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Recommended Citation

Wu, Jinnan; Huang, Lihua; and Liu, Lin, "Impact of Information Technology Capability on Financial Performance of Chinese Listed Companies during the Period of Economic Downturn" (2014). *WHICEB 2014 Proceedings*. 43.
<http://aisel.aisnet.org/whiceb2014/43>

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Impact of Information Technology Capability on Financial Performance of Chinese Listed Companies during the Period of Economic Downturn

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Abstract: The information technology (IT) resource-based view suggests that IT capability is one of the determinants of a firm's competitive advantage and financial performance. However, we know relatively little about the relationship between IT capability and financial performance during the period of economic downturn. Even fewer research related to this is done in China as the largest emerging We used the matched sample comparison group method to collect data from 248 listed companies before and after the 2008 financial crisis during 2007-2009, and to investigate the impacts of IT capability on financial performance during economic downturn. The findings show that even during the period of financial crisis, companies with superior IT capability have better average profit ratios than a control sample of companies, but differences in the cost ratio of suggest no statistical significance between two samples.

Keywords: IT capability, resource-based view, financial crisis, matched sample comparison group method

1. INTRODUCTION

The global financial crisis triggered by the USA loan crisis not only makes developed countries' economy fall into recession, also causes China's significant economic downturn. Chinese official statistics shows a sustainable decline of China's GDP growth from the first quarter of 2008. The rate of GDP growth hits a record low of 6.6% in the first quarter of 2009. Macroeconomic downturn increases Chinese firms' operation risk and survival pressure. Furthermore, research has shown that during economic downturns, many firms that performed well in previous economic expansions are unable to sustain their superior performance^[1], and the number of firms reporting losses increases^[2]. Influenced by this financial crisis, the income of Chinese listed companies grows 16.63% in 2008, but the profits fell 16.88%. The percentage of Chinese listed companies reporting losses has increased to 15.64%. Also, the number of companies reporting losses is two times that of 2007.

IT capability has been widely viewed as an important organizational capability to reduce operating costs and improve profitability^[3, 4]. A lot of studies have validated the positive impact of IT capability on financial performance^[5, 6], but the impact of IT capabilities on firm performance during the period of economic downturn is not clear^[7]. Although Bharadwaj (2000)^[5] and Santhanam and Hartono (2003)^[8] used IT capability data before 1995 and performance data until 1997, many things have changed dramatically^[9]. Chen et al. (2011) covered the period of the dot-com bubble in their analysis, but focus on effects of IT capability sustainability on abnormal return on equity^[7]. However, there are few studies investigating the linkage between IT and accounting-based performance at the firm level^[9]. Can IT capability be used to distinguish firms with superior performance from its competitors during the period of economic downturn? To answer this question, in this study, we investigate the impact of IT capability on financial performance during the financial crisis in 2008.

Moreover, although Western scholars have increasingly emphasized the importance of IT capability, we know relatively little about the impact of IT capability in an emerging context. We suggest that China provides a

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different context, and that there is good reason to look at China because of its anticipated importance in the 21st century global economy. Another purpose of this study is to provide an understanding of the relationship between IT capability and financial performance in Chinese context.

2. LITERATURE REVIEW AND HYPOTHESES

While value creation remains the holy grail of strategic management, the fact is that firms experience losses, and the probability of experiencing losses is much greater during an economic downturn^[2]. Recovering from losses during an economic expansion is presumably easier, because the market demand will be expanded and consumers' purchasing potential will be increased by overall economic growth, and leader's production capacity is not enough to serve the entire market. However, during an economic downturn, many firms are unable to effectively respond to pressure caused by consumers' price sensitivity and preference change. A lack of firms' core competence will lead to significant decrease in sales and profits. These firms are also at a competitive disadvantage in reducing operating costs and tapping new profit source. Thus, a firm's ability to fast response to consumers' preference change and industry competitive pressure becomes more salient in the period of economic downturn, as this determines whether a firm will recover from economic losses^[7].

