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An empirical study of the relationship between a self-service technology investment and firm financial performance

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ABSTRACT

More and more enterprises are taking advantage of self-service technologies (SSTs) in their customer-related operating activities, especially service firms. Although research on SSTs is prevalent, few studies have examined the impact of SSTs on firm financial performance. Given the growing importance of SSTs in the service industries in general and in the banking industry in particular, we therefore empirically examined the impacts of ATMs, one of the most widely accepted SSTs, on bank financial performance. Contrary to the existing literature, our results show ATMs have a positive relationship with profitability. However, we find no association between ATMs and growth performance.

Introduction

For the last decades, firms have been investing in IT steadily and increasingly (Michael, 2007). Firms investing in information technology (IT) presumed that such investments would enhance operating efficiency and thus improve financial performance. From a strategic point of view, Porter and Millar (1985) suggest that IT is a business driver and thus can be used to reinforce competitive edge.

The great progress of IT capability as well as high labor costs is driving firms to reshape their service delivery systems. The technologies are adapted in order to allow customers to produce and consume services electronically, without direct contact with firm employees. These kinds of technological

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interfaces are referred to as self-service technologies (SSTs) (Meuter et al., 2000). SSTs have been increasingly prominent in the service industries in particular. For example, hotels utilize automated check-in systems and airports take advantage of check-in kiosks. Other examples of SSTs include automated ticketing machines, electronic retailing, automated phone systems, automated teller machines (ATMs), telephone banking and mobile banking.

Service providers who introduce SSTs may increase customer satisfaction, productivity and efficiency (Walker et al., 2002; Zeithaml and Gilly, 1987; Meuter et al., 2003). The introduction of SSTs does not automatically lead to their acceptance and usage. Hence, many researchers have studied customer acceptance from the viewpoints of technology readiness (Liljander et al., 2006; Lin and Hsieh, 2007), technology anxiety (Meuter et al., 2003), or e-commerce trust (e-trust) (Hwang and Kim, 2007). However, research examining the impact of SSTs on firm financial performance has been limited.

The banking industry is one of the pioneers of SSTs applications and today heavily depends on SSTs in reshaping its service delivery systems. Several SSTs have already been utilized for years by the banking industry. Since the first ATM was installed in the late 1960s, ATMs have been considered as the most well-known and classic example of SSTs application in the banking industry. Banks were eager to deploy ATMs and replace costly counter tellers in order to improve cost efficiency and thus financial performance (Hannan and McDowell, 1984; Banker et al., 1990). However, deploying each ATM machine now costs between $15,000 and $50,000. In addition, the maintenance and operation expenses range from $12,000 to $15,000 per ATM per year (Stavins, 2000). The tradeoff between the benefits and costs of deploying SSTs in general and ATMs in particular is an empirical issue to be examined.

Prior research which examined the effects of ATMs on cost reduction or efficiency improvement usually used a dummy variable to distinguish ATM investment versus non-ATM investment. This dummy variable approach cannot precisely measure the intensity of ATM investment and thus may lose the power of detecting the precise impact of ATMs. In this paper, we collect the actual financial and operating data in our empirical analysis. Specifically, we use the actual number of ATMs of each bank, rather than using a dummy variable, to measure the extent of ATM investment. Therefore, we can better estimate the financial impacts of ATMs, one of the most typical SSTs used by the banking industry.

In 2002, the banking industry ranked first in terms of IT investment (Kudyba and Diwan, 2002) with ATMs being one of the major investments. By studying the relationship between ATM investment and financial performance, we can provide more insights into the financial contributions of IT investment in general and one kind of SST investment (ATM) in particular. Our empirical results show that ATM investment has a significant and positive association with bank financial performance, but has no association with bank growth performance. Our findings provide evidence for the reasons behind the continual investment in ATMs, a well accepted SST, in the banking industry.

