bidders have negative surplus (Mishra et al. 2002):

$$G^* = \frac{(2/n)\sum_{j=1}^{n} j s_j - \frac{n+1}{n}}{\left[1 + (2/n)\sum_{j=1}^{m} j s_j\right] + (1/n)\sum_{j=1}^{m} s_j \left[\frac{\sum_{j=1}^{m} s_j}{s_{m+1}} - (1+2m)\right]}$$

where $s_j = S_j/n\bar{S}$ and $\bar{S} = \sum_{j=1}^{n} S_j/n > 0$. n denotes the total number of bidders, S_j is the surplus of bidder j, s_j is the share of surplus of bidder j, and m denotes the size of the subset of the bidders whose accumulated surplus is zero in the order of $S_1 \leq \cdots \leq S_m$.

(3) Consumer Retention (for Model 2)

For each unique bidder in each week, we create a dummy variable: it is one when the bidder spent at least one token in that week and is zero otherwise.

(4) Auctions Participation (for Model 3)

We operationalize "participation" in two ways: (1) the number of auctions participated by a unique bidder in one week. (2) the number of tokens spent by a unique bidder in one week.

2.4 Key Control Variables

(1) Bidder Types (for Models 2 and 3)

We split bidders into two groups: frequent (aggressive) bidders and occasional (marginal) bidders. Frequent bidders are defined as bidders who violated any one of the three rules before September 23rd 2010. In other words, it is highly possible that these bidders may be constrained by the three rules. Occasional bidders are the rest of the bidders who never violated three rules before September 23rd 2010. In other words, those bidders supposedly may not be affected by the three rules after September 23rd 2010. However, they may be indirectly affected by the rules change because frequent bidders will bid less after the rules change. Occasional bidders may win more and also could bid more due to their higher expectation of winning chances.

(2) Consumer Surplus History (for Models 2 and 3)

We create four control variables based on the history of consumer surplus of each unique bidder. First, we use the weekly consumer surplus right before the target week. We further redefine this variable into two variables: win surplus and loss surplus if the bidder receive positive and negative surplus, respectively. Specifically, win surplus is defined as the total surplus that a bidder obtain in a week if it is positive and it is zero otherwise. For completeness, we also create two similar variables using the cumulative life-time total win surplus and loss surplus, rather than the lagged one week's surplus.

(3) The Number of Products Auctioned in One Week(for Models 2 and 3)

We include two variables to control for the impacts of product offerings. One variable is the number of hot products sold in the target week. We define hot products by finding the 10% most popular products during the 16-weeks sample period. The popularity of products is calculated by ranking the associated auctions from high to low by the number of participants. The rest of products are defined as common products. We use the number of common products as the other control variable.

3. Regression Models

3.1 Model 1: Regression on Gini Coefficient

To examine our research question 1, we use a simple OLS regression model with the adjusted Gini coefficient as the key dependent variable.

$$G_t = \alpha + \beta d_rule_t + \varepsilon$$

where G_t is the value of the adjusted Gini coefficient at time t, d_rule_t is a dummy variable indicating if the rules are implemented at time t.

3.2 Model 2: Logit

To investigate our research question 2, we use the following panel logit regression (Wooldridge 2007). This analysis is conducted at the unique bidder level with "one week" as one period in this panel dataset. We model the probability of bidder's participation as (Cameron and Trivedi, 2005)

$$\Pr(y = 1|\boldsymbol{x_{it}}) = \frac{\exp(\boldsymbol{x_{it}}\beta)}{1 + \exp(\boldsymbol{x_{it}}\beta)}$$

where y is the binary outcome dependent variable in which 1 represents participating: the target bidder bids at least once in that week and y=0 otherwise. x_{it} is a vector of covariates for bidder i at time t which includes: (1) dummy variable of rule changes; (2) past consumer surplus; and (3) auction product types.

3.3 Model 3: Poisson

To answer our research question 3, we use the panel Poisson regression which is widely applied to model nonnegative integer dependent variable (Cameron and Trivedi, 2005). To apply the Poisson model, following assumptions are made: (1) the dependent variable has a Poisson distribution; and (2) the occurrences of a bid and participating in an auction (i.e. auction participation) are independent. Therefore, we have the Poisson regression model specification:

$$f(y|\boldsymbol{x_{it}}, \beta) = e^{-\exp(\boldsymbol{x_{it}}'\beta)} \exp(\boldsymbol{x_{it}}'\beta)^y / y!$$

where y denotes number of auctions participated (or number of bids placed) within a week, x is a vector of covariates including the dummy variable of rule changes and control variables.

4. Conclusions

In this study, we conduct a field experiment on a penny auction website to analyze the effects of bidding restrictions on customer retention and surplus distribution. We provide evidence that there is skewed surplus distribution on the penny auction website before the implementation of the restrictions. Then we use three empirical models to analyze the impacts of restrictions. Empirical results show that the rules can significantly equalize customer surplus and mitigate the issue that frequent bidders win most of the auctions. With a more equalized surplus distribution, occasional bidders are shown to be more probable to bid again. Besides, they are more likely to place more bids in the auctions they participated.

This study is not without limitations, which also provide opportunities for future research. First, our research design is a quasi-experiment. It would be perfect if researchers can conduct a natural experiment with randomly assigned bidders. Second, due to the limitation of page length, we focus on analyzing the impacts on the aggregated consumer behaviors. Third, "learning" is generally a popular topic in the academic literature across disciplines. Last, with our dataset, we can study several interesting bounded rational behaviors in the penny auction setting.

References

Augenblick, N. (2009). "Consumer and Producer Behavior in the Market for Penny Auctions: A Theoretical and Empirical Analysis." Working paper. Stanford University.

Cameron, A. C. and P. K. Trivedi (2005). Microeconometrics : methods and applications: A. Colin Cameron, Pravin K. Trivedi, Cambridge University Press.

Chua, C. E. H., J. Wareham, et al. (2007). "The role of online trading communities in managing internet auction fraud." Mis Quarterly 31(4): 759-781.

Ho, T., Y.-H. Park, et al. (2006). "Incorporating Satisfaction into Customer Value Analysis: Optimal Investment in Lifetime Value." Marketing Science 25(3): 260-277.

Mishra, A. K., H. S. El-Osta, et al. (2002). Income, Wealth, And The Economic Well-Being Of Farm Households, United States Department of Agriculture, Economic Research Service.

Platt, B. C., J. Price, et al. (2010). "Pay-to-Bid Auctions." Working paper.

Best Buy's Exit from China's Market –Anachronistic Strategy to Blame?

Hongjie Qiang
Xiamen University
342763475@qq.com

Zhangxi Lin
Texas Tech University
zhangxi.lin@ttu.eud

Abstract

This paper is intended to study the exit of Best Buy from China's market from the angle of monopolistic competition. It is shown that in the era of e-commerce, the diversity of goods in electronic stores tends to be infinite, which limits retailers' markup space and further increases its importance. Thus, traditional retailers like Best Buy may not be competent enough to those with agilely customizable goods.

Keywords: E-commerce, Monopolistic Competition, Diversity, Firm exit

1. Introduction

On February 22nd, 2011, Best Buy, the world's largest retail group of home appliances and electronic products, officially announced that they will shut down all their 9 stores in Mainland China, as well as its retail headquarter in Shanghai, implying that its operation pattern has hit the curb in China (see http://star.news.sohu.com/s2011/bestbuy/index.shtml). Best Buy's exit triggered a heated debate and most comments ascribed this to the differences in consumption habits between Chinese and westerners. But it seemed that things could be more complicated. According to the third quarterly report that Best Buy published in the early December of 2010, the profit of Best Buy had fallen by 4.4%, alluding that Best Buy is losing its market share because of the snatch of Amazon—a competitor based on the Internet and Wal-Mart— a large shopping mall. Evidence has shown that the e-commerce development and the new market demands with its core features of low prices and diversified goods supported by it are generating more and more shocks and impacts to the traditional way of production and sales. This paper is intended to illustrate that diversity will be the core essential of retail strategy in the era of e-commerce regarding Best Buy's exit from the economics perspective.

Economists have broached several discussions around the topic of monopolistic competition (e.g., for example, Dixit and Stiglitz 1977, Salop 1979, and Salop and Stiglitz 1982). Salop (1979) built a model that described the behavior of firms involved in spatial competition in a two-industry economy and analyzed possible equilibria on a kinked demand curve. Salop and Stiglitz (1982) discussed the possibility of divergent equilibrium prices in a sector using the assumption that consumers will make trade-offs between the high price they meet unfortunately and costs of entering the market again. All of the above shed light on our current research.

2. Basic Settings of the Model

Consider a single-industry economy with N consumers and n firms. Firstly, we assume that all the possible combinations of the characteristics of the goods in industry can form a circle with

a circumference of 1 (Salop and Stiglitz 1982). On this circle, l_i is the position for firm *i* located in terms of the characteristic combination of the good that firm *i* produced, and s_j is the position for consumer *j* located at the position in terms of the characteristic combination of the goods that brings consumer *j* the highest utility location.

Secondly, assume that consumers are uniformly distributed around the circle, and:

i) The currency value for the highest utility that each consumer can get in this industry is U^*;

ii) Consumer *j* makes deal with firm *i* to maximize his consumer surplus:

$$s_{ji} = U^* - v \bullet \| l_i - s_j \| - p_i \quad (3.1)$$

where constant v presents the currency price for the loss of consumers who do not buy a good that brings him the highest utility;

Thirdly, if each firm in this industry produces homogeneous goods with little difference under the same production condition, or every firm face the same production function, we can assume that each firm produces only one kind of good. Further,

1) Denote firm *i*'s fixed cost for production as $F_i = \overline{F}$, and the marginal cost as $c_i = \bar{c}$. So the cost curve that a typical firm *i* faces can be written as: $C_i = \overline{F} + \bar{c} \bullet Q_i$ (3.2);

2) Firm *i* asks p_i ($\bar{c} < p_i < U^*$) for each unit of its good and occupies a market share of q_i ($0 < q_i < 1$). Thus, we have: $Q_i = q_i \bullet N$ (3.3);

3) The profit function of firm *i* can be written as: $\pi_i = p_i \bullet Q_i - C_i$ (3.4);

4) Firm *i* will come into the industry only if π_i is non-negative.

3. Model Framework

3.1 Equilibrium price and market shares

We discuss the equilibrium price and market shares each firm can occupy when $n \to \infty$ with following deductions from model settings mentioned above:

1) Since consumers are uniformly distributed on the circle, the sales environment for each firm is similar, so that the label of each firm do not make a difference and thus we can assume that other firms will choose the average price with regard to each typical firm *i*;

2) Since consumers are uniformly distributed on the circle, and each firm will face competitors that charge the same price, we can also assume that, at the equilibrium, firms are uniformly

distributed on the circle. Thus, the distance between each two adjacent firms will be $\frac{1}{n}$;

3) As firms are under monopolistic competition environment, consumers located at the edge of firm *i*'s market sphere will be indifferent between buying goods from firm *i* and making deal with its adjacent competitor. The maximization behavior of firm *i* will be subject to the fact:

$$U^* - v \bullet \frac{q_i}{2} - p_i = U^* - v \bullet \left(\frac{1}{n} - \frac{q_i}{2} \right) - \bar{p} \quad (4.1) \text{ (from equation 3.1)}$$

Then our work can be transformed to a maximization problem of a firm facing competitors who produce goods differring $\frac{1}{n}$ from it and charge $\bar{p}$ for each unit of good at both sides. This maximization problem can be described as:

Max: $\pi_i = (p_i - \bar{c}) \bullet q_i \bullet N - \bar{F}$ (from equation 3.2 to 3.4)

s.t. $q_i = \frac{1}{n} - \frac{p_i - \bar{p}}{v}$ (from equation 4.1)

Solving this problem, we can obtain:

$p_i = \frac{v}{2n} + \frac{\bar{p}}{2} + \frac{\bar{c}}{2}$ (4.2); and $q_i = \frac{1}{2n} + \frac{\bar{p}}{2v} - \frac{\bar{c}}{2v}$ (4.3).

Let $p_i = \bar{p}$, substitute this into equation (4.2), and we have: $\bar{p} = \frac{v}{n} + \bar{c}$ (4.4)

By substituting (4.4) into equation (4.3), we can get: $\bar{q} = \frac{1}{n}$ (4.5)

At this point, all the firms have maximized their profits in accordance with the prices given by all other competitors. Thus, no one has the motivation to change its price and the equilibrium is reached. From equation (4.4) we can deduce that when the number of equilibrium firms—or kinds of goods, i.e. n→∞, or $\frac{1}{n} \to 0$, the equilibrium price $\bar{p} \to \bar{c}$. Noting that retailers have not been recommended here, so retailers' revenues have been contained in the equilibrium price which means there won't be too much markup space left for retailers in the era of e-commerce.

Proposition 1: *If the variety of goods within a department tends to infinity, then only marginal-cost-level price can be accepted in this department*

3.2 Good Diversity

In the e-commerce market environment, we have:

a) The space for commodity storage, circulation and exhibition is large. There is no limit of good categories on the shelves, and retailers can display unlimited variety of goods a very low marginal cost;
b) Goods publishing channels is abundant enough, and putting restrictions on new entries is

almost impossible. So, firms can enter the market continuously as long as they expect that they can get non-negative profit from the market;

c) Production costs of goods descend to a level that even individuals can handle production themselves and the cost of sale is reducing dramatically, so that $\overline{F} \to 0$;

d) Information dissemination is sufficient, so that the information of goods can be published to a large number of consumers, i.e. N→∞.

Substituting equation (4.4) and (4.5) into equation (3.2) and (3.3) and then substituting the results into equation (3.4), according to assumption 4) in section 3 we obtain:

$\pi_i = \frac{v}{n^2} \bullet N - \overline{F} \geq 0$, i.e. $n \leq \sqrt{\frac{N \bullet v}{\overline{F}}}$, where n is positive (4.6).

On the other hand, the market environment we mentioned above suggests that firms will continuously enter the industry until one more competitor will drive the profit of all firms down to negative level, i.e. $\pi_i = \frac{v}{(n+1)^2} \bullet N - \overline{F} < 0$, or $n > \sqrt{\frac{N \bullet v}{\overline{F}}} - 1$ (4.7).

As a commonsense, *n*, the number of firms in the industry, must be a positive integer in the interval $\left(\sqrt{\frac{N \bullet v}{\overline{F}}} - 1, \sqrt{\frac{N \bullet v}{\overline{F}}} \right]$. Thus, with $\overline{F} \to 0$, $N \to \infty$ and v hold constant, and both $\sqrt{\frac{N \bullet v}{\overline{F}}} - 1$ and $\sqrt{\frac{N \bullet v}{\overline{F}}}$ will tend to be infinite, so will the number of firms, i.e. *n*. Furthermore, even firms can siege only a small part of the market, they can survive in the industry all the same. This can be derived from the previous assumption.

Propositon 2: *In the era of e-commerce, the variety of goods within a department will tend to infinity, the hypothesis of proposition1 is true.*

4. Welfare Analysis

According to the model we discussed in last section, consumer surplus in the market sphere of firm *i* will be evenly distributed between $U^* - v \bullet \frac{q_i}{2} - p_i$ and $U^* - p_i$. The closer s_j to l_i, the greater surplus consumer j can obtain from the industry. Moreover, around any l_i on the industry circle, the distribution of consumer surplus will be the same. Thus, the net surplus consumer *j* can expect in this industry is: $E(s_j) = U^* - \overline{c} - \frac{5}{4} \bullet \frac{v}{n}$ (5.1).

From equation (5.1), we can deduce that each consumer can expect a higher net surplus as the number of firms increases, so as the variety of goods in the industry increases. The additional expected net surplus comes from two aspects: the lowered equilibrium price level, indicated by

the term of $-\frac{v}{n}$ in equation (5.1), and the more diversified goods in line with consumer requirements which can be indicated by the $-\frac{1}{4}\bullet\frac{v}{n}$ term in the same equation.

But since consumers cannot meet all the firms at once in a unified retail platform as we assumed, they have to choose the retail platform by goods from firms at first. Then there exists the problem of entry cost, though in the e-commerce this cost could be trivial as it may not change consumers' final decisions (Salop and Stiglitz 1982). According to equation (5.1), if we regard the whole circle as a typical retailer, say retailer *k*, the net surplus that consumer *j* can expect from making deal with retail *k* should be: $E\left(s_{jk}\right)=U^{*}-\bar{p}-\bar{c}-\frac{1}{4}\bullet\frac{v}{n_k}$ (5.2),

where n_k is the number of goods consumer *j* can find in retailer *k*, $\bar{p}$ and $\bar{c}$ is decided by the market equilibria.

Thus, we can conclude that a typical consumer can expect a higher surplus from a retail platform when goods from more producers can be found there because they can purchase goods more in line with their requirements. Furthermore, consumers will tend to search goods in a retail platform with more choices at first or they may have to change shopping platforms constantly.

Proposition 3: *Retail platform with higher goods diversity will attract more clients at the same price level.*

5. Conclusion

As we have shown in this paper, with the support of modern information technology and transportation method, price competition will be carried to the extreme that only marginal-cost-level price can be accepted and the diversity of goods will become a determinant part of a retail platform's competitiveness. That is why franchisee operating entity stores like Best Buy will face an increasingly competition from large supermarkets and online shopping in recent years. Especially for Best Buy, its strategy that emphasizes on the retail brand and depreciates good brands with the narrowed retail channel in China has limited its goods richness. Its price decision is also divergent from market demands for the low price in the era of e-commerce. These two anachronistic strategies together with other cultural factors eventually limits its development in China.

References

1. Steven C. Salop (1979). "Monopolistic Competition with Outside Goods", The Bell Journal of Economics, Vol. 10, No. 1 (Spring, 1979), pp. 141-156
2. Steve Salop and J. E. Stiglitz (1982). "The Theory of Sales: A Simple Model of Equilibrium Price Dispersion with Identical Agents", The American Economic Review Vol. 72, No. 5 (Dec., 1982), pp. 1121-1130

Human Capital and Information Technology Capital Investments for Firm Innovation: Curvilinear Explanations

John Qi Dong
Hong Kong University of Science and Technology
dongqi@ust.hk

Jinyu He
Hong Kong University of Science and Technology
mnjhe@ust.hk

Prasanna Karhade
Hong Kong University of Science and Technology
karhade@ust.hk

Abstract

We investigate the relationship between a firm's investments in knowledge-related assets and innovation. We propose curvilinear relationships — inverted-U relationships — between human capital investments and IT capital investments and firm innovation. Based on the analysis of a recent, large-scale cross-industry cross-country survey data set, corroborating support for the proposed curvilinear relationships is presented. We contribute to the existing work on RBV by identifying the possible downsides associated with the excessive accumulation of strategic resources.

Keywords: Resource Based View of the Firm, Human Capital, Information Technology Capital, Innovation

1. Introduction

The resource-based view of the firm (RBV) maintains that firms that are able to accumulate and deploy valuable, rare, costly to imitate, and non-substitutable resources are positioned to generate and sustain competitive advantage (Barney, 1986; 1991). Among various resources that a firm possesses, its knowledge assets are often regarded as having the advantageous characteristics prescribed by RBV (Kogut and Zander, 1992; Grant, 1996). Scholars have recognized that a firm's knowledge that enables it to generate sustainable competitive advantage is often embedded in its employees (Nonaka and Takeuchi, 1995; Wright et al., 2001). And, as Kogut and Zander point out, "the knowledge of the firm must be understood as socially structured, or, more simply stated, as resting in the organizing of human resources" (1992, p. 385; emphasis added). In this regard, the role of the firm is to create an environment that facilitates the sharing and recombination of individually possessed knowledge (Argote et al., 2003). Key components of this environment are a firm's information technology (IT) assets and investments which facilitate the exploration, sharing, and organizing of knowledge (Alavi and Leidner, 2001). So, consistent with the RBV logic, firms are investing both in assembling a capable team of knowledge workers and in developing superior IT resources (Sambamurthy and Zmud, 2000).

Scholars often propose innovation as an appropriate and immediate outcome of knowledge-intensive activity within the firm (Katila and Ahuja, 2002). Prior research that builds on the RBV tends to imply a linear relationship between the accumulation of human/IT capitals and innovation. We, however, argue in this paper that the relationship between human and IT capital investments and innovation is more likely to be curvilinear (i.e., following an inverted-U shape). In other words, we maintain that (excessive) accumulation of strategic resources may lead to undesirable outcomes. Specifically, while human capital and IT capital investments may initially increase a firm's ability to innovate, excessive accumulation of these resources is likely to be associated with inefficiencies due to increased complexity and information overload (e.g.,

Penrose, 1959; Tan and Mahoney, 2005). As a consequence, further investments in human and IT capitals may hinder a firm's capacity to innovate. We test our predictions using survey data collected by the European Commission in 2006. In order to effectively capture the contributions of human and IT capitals to innovation, we choose to focus only on firms in the high-technology industries. Given the distinction between process and product innovations, we analyze both types of innovation and find consistent results corroborating our theoretical arguments.