According to the IT resources-based view^[5], IT resources may be easily replicated by competitors through purchasing same hardware and software, but the IT capability which has real impact on overall performance is unique. Those firms with superior IT capabilities are better at leveraging information technologies to improve operational efficiency, reduce costs, improve management and decision-making, and make full use of the changes in consumer preferences^[10]. Bharadwaj (2000) made an empirical comparison of financial performance measures between IT leader firms and control sample of firms, and her results indicated that firms with high IT capability tend to outperform a control sample of firms on a variety of profit and cost-based performance measures^[5]. More recent researches focus on the indirect impact of IT capability on firm performance. They argue that the impact of IT on business process should be investigated^[3, 11], as IT actually has an effect on the process rather than the product. Chen and Tsou (2012) examines how IT capability creates a firm's performance by improving the level of customer service^[12]. Gu and Jung's (2013) study further indicated that information systems capabilities not only has an important direct impact on business process performance, but also makes an indirect effects on business process performance by enhancing information systems qualities and usefulness. In turn, business process performance positively influences firm performance^[13].

Continuous change and innovation of internal business processes could be more important for firms facing an economic downturn. They want to constantly optimize business processes by a strategic use of IT. For some firms in a mature or declining industry with lower environmental munificence will also face fierce competitive pressure. They will pay more attention to the strategic use of IT to improve operational efficiency, reduce operating costs and transaction cost. Therefore, firms with superior IT capabilities could improve business process efficiency, reduce product / service cost through accumulated investment and deployment of IT before the financial crisis.

In the economic downturn, IT capability not only can help a firm reduce costs, but also help it increase sales. Many firms with superior IT capabilities can create information efficiency, improve analytical skills and provide market sensitivity, which in turn enables them to quickly find an abnormal market, and to effectively respond to this change before competitors. Also, there are a lot of firms using Internet technologies to expand online sales channels, thus realizing synergies advantage between online and offline sales channels and opening up global market. Both are able to help a firm timely recover from economic losses.

Based on the above analysis, we propose the following hypotheses:

Hypothesis 1: During the period of economic downturn, the average profit ratios of firms that have

superior IT capability are higher than that of all other firms in the industry.

Hypothesis 2: During the period of economic downturn, the average cost ratios of firms that have superior IT capability are lower than that of all other firms in the industry.

3. RESEARCH DESIGN

3.1 Research method

The “matched sample comparison group” methodology has been widely used in several research studies in the accounting, finance, and marketing literatures to compare the levels of interest variables across two samples^[14-16]. In the information systems research, Bharadwaj (2000)^[5], and Santhanam and Hartono (2003)^[8] investigated the impact of IT capability on firm performance with the “matched sample comparison group” methodology. We also use this methodology to empirically test the impact of IT capability on Chinese listed companies’ financial performance. In this study, the *treatment sample* is a sample of firms with superior IT capability, and a carefully selected *control sample* of firms matched to the treatment sample by size and type. The performance of the matched control sample of firms serves as a benchmark and helps remove the confounding effects of extraneous variables and market forces that could influence firm performance^[5]. Considering a non-parametric test would be more appropriate to examine the underlying distribution of the variables, the Wilcoxon Rank Sum Test was used to evaluate the differences in the levels of the profit and cost-based performance measures for the two groups of firms. This test is considered to be more powerful than the pairwise t-test which assumes the sample distribution is normal^[17].

Measurements

Explanatory Variable. IT capability is a critical mechanism which links IT resources and firm performance, and includes both abilities to develop and use information systems. According to previous literature^[5, 6], we use the informatics 500 ranking published by the National Informatization Evaluation Center of China (NIEC) in every year. The NIEC is an official evaluation institution dedicated to assess the informatics level of China and Chinese firms. From 2003 to 2008, it inquired into development level and application effectiveness of information systems in thousands of Chinese largest firms, and published a list of 500 firms that were rated as Chinese informatics leaders. Because indicators in this inquiry includes IT strategy, profitability, IT human resource, IT use, IT effectiveness, decision support, e-commerce, IT-enabled collaboration, and IT-enabled innovation etc, this informatics ranking are reasonable and representative and can be used to evaluate Chinese firms’ IT capability accurately.

Dependent Variables. Referencing to existing IT capability literature^[5, 6], four performance measures in this study were used to measure financial performance from two aspects of profit and cost ratios. The profit ratios include Return on assets (ROA) and Return on sales (ROS). The cost ratios include operating cost to sales (OC/S) and cost of selling and managing to sales (S-M/S). Table 1 describes these four performance measures.