The "IT/SST Investments and Performance" section provides a review of the literature on IT and SST investments. The "Research Model and Methodology" section presents the research model and methodology. The sample and empirical results are discussed in "The Sample and Empirical Results" section. The final two sections present the sensitivity analysis and conclusions respectively.

IT/SST investments and performance

For the past half-century, firms have dramatically increased their investments in IT. The contributions of these IT investments and their effect on the efficiency of value chain activities have been research issues of many prior studies (Porter, 1980). Bakos (1987) claimed that IT had an impact on organizational structure and process, thereby affecting organizational performance. Furthermore, IT has led to changes in industry structure and competition and many firms have used IT to support the creation of new businesses. Firms that use IT effectively are expected to outperform their rivals (Porter and Millar, 1985) as IT could reduce the cost of coordination between activities and create value for the client (Bakos, 1991; Clemons and Row, 1991). Banker et al. (1990) studied the impact of IT investment on sales and order management in Hardees fast food stores, and found that IT improved cost efficiency by cutting down material costs.

SSTs, one form of IT, allow customers to perform transactions and complete services by themselves, reducing the need for tellers and thus saving the associated salary expense and cost of branch

establishment in the banking industry (Dos Santos and Peffers, 1995; Hannan and McDowell, 1984; Ladernman, 1990; Aladwani, 2001; Premkumar and Roberts, 1999; Sriram and Stump, 2004).

Over the last two decades, many prior studies have been devoted to the issue of IT and firm performance. However, prior research focusing on the impact of IT investments on accounting profitability has provided mixed evidence with many studies failing to show a clear relationship between the two. Most of this research has usually taken non-financial sectors for sample study. Examining the banking industry, Markus and Soh (1993) find that most US banks did not achieve financial benefits from IT investments. Specifically, small banks did not show a significant association between IT investment and profitability while large banks showed negative returns from their IT investments.

Beccalli (2007) studied the banking industries of five European countries for the period from 1995 to 2000. In his work, IT investments refer to the spending on IT hardware, IT software, and IT services. He found that investment in IT services (such as consulting services, training and education, and support services) appears to have a positive influence on accounting profit, while the acquisition of hardware and software seems to reduce bank profitability.

At an early stage, ATMs were deployed by banks to replace costly counter tellers with the expectation of significant cost savings, as transaction costs through ATMs were cheaper than those conducted by tellers. However, Stavins (2000) points out the costs of deploying ATMs and their related maintenance and operations expenses during their service period were significant. Considering both the benefits and costs of ATMs, Florian et al. (2004) believe that banks are losing money on their ATMs investments.

Based on economic theory, innovators may achieve superior financial performance if they can capture favorable market positions and secure scarce resources before their competitors can imitate them. The theory of competitive advantage argues that a general available technology will not provide sustainable advantage (Porter, 1980, 1985). Dos Santos et al. (1993) argued that non-innovative technologies, such as ATMs, are not likely to improve a firm's value, because non-innovative technology is not expected to help firms gain competitive edge.

ATMs mainly provide routine services, such as cash withdrawals and account balance inquiries, and thus are considered as a kind of non-innovative technology. Since ATM investments are not innovative and no improvement in bank financial performance is expected, we test the following null hypothesis:

H_0. ATMs have no positive relationship with bank financial performance.

Research model and methodology

The objective of this study is to investigate whether or not ATM investment has a positive impact on bank financial performance. We first estimate the determinants of ATM investment and then estimate the impacts of ATMs on bank financial performance. Prior research indicated that IT investment decisions are affected by many organizational factors, such as business scale (Egelhoff and Haklisch, 1994; Hwang et al., 2004; Levitas et al., 2006; Thong and Yap, 1995) and cost structure (Aladwani, 2001; Premkumar and Roberts, 1999; Sriram and Stump, 2004). One of the main purposes for deploying self-service technologies, such as ATMs, is to provide service convenience for customers in order to improve customer satisfaction (Avery et al., 1997; