

Comparing the Impact of IT Investment on Firm Performance in the United States and China

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Abstract

Over the past three decades, the impact of IT investments on firm performance has been the subject of active research. Although many studies have shown positive and significant benefits derived from IT investment, the findings of almost all these studies are based on data collected in developed countries. This study tries to investigate the effects of IT investment on firm financial performance in the Chinese electronics industry, a typical developing country, and compare it with the United States. Findings show that there is a positive impact of IT investment on firm performance in China. Moreover, the impact in China is not different from what occurred in the United States in the direction and the size against the assertion of previous studies and expectation.

Keywords:

Business Value of IT; Productivity; China; the United States

Introduction

Investing in IT is widely regarded as having enormous potential for reducing costs and gaining competitive advantage [21, 24]. With the continuous increase in IT investment, executives and government policymakers have been concerned about the productivity and profitability of IT investment. The more attention executives give to the tangible benefits of IT investments, the more researchers are becoming interested in measuring the effects of IT investment. Although there has been considerable long-running debate about whether or not IT investment actually results in higher productivity, the majority of researchers come to believe in the positive effects of IT investment on firm performance with accumulation of IT business value research in IT literature.

Some researchers, however, have doubts about the generalization of the findings, because the findings of existing studies that have shown the positive impact of IT on firm performance are mainly based on data collected from developed countries, particularly the United States [8].

It is unclear whether the findings of previous firm-level studies in developed countries are applicable to other developing countries because there are cross-country differences in productivity and economic growth [10, 23]. Furthermore, macro characteristics such as price of labor, competition, IT resources, culture, and education, can affect the mechanism of IT value creation [19]. A few studies (e.g., [26]) were conducted on some developing countries, but it is still difficult to search for firm-level empirical studies, which show consistent results, on the relationship between IT investment and firm performance up to recent. Since both excessive emphases on U.S. firms and lack of cross-country studies have inhibited knowledge accumulation concerning the IT business value, research regarding the effect of IT investment on firm performance in developing countries can be one of important topics for the future study [8].

This study investigates the effect of IT investment on firm performance in China, which is one of the developing countries. Furthermore, the size of the effect will be compared between China and the United States, because differences in country characteristics can affect value creation of IT investment. Accordingly, based on data from China, the current study attempts to generalize the findings of previous research concerning the effect of IT investment on firm performance in developed countries, to developing countries, which is indicated as an important context extension of research [1].

The structure of this paper is as follows: The following section offers a review of previous studies to demonstrate the importance of this study and hypotheses to find new things. Next, the research model, variables and constructs, and data sources are described in the method section. In the results section, the results of the research are presented with analysis. Then, the contribution and implications of the findings are discussed. Finally, in the conclusions and limitations section, the results are summarized, limitations of the research are identified, and concluding remarks and future studies are provided.

Literature Review and Hypothesis Development

The debate concerning the effects of IT investment on cost and efficiency-related performance has decreased according to accumulated knowledge stock [16, 22]. However, because these previous studies were based on the data from developed countries, particularly the United States [8], the findings and agreements cannot be simply generalized to apply to developing countries, which are different from developed countries in many aspects. There can be variation of macro- environments – such as productivity, economic growth [10], regulation levels [28], labor costs, IT skills' availability and heterogeneity [23], competition, complementary organizational innovations [9], culture [22] across countries. Such country characteristics can “create country-specific sets of IT attributes, and thereby impact firms' IT choices and resultant organizational performance impacts” [19, p. 310]. For instance, if unit cost of labor is relatively cheaper than IT, as in the majority of developing countries, many firms may firstly consider investing in labor more than IT for similar business performance payoffs according to the microeconomic-based view [23]. Moreover, if there is a government subsidy or regulation for IT investment, as is often happening in developing countries, the effect of IT investment would be distorted [22]. Therefore, it cannot be said that the effects of IT investment in developing countries are similar to those in the developed countries.

Several studies [13, 26] were conducted on newly-industrialized economies, but the results were too inconsistent and limited to be used to understand the relationship between IT investment and firm performance in developing countries. Zhu, et al. [28] found the positive effect of IT investment on implementation of e-business in developing countries with a survey's data. Thus, because of little prior firm-level empirical research on this issue in developing countries despite obvious differences of country characteristics [8], the preceding issue—whether or not there are cost-efficiency benefits derived from IT investment in China, is being tested in the first hypothesis.