Table 1. Definition of dependent variables

Measures	Calculation formula	Meanings
ROA	Net profit/ Total assets	how much profit a firm derives from each dollar of assets they control
ROS	Net profit/ product sales	how much profit a firm derives from each dollar of product sales
OC/S	Operating cost/ Total sales	how much operating cost a firm consumes for each dollar of total sales
S-M/S	Cost of selling and Managing / Total sales	how much cost of selling and general management a firm consumes for each dollar of total sales

3.2 Sample selection and data source

Treatment sample selection. In this study, firms in the treatment sample were selected from Chinese listed Companies in the “informatics 500 ranking” from 2003 to 2008. In order to develop a more robust and validating sample of IT leader, firms which do not meet at least one of the following criteria were filtered out: (1) entering the “informatics 500 ranking” at least 2 times, (2) having complete financial data during 2007-2009, (3) maintaining healthy financial situation. This yielded a list of 124 firms considered to be IT leaders.

Control sample selection. After selecting the treatment sample of IT leaders, the next step was to create a matching set of control firms from the *Sinofin Economic and Financial database* in the China Center for Economic Research. Being similar to Bharadwaj (2000) [5], the following procedure was used for ensuring that the comparison between the treatment sample and control sample is more subjective. First, according to the *Listed Companies Industry Categories Guide*, the IT leaders were grouped into different industry categories based on their two digit primary SIC. A two-step process was then used to identify a matching firm for each firm in the treatment sample. First, for each firm in the treatment sample, the choice was narrowed to a set of only those firms with the same primary two-digit SIC code as the IT leader firm. Next, from the set of potential control firms, the matching control firm chosen was one that reported a size level of employees and assets that was closest to the level reported by the IT leader firm. Further, both the ST firms with unhealthy financial situation and the firms with incomplete financial data during 2007-2009 were rejected. This yielded a list of 124 firms in the control sample.

Data collection. Because this study particularly focuses on the impact of IT capability on financial performance during the period of economic downturn, we chose 2007-2009 as time span for collecting data. Figure 1 provides the economic growth in the world’s major economies during 2007-2009. Although the financial crisis peaked in 2008, the active phase of the crisis can be dated from August 9, 2007. Actually, as shown in figure 1, Chinese economy suffers a sustainable decline since the third quarter of 2007, and hits a record low of 6.6% in the first quarter of 2009. Therefore, we collected original financial data of firms in the IT leader sample and the matched control sample during the period of 2007-2009 from the *Sinofin Economic and Financial database*. The data of profit and cost-based ratios were computed by EXCELL with these original financial data.

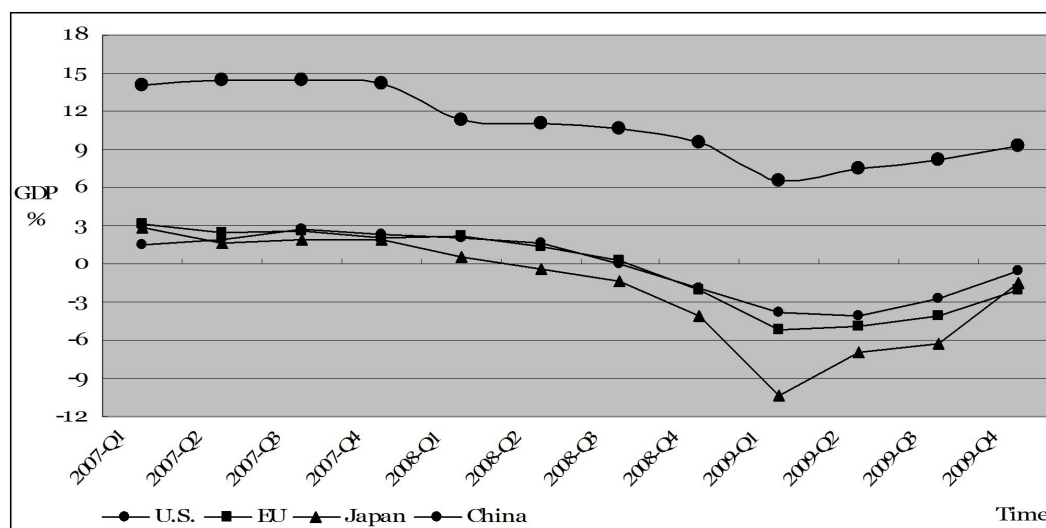


Figure 1. economic growth in the world's major economies during the period of financial crisis

Table 2 describes the industry distribution of all listed companies in the treatment sample (N=124) and the control sample (N=124). The primary difference between the two firms in each pair is that the target firm in the treatment sample was ranked as an IT leader whereas the firms in the control sample were not ranked as such.

The two groups were also compared using commonly employed measures of firm size such as total assets and sales. Both t-test and sign test carried out to check if there was any difference between the two groups on the two size measures did not reveal any significant difference between the groups. Table 3 provides descriptive statistics for the two groups.

Table 2. Industry distribution of firms in two groups

Code	Industry	Treatment sample	Control sample	Code	Industry	Treatment sample	Control sample
C01	Food processing	4	4	C57	Other electronic equipment manufacturing	0	1
C03	Food manufacturing	1	2	C61	Nonmetal mineral products manufacturing	6	4
C05	Drink manufacturing	7	6	C65	Ferrous metal smelting and rolling processing	5	5
C11	Textiles	2	2	C67	Nonferrous metal smelting and rolling processing	2	2
C13	Clothing and other fiber products manufacturing	1	2	C69	Metal products	2	2
C31	Paper-making and paper products	7	5	C71	General machinery manufacturing	6	5
C35	Printing	1	1	C73	Special equipment manufacturing	11	11
C43	Chemical materials and chemical Products manufacturing	10	8	C75	Transportation equipment manufacturing	16	13
C47	Chemical fiber manufacturing	2	3	C76	Electrical machinery and equipment manufacturing	11	10
C48	Rubber manufacturing	2	1	C78	Instrument, culture and office machinery manufacturing	3	3
C49	Plastics manufacturing	2	3	C81	Medicine manufacturing	11	18
C51	Electronic components manufacturing	6	6	C85	Biological products manufacturing	3	3
C55	Daily electronic equipment manufacturing	3	4	Number of sample		124	124

Table 3. Difference test for the two samples on firm size

	Treatment sample		Control sample		T	Z
	Means	Medians	Means	Medians		
Total sales (RMB)	9.54E+09	3.15E+09	6.12E+09	1.80E+09	1.411	-4.465***
Total assets (RMB)	1.04E+10	4.57E+09	6.65E+09	2.57E+09	1.501	-4.716***

*** Significant at the 0.01 level

4. RESULTS

Table 4 provides the descriptive statistics for four performance measures of all firms in the treatment sample (IT leaders) and matched control sample during 2007-2009. Table 4 shows the mean and the median of four performance variables of firms in two paired samples from 2007 to 2009. According to this preliminary result of descriptive statistics in table 4, the means of profit ratios measures (ROA and ROS) of firms with superior IT capability in the treatment group are higher than that of firms in the control group during 2007-2009. However, the mean difference in cost ratios of paired firms in two groups appears inconsistent results. The OC/S levels of IT leaders is slightly lower than firms in the control sample, but the S-M/S levels of IT leaders is slightly higher than firms in the control sample, suggesting that IT capability contributes more to reduce a firm's total operating expense than to reduce its expense of selling and general management.

Table 4. Descriptive statistics

Performance variables	2007			2008			2009		
	Means	Medians	SD	Means	Medians	SD	Means	Medians	SD
ROA_Leader (%)	11.809	9.200	9.948	9.698	7.530	10.402	7.207	6.125	11.698
ROA_Control (%)	5.424	5.315	8.253	3.460	4.150	11.203	2.247	3.390	9.141
ROS_Leader (%)	7.300	5.145	8.535	6.488	4.705	10.632	4.012	3.020	7.635
ROS_Control (%)	3.699	3.185	5.271	2.569	2.550	9.005	1.487	2.025	7.926
OC/S_Leader (%)	76.219	81.870	16.805	77.125	81.165	15.042	78.464	82.140	14.366
OC/S_Control (%)	80.091	81.860	10.694	80.299	81.800	10.863	81.404	83.160	10.904
S-M/S_Leader (%)	13.400	10.760	9.046	14.241	11.725	9.008	13.108	11.040	8.583
S-M/S_Control (%)	12.959	11.165	7.585	13.560	11.935	7.791	12.538	10.290	7.769

To make a further statistical significant test for the preliminary conclusion outlined above, The Wilcoxon Rank Sum Test method in this study was used to test the difference of both profit and cost-based measures between the treatment sample and the control group sample. Table 5 reports the results for all three years. As the financial data are not normally distributed, the medians are extremely robust to outliers and other deviations from normality. The test results are displayed as Wilcoxon Rank Sum Z-statistics, because the matched pair Wilcoxon test statistic has a normal distribution for sample size greater than 14^[5].

As we hypothesized above, both profit ratios (ROA and ROS) in each of the three years are significantly higher for the IT leaders when compared to the control sample of firms. Therefore, H1 is supported by evidence, indicating that IT capability has a significant impact on a firm's profitability even during a period of economic downturn. However, contrary to our expectations, the Wilcoxon Rank Sum test does not reveal any significant difference between the two samples on the two cost-based ratio measures (OC/S and S-M/S) in any year. Thus, H2 is not supported in this study, suggesting that IT capability does not make any effect on reducing operating cost and selling and general management cost for Chinese listed companies in economic downturn.

Table 5. Results

Performance variables	2007			2008			2009		
	Median	Rank	Z value	Median	Rank	Z value	Median	Rank	Z value
ROA-Leader	9.200	148.88	-5.35***	7.530	145.14	-4.53***	6.125	140.37	-3.48***
ROA-Control	5.315	100.12		4.150	103.86		3.390	108.63	
ROS-Leader	5.145	142.71	-4.00***	4.705	140.07	-3.42***	3.020	134.49	-2.19**
ROS-Control	3.185	106.29		2.550	108.93		2.025	114.51	
OC/S-Leader	81.870	119.42	-1.12	81.165	119.91	-1.01	82.140	118.86	-1.24
OC/S-Control	81.860	129.58		81.800	129.09		83.160	130.14	
S-M/S-Leader	10.760	124.31	-0.04	11.725	126.83	-0.51	11.040	126.62	-0.47
S-M/S-Control	11.165	124.69		11.935	122.17		10.290	122.38	

*** Significant at the 0.01 level

** Significant at the 0.05 level

5. DISCUSSION AND CONCLUSION

Nowadays, firms in almost every industry are facing a rapidly changing competitive environment. Specially in economic downturn, an organizational capability to deal with the challenges of uncertain environment can

have a detrimental effect on a firm's ability to sustain value creation and recover from losses [7]. The role of IT capability in creating business value has been described and validated in the IT literature [4-6, 10]. However, most of them are made in economic growth. We know relatively little about the relationship between IT capability and firm financial performance in the period of economic downturn. Even less is known in an emerging context different from Western countries. We reduced these gaps in the literature by examining the relationship between a firm's IT capability and its financial performance during a period of economic downturn in Chinese context.

Our findings suggest that the profit ratios of IT leaders during economic downturn are significantly higher than that of firms in the control sample. Our results provide evidence that firms with superior IT capability perform better than the firms within the same industry in times of economic downturns (2008) as well as in recovering periods (2009) and former phases of stability or growth (2007). These results are basically consistent with prior findings in economic growth context [5, 8], and provide Chinese evidence to another recent study in economic downturn context [9].

Contrary to our expectation, the hypothesis 2 that the average cost ratios of firms that have superior IT capability are lower than that of all other firms in the industry during the period of economic downturn is not supported by our results. An interesting finding in this study is that IT leaders do not demonstrate a better cost ratio of OC/S. This is contrast to prior findings both in the period of economic growth [5] and economic downturn [9]. In addition, although the result that firms with superior IT capability do not outperform their competitors in the selling and general management cost to sales (S-M/S) ratio is also in consistent with the findings of Schaefferling et al. (2012) [9]. These inconsistent results suggest that IT leader firms in China do not necessarily have a cost focus, but tend to exploit IT to increase sales and decrease stocks for generating superior revenues. Related to this, an IT capability may be developed and sustained even at higher costs in China.

Our study contributes to IT literature in at least two ways. Firstly, this study tests whether or not prior findings still hold and whether or not IT capability as well makes a performance difference in a phase of economic downturn. Although extent IT literatures focus on IT capability and its correlation to firm performance, to our best knowledge they were made in economic growth times which providing a firm better and more opportunities. There has been limited empirical research on the role of IT capability in responding to an economically turbulent environment. We specially tested whether or not firms with superior IT capability outperform on profit and cost ratios before, during and after the 2008 financial crisis. Our results validated the critical role of IT capability in improving firms' ability to recover from economic losses, also suggested partly inconsistent results on the cost ratios with prior findings.

Secondly, we extend existing research on IT capability by providing newly data from Chinese firms during the period of economic downturn. We suggest that China provides a context different from developed western countries. This is not only because of its anticipated importance in global economy, also because of its distinctive institutional and social culture. We focused on Chinese listed companies facing transition pressure, and selected the secondary IT capability data of the "Informatics 500 ranking" published by the NIEC and financial performance data from the Sinofin Economic and Financial database from 2007 to 2009. Unlike the findings of Schaefferling et al. (2012) [9], we did not find significant difference of S-M/S ratio between the IT leaders sample and the matched control sample in Chinese context. Maybe in China, firms tend to leverage IT to generate revenues rather than reduce selling and general management expenses in economic downturn time.