We contribute to the body of work on RBV by identifying the possible downsides of accumulating strategic resources. Our findings of curvilinear effects of strategic resources on firm innovation remind both researchers and practitioners the danger of an oversimplified interpretation of the RBV of the firm (Barney, 1986; 1991). By highlighting the role of IT training in galvanizing a firm's IT investments, we are able to exemplify a particular integrative, complementary capability that firms could potentially develop to effectively leverage their resource bundles. Thus, our research provides further support to Makadok's (2001) proposition which maintains that resource picking and capability building can be complementary.

2. Theory Development

For the assets possessed by a firm, a distinction is often made between invisible and physical assets (Itami, 1987) with the former being those knowledge-based resources that are accumulated and produced by the firm's employees. It has been well recognized that "physical (visible) assets must be present for business operations to take place but invisible assets are necessary for competitive success" (Barney and Arikan, 2001, p. 136). Knowledge resources serve as vital inputs to a firm's innovation activity (Cohen and Levinthal, 1990; Miller et al., 2007), which is often regarded as the driver of a firm's competitiveness (Schumpeter, 1934). We theorize the relationship between firm knowledge assets and innovation. Firms are now making extensive human-capital and IT-capital investments to develop their knowledge stocks to compete in today's economy (Krishnan et al., 2007) as the former is the ultimate generator of new knowledge (Davenport and Prusak, 1998; Kogut and Zander, 1992) and the latter facilitates the exploration, sharing, and organization of knowledge (Alavi and Leidner, 2001). Accordingly, we study a firm's knowledge assets in terms of their human capital and IT capital investments and maintain that these two resources are likely to serve as two key antecedents to a firm's innovation activity.

2.1 The curvilinear relationship between human capital and innovation

Knowledge embedded in a firm's human capital is regarded as possessing valuable, rare, and non-substituable characteristics (Wright et al., 2001). Accordingly, firms often consider investing in accumulating human capital an essential strategy to effectively compete with other firms (Ployhart et al., 2009). Empirical studies have been supportive of the positive relationship between the accumulation of human capital and various organizational outcomes (Aaronson et al., 2007; Ployhart et al., 2009). We propose that a curvilinear relationship between the accumulation of human capital and firm innovation is more likely for two reasons. First, the accumulation of human capital necessarily increases the complexity of interactions between the firm's employees. As employees need to pool their individually possessed knowledge together, an effective control system is inevitably required to facilitate continuous knowledge sharing and generation. As the level of accumulated human capital increases, the corresponding control systems also need to grow. To the extent that individual actors are bounded in their rationality (Simon, 1947), increased complexity is likely to frequently render the existing control systems

ineffective. As a consequence, when the accumulation of human capital exceeds a certain point, the control system as a whole may not be able to function effectively to ensure that the firm can continue to generate innovation outputs (Penrose, 1959). Second, accumulating more human capital may also increase the diversity among employees. While diversity can bring about more creative ideas, the scarcity of the firm's attention (Simon, 1947; Mahoney, 2005) renders it difficult for the firm to focus on the right next "big ideas." Moreover, lengthy debates over an excessive number of options generated by a diverse group of knowledge workers may further encumber decision-making processes and eventually weaken the firm's capacity to implement promising R&D projects.

H1: Accumulation of human capital and firm innovation are likely to have an inverted-U shaped relationship.

2.2 The curvilinear relationship between IT capital and innovation

IT facilitates access to knowledge by creating electronic links not only within a focal firm but also across its entire supply chain (Rai et al., 2006). IT is a vital resource for supporting business processes that span firm boundaries (Saraf et al., 2007). As a firm grows in size, it also typically relies on IT to systematically organize knowledge dispersed within firm boundaries (Gattiker and Goodhue, 2005). IT can thus enable a firm to systematically acquire, assimilate, transform and explore knowledge resulting in innovations (Joshi et al., 2010). Thus, empirical studies have been supportive of the positive relationship between the accumulation of IT capital and various firm outcomes including innovation. However, we propose that this relationship is more likely to be curvilinear for the following three reasons. First, after a certain level, higher IT capital accumulation and excessive deployments of IT systems can be associated with information overload (Ackoff, 1967) which is likely to reduce the productivity of various parties engaged in IT-enabled knowledge work. Such an information overload could arguably also explain the presence of an IT productivity paradox where increased IT capital was associated with reduced employee productivity (Brynjolfsson and Hitt, 1996; Grise and Gallupe, 2000). Due to the challenges associated with managing information overload (Langley et al., 1995), the productivity of innovation activity is likely to suffer in the presence of excessive IT capital investments. Second, after a certain optimal limit, the value of additional investments in IT can be constrained by lack of investments in complementary capabilities (Sambamurthy et al., 2003; Ray et al., 2005). IT resources are not utilized in a vacuum. Complementary capabilities such as business process redesigns (Broadbent et al., 1999) enable IT resources realize their true potential value in the actual productive activities of the firm. The efficacy of firm innovation activity not only depends on IT capital investments but also critically depends on investments in such complementary capabilities. With more investments in IT assets, a firm experiences greater needs and pressures to develop such additional complementary capabilities. Thus, after a certain optimal level of IT capital investment, the relative shortage of investments in complementary capabilities is likely to be detrimental for innovation. Finally, as a firm continues to invest in IT, it leverages additional IT systems to reorganize its productive activities. Thus additional IT investments and the resulting additional IT systems need to be systematically integrated into the ecosystem of existing IT applications. Thus as firms continue to increase their investments in IT, they incur high data and system integration costs (Goodhue et al., 1992). If a firm does not make the necessary investments to integrate their new IT investments, firm innovation activity is likely to suffer (Weill and Ross, 2004).

H2: Accumulation of IT capital and firm innovation are likely to have an inverted-U shaped relationship.

2.3 The moderating role of IT training on the relationship between IT capital and innovation

The aforementioned constraints on the effective leverage of IT capital also suggest ways of overcoming the downsides often accompanying further accumulation of IT capital. To the extent that the firm's lack of complementary and integrative capabilities may negate the positive effects of accumulating IT capital, managers and employees need to develop a broad set of skills to conceive of, improve, and exploit IT applications to support and enhance their firm's productive activities (Mata et al., 1995). Without these essential skills, the full potential of IT will not be realized. Although such skills are often developed over time, regular IT training can help mitigate some time compression diseconomy (Dierickx and Cool, 1989) and expedite the process of integrating newly acquired IT resources. And, IT training can be particularly relevant to innovation activities as knowledge workers that are better trained at utilizing IT to process and disseminate information are more likely to derive extensive benefits from their firm's IT investments (Sharma and Yetton, 2007). Regular training is likely to encourage more actual use of existing IT assets and this usage is often argued to be vital for extracting gains from IT assets (Devaraj and Kohli, 2003). Second, regular investments in IT training are critical for reinvigorating human knowledge assets within a firm. IT assets are likely to enable firm employees to gain access to a vast amounts of information and regular training on the effective use of these IT assets is likely to help employees to effectively sort and prioritize the discovered information. Regular training in the effective use of these powerful IT assets is thus likely to galvanize internal human knowledge assets. In sum, we propose that firms that conduct regular training for their managers and employees are likely to extract productive returns from.

H3: IT Training strengthens the positive effect of IT capital on firm innovation and mitigates the negative effect of IT capital on firm innovation.

3. Methods

Data used for our study are based on a large-scale survey conducted by the European Commission (EC) in 2006. To effectively test our theoretical predictions, we chose to only focus on firms in high-technology industries, because these industries are suggested to be actively involved in innovation activities (Cohen and Levinthal, 1990; Zhou and Wu, 2010). We identified firms in high-technology industries according to their two-digit NACE Rev 1.1 codes and the classification scheme developed by Eurostat. After strictly excluding the observations with missing values on any of the variables of interest in our research model, we were left with a usable data set of 1902 firms.

Dependent variables: Given the distinction between product and process innovations, we tested our theoretical predictions on both types of innovation respectively using binary variables. Similarly, Leiponen and Helfat (2010) also employed binary measures of innovation based on survey data. Product innovation was assigned a value of 1 for firms that introduced new or substantially improved products or services to the marketplace within the past 12 months. Likewise, process innovation was assigned a value of 1 if firms introduced new internal processes for producing or supplying products/services to the marketplace within the past 12 months. We included both types of innovations as both these innovations are vital to a firm's competitive advantage.

Explanatory variables: We measured human capital closely related to innovation as the percentage of a firm's employees with college degrees. Such a ratio-based measure reflects the stock of knowledge embedded in a firm's knowledge workers (Bresnahan et al., 2002). To measure a firm's IT capital, we divided a firm's total IT spending by its total costs (Hitt, 1999). Our measure of total IT spending of a firm included not only expenditures in hardware, software, and IT labor but also IT service costs (Hitt and Brynjolfsson, 1996). Finally, we used a binary variable indicating whether a firm had conducted regular IT training for their employees (Mata et al., 1995; Ray et al., 2005).

Controls: Based on a systematic survey of the extant literature on innovation, we controlled for the effects of several factors pertinent to innovation. A decision to outsource IT activities can free up a firm's resources and enable it to focus more on core issues related to innovation (Susarla et al., 2010). Therefore, we included IT outsourcing, a binary variable indicating whether a firm outsourced IT services conducted in-house previously. Additionally, major changes to the pool of human resources can influence the likelihood of innovation (Leiblein and Madsen, 2009). Therefore, we included two dummy variables to capture increase or decrease with firm size respectively. The reference group is those firms that had no significant changes with their sizes. The scope of the market served by a firm is likely to influence its needs for innovation (Lahiri, 2010). Firms in our sample differed in their geographical reach (i.e., regional, or domestic, or international. To capture such differences, we created two dummy variables, domestic market and international market, with the reference group being those firms that only served individual regional markets. We controlled firm size by including a logarithmic transformation of the total number of firm employees (Brynjolfsson et al., 1994). We controlled firm age (Sorensen and Stuart, 2000) by including a logarithmic transformation of the number of years for which each firm had been registered prior to 2006. We also included industry dummies (Aghion et al., 2005) and country dummies (Freeman, 1995) to systematically account for country-and industry-level forces that may influence firm innovation.

4. Results

We used a stepwise procedure to examine our curvilinear hypotheses (Katila and Ahuja, 2002; Lahiri, 2010; Xue et al., 2010). Given that our dependent variables, product innovation and process innovation, are binary, we employed logit regression models for our analysis. Because our data are cross-sectional and because firms' decisions on human and IT capital investments may be endogenously determined, we used Heckman two-stage approach to control for endogeneity bias in our analysis (Heckman, 1979; Shaver, 1998; Bharadwaj et al., 2007). Tables 1 present the results of our empirical testing.

H1 was tested by estimating a model with human capital in the first step and with both human capital and the square of human capital in the second step. Models (3) suggest that human capital is positively associated with (both product and process) innovation, while human capital squared is negatively associated with innovation. Together, they provide corroborating evidence for the inverted-U shaped relationship between human capital and innovation. Thus, H1 is supported.

Similarly, H2 was tested by estimating a model with IT capital in the first step and with both IT capital and the square of IT capital in the second step. Models (4) suggest that IT capital is positively associated with innovation, while IT capital squared is negatively associated with innovation. Therefore, H2, which proposes an inverted-U shaped relationship between IT capital and innovation, is also supported. To test H3, we further estimated our model with the product of IT capital and IT training in the first step and with this product and the product of IT capital

squared and IT training in the second step. Models (5) and (6) suggest that IT training negatively moderates the relationships between IT capital and IT capital square and innovation.

Table 1. Logistic Regression Results on Product Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
Human Capital		0.646**	2.173**	0.624**	0.632**	0.606**
		(0.148)	(0.571)	(0.149)	(0.149)	(0.149)
Human Capital Squared			-1.553**			
			(0.560)			
IT Capital		1.496**	1.489**	3.740**	1.833**	4.868**
		(0.295)	(0.295)	(0.805)	(0.364)	(0.959)
IT Capital Squared				-2.865**		-3.942**
				(0.939)		(1.127)
IT Capital × IT Training					-1.076†	-3.767*
					(0.562)	(1.643)
IT Capital Squared × IT Training						3.567†
						(1.975)
Inverse Mills Ratio	-1.167	-1.631	-1.183	-1.677	-1.443	-1.448
	(1.190)	(1.195)	(1.224)	(1.196)	(1.191)	(1.199)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Log Likelihood	-1165.06	-1137.37	-1133.50	-1132.68	-1135.56	-1129.50
Wald χ^2	245.94**	269.26**	276.56**	276.10**	277.35**	284.06**
Pseudo R^2	0.115	0.136	0.139	0.140	0.138	0.142

Note: N = 1902. † significant at 10%; * significant at 5%; ** significant at 1%. Robust standard error in parentheses. Control variables are not tabulated.

By plotting the moderating effect of IT training in Figure 2, we uncovered support for H3 and discovered some interesting patterns. For firms that conducted regular IT training, the relationship between IT capital and the probability of product innovation is positive and almost linear. For firms that did not conduct IT training regularly, this relationship is curvilinear. Similar patterns were also found when we chose to examine the probability of process innovation. These observations imply that only firms that conduct regular IT training continue to benefit from additional investments in IT capital, whereas firms that do not conduct regular IT training are less likely to extract yields after their IT investments exceed an optimal level. Based on the plotting the moderating effect on IT training in Figure 1, we discover support for H3.

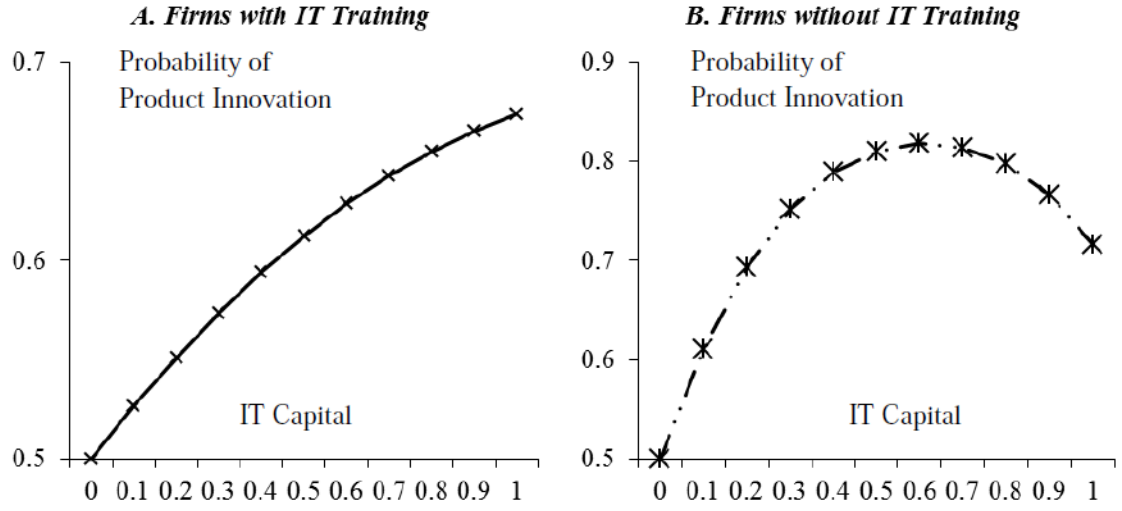


Figure 1. Moderating Effect of IT Training on the Relationship between IT Capital and Innovation

5. Concluding Remarks

Our empirical results lend support to the proposed curvilinear relationships between human and IT capital to firm innovation. After an optimal level, excessive IT capital investments are likely

to be detrimental to the firm innovation activity. Similarly, excessive accumulation of human capital is likely to increase complexity and heterogeneity in organizational communication which is likely to be counterproductive to the innovation activity. The theoretical contributions of our research are in highlighting that excessive accumulation of strategic resources is also undesirable and can lead to detrimental outcomes for firm innovation. Our findings regarding the role of IT training can serve as a useful guide to managers. The moderating influence of IT training can encourage managers can focus their attention on conducting regular IT training for their internal employees and developing the necessary integrative complementary capabilities for continuously galvanizing their IT investments. In the presence of such complementary capabilities, the risk of diminishing returns from excessive accumulation of IT resources is likely to be effectively mitigated.

References

1. Aaronson, D., Barrow, L., and Sander, W. 2007. "Teachers and Student Achievement in the Chicago Public High Schools," Journal of Labor Economics (25:1), pp. 95-135.
2. Ackoff, R. L. 1967. "Management misinformation systems," Management Science, 14, pp. 147-156.
3. Aghion, P., Bloom, N., Blundell, R., Griffith, R., and Howitt, P. 2005. "Competition and Innovation: An Inverted-U Relationship," Quarterly Journal of Economics (120:2), pp. 701-728.
4. Alavi, M., and Leidner, D. 2001."Knowledge Management And Knowledge Management Systems: Conceptual Foundations and Research Issues," MIS Quarterly (25:1), pp. 107-136.
5. Argote, L., McEvil, W., and Reagans, R. 2003. "Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes," Management Science (49), pp. 571-582.
6. Barney, J. B. 1986. "Strategic Factor Markets: Expectations, Luck and Business Strategy," Management Science (32:10), pp. 1231-1241.
7. Barney, J. B. 1991. "Firm Resources and Sustained Competitive Advantage," Journal of Management (17:1), pp. 99-120.
8. Barney, J. B., and Arikan, A. M. 2001. The Resource-Based View: Origins and Implications, Malden, MA: Blackwell Publishers Inc.
9. Bharadwaj, S., Bharadwaj, A., and Bendoly, E. 2007. "The Performance Effects of Complementarities between Information Systems, Marketing, Manufacturing, and Supply Chain Processes," Information Systems Research (18:4), pp. 437-453.
10. Bresnahan, T. F., Brynjolfsson, E., and Hitt, L. M. 2002. "Information Technology, Workplace Organization, and Remand for Skilled Labor: Firm-Level Evidence," Quarterly Journal of Economics (117:1), pp. 339-376.
11. Broadbent, M., Weill, P., Clair, D. S., and Kearney, A. T. 1999. "The Implications of Information Technology Infrastructure for Business Process Redesign," MIS Quarterly (23:2), pp. 159-182.
12. Brynjolfsson, E., and Hitt, L. M. 1996. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," Management Science (42:4), pp. 541-558.
13. Brynjolfsson, E., Malone, T., Gurbaxani, V., and Kambil, A. 1994. "Does Information Technology Lead to Smaller Firms?" Management Science (40:12), pp. 1645-1662.
14. Cohen, W. M., and Levinthal, D. A. 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation," Administrative Science Quarterly (35:1), pp. 128-152.

15. Davenport, T. H., and Prusak, L. 1998. Working Knowledge: How Organizations Management What They Know, Cambridge, MA: Harvard Business School Press.
16. Devaraj, S., and Kohil, R. 2003. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link?" Management Science (49:3), pp. 273-289.
17. Dierickx, I., and Cool, K. 1989. "Asset Stock Accumulation and Sustainability of Competitive Advantage," Management Science (35:12), pp. 1504-1511.
18. Freeman, C. 1995. "The 'National System of Innovation' in Historical Perspective," Cambridge Journal of Economics (19:1), pp. 5-24.
19. Goodhue, D. L., Wybo, M. D., and Kirsch, L. J. 1992. "The Impact of Data Integration on the Costs and Benefits of Information Systems," MIS Quarterly (16:3), pp. 293-311.
20. Grant, R. M. 1996. "Toward a Knowledge-Based Theory of the Firm," Strategic Management Journal (17), pp. 109-122.
21. Grise, M. L., and Gallupe, R. B. 2000. "Information Overload: Addressing the Productivity Paradox in Face-to-Face Electronic Meetings," Journal of Management Information Systems (16:3), pp. 157-185.
22. Hitt, L. M. 1999. "Information Technology and Firm Boundaries: Evidence from Panel Data," Information Systems Research (10:2), pp.134-149.
23. Hitt, L. M., and Brynjolfsson, E. 1996. "Productivity, Business Profitability, and Consumer Surplus: Three Different Measures of Information Technology Value," MIS Quarterly (20:2), pp. 121-142.
24. Itami, H. 1987. Mobilizing Invisible Assets, Cambridge, MA: Harvard University Press.
25. Joshi, K. D., Chi, L., Datta, A., and Han, S. 2010. "Changing the Competitive Landscape: Continuous Innovation Through IT-Enabled Knowledge Capabilities," Information Systems Research (21:3), pp. 472-495.
26. Katila, R., and Ahuja, G. 2002. "Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction," Academy of Management Journal (45:6), pp. 1183-1194.
27. Kogut, B., and Zander, U. 1992. "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology," Organization Science (3:3), pp. 383-397.
28. Lahiri, N. 2010. "Geographic Distribution of R&D Activity: How Does It Affect Innovation Quality?" Academy of Management Journal (53:5), pp. 1194-1209.
29. Langley, A., Mintzberg, H., Pitcher, P., Posada, E., and Saint-Macary, J. 1995. "Opening up Decision Making: The View from the Black Stool," Organization Science (6:3), pp. 260-279.
30. Leiblein, M. J., and Madsen, T. L. 2009. "Unbundling Competitive Heterogeneity: Incentive Structures and Capability Influences on Technological Innovation," Strategic Management Journal (30:7), pp. 711-735.
31. Leiponen, A., and Helfat, C. E. 2010. "Innovation Opportunities, Knowledge Sources, and the Benefits of Breadth," Strategic Management Journal (31:2), pp. 224-236.
32. Mahoney, J. T. 2005. Economic Foundations of Strategy, Thousand Oaks, CA: Sage Publications.
33. Makadok, R. 2001. "Toward a Synthesis of the Resource-Based and Dynamic-Capability Views of Rent Creation," Strategic Management Journal (22:5), pp. 387-401.
34. Mata, F. J., Fuerst, W. L., and Barney, J. B. 1995. "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," MIS Quarterly (19:4), pp. 487-505.

35. Miller, D. J., Fern, M. J., and Cardinal, L. B. 2007. "The Use of Knowledge for Technological Innovation within Diversified Firms," Academy of Management Journal (50:2), pp. 308-326.
36. Nonaka, I., and Takeuchi, H. 1995. The Knowledge-Creating Company, New York, NY: Oxford University Press.
37. Penrose, E.T. 1959. The Theory of the Growth of the Firm, New York, NY: Wiley.
38. Ployhart, R. E., Weekley, J. A., and Ramsey, J. 2009. "The Consequences of Human Resource Stocks and Flows: A Longitudinal Examination of Unit Service Orientation and Unit Effectiveness," Academy of Management Journal (52:5), pp. 996-1015.
39. Podsakoff, P., Mackenzie, S., Lee, J. Y., and Podsakoff, N. 2003. "Common Method Biases in Behavior Research: A Critical Review of the Literature and Recommended Remedies," Journal of Applied Psychology (88:5), pp. 879-903.
40. Rai, A., Patnayakuni, R., and Seth, N. 2006. "Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities," MIS Quarterly (30:2), pp. 225-246.
41. Ray, G., Muhanna, W. A., and Barney, J. B. 2005. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," MIS Quarterly (29:4), pp. 625-652.
42. Sambamurthy, V., and Zmud, R.W. 2000. "The Organizing Logic for an Enterprise's IT Activities in the Digital Era: A Prognosis of Practice and a Call for Research," Information Systems Research (11:2), pp. 105-114.
43. Saraf, N., Langdon, C. S., and Gosain, S. 2007. "IS Application Capabilities and Relational Value of Interfirm Partnerships," Information Systems Research (18:3), pp. 320-339.
44. Schumpeter, J. A. 1934. The Theory of Economic Development, Cambridge, MA: Harvard University Press.
45. Sharma, R., and Yetton, P. 2007. "The Contingent Effects of Training, Technical Complexity and Task Interdependence on Successful Information Systems Implementation," MIS Quarterly (31:2), pp. 219-238.
46. Shaver, J. M. 1998. "Accounting for Endogeneity When Assessing Strategy Performance: Does Entry Mode Choice Affect FDI Survival?" Management Science (44:4), pp. 571-585.
47. Simon, H. A. 1947. Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations, New York, NY: Macmillan.
48. Sorensen, J. B., and Stuart, T. E. 2000. "Aging, Obsolescence, and Organizational Innovation," Administrative Science Quarterly (45:1), pp. 81-112.
49. Susarla,A., Subramanyam, R., and Karhade, P. 2011. "Contractual Provisions to Mitigate Holdup: Evidence from Information Technology Outsourcing," Information Systems Research (21:1), pp. 37-55.
50. Tan, D., and Mahoney, J. T. 2005. "Examining the Penrose Effect in an International Business Context: The Dynamics of Japanese Firm Growth in U.S. Industries," Managerial and Decision Economics (26:2), pp. 113-127.
51. Weill, P., and Ross, J. W. 2004. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results, Cambridge, MA: Harvard Business School Press.
52. Wright, P. M., Dunford, B. B., and Snell, S. A. 2001. "Human Resources and the Resource Based View of the Firm," Journal of Management (27:6), pp. 701-721.
53. Xue, L., Ray, G., and Gu, B. 2010. "Environmental Uncertainty and IT Infrastructure Governance: A Curvilinear Relationship," Information Systems Research, Forthcoming.

54. Zhou, K. Z., and Wu, F. 2010. "Technological Capability, Strategic Flexibility, and Product Innovation," Strategic Management Journal (31:5), pp. 547-561.
55. Zhu, K. and Kraemer, K. L. 2005. "Post-Adoption Variations in Usage and Value of E-Business by Organizations: Cross-Country Evidence from the Retail Industry," Information Systems Research (16:1), pp. 61-84.

The Motivations and Impacts of Innovation in Open Source Software

Wei Chen Vish Krishnan Kevin Zhu
Rady School of Management, University of California, San Diego
wei.chen@rady.ucsd.edu vkrishnan@ucsd.edu kxzhu@ucsd.edu

Abstract

This paper shows that innovation plays an important role in connecting motivations and success of open source software projects. With archived data collected from Sourceforge.net, we show that faster innovation is associated with higher download performance in the future. Regarding the antecedents of innovation, we find that external motivations such as download and donation numbers are associated with faster future innovation. We also find that the open source license works through the motivations factors.

Keywords: Innovation, Open Source, Motivation, Licensing, Success

1. Introduction

Open source software (OSS) has become an important alternative to proprietary software. Private and government organizations have been more and more dependent on OSS. However, even though we often hear of successful stories of OSS, many OSS projects fail. Half of the 160,000 hosted projects on SourceForge.net (SourceForge) have never released any programs for users to download. Therefore, it is interesting to ask what determines OSS projects success. In this research, success of an OSS project is defined as the download numbers of the project in a month. Several studies have revealed different factors that may be important to the success of OSS projects, including license choice, organizational sponsorship, network embeddedness, and various attributes of OSS projects (e.g. Stewart et al. 2006, Grewal et al. 2006, Subramaniam et al. 2009). Moreover, studies on motivation of OSS contributors indicate that understanding of motivations will help us gain insights into how the open source innovation sustains (Belenzon & Schankerman 2008). However, we are still at an early stage of understanding the success of OSS projects. Utilizing the motivations does not necessarily lead to success of OSS projects, because most of normal users do not know the effort of developers unless they can see and use the product. We could not ignore the efforts of developer teams and their efforts in innovation and releases of new versions. Therefore, we think there is a gap between motivations of developers and the success of OSS projects.

In this paper, we argue that innovation of OSS is an important link between motivation of developers and the success of OSS projects. Innovation in this study is defined as the frequency of new version releases of an OSS project in a month. As Stewart et al. (2006) argued, OSS projects must signal to potential users that the project is likely to provide a high level of overall quality. The only delivery of a program the users could see is the release of a new version. It is important to understand whether innovation of projects affects the outcome. Our second question concerns the antecedents of innovation. Several previous studies have investigated the effects of various variables on innovations, though they did not see it from the innovation perspective.

Our work is designed to extend past research in at least two different directions. First, we provide a new perspective to understand the success of OSS project by applying the theoretical

framework from new product development, proposing innovation as an important link between motivations of developers and the success of projects. Second, we contribute to work on new product development by identifying and empirically testing the antecedents and outcome of innovation on project level.

2. Theoretical Framework

The theory base of our study comes from the general model of innovation speed antecedents and outcomes (Kessler and Chakrabarti 1996). In this framework, innovation of a project can be affected by strategic-orientation factors, which may influence project outcomes. Applying this model to the OSS context, we propose that innovation plays an important role in the success and sustainable development of an OSS project.

2.1 Download Performance: Consequence of OSS Innovation

Research has explored several factors that could affect the success of OSS. Stewart et al. (2006) investigate the impact of license type and organizational sponsorship on user interests and developer activities of OSS. They find that organizational sponsorship has a significant effect on both user interests and developer activities, and that projects with unrestrictive license would attract more user interests. Subramaniam et al. (2009) use longitudinal data to identify several time-variant and time-invariant factors that impact three measures of project success: developer interest, user interest, and development activity. Their findings suggest that these three measures affect the subsequent success.

In this paper, we propose that the innovation of an OSS project has a strong influence on the success of the project. Research on consumer behavior suggests that customers make purchase decisions according to perceived value, which is assessed by product cost and product quality (Zeithaml 1988; Dodds et al. 1991). Since OSS normally has little or no cost at initial adoption, quality of OSS becomes an important determinant of OSS project success. Each innovation of a project is an effort to improve the quality of the software. This quality improvement will affect user adoptions and lead to better download performance in later period.

Hypothesis 1: *Higher release frequency is associated with higher consequential download numbers.*

2.2 Licensing & Motivation: Antecedents of OSS Innovations

OSS gives people the impression that developers are contributing "freely". However, Lerner and Tirole (2002) point out that the developers gain private benefit by signaling to the potential employers their programming skill. Further exploration on this direction reveals that developers' motivation can be intrinsic or extrinsic and that the motivations are related in a complex way (Roberts et al. 2006). Belenzon and Schankerman (2008) find that developers are strongly sorted by license type, project size and corporate sponsorship. In this paper, we extend this stream of research to show the effect of motivations on the innovation of OSS projects. If developers are seeking reputation or monetary return from the software, then the popularity of the project would matter. Moreover, direct monetary return (such as donations) would also have an effect on their contribution behaviors.

Hypothesis 2A: *Higher download numbers are associated with higher subsequent release frequency.*

Hypothesis 2B: *More donations are associated with higher subsequent release frequency.*

Studies on motivations of OSS development find that the license choice of a project will have an impact on the success of the project. Stewart et al. (2006) find that OSS projects with an unrestrictive license attract greater user interest over time than those with a restrictive license. Subramaniam et al. (2009) find that restrictive licenses have positive or negative impact on user interests depending on the audience of the software. Calazo and Fang (2009) also find that the restrictive licenses lead to faster development speed. We find these results interesting but not completely convincing. The license type of a project is decided as it is started. If the license has a direct impact on project performance, there will be only one type of license. We argue that OSS license works through other variables, such as external motivations.

Hypothesis 3A: *The effect of download numbers on release frequency is smaller in more restrictive projects.*

Hypothesis 3B: *The effect of donations on release frequency is smaller in more restrictive projects.*

2.3 Network Effects and Product Diffusion

Besides the effect of innovation, we expect that some other variables also have an influence on the performance of OSS projects. One important factor that will affect the adoption of OSS project is network effect. Network effects indicate that the value of a product increases with the size of the network. It has been observed in many technology adoption behaviors (Kauffman, McAndrews & Wang 2000). We control this by the install base (cumulative download numbers) of the program. Another important factor could be product diffusion. The product diffusion literature shows that consumer adoption is influenced by the current user base and the number of potential users (e.g., Bass 2004). We control this by decomposing the product diffusion effect into product fixed effect and its age.

3. Econometric Specification

We specify our econometric model with two panel data equations. First, we are interested in investigating the impact of innovation on download performance.

$$\log(Download_{it}) = \alpha_i + \alpha_t + \beta_1 \mathrm{Re}leases_{it-1} + \beta_2 X_{it} + u_{it} \quad (1)$$

Where $Download_{it}$ is the download numbers of project i in month t. $Releases_{it}$ is measured by the number of releases in month t, and X_{it} contains control variables such as cumulative download and age of the project. We need to consider two problems when we estimate model (1). First, when a new version is released, we do not know whether the download comes from the upgrades of existing users or new installations of new users. This issue is partially controlled by putting cumulative download numbers of the software (install base) in X_{it}. Second, there may be endogeneity issues due to unobserved contributors' motivations. Since this is a study in progress, we are still investigating proper instruments to identify the causal relationship. We put further exploration in the discussion section.

As stated in section 2, we expect that the innovation of a project is associated with the motivations of developers. We use the download performance and donations to the project at time t as a proxy of the extrinsic motivations of the developers.

$$\begin{aligned}\log(\mathrm{Re}\,leases_{it}) &= \mu_i + \mu_t + \gamma_1 Download_{it-1} + \gamma_2 CuDownload_{it-1} \\ &+ \gamma_3 Donations_{it-1} + \gamma_4 Trac\ker s_{it-1} + \sigma_{it}\end{aligned} \quad (2)$$

Note that since license type does not change over time, its effect will be captured by the project fixed effect. As stated in section 2, we propose that license type works through these motivation variables. We add interaction terms to capture the effect of license type over time.

4. Results

The data of this research come from SourceForge.net, which is the main platform for open source software development, distribution and maintenance since 1999. Currently, our sample contains 83 programs in the "file sharing" category with more than 100,000 downloads.

Table 2 shows the estimates of the effects of release frequency on download numbers. In each column the model specification (1) is estimated with fixed effect. The results suggest that H1 is supported. The coefficient of $Releases_{it-1}$ suggests that with one more new version release in a period is associated with about 5% download increase in the next period.

Table 2 Effects of Innovation on Download Performance

Dependent Variable: $log(Download_{it})$		
$Release_{it-1}$	.063*** (.015)	.055*** (.015)
$Cu_Download_{it-1}$	4.24e-09***(4.87e-10)	3.72e-09*** (5.28e-10)
Age_{it}	-.00037*** (.0000189)	-.0003684*** (.0000189)
$Cu_Download \times Releases_{it-1}$		9.51e-10** (3.79e-10)
N *Group* R^2	7029 82 0.75	7029 82 0.61

Table 3 presents the estimation results of model (2). Column (1) shows the model without any interaction term. H2A is supported by the positive coefficient of $LogDownload_{it-1}$. To our surprise, the sign of the coefficient of donations goes to opposite direction as we predicted. This problem disappears when we add the interaction term $License_i \times LogDownload_{it-1}$. According to Column (3), H2B and H3B are supported. The negative sign of the interaction term tells us that the effect of extrinsic motivators is lower in projects with highly restrictive licenses. This result conforms to Belenzon and Schankerman (2008) because if developers are sorted according to license type, developers in restrictive projects may contribute mainly out of intrinsic motivations. This lowers the power of extrinsic motivators. Results from column (2) confirm this and support H3A.

Table 3 Effects of Motivations on Innovations

Dependent: $Log_Release_{it}$	*(1)*	*(2)*	*(3)*
$Log_Download_{it-1}$	.060**(.025)	.175**(.073)	.061**(.024)
$Log_Cu_Download_{it-1}$	-.119***(.024)	-.122***(.024)	-.119***(.024)
Age_{it}	.000(.000)	.000(.000)	.000(.000)
$Trackers_{it}$	.001(.002)	.001(.002)	.001(.002)
$Donations_{it}$	-.006*(.003)	-.005*(.003)	4.126**(1.653)
$License_i \times LogDownload_{it-1}$		-.040*(.024)	
$License_i \times Donation_{it-1}$			-1.377**(.551)
N *Category*	968 78	968 78	968 78

R^2	0.2836	0.2858	0.2886

5. Discussion

In this paper, we investigate the antecedents and consequences of innovations in OSS projects. We propose a new perspective to interpret the sustainability of OSS. Our results show that innovation plays an important role in connecting motivations and success of OSS projects. Our findings could help OSS project leaders achieve better performance. Meanwhile, our results also indicate how to utilize developer motivations to accelerate the innovation of the project. Several issues still exist in this study. First, without proper instruments, our estimation of models may be biased. This may lead to misinterpretation of the results. We are working on construct valid and relevant instruments. Second, we currently do not take into account that all these OSS projects are essentially competing in the same market. What the effects of competition on innovations are in the OSS context may be an interesting direction to explore.

References

1. Bass, F. M. "A New Product Growth for Model Consumer Durables," *Management Science* (50:13), 2004, pp. 1825-1832.
2. Belenzon, S., & Schankerman, M. "Motivation and Sorting in Open Source Software Innovation," *C.E.P.R. Discussion Papers*, 2008.
3. Grewal, R., Lilien, G. L., & Mallapragada, G. "Location, location, location: How network embeddedness affects project success in open source systems," *Management Science* (52:7), 2006, pp. 1043-1056.
4. Colazo, J., & Fang, Y. "Impact of license choice on Open Source Software development activity," *Journal of the American Society for Information Science and Technology* (60:5), 2009, pp. 997-1011.
5. Dodds, W. B., Monroe, K. B., & Grewal, D. "Effects of Price, Brand, and Store Information on Buyers' Product Evaluations," *Journal of Marketing Research* (28:3), 1991, pp. 307-319.
6. Kauffman, R. J., McAndrews, J., & Wang, Y. "Opening the "Black Box" of Network Externalities in Network Adoption," *Information Systems Research*, (11:1), 2000, pp. 61-82.
7. Kessler, E. H., & Chakrabarti, A. K. "Innovation Speed: A Conceptual Model of Context, Antecedents, and Outcomes," *The Academy of Management Review* (21:4), 1996, pp. 1143-1191.
8. Lerner, J., & Tirole, J. "Some Simple Economics of Open Source. *The Journal of Industrial Economics*," (50:2), 2002, pp. 197-234.
9. Roberts, J. A., Hann, I. H., & Slaughter, S. A. "Understanding the motivations, participation, and performance of open source software developers: A longitudinal study of the Apache projects," *Management Science* (52:7), 2006, pp. 984-999.
10. Stewart, K. J., Ammeter, A. P., & Maruping, L. M. "Impacts of License Choice and Organizational Sponsorship on User Interest and Development Activity in Open Source Software Projects," *Information Systems Research* (17:2), 2006, pp. 126-144.
11. Subramaniam, C., Sen, R., & Nelson, M. L. "Determinants of open source software project success: A longitudinal study," *Decision Support Systems* (46:2), 2009, pp. 576-585.
12. Zeithaml, V. A. "Consumer Perceptions of Price, Quality, and Value: A Means-End Model and Synthesis of Evidence," *The Journal of Marketing* (52:3), 1988, pp. 2-22.

Introducing Basic Project Management Skills in an Introductory Information Systems Course

Yuzhu Li
University of Massachusetts Dartmouth, USA.
yuzhu.li@umassd.edu

Abstract

This paper contributes to the scholarship of teaching and learning Management Information Systems (MIS) and Project Management (PM). It reflects on the experience of exploring student learning effectiveness from an exploratory trial of introducing basic project management concepts in an introductory information systems course at a southeastern public university in fall 2010. First, the larger context will be introduced and the importance of project management skills for business majors is presented. Second, the approach of outcome-based learning will be presented particularly within the context of the introductory MIS course and of the larger college context. In the future research stages, the detailed project management exercise will be introduced and initial results will be analyzed. Insights and future improvements will be discussed for further improvement of MIS and PM education.

Keywords: Management Information Systems Education, Project Management Education

1. Introduction

Traditional business curriculum has been questioned and challenged because of the increasing dynamic and complex business environment and changing demands for business graduates. Highly complex environments are inherently unpredictable, leading to much irresolvable uncertainty about the future. Students must be prepared for working in a dynamic, changing, and possibly chaotic business environment. Except the specific knowledge body that students must master, students have to learn to cope with the complexity of business environments. Given the increasing significance of projects in all organizational contexts, emerging leaders need to be prepared to effectively contribute to project environments and to particular projects. Hence, the ability to lead, to manage, and to do a project is a key skill of today and has been an important topic in recent information systems textbooks (Kroenke 2009; Rainer et al. 2009). Project management skill is the top one skill in high demand (Leung 2010).

While general business graduates with project management skills can stand out in the job market, Management Information Systems (MIS) graduates are required to have project management skills since the majority of information system functions are delivered in the form of projects. IS curriculum 2010 has specifically included IS project management as a core course for the MIS curriculum guideline (Topi 2010). When some business college particularly set up a project management course, the others are constrained to add a new project course in the curriculum for various reasons. The goal of this study is to explore an approach of effectively introducing project management skills in an existing business course of the core curriculum. I particularly chose the introductory information system course which also needs a complement to address its own delivery issue.

Information technology courses have become required core business courses in many AACSB accredited business schools (AACSB 2007). They are required for all the business majors. However, the delivery of information technology courses is challenging because students have varied technology skills and efficacy in learning technology. In addition, technology is viewed as a tool of supporting general business processes. Technology management cannot be learned without an appropriate context. Today's business world is characterized as velocity and complexity which traditional undergraduates who has zero or less work experience find it difficult to understand the effectiveness of information systems in an organization context. How to teach information systems knowledge effectively and enable students to appreciate the importance and significance of technology for organizational success in an uncertain and dynamic business environment becomes challenging.

In this study, I propose that the effective teaching and learning of project management skills in a course technology project provides a concrete context for business students to learn information systems. Given the particular audience of undergraduate students, the focus of the project at hand will be more on simple information system development projects and the respective basic project management skills than on the details of the Project Management Body of Knowledge (Project Management Institute 2004). The related skills and tools will be customized adopted from industry practice. The education outcomes related to the learning of project management skills should be identified and be able to effectively reflect the students' performance and course effectiveness. The focused PM skills in this IS project are the skills of (1) initiate and plan an IS development project; (2) execute and control the projects and (3) effectively manage cross-functional teams.

Following the framework of teaching and learning which includes asking questions about teaching and learning, gathering and exploring evidence, trying out and refining new insights, and going public, I will first review the literature of teaching high-order business skills and adaptive capability, the literature of information systems education and project management education, and the teaching methodology of outcome-based learning. Next, I discussed the implementation of a technology course project in parallel with project management training in an MIS introductory course at a southeastern public university at fall 2010. Data collection process will be described. Data analysis plan and expected results will be discussed.

2. Literature review

2.1 High-order Business Skills and Adaptive Capability

The four key skills that business executives expect business graduates to have and business programs should deliver are (1) ability to communicate effectively, (2) ability to work well with others, (3) general problem-solving ability, and (4) ability to learn (Gill 2009). Kane's (1993) study reported that Fortune 500 recruiters assumed that graduates already possess the appropriate technical skills, so they should pinpoint their focus on the candidate's people skills. Practitioners are looking for college graduates with general business skills, especially people skills and problem-solving skills. Other studies have shown that technical skills are important, but do not outweigh having a good understanding of business while commanding effective communication, teamwork, interpersonal, and organizational skills (Gabric et al. 2001; Nelson 1991; Silva et al. 2005). From an industry perspective, over 90 per cent of the employers look for people who are

flexible and adaptive, willing to learn on the job, team players, technically competent and committed to excellence (Thompson et al, 2008).

Graduate employability has been traditionally used as an anchor of business graduate capabilities (Crossman et al. 2010). In general , employability is defined as having the skills and abilities to find employment, remain in employment or obtain new employment as, and when, required (Crossman et al. 2010). It represents a range of individual characteristics that enable adaptive behaviors necessary to main ongoing employment. In order to achieve business graduates' employability, curriculum has been designed to focus on the acquisition of critical subject knowledge and skills and transferrable knowledge skills and attitudes (Cassidy 2006). Transferrable skills include oral communication, high level learning skills, problem solving, decision making and affective skills and work traits such as responsibility, interpersonal skills and working in a team and independently (Cassidy 2006).

2.2 Project Management Education

In more and more industries, project-based organization has become a valuable organizational structure. Project management has received a great amount of attention from top management, human resources and in some particular business functions such as Information technology and R&D (Whittington et al. 1999). Various project management training programs, certifications and specialized courses were created. Today project management is an important part of MBA and executive education syllabus (Berggren et al. 2008). For the undergraduate education, project management has been incorporated by curriculum of various majors such as leadership and management information systems (Mengel 2008; Topi et al. 2010).

2.3. Outcome-based learning

At a general AACSB-accredited college, the goals of core business course have been collectively developed. These learning goals are generally expected outcomes and used to determine and implement effectively learning outcomes and can be further detailed to examine how specific course objectives are consistent with the overall learning goals (AACSB 2007). These learning goals include global business, ethical behavior and social responsibility, diversity, quantitative reasoning, managerial problem-solving/decision-making, information literacy, technology proficiency, oral communication, and written communication. Specific skills such as critical thinking skills and problem solving skills, etc are particularly spelled out. Measures of these outcomes can support the two principles of AACSB accreditation, accountability and continuously improvement. The project of a real IS development provides good opportunities for students to learn the technical skills. The introduction and application of PM skills in a real IS development project expose students to project initiation and plan, project execution and control and team management.

3. Methodology

An information system development project was required in the introductory Information Systems course at a southeastern public university at fall 2010. While exposing students to real projects within the problem or project-based learning approaches is quite common (Liegel 2004; Markham et al. 2003) this approach rarely includes teaching students the necessary PM tools, techniques, and skills. Based on the approaches to outcome-based learning and to educational effectiveness and accountability I intended to enhance the students' project learning experience

by designing the project towards achieving particular PM outcomes and towards including the respective teaching and reflection into the coursework.

Students in small teams are required to develop an information system database using MS Access. In fall 2010, students in two sections of this course were exposed to three particular PM related outcomes – (1) initiate and plan an IS development project; (2) execute and control the projects and (3) effectively manage cross-functional teams. In addition to informal feedback and coaching, each team is required to submit a project precedence diagram, three earned valued management reports at different phases of the project, and a reflection paper on the learning of PM skills. In fall 2010, about 100 students, 16 teams completed the project of developing an information system database and required project management exercise. Students formed teams by themselves. There were three cases with different business contexts and similar required system functions. Each team picked up a case out of three choices and received a 50-minute lecture of the basic project management concepts and explanation of the technical project and the parallel project management exercise. Each team consulted the instructor before submitting the project plan. The approved project plan was treated as a contract between the project team and the instructor (project sponsor). Any violation of the project plan would be penalized. Data collection has been completed along the project process. Each team's project plan, EVM reports and project reflection papers will be analyzed in different approaches. Table 1 shows the map of learning outcomes and assessment methods. For the future data analysis, a qualitative analysis will be done with the individual reflection paper. Individual reflection paper will be carefully examined, categorized and cross-referenced. A survey of students perceived learning outcomes of project management skills will be collected. A correlation between perceived learning outcome and each team performance will be examined.

Table 1 The map of learning outcomes and assessment methods

Learning outcomes	Assessment methods	Assessment level
Developing a project plan	Project plan (precedence diagram)	Team-based
Executing a project	Project milestones (MS databases as the milestone output)	Team-based
Monitoring and controlling a project	Earned valued management (EVM) reports Oral and written communication between the project team and the professor	Team-based Team or individual-based
Closing a project	Reflection paper (lesson learned)	Individual-based

4. Conclusion

To meet the demand of teaching business graduates with adaptive capability and the challenge of delivering introductory information systems course effectively to business students with minimum work experience, this study proposed to use a technology course project with a project management exercise to effectively solve the challenge and teach students the knowledge and skills of being adaptive. In the next stage of this research project, I will conduct a combine the quantitative analysis of students' perceived learning outcomes and team performance, and qualitative analysis of students' reflection paper and other forms of written communication. Insights and future improvement will be discussed. This discussion will contribute to the scholarship of teaching and learning MIS and PM.

References

1. AACSB "AACSB Assurance of Learning Standards: An Interpretation," 2007.
2. Berggren, C., and Soderlund, J. "Rethinking project management education: Social twists and knowledge co-production," *International Journal of Project Management* (26:3) 2008, pp 286-296.
3. Cassidy, S. "Developing employability skills: peer assessment in higher education," *Education + Training* (48:7) 2006, pp 508-517.
4. Crossman, J., and Clarke, M. "International experience and graduate employability: stakeholder perceptions on the connection," *Higher Education* (59:5) 2010, pp 599-613.
5. Gabric, D., and McFadden, K.L. "Student and employer perceptions of desirable entry-level operations management skills," *Mid-American Journal of Business* (16:1) 2001, pp 51–59.
6. Gill, T.G. "Coping with Complexity," *Decision Sciences Journal of Innovative Education* (7:2) 2009, pp 339-340.
7. Kane, K.F. "MBAs: A recruiter's eye view," *Business Horizons* (36:1) 1993, p 65.
8. Kroenke, D. *Using MIS*, (3rd ed.) Prentice Hall, 2009.
9. Leung, L. "Top 10 Skills in Demand in 2010," 2010.
10. Liegel, K. "Project-based learning and the future of project management," in: *PMI global conference 2004 - North America*, Project Management Institute, Newton Square, PA., 2004.
11. Markham, T., Larmer, J., and Ravitz, J. *Project based learning handbook*, (2nd ed.) Buck Institute for Education, Novato, CA., 2003.
12. Mengel, T. "Outcome-based project management education for emerging leaders - A case study of teaching and learning project management," *International Journal of Project Management* (26:3) 2008, pp 275-285.
13. Nelson, R.R. "Educational Needs as Perceived by IS and End-User Personnel: A Survey of Knowledge and Skill Requirements," *MIS Quarterly* (15:4) 1991, pp 503-525.
14. Project Management Institute *A guide to the project management body of knowledge (PMBOK guide)*, (3rd ed.) Project Management Institute, Inc., Newtown Square, PA., 2004.
15. Rainer, R.K., and Turban, E. *Introduction to Information Systems*, (2nd ed.) Wiley, 2009.
16. Silva, D., and McFadden, K.L. "Combining Operations Management and Information Systems Curricula: Assessing Alumni Preparations for the Workforce," *Decision Sciences Journal of Innovative Education* (3:2), Fall2005 2005, pp 307-321.
17. Topi, H., Valacich, J.S., Wright, R.T., Kaiser, K., Nunamaker, J., F., J., Sipior, J.C., and de Vreede, G.J. "IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems," *Communications of the Association for Information System* (26:18) 2010.
18. Whittington, R., Pettigrew, A., Simon, P., Fenton, E., and Conyon, M. "Change and Complementarities in the New Competitive Landscape: A European Panel Study, 1992-1996," *Organization Science* (10:5) 1999, pp 583-600.

Effects of Outsourcing on IT Professionals

H. Michael Chung and M. B. Khan
College of Business Administration
California State University, Long Beach
U.S.A.
hmchung@csulb.edu, mkhan@csulb.edu

Abstract

This research examines the effects of Information Technology (IT) outsourcing on key factors (demand, supply, salary and cost) affecting IT professionals. While demand has decreased for computer programmers in the U.S., software engineers and systems analysts continue to show increasing demand. The supply of IT professionals shows a mixed trend. The cost of producing IT workforce appears to be independent of outsourcing and has been increasing. No negative effect of outsourcing on salary was found and average salary continues to increase. The study supports the emphasis and resource allocation in producing value added workforce to meet the domestic IT needs.

Key Words: outsourcing, information technology, IT workforce, supply and demand

1. Introduction

Since the 1960s, the United States has been moving from a manufacturing based economy to a service based economy. At the present time, the service sector represents about 68% of the American post industrial Gross Domestic Product. This change of economic emphasis has brought about a transformation in the characteristics of the labor force resulting in production of a moderate to high-skilled labor force. The availability of international high skilled workers has signaled an opportunity for U.S. companies to lower their IT costs by contracting work overseas where labor costs are, on the average, one-tenth of those in the U.S. Among diverse IT related occupations ranging from high to low-skilled, the ones that are mainly being outsourced in the high-skilled level are computer programmers, computer software engineers (applications and systems), and computer systems analysts. For the moderate to low skill level, the occupations off-shored are: data entry keyers, billing and posting clerks and machine operators. As more and more IT work is outsourced resulting in a significant loss of certain IT jobs in the U.S., outsourcing and its effects on the U.S. job market has captured the attention of many – researchers, government, and industry.

Most of the research on outsourcing has focused on assessing its effects in the manufacturing and service sectors. A large part of research has employed economic theories to model outsourcing under a closed system assumption. Some work has been done on the impact of outsourcing on the IT profession. However, little research shows the impact of outsourcing on demand, supply, and compensation of IT workforce from a holistic perspective.

This research describes the effects of outsourcing on key factors - demand, supply, salary and cost - affecting three categories of IT professionals - computer programmers, software engineers, and systems analysts - in the outsourcing country.

2. Literature Review

2.1. Outsourcing-Definition and the Scope

Multiple definitions of outsourcing have been offered causing a dislocation of the theoretical coherence across disciplines. The lack of agreement on fundamental issues such as if outsourcing should be studied in a domestic or in an international setting, or if it is an intra or an inter-firms practice, are some examples (Amiti et al., 2005a). For instance, Stack and Downing (2005) indicates that outsourcing is a decision to "hire-out" what happens at the firm level in which the hiring company assumes a loss of control over production. Differently, Grossman and Helpman (2005) argue that outsourcing is a bilateral partnership that goes further than just the purchase of raw materials and goods. Skaksen (2004) tries to reconcile these approaches by offering a combination of them in which outsourcing is determined by international wage settings but stipulated by firms through prior wage negotiations. In this line of reasoning, Lommerud, et al. (2005) highlight that domestic forces as well as internal features of the firms (such as the presence of unions) have an influence on outsourcing.

In an effort to simplify the conceptualization of outsourcing, Bhagwati et al. (2004) suggest that outsourcing is just a trade phenomenon. using such reasoning, they employ the standard two-country, two-factor, two-good Heckscher-Ohlin model to illustrate that outsourcing follows the traditional analysis of trade policy.

All of these examples illustrate the ebbs and flows related to the current difficulties faced by academics when trying to assemble a consistent, clear, and useful definition of outsourcing. In addition, throughout literature, outsourcing has been difficult to measure because data on the types and amount of outsourced products and services are still non-existent.

Nevertheless, a few authors including Weiderhold et al.(2010) and Qu and Pinsonneault(2011) have developed different empirical models to capture the extent of outsourcing. These authors have taken different paths in order to calculate indicators of outsourcing and their effects on the labor market. In addition, Ranganathan and Outlay (2009) report an empirical analysis on resizing IT workforce. Sia, et al. (2008) studied outsourcing flexibility. In summary, despite the value of the contributions brought by this scholarship, research on outsourcing still depends on a dispersed list of indicators that echoes the lack of inconsistency in the definition described above.

2.2. The impact of Outsourcing on Wages and Employment

Researchers have shown an interest in the effects that outsourcing may have over wages, productivity, and employment, as well as its influence over many other sectors of the economy. Special emphasis has been put on manufacturing, services, information technology, and health care. For instance, Feenstra and Hanson (1999) find that wage increases of skilled workers in relation to those of unskilled workers is explained by computers' expenditure (35 percent) and by outsourcing (15 percent) when independent structural variables behave linearly.

Regarding the effects of the outsourcing of services on U.S. employment, Amiti and Wei (2005b) find a small negative effect of less than half percent on US employment once the economy is decomposed into 450 sectors. However, this negative effect disappears when the sectors are disaggregated into just 96 sectors, that is, as the level of disaggregation becomes more narrow. These results find echo in Hsieh and Woo's (2005) study of the Hong Kong labor market. Tambe and Hitt (2008) study the effects of IT outsourcing on the U.S. workforce and on the demand for IT skills among U.S. IT workers in the future.

The influence of outsourcing has also been studied in different sectors of the economy. According to data collected by Cooke (2003), the information technology (IT) sector has experienced a loss of jobs in the United States. However, little research considered the effect of outsourcing from a holistic perspective involving demand, supply, salary and cost.

3. Research Questions, Methodology, and Analysis

Our research focuses on the effects of outsourcing on demand, supply, salary and cost of three categories of IT professionals: computer programmers, software engineers, and systems analysts. Specifically, our research attempts to address the following questions: Has outsourcing affected the demand for IT workforce? Has outsourcing change the level of supply of IT workforce supplies? How does outsourcing affect the cost of producing IT workforce? Are salaries of the three categories of IT professionals dependent on the level of demand? What is the effect of outsourcing on salary of IT professionals? What is the relationship between supply and demand for each of the three categories of IT professionals?

In our study, we define computer programmers as those individuals who write computer software. This definition is broad as it includes all types of programmers regardless of their experience level (entry-level, junior and senior) and the type of software (applications and systems) they write. In a similar manner, the definition of systems analysts is also broad as it encompasses all systems analysts. We accept these broad definitions since the relevant data (supply, demand, cost, and salary) that we use to support our research are available in accordance with such definitions. On the other hand, software engineers are defined separately as applications and systems software engineers since the relevant data are available separately for these two types of software engineers.

In our analysis, supply is represented by the number of graduates (with undergraduate degrees in Computer and Information Sciences) who enter the IT job market each year. This data comes from the U.S. Department of Education that defines Computer and Information Sciences as a field of study for which it reports graduation data. Demand is represented by the number of future job openings in the U.S. for computer programmers, software engineers and systems analysts. Salary is represented by the average starting salary of computer programmers, software engineers and systems analysts. Cost is represented by the total tuition and fees of a four-year degree program in Computer and Information Sciences.

This paper analyzes data obtained from the U.S. Department of Labor, U.S. Department of Education, and Job Employment Guide and the National Association of Colleges and Employers.

These data represent the years 1999-2006 – the time periods for which all relevant data were available. We conducted an extensive statistical analysis (the tables are truncated here.). Our analysis centers on the effects of outsourcing on demand, supply, cost and salary of IT professionals. We extend the analysis by presenting relationships between demand and supply, demand and salary, and demand and cost. In particular, we focused on: Effects of Demand for IT Professionals; Effects on Supply of IT Professionals; Effects on Cost of IT Professionals; Effects on Salary of IT Professionals; Relationship between Demand and Supply; Relationship between Demand and Salary; and Relationship between Demand and Cost among others.

4. Conclusions

The present paper discusses the effects of outsourcing on four factors (demand, supply, cost and salary) pertaining to three types of IT professionals – computer programmers, software engineers, and systems analysts. The following observations are noteworthy in our research.

- Despite outsourcing of IT work, the demand for software engineers (both applications and systems) and systems analysts has continued to rise from 1999 through 2006 and is expected to rise through 2018. Programmer's demand, on the other hand, has shown a steady decrease since 1999 and will continue to fall.
- Supply of all three types of IT professionals has maintained a somewhat mixed relationship. We notice an overall increased supply of IT workforce from 2000-01 through 2003-04 after which it starts decreasing. The decreasing supply after 2003-04 is consistent with decreasing enrollment in IT and IT-related academic programs in the U.S.
- The cost of producing IT graduates is independent of outsourcing and levels of demand and supply. This cost will continue to rise.
- The salary of IT professionals remains unaffected by outsourcing and levels of demand and supply.
- Demand and supply do not show a strong relationship. The same is true of the relationship between demand and cost of educating IT graduates.

The study analyzes the impact of outsourcing on different IT professionals. In addition, this research presents a holistic view and the relationship among demand, supply, cost and salary involving IT outsourcing. Despite the global outsourcing of IT workforce, the demand for more value added workforce has not been affected as much. Thus, the implication of the study supports the emphasis and resource allocation in producing value added workforce to meet the domestic IT needs in the future.

There are several shortcomings of this research. First, there are two issues associated with research on IT outsourcing. These issues are the lack of acceptance of a generally agreed-upon definition of the term outsourcing and the difficulties in measuring the volume of outsourcing. Secondly, our definition of supply is somewhat broad as well as the weakness of analysis in an open system environment. In addition, we need to consider those who change careers and other lateral movement in supply and demand. Thirdly, we do not consider the time lag between outsourcing years and the supply and demand years. Generally, the impact of outsourcing is felt a few years later. In our research, we use uniform time periods (1999-2006) for outsourcing, demand, and supply. Lastly, we consider the total number of graduates as our supply pool. Since we are considering the impact of outsourcing in the outsourcing country, our

supply needs to be restricted to those graduates who seek employment in the U.S.

In the future research, we plan to further analyze the impact of outsourcing on different categories of IT professionals along with more data on different sources of IT supply. In addition, we plan to explore the cases and impact of workforce preparation in meeting the demand of domestic IT needs.

References

1. Amiti, M. and Wei, S. "Fear of Service Outsourcing: Is It Justified?" *Economy Policy*. 20, 2005a, pp 308-347.
2. Amiti, M. and Wei, S. "Service Offshoring, Productivity, and Employment: Evidence from the United States," *IMF Working Paper*, 2005b.
3. Bhagwati, A., Arvin, J. and Srinivasan, T. "The Muddles over Outsourcing," *The Journal of Economic Perspectives*, 18(4), 2004, pp 93-114.
4.Cooke, S. *Information Technology Workers in the Digital Economy. Economics and Statistics Administration*. *Digital Economy Report*, 2003, https://www.esa.doc.gov/reports/DE-Chap2.pdf.
5.Feenstra, R. and Hanson, G. "Globalization, Outsourcing, and Wage Inequality," *American Economic Review*,*86*, 1996, pp 240–245.
6.Feenstra, R. and Hanson, G. "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United State, 1979-1990," *The Quarterly Journal of Economics*, 1999, pp 907-940.
7.Grossman, G. and Helpman, E. " Outsourcing in Global Economy," *Review of Economic Studies*, 72(1), 2004, pp 135-159.
8.Hsieh, C. and Woo, K. "The Impact of Outsourcing to China on Hong Kong's Labor Market." *The American Economic Review*, 95(5),2005 pp 1673-1687.
9.Lommerad, E., Meland, F. and Straume, O. "Can Deunionization Lead to International Outsourcing?" *Center for Economic Studies and Ifo Institute for Economic Research Working Paper*, 2005.
10.Qu, W. and Pinsonneault, W. "Country Environments and the Adoption of IT Outsourcing", *Journal of Global Information Management*, Volume 19, No. 1, 2011.
11.Ranganathan, C. and Outlay, C. "Life After IT Outsourcing: Lessons Learned from Resizing the IT Workforce," *MIS Executive*, 8(4), 2009
12.Shaksen, R. "International Outsourcing When Labor Markets are Unionized," *Canadian Journal of Economics*, 37(1), 2004, pp 78-94.
13.Sia, S., Koh, C., and Tan, C. "Strategic Maneuvers for Outsourcing Flexibility: An Empirical Assessment," *Decision Sciences*, 39(3), 2008 pp407-443.
14.Stack, M. and Downing, R. "Another Look at Offshoring: Which Jobs are at Risk and Why?" *Business Horizons*, 43, 2005, pp 513-523.
15.Tambe, P. and Hitt, L. "How Does Offshoring Affect Information Technology Workers?" Social Science Research Network Working Paper, 2008, http://ssrn.com/1259323.
16.Wiederhold, G., Gupta, E. and Neuhold, E."Offshoring and Transfer of Intellectual Property", *Information Resources Management Journal*, Volume 23, No. 1, 2010.