Hypothesis 1. There is a positive relationship between IT investment and cost-efficiency in China.

Hypothesis 1a. There is a positive relationship between IT investment and ROA.

Hypothesis 1b. There is a positive relationship between IT investment and ROE.

Hypothesis 1c. There is a positive relationship between IT investment and profit margin.

Although the positive relationship between IT investment and cost-efficiency has been accepted by more and more scholars and practitioners recently, the results of the effects of IT investment on organizational growth are still mixed. Ives and Learmonth [14] indicated that investment in IT could be used to gain competitive advantages and increase market share (strategic IT investment), via sales growth. This can happen when IT can be used as an enabling technology to better meet market demand (e.g., customer relationship management (CRM) system) and to spawn new businesses (e.g., new IT-based auxiliary products and

services), or as an industry platform eventually restructuring an industry (e.g., e-business) [21, 27]. Despite these arguments, however, there is not much clear empirical evidence to make a conclusion. The study by Weill [27] reveals that strategic IT investment has a negative impact on sales growth, but transactional IT investment has a positive impact. Brown, Gatian, and Hicks [4] found that investment in strategic information systems (SIS) could contribute to a firm's growth. More recently, while some other scholars [20] revealed that IT investment is an important contribution to a firm's growth, some empirical studies [12, 17] still found no statistical evidence that IT investments have resulted in improvement of organizational growth in the United States. Although this issue has been widely studied, the results are still inconsistent, regardless of whether the samples are from developed countries or not. Therefore, the second hypothesis will investigate this issue with China data.

Hypothesis 2: There is a positive relationship between IT investment and organizational growth in China.

Hypothesis 2a. There is a positive relationship between IT investment and sales growth.

Hypothesis 2b. There is a positive relationship between IT investment and EPS growth.

The size of the effect of IT investment on firm performance can vary according to the degree of economic development in a nation [19, 22, 26]. This argument can be based on the Resource-Based View (RBV) (For RBV see Melville, et al. [19]). Resources can be classified into IT resources and complementary organizational resources. IT resources can be further divided into (1) infrastructure and (2) business application as technology IT resources, and (3) technical skills and (4) managerial skills as human IT resources [19]. Decision-makers in the firms have acquired the best combination of such resources for their firms. Although the firms might have the same combination of resources, the firms can reveal differences in firm performance because some country characteristics can affect the creation of IT business value.

Some country characteristics in developed countries can better affect the creation of IT business value than in developing countries. First, as telecommunication infrastructure can moderate the effect of IT on the firm and its trading partners in the supply chain [19], developed countries have better and wider telecommunication infrastructure in general. Second, there are richer resources of IT-skilled workforce to shape IT business value in developed countries. Comparing workers in developing countries, the workers in developed countries have accumulated more than enough experience in the effective use of IT due to the early introduction of IT [17]. Third, developed countries have already built up enough knowledge-base to create or transform the value from IT investment [9]. Lastly, developed countries have advantages in many other aspects such as higher substitutability IT for labor, relatively less complex trade policies, and more complementary organizational

innovations than developing countries [22]. Empirically, Zhu, et al., [28] found that the effect of e-business investment on firm performance in developed countries is smaller than in developing countries, against most expectations based on existing research, but the statistical significance of comparison was not reported. This study will directly compare business value of IT investment in the United States with China in the third and fourth hypotheses.

Hypothesis 3: The effect of IT investment on cost efficiency in the United States is larger than in China.

Hypothesis 4: The effect of IT investment on organizational growth in the United States is larger than in China.

Method

Research Model

This study revolves around the relationship between IT investment and firm financial performance in China and the United States (Figure 1). Although various research models have been suggested in IT business value literature (e.g., [2, 5, 24, 28]), the research model without any intermediate variable (e.g., business processes) and non-IT production factors (e.g., complementary organizational resources), which has often been used in IT business value research (e.g., [15, 16, 17]) in developed countries such as the United States, is still considered in this study. This study's concern is centered on the effect of IT investment on firm performance in China, and the size of the effect in China will also be compared to that in the United States.

This study indirectly controls two contextual factors, which can influence the relationship between IT investment and firm performance, such as a firm's size [3, 6, 18, 28], and the information intensity of the industry that is one of industry characteristics [17, 19].

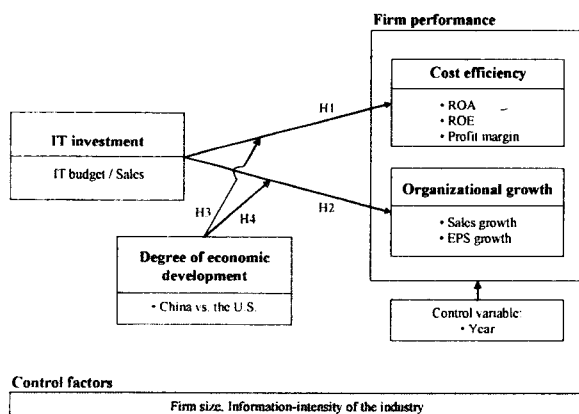


Figure 1 - Conceptual research model

The equation to find the effects of IT investment on firm performance in China (the first hypothesis and the second hypothesis) follows (1).

$$FP_i = \alpha + \beta \cdot IT_i + \varepsilon_i \quad (1)$$

where the FP_i is firm performance at firm i , IT_i is IT investment at firm i , α is the intercept, β is the coefficient of IT investment that influences firm performance, and ε_i is the error term.

The equation to compare the difference in the size of effect of IT investment on firm performance depending on the degree of economic development in nation (the third hypothesis and the fourth hypothesis) is below.

$$FP_i = a_0 + a_1 \cdot D + b_0 \cdot IT_i + b_1 \cdot D \cdot IT_i + c \cdot year + u_i \quad (2)$$

where the FP_i is firm performance at firm i , IT_i is IT investment at firm i , $year$ is a control variable for difference in the sampling period, a_0 is the intercept, a_1 is the differential intercept, b_0 is the partial coefficient of IT investment that influences firm performance, b_1 is the differential slope coefficient, c is the coefficient for year, $D=1$ for observations in the United States and zero for observations in China, and u_i is the error term.

Independent and Dependent Variables

This study decides that IT budget to sales, which can control the differences in each firm's size, can be the operational definition of IT investment in accordance with some previous studies (e.g., [17]).

For performance variables, this study selects ROA, ROE, and profit margin as measures of profitability, the rate of sales growth and the rate of EPS growth as measures of organizational growth since financial analysts, businessmen, investors may have measured the value of firms with traditional financial ratios.

Data

For the context of China, the sample comprises data from the survey, which was conducted by China Ministry of Information Industry, concerning informatization of firms in the Chinese electronics industry. The 100 firms investing the most in IT were then published in the annual report, which is "China's ITTOP 100 Firms" [7]. This study uses the 2005 annual report for 2004.

Various measures on financial performance were obtained from the China Securities Regulatory Commission. The listed firms on the Shanghai Stock Exchange or Shenzhen Stock Exchange have to report annually concerning financial status and performance information to the Commission.

For the context of the United States, our sample comprises data from *InformationWeek* magazine. *InformationWeek* data are gathered from an annual survey and published in its annual special issue, "*InformationWeek 500*." This study uses the annual IT budget data normalized by sales for the three-year period from 1995 to 1997. Corresponding financial measures were acquired from the "Annual Report on American Industry" section of *Forbes* magazine like Lee

and Kim [17]. Controlling for the information-intensity of the industry that is one of moderating variables in business value of IT investment literature [17], this study uses the data in the U.S. high information-intensive industry corresponding to the Chinese electronics industry.

Analysis and Results

Analysis and Results for China

Table 1 - Descriptive statistics for China

Variables	N	Minimum	Maximum	Mean	Standard Deviation
IT Investment	87	0.009	3.260	0.348	0.495
ROA	35	0.365	10.258	3.887	2.713
ROE	37	1.187	27.962	9.722	6.477
Profit margin	38	0.309	16.277	5.226	4.597
Sales growth	71	-25.759	58.211	19.909	16.404
EPS growth	34	-97.080	91.429	-5.937	44.948

Table 1 is the descriptive statistics for China. After an examination of the validity of the basic assumptions (e.g., no outliers, normality, linearity, homoscedasticity, no autocorrelation) for the regression analysis [17], we could continue the regression analysis. Table 2 presents the results of linear regression analysis for various firm performance variables. The F-statistic is 3.576 for profit margin (in the fourth column) and the significance is at the 10% level. The adjusted R^2 is only 0.065. The coefficient of IT investment is 5.617 at the 10% significance level. There is a positive and significant effect of IT investment on profit margin, while evidence of any significant impact on other firm performance variables cannot be found. The result of regression analysis can support only *Hypothesis 1c*, while this cannot support *Hypothesis 1a*, *Hypothesis 1b*, *Hypothesis 2a*, and *Hypothesis 2b*.