We acknowledge several limitations of this study that limit the generalizability of our findings. Future analysis is needed regarding why IT leaders do not perform better average cost ratios than that of firms in the matched control sample in Chinese context. Furthermore, further research should investigate more time periods and extend this study by longitudinal analysis to account for time effects and how they change as well as to better identify the length of lag effects. In addition, for firms of different ownership in China, the impact of IT

capability on financial performance could be different. Therefore, future studies should examine the moderating effect of ownership when investigating the role of IT capability in creating business value.

ACKNOWLEDGEMENTS

This research was supported by the National Natural Science Foundation of China under Grant 71101065, 71302140, and 71371013, the Chinese Postdoctoral Science Foundation under Grant 2013M541470, and the Natural Science Foundation of Anhui Province under Grant 1208085QG128.

REFERENCES

- [1] Alessandri T M, Bettis R A. Surviving the Bulls and the Bears: Robust Strategies and Shareholder Wealth[J]. *Long Range Planning*, 2003, 36(1): 13-35.
- [2] Klein A, Marquardt C A. Fundamentals of Accounting Losses[J]. *The Accounting Review*, 2006, 81(1): 179-206.
- [3] Kim G, Shin B, Kim K K, et al. It Capabilities, Process-Oriented Dynamic Capabilities, and Firm Financial Performance[J]. *Journal of the Association for Information Systems*, 2011, 12(7): 487-517.
- [4] Rai A, Pavlou P A, Im G, et al. Interfirm It Capability Profiles and Communications for Cocreating Relational Value: Evidence from the Logistics Industry[J]. *MIS Quarterly*, 2012, 36(1): 233-262.
- [5] Bharadwaj A S. A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation[J]. *MIS Quarterly*, 2000, 24(1): 169-196.
- [6] Stoel M D, Muhanna W A. It Capabilities and Firm Performance: A Contingency Analysis of the Role of Industry and It Capability Type[J]. *Information & Management*, 2009, 46(3): 181-189.
- [7] Chen C, Lim J-H, Stratopoulos T C. It Capability and a Firm's Ability to Recover from Losses: Evidence from the Economic Downturn of the Early 2000s[J]. *Journal of information Systems*, 2011, 25(2): 117-144.
- [8] Santhanam R, Hartono E. Issue in Linking Information Technology Capability to Firm Performance[J]. *MIS Quarterly*, 2003, 27(1): 125-165.
- [9] Schaefferling A, Wagner H-T, Becker J. It Capability and Firm Performance: Findings from Periods of Economic Downturn[C]Americas Conference on Information Systems (AMCIS). Paper 10, 2012.
- [10] Wu J N, Liu L, Wang N X, et al. Inter-Organizational It Capability in China: An Empirical Analysis of Dimensions and Influences[J]. *Journal of Electronic Commerce in Organizations*, 2012, 10(3): 56-71.
- [11] Ray G, Muhanna W A, Barney J B. Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis[J]. *MIS Quarterly*, 2005, 29(4): 625-651.
- [12] Chen J-S, Tsou H-T. Performance Effects of It Capability, Service Process Innovation, and the Mediating Role of Customer Service[J]. *Journal of Engineering and Technology Management*, 2012, 29(1): 71-94.
- [13] Gu J-W, Jung H-W. The Effects of Is Resources, Capabilities, and Qualities on Organizational Performance: An Integrated Approach[J]. *Information & Management*, 2013, 50(2-3): 87-97.
- [14] Kalwani M U, Narayandas N. Long-Term Manufacturer-Supplier Relationships: Do They Pay Off for Supplier Firms?[J]. *Journal of Marketing*, 1995, 59(1): 1-16.
- [15] Mikhail M B, Walther B R, Willis R H. Earnings Surprises and the Cost of Equity Capital[J]. *Journal of Accounting, Auditing & Finance*, 2004, 19(4): 491-513.
- [16] Boehmer E. Dimensions of Execution Quality: Recent Evidence for Us Equity Markets[J]. *Journal of Financial Economics*, 2005, 78(3): 553-582.
- [17] Conover W J. *Practical Nonparametric Statistics*[M]. New York: John Wiley & Sons, 1998