Investigating the Effects of Information Technology Investment on Productivity in the Chinese Electronics Industry

Jun Yong Xiang[a], Sangho Lee [b], and Jae Kyeong Kim[a]

[a] *School of Business Administration, Kyung Hee University*
1 Hoeki-dong, Dongdaemoon-gu, Seoul, 130-701, Korea
Tel: +82-2-961-9355, Fax: +82-2-967-0788, E-mail:gysang@yahoo.com, jaek@khu.ac.kr

[b]*Korea Institute for Defense Analyses*
Chungryang P.O. Box 250, Seoul, 130-650, Korea
Tel: +82-2-961-1178, Fax: +82-2-961-1165, E-mail: sangholee@.kaist.ac.kr

Abstract

The importance of information technology (IT) has been emphasized in developing countries recently. Despite the importance of the topic area of the productivity of IT in developing countries, the literature to date is relatively sparse. The findings of almost all these studies are based on data collected in developed countries. Few studies have been conducted to validate these results and to see if they are still applicable in developing countries. This study tries to investigate the effects of IT investment on productivity in the electronics industry of China, which is a representative developing country, with production function model. The results show that there is a positive impact of IT investment on productivity in China similar to previous studies in developed countries.

Keywords:

IT investment, Productivity, Production function, China

Introduction

China has been the largest information technology (IT) market in the Asia/Pacific area, and IT spending by China's industries will grow at a compound annual growth rate of 6.2 percent to 85 billion US dollars in 2009 [23, 24]. With the continuous increase in IT investment, executives and government policymakers have been concerned about the productivity and profitability of IT investment. However, Dewan and Kraemer [8] indicated that the investment in IT does not have substantial contribution in developing countries.

Some evidences from China show that firms have been enjoying the benefits of IT investments. Lenovo, the world's third-largest personal computer (PC) maker, is a good example of how to achieve efficiency gains and increased productivity through IT in the competitive global market. Benchmarking on the Dell's supply chain management (SCM), Lenovo has been investing heavily on its supply chain automation and SCM systems. This has helped it become China's leading PC maker and enabled it to acquire IBM's PC business for 1.75 billion US dollars in December 2004.[21]

Another example is Huawei, one of the largest networking equipment firms in China. It forged a joint venture with 3Com and invested in technologies to make its systems compatible with those from 3Com and coordinate their common business activities. These systems included SCM, market research, and customer relationship management (CRM) systems. This helps Huawei's network products gain traction in the relatively established and highly competitive North American market against other network giants (such as Cisco Systems and Nortel). [21]

These cases show the positive impact of IT investment on productivity. A few studies (e.g., [20, 21] were conducted on China, but it is still difficult to search for firm-level empirical studies on IT investment and productivity, despite the increasing global importance of China and its vast population. Therefore, Walsham et al. [28] pointed out that research on IT investment and productivity within China is one of the dimensions for expansion.

This study investigates how the investment of IT in China has affected business productivity by applying methods based on economic theory. It analyzes firm-level data on investment in IT as an input in a standard production function, and estimates productivity coefficients of electronics industry for the period from 2004 to 2006. Accordingly, based on data from China, the current study attempts to generalize the findings of previous research concerning the effect of IT investment on productivity in developed countries, to developing countries, which is indicated as an important context extension of research [2, 28].

The structure of this paper is as follows: The following section offers a review of previous studies to demonstrate the importance of this study. Next, the research method, 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, the results are summarized, limitations of the research are identified, and concluding remarks and future studies are provided.

Theoretical Background

To evaluate payoff at the firm level, considerable research on the impact of IT investments on business productivity has been conducted in recent years [27]. The early studies, conducted in the 1980s and early 1990s, did not show consistent results concerning the positive impacts on productivity (e.g., [1, 17, 28]). Some studies (e.g., [17]) even argued that IT investment could have a negative impact on the productivity of an organization due to the increase in coordination cost after installation of new information systems.

Recent works by Brynjolfsson and Hitt [3, 4, 5], Dewan and Min [9], Hitt and Brynjolfsson [12], Kudyba and Diwan [13], Lehr and Lichtenberg [15], and Lichtenberg [16] have taken a microeconomic approach to study this problem at the firm level. Contrary to early work, these studies found that IT investment does contribute significantly to the output of a firm. Brynjolfsson and Hitt [3, 4] made some new approaches in both data construction and econometrics, and indicated that IS spending has made a substantial and statistically significant contribution to firm output. A later study [5] also found that computerization makes a contribution to measured productivity and output both in short term and long term. Dewan and Min [9] observed that IT capital is a net substitute for both ordinary capital and labor, and this suggests the factor share of IT in production will grow to more significant levels over time. Using firm-level data on IT spending by 370 large firms, Hitt and Brynjolfsson [12] indicated that IT has increased productivity and created substantial value for consumers. Kudyba and Diwan [13] analyzed firm-level investment in IT capital and flow, and found that IT investment enhances productivity over the period from 1995-1997 and has illustrated increasing returns over time. Lichtenberg [16] examined the output contributions of capital and labor deployed in IS and suggested there are substantial excess returns to both IS capital and IS labor. Then Lehr and Lichtenberg [15] examined the trend in computer usage the effects on productivity and found that computers do contribute positively to productivity growth, yielding excess returns. The results suggested that IT provides enhanced productivity impacts to firms in more competitive industries without any productivity loss in dynamic industries, in contrast to regular capital. These results indicate that IT generates not only positive but excess returns on investment. In addition, the use of econometric models provides a more rigorous and promising approach to study the impact of IT investments at the firm level [27].

Although the majority of the researchers believe that IT investment has a positive effect on productivity, some questions still remain. The findings of these studies are mainly based on data collected from developed countries, particularly from the United States [7]. Tam [27] investigated the impact of IT on firm-level productivity in three Pacific-rim economies (Hong Kong, Singapore, and Malaysia), but it remains a little unclear whether this empirical findings are also applicable to firms residing in other developing countries. Therefore, more evidences are necessary to confirm whether such findings are unique or robust enough to be applicable across national boundaries. The answer to this question has important ramifications to developing countries that are experiencing fast growth in IT demand, such as China. Despite the increasing global importance of China and its vast population, the IS in China is very poorly represented in the English language literature [18, 25, 28, 29]. In addition, Walsham et al. [28] have indicated that research on IT investment and productivity within mainland China is one of the dimensions for expansion.

Models and Data

Estimation Framework

Many empirical studies employed production theory to assess the value of IT (e.g., [1, 4, 5, 9, 13, 16]). Production theory has a strong economic foundation and has been widely applied to study the relationship between firm output and production factors [27]. The theory of production states that the inputs a firm uses can be related to output via a production function.

Based on the previous studies, this study uses the Cobb-Douglas production because this form facilitates the estimation of elasticity of production inputs through linearization the equation [13]. The Cobb-Douglas production in this study is considered as:

$$Q = (C^{\beta_C}, K^{\beta_K}, L^{\beta_L}) \tag{1}$$

where Q is output, C is IT capital, K is non-IT capital, and L is labor.

The linearized version becomes:

$$\log Q_{it} = \alpha + \beta_C \log C_{it} + \beta_K \log K_{it} + \beta_L \log L_{it} + \varepsilon_{it} \tag{2}$$

where the α is often referred to as the multifactor productivity level or, more ambitiously, total factor productivity level, captures differences in output across firms and over time that are not accounted for by changes in the input use, the β values are the parameters that denote the elasticity of each of the input factors, and ε_{it} is the error term.

An alternate approach is to estimate the production function using an IT Flow measure as opposed to IT Capital [3, 13]. Kudyba and Diwan [13] also indicate that this approach may provide a more appropriate analysis given the flow nature of each of the output measures (e.g., Sales and Value Added). The following analysis uses the IT Flow, which is the annual expenditure of IT hardware, software, and related services, in place of the IT Capital.

$$\log Q_{it} = \alpha + \beta_C \log CF_{it} + \beta_K \log K_{it} + \beta_L \log L_{it} + \varepsilon_{it} \tag{3}$$

where Q is output, CF is IT flow, K is non-IT capital, and L

is labor.

Data Sources

As the source of IT data, this study primarily uses the information available in IT TOP 100, published on an annual basis from the years 2005-2007. This information is obtained from a detailed survey conducted by Ministry of Information Industry of the People's Republic of China, which ranks the top 100 corporate users of information technology in electronics industry. The detailed information included in the surveys includes the IT investment, R&D investment, sales, gross profits, taxes, export performances, and products.