Table 2 - Results of regressions for China

Parameter in Equation (1)	Performance variable				
	ROA	ROE	Profit margin	Sales growth	EPS growth
α	3.094***	9.008***	3.760***	18.485***	-2.688
β	2.883	2.636	5.617*	5.446	-13.280
N	35	37	38	71	34
Adjusted R^2	.043	-.018	.065	-.006	-.026
F-statistic	2.539	.349	3.576*	.583	.153

Analysis and Result for Comparing China with the United States

To compare the difference of regression models in between China and the United States, this study analyzed Equation (2) with a dummy variable approach. The observation number for profit margin in China and in the United States is 38 as seen in the above section and 65, respectively (Table 3). The F-statistic is 8.437 and significant at the 1% level. The explanation power of the model is 26.7%. The

intercept in China (a_0) is 3.760 and significant at the 1% level, while the differential intercept (a_1) is -0.681 but insignificant. While the partial coefficient for profit margin in China (b_0) is 5.617 and significant at the 5% level, the differential slope coefficient (b_1) is -4.331 but insignificant. Therefore, we conclude that the size of the effect from IT investment on profit margin in China is not statistically different to that in the United States. The control variable (*year*) is statistically significant. However, for sales growth and EPS growth in both China and the United States, all results are not significant, and these are not reported in the study. As a result of this, we cannot support *Hypothesis 3* and *Hypothesis 4*.

Table 3 - Testing the equality of two regressions in China and the United States using Equation (2) for profit margin

Parameter in Equation (2)	Unstandardized Coefficients	Standard Deviation	Significance
a_0	3.760 ***	(0.976)	0.000
a_1	-0.681	(1.596)	0.670
b_0	5.617 **	(2.739)	0.043
b_1	-4.331	(2.753)	0.119
Adjusted R^2	.267		
N_0	38		
N_1	65		
F-statistic	8.437 ***		

Note. a_0 is the intercept, a_1 is the differential intercept, b_0 is the partial coefficient of IT investment that influences firm performance, b_1 is the differential slope coefficient, N_0 is the observation number in China, and N_1 is the observation number in the United States. *** denotes significant at the 1% level, and ** denotes significant at the 5% level.

Discussion and Implications

Based on the Chinese secondary data, this study represents one of the first researches to empirically investigate the impact of IT investment on firm performance in China comparing the United States. The results show that IT investment has a significant positive effect on firm performance in China, and the size of the impact of IT investment on cost efficiency (profit margin) does not differ according to the degree of economic development in nation. This study contributes to IT business value literature in the following ways: Firstly, this research is one of the first studies to assess the impact of IT investment on firm-level performance in China with secondary data, rather than with a questionnaire. It is interesting to note that while the business value from IT investment has been refined largely in the U.S. context, this study suggests that there also exists a positive impact from IT investment in the Chinese context. The issue for developing countries is one of future research opportunities in IT business value literature as before [8, 19]. The findings add to the evidence that IT investment has a positive impact on firm performance, thus expanding the scope of the evidence from developed countries to China. It may be meaningful to generalize theories on the relationship between IT investment and firm performance to overall economies, as context extension of research [1].

Second, this study can reveal the purpose of IT investment by Chinese electronics firms in 2004. The study did not reveal a positive impact of IT investment on organizational growth, while it demonstrated a positive effect of IT investment on cost-efficiency. If IT investment is not in the interests of a firm's expansion but primarily for the sake of a firm's efficiency, such as cost-saving, then one may fail to find a positive effect of IT investment on a firm's expansion-related performance, such as sales growth and EPS growth. Some previous firm-level studies (e.g., [2, 3, 15, 16, 17, 18]) that used profit-related performance variables have found significant positive relationship or effects between IT investment and firm performance. In contrast, some studies [12, 16, 17] that used sales growth as a firm performance variable found no impact, or even a negative impact, on sales growth, as illustrated in this study. It can be cautiously concluded that Chinese electronics firms did not invest in IT in 2004 for expansion, but efficiency. When the study to determine the effect of IT investment on firm performance is planned, it is necessary to interpret efficiency indicators and growth indicators differently.