Data were also gathered from corporate disclosure annual reports published from the years 2005-2007, which contained detailed sales, labor expenses, employees, and financial information to determine capital. These firms in the sample are mainly listed in Shanghai Stock Exchange, Shenzhen Stock Exchange, or Hong Kong Stock Exchange.

Factor Input Calculations

Generally, production function inputs consisted of Capital, IT Capital, and Labor, where output variable includes Sales and Value Added. The following definitions and calculations are given for each of the production function variables.

IT Capital: IT Capital is the portion of the overall IT investment which encompassed hardware which needed to be estimated. The percentage hardware portion of the IT investment is published by China ComputerWorld Research [6]. The IT capital is calculated with this percentage of hardware portion from the overall IT investment for each firm from 2004-2006.

The IT investment data of IT TOP 100 is from the parent company perspective. Some of the data from corporate annual reports are only subsidiary company data. To adjust the scope of company, the final IT investment data are normalized with the sales data of parent company and subsidiary.

As this study uses longitudinal data, depreciation is needed. Although the United States reports price indexes for IT capital (e.g., Price indexes for private fixed investment for Computers and peripheral equipment of Bureau of Economic Analysis), similar statistics are not available for China in this study. To incorporate the steep downward-sloping price trend of IT, this study modifies the deflator $d_{cn,t}$ indicated by Tam [27].

$$d_{cn,t} = \frac{(1+I_{us,t})}{(1+I_{cn,t})(1+d_{us,t})} \tag{4}$$

where $I_{us,t}$ is the inflation rate in the United States in year t, $I_{cn,t}$ is the inflation rate in China in year t, and $d_{us,t}$ is the price deflator for computers and peripheral equipment of the United States in year t where $04 \le t \le 06$. Finally, the $d_{cn,t}$ is multiplied by C_0 to form the final C_{it}.

IT Flow: IT Flow is defined as the total expenditure of computer hardware, software, and related services dedicated to supporting these capabilities for each firm. The value of IT Flow is also deflated with a modified equation.

$$df_{cn,t} = \frac{(1+I_{us,t})}{(1+I_{cn,t})(1+df_{us,t})} \tag{5}$$

where $df_{us,t}$ is the price deflator for information processing equipment and software of the United States in year t where $04 \le t \le 06$. Then, the $df_{cn,t}$ is multiplied by C_0 to form the final CF_{it}.

Non-IT Capital: Non-IT Capital is defined as the mean value of total net property, plant, and equipment (PPE) at the beginning and end of the fiscal year. This value is then adjusted downward by the value of IT Capital to avoid double counting (e.g., [13, 16]). Finally, it is adjusted for inflation by the ratio of the GDP deflator for fixed investment of China, as indicated in the previous studies (e.g., [4, 9, 27]).

Labor Expense: Labor Expenses are exposed in the in the corporate annual reports. Price Index for Intermediate Materials, Supplies and Components was used as the deflator of Labor Expenses in existing studies (e.g., [4]). Thus, this study uses it to deflate Labor Expense.

Sales: Sales is the total sales for the corresponding firm. Brynjolfsson and Hitt [4] indicated that sector level Producer Price Index for Intermediate Materials, Supplies and Components could be used as the deflator of total sales. Since no reliable sector level index in China, the second best choice is the total Producer Price Index for Intermediate Materials, Supplies and Components.

Value Added: Value Added refers to deflated Sales less deflated non-Labor Expense. Non-Labor Expense is calculated by subtracting Labor Expense from total expenses and deflating the resulting value using the Producer Price Index for Intermediate Materials, Supplies and Components [3, 9].

Data

Table 1 - Sample summary statistics: Averages per Firm (RMB figures in Million)

	2004	2005	2006
Sales	4203.86	6483.80	6779.21
Value Added	692.22	688.98	882.70
IT Capital	15.51	15.17	13.82
IT Flow	25.00	25.53	24.01
Net PPE	741.61	923.85	1012.11
Labor Expenses	275.73	366.68	383.79
Total Employees	6057	6388	8236
N	60	60	63

Not all variables were available for each firm listed in the IT TOP 100 survey. Especially, many firms still do not list in stock exchanges. Therefore, the number of observations for which all data is available varies from year to year. 2004 includes 60 firms, 2005 includes 60 firms, and 2006 includes 63 firms. A total of 183 firms are analyzed in the final test. The production function variables are summarized in Table 1.

Empirical Results

Production Function Estimation

Before the regression analysis, an examination of the validity of the basic assumptions (no outliers, normality, linearity, homoscedasticity, no autocorrelation, etc) for the regression analysis [11, 14] is conducted. We first estimate equation (2) with no dummy variables as a base function. The results are illustrated in Table2.

Table 2 – Results of Regression for IT capital

Parame-ters	Sales			Value Added		
	Unstd. Coeff-icient	Std. Coeff-icient	t-stat	Unstd. Coeffic-ient	Std. Coeff-icient	t- stat
C	0.181	0.272	5.264***	0.073	0.127	3.372***
K	0.157	0.135	2.084**	0.294	0.306	6.586***
L	0.621	0.550	7.670***	0.602	0.603	11.807***
N	165			146		
Adj. R^2	0.705			0.857		
F-Stat.	131.880***			291.296***		
D-W	1.882			1.966		

Note. * Significant at the 0.10 level, ** Significant at the 0.05 level, and *** Significant at the 0.01 level.

The coefficients of β_C, β_K, and β_L are all positive and significant at the 0.05 level or greater. The estimate of β_C indicates that IT Capital is correlated with a statistically significant increase in Outputs (Sales and Value Added). The elasticities of outputs for IT Capital are 0.181 (Sales) and 0.073 (Value Added) when all the other inputs are held constant. The elasticity of output for Labor Expenses is highest among three inputs.

The production function estimates that include year dummy variable are shown in Table 3. The elasticity of Sales for IT Capital increases from 0.181 without year effects to 0.205 when year effects are accounted for. All coefficients in the regression are statistically significant at the 0.05 level of greater. However, the elasticity of Value Added for IT Capital does not show statistical change when year effects are accounted for.

Table 3 - IT Capital Regression Results (Cobb-Douglas Production Function) outputs with year control

Paramet ers	Sales			Value Added		
	Unstd. Coeffi cient	Std. Coeffi cient	t-stat	Unstd. Coeffici ent	Std. Coeffi cient	t- stat
C	0.205	0.308	5.743***	0.073	0.127	3.188***
K	0.173	0.149	2.307**	0.296	0.307	6.576***
L	0.584	0.517	7.119***	0.602	0.602	11.582***
N	165			146		
Dummy Variable	Year**			Year		
Adj. R^2	0.712			0.856		
F-Stat.	82.281***			173.267***		
D-W	1.934			1.975		

Estimates of variants of the production function (3) are presented in Table 4. The incorporation of an IT Flow variable in stead of the IT Capital yields little change to the original results. IT Flow coefficients remain positive and statistically significant and within a reasonable range of the IT Capital coefficients. The Value Added equation depicts a similar situation to the Sales function. This is consistent with the results indicated by Kudyba and Diwan [13].

Table 4 - Results of Regression for IT Flow

Paramet ers	Sales			Value Added		
	Unstd. Coeffi cient	Std. Coeffi cient	t-stat	Unstd. Coeffic ient	Std. Coeffic ient	t- stat
CF	0.181	0.271	5.283***	0.090	0.154	3.524***
K	0.160	0.139	2.142**	0.321	0.339	6.515***
L	0.621	0.550	7.689***	0.489	0.527	8.875***
N	166			147		
Adj.R^2	0.710			0.829		
F-Stat.	135.442***			237.264***		
D-W	1.975			2.021		

Table 5 illustrated the production function estimates with year dummy variable. The results show that the IT Flow function depicts a similar situation to IT Capital function. The elasticity of Sales for IT Capital increases from 0.181 without year effects to 0.205 when year effects are accounted for. All coefficients in the regression are statistically significant at the 0.05 level of greater. And, the elasticity of Value Added for IT Flow does not show statistical change when year effects are accounted for.

Table 5 - IT Flow Regression Results (Cobb-Douglas Production Function) outputs with year control

Paramet ers	Sales			Value Added		
	Unstd. Coeffi cient	Std. Coeffi cient	t-stat	Unstd. Coeffic ient	Std. Coeffic ient	t- stat
CF	0.205	0.307	5.767***	0.089	0.153	3.266***
K	0.175	0.152	2.361**	0.321	0.339	6.484***
L	0.584	0.517	7.138***	0.490	0.527	8.673***
N	166			147		
Dummy Variable	Year**			Year		
Adj. R^2	0.717			0.827		
F-Stat.	84.488***			140.800***		
D-W	2.025			2.021		

Discussion

Based on the Chinese secondary firm-level data for 2004-2006, this study represents one of the first researches to empirically investigate how the investment of IT in China has affected business productivity by applying methods based on economic theory. The estimates of the standard Cobb-Douglas production function indicate that investments in various forms of IT have made statistically significant contributions to firm-level output measured either by sales or value added.

This study contributes to IT business value literature in the following ways: First, this research is one of the first studies to assess the output contributions of IT investment in China with secondary data. It is interesting to note that while the productivity of IT has been refined largely in the United States context, this study suggests that there also exists a positive impact from IT investment in the Chinese context. The importance of the IT's impacts in developing countries has been emphasized by many scholars [7, 18, 25, 28]. The findings add to the evidence that IT investment has a positive impact on organizational output, thus expanding the scope of the evidence from developed countries to China. It may be meaningful to generalize theories on the IT productivity to overall economies, as context extension of research [2].

Second, these results represent that the size of the contribution of IT investment in China is quite similar to that in the United States. The finding is different from the review of Melville, et al. [18] and the arguments of some studies (e.g., [8, 14, 20]). 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 [10]. 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 [21]. At the same time, China has recently achieved great progress in economic development, and China is currently fourth in global GDP ranking [22]. 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 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.

Finally, the elasticity for labor expenses is obviously larger than elasticities for IT Capital(or IT Flow), non-IT Capital. In China, the labor force is still abundant and relatively inexpensive when compared to other production factors, i.e. IT capital or non-IT capital. The firm does not replace labor with IT until the marginal return of the technology is greater than the cost of labor. For example, the Intime Department Store (Group) Company Limited, one of the top 500 companies of China's service industry, still integrates the customer data through hiring more employees instead of introducing an integrated customer relationship management system. The results are consistent with the study of Quan et al. [21], who argued that many firms find it to their advantage to purchase human resources rather than additional IT resources, when labor is relatively inexpensive.

Conclusion

Using a standard Cobb-Douglas production and firm-level data of Chinese electronics industry for 2004-2006, this study has analyzed the productivity of IT in developing country. The results indicate that: First, there is a positive impact from IT investment in China like in the United States context. Second, the size of contribution of IT is quite similar to that in the United States. Third, labor expenses still have the largest influence on the production outputs.

There are several limitations in this study. First, the IT data is taken from a survey which potentially has a problem of sample selection. The sample is comprised of high performing firms, of which sales are more than 23 percent of the whole electronics industry [19]. This might lead to an upward bias in the estimates. Second, 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. IT investment is necessary to obtain the payoffs from it, whether in the United States context or not. Since the majority portion output variance can be explained by Labor Expenses in China, 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. [21].

Further studies are needed to improve understanding of the output contribution of IT in other business environments whether in developed countries or not. Continuous empirical studies using similar methods and different data may be necessary to devise a theory in IT productivity literature [2, 25, 28]. Longitudinal studies can also be conducted in the long time span to understand the role of IT as a production factor. Moreover, exploration of the role and mechanism of country characteristics in IT productivity is also needed.

References

[1] Alpar P. and Kim M. (1990). "A microeconomic approach to the measurement of information technology value," *Journal of Management Information Systems*, Vol.7, No.2, pp.55-69.

[2] Berthon, P., Pitt, L., Ewing, M., and Carr, C.L. (2002). "Potential research space in MIS: A framework for envisioning and evaluating research replication, extension, and generation," *Information Systems Research*, Vol.13, No.4, pp. 416-427.

[3] Brynjolfsson, E. and Hitt, L.M. (1995). "Information technology as a factor of production: The role of differences among firms," *Economics of Innovation and New Technology*, Vol.3, pp. 183-199.

[4] Brynjolfsson, E. and Hitt, L.M. (1996). "Paradox Lost? Firm-level evidence on the returns to information systems spending," *Management Science*, Vol.42, No.4, pp.541-558.

[5] Brynjolfsson, E. and Hitt, L.M. (2003). "Computing productivity: Firm-level evidence," *Review of Economics and Statistics*, Vol.85, No.4, pp.793-808.

[6] China ComputerWorld Research (2004-2007). http://www.ccwresearch.com.cn,.

[7] Dedrick, J., Gurbaxani, V. and Kraemer, K.L. (2003). "Information technology and economic performance: A critical review of the empirical evidence," *ACM Computing Surveys*, Vol.35, No.1, pp.1-28.

[8] Dewan, S. and Kraemer, K.L. (2000). "Information technology and productivity: Evidence from country-level data," *Management Science*, Vol.46, No.4, pp. 548-562.
[9] Dewan, S. and Min, C. (1997). "The substitution of information technology for other factors of production: A firm level analysis," *Management Science*, Vol.43, No.12, pp. 1660-1675.
[10]Farhoomand, A.F. and Lovelock, P. (1999). "Building China's NII: Policy Coordination and the "Golden Projects," *The University of Hong Kong business case HKU022*.
[11]Hair, J. Jr., Anderson, R.E., Tatham, R.L., and Black, W. C. (2005). *Multivariate Data Analysis, 5th ed.*, Prentice-Hall International Inc., Upper Saddle River, New Jersey.
[12]L.M. Hitt and Brynjolfsson, E. (1996). "Productivity, profitability and consumer surplus: Three different measures of information technology," *MIS quarterly*, Vol.20, No.2, pp.121-142.
[13]Kudyba, S. and Diwan, R. (2002). "Research report: increasing returns to information technology", *Information Systems Research*, Vol.13, No.1, pp.104-111.
[14]Lee, S. and Kim, S.H. (2006). "A lag effect of IT investment on firm performance," *Information Resources Management Journal*, Vol.19, No.1, pp.43-69.
[15]Lehr, W. and Lichtenberg, F.R. (1999). "Information Technology and its Impact on Productivity: Firm- level Evidence from Government and Private Data Sources, 1977-1993,"*Canadian Journal of Economics*, Vol.32, No.2, pp.335-362.
[16]Lichtenberg, F. R. (1995). "The output contributions of computer equipment and personnel: A firm-level analysis," *Economics of Innovation and New Technology*, Vol.3, pp. 201-217.
[17]Loveman, G.W. (1994). "An assessment of the productivity impact of information technologies," In T. J. Allen and M. S. Morton (Eds.), *Information technology and the corporation of the 1990s: Research studies* (pp. 84-110), Cambridge, MA, MIT Press.
[18]Melville, N., Kraemer, K., and Gurbaxani, V. (2004). "Information technology and organizational performance: An integrative model of IT business value," *MIS Quarterly*, Vol.28, No.2, pp. 283-322.
[19]Ministry of Information Industry of China (MII) (2005-2007). www.mii.gov.cn.
[20]Quan, J. and Hu, Q. (2006). "Using IT to create business value in China: What can be learned from IT research and practices in the developed countries," *International Journal of Internet and Enterprise Management*, Vol.4, No.1, pp. 5-19.
[21]Quan, J., Hu, Q., and Wang, X. (2005). "IT is not for everyone in China," *Communications of the ACM*, Vol.48, No.4, pp. 69-72.
[22]Reuters (2005) "China moves to fourth in global GDP rankings," http://www.chinadaily.com.cn/english/doc/2005-12/14/content_503281.htm.
[23]Rose, E. (2005). *Market focus: Business IT spending by industry, Asia/Pacific, 2003-2008*, Gartner.
[24]Rose, E. (2006). *Market Trends: Industry Analysis, China, 2004-2009*, Gartner.
[25]Saunders, C. (2007). "Information Systems in Developing Countries," *MIS Quarterly*, Vol.31, No.2, pp.iii-vi.
[26]Strassmann, P.A. (1990). *The business value of computers: An executive's guide*, Information Economics Press, New Ganaan, CT.
[27]Tam, K.Y. (1998). "Analysis of firm-level computer investments: A comparative study of three Pacific-rim economies," *IEEE Transactions on Engineering Management*, Vol.45, No.3, pp.276-286.
[28]Walsham, G., Robey, D., and Sahay, S. (2007). "Foreword: Special issue on information systems in developing countries," *MIS Quarterly*, Vol.31, No.2, pp.317-326.
[29]Xiang, J.Y., Lee, S. and Kim, J.K. (2006). "An exploratory study on the relationship between information technology investment and firm performance in Chinese electronics industry," *Proceedings of 2006 spring Korean Management Information Systems Conference*, pp.914-920.