Finally, these results represent that the direction and the size of the impact of IT investment on firm performance in China is quite similar to that in the United States. The finding is different from the review of Melville, et al. [19] and the arguments of some studies (e.g., [9, 17, 22]). There may be two explanations for this:

One explanation is the leap of China, which is still one of the developing countries until recently. In 1993, the Chinese government embarked on a series of "Golden Projects," aiming to modernize the country's IT infrastructure [11]. Subsequently, increasing numbers of investments have been made in IT-related areas. China may have achieved significant improvement in necessary IT infrastructure and knowledge-base to support IT [23]. At the same time, China has recently achieved great progress in economic development, and China is currently fourth in global GDP ranking [25]. Therefore, it is no surprise to see that IT investment has a similar positive impact on firm performance in China as in the United States, as shown by the results of this study.

Another explanation is that while some country characteristics positively impact in China, the others negatively impact in China. Chinese firms in this study are mostly large firms competing in the global marketplace, as they show total sales of approximately 60% of the entire Chinese electronics industry. After China joined the World Trade Organization (WTO) in 2001, they have also experienced intense competition in the domestic market as well as the global marketplace. As seen in the review of Melville, et al. [19], firms offering high-quality products with low-cost operating structures are more likely to achieve efficiency gains and increased productivity through IT than in less optimum situations. Furthermore, firms in developing countries such as China can more likely decrease risk by adopting successful technologies that have been tested and validated in developed countries such as the United States. Thus, these Chinese firms may even enjoy

similar benefits to the United States despite the lack of complementary assets, less experience, and insufficient knowledge-base.

Conclusions and Limitations

This study is a firm-level empirical analysis of the relationship between IT investment and firm performance in China, one of the developing countries. The following findings of this study were obtained: First, there is a positive relationship between IT investment and cost-efficiency in China (*H1*). Second, IT investment has no effect on organizational growth in China (*H2*) like in the U.S. context. Third, these findings do not differ according to the degree of economic development (*H3, H4*). Consequently, it can be proposed that there is also a significant positive relationship between IT investment and firm performance in China, in contrast to the review of Melville, et al. [19].

There are several limitations in this study. First, since there is still no stable large-sample data set concerning IT investment information in China, this study used limited sample data from China, and this could lead to errors of too early generalization. Second, this study could not use a longitudinal approach due to the limited IT investment data available in 2004; hence, a more refined research model, including factors such as a time-lag [16, 17], cannot be investigated. Third, the firms in the sample are comparatively heavy IT investment firms, so this may not indicate the entire environment, and could produce a skewed distribution. Fourth, regression analysis with only IT investment may not provide a total view of the mechanism concerning the creation of a firm's performance. Finally, the electronics industry is a highly information-intensive industry; more empirical evidence is thus required to generalize the findings to low information-intensive industries.

Despite these limitations, this study empirically reveals the benefits of IT investment in China. The size of the effect in China is similar to that in the United States. IT investment is also necessary to obtain the payoffs from it, whether in the U.S. context or not. Since only a small portion (6.5%) of profit margin variance can be explained by IT investment in China, it may be necessary to increase IT investment to improve a firm's performance with improvement of IT-enhancing complementary factors, such as capital stock, organizational innovativeness, and telecommunication infrastructure, at the same time. Moreover, it is necessary to establish the appropriate competitive strategy with IT, depending on the macro and industry characteristics, such as labor and other forms of capital, as Quan, et al. [23].

Further studies are needed to improve understanding of the business value from IT investment in other business environments whether in developing countries or not. Continuous empirical studies using similar methods and different data may be necessary to devise a theory in IT business value literature [1]. Longitudinal studies can also be conducted in the long time span to understand the real value of IT investment. Moreover, exploration of the role

and mechanism of country characteristics in IT business value is also needed.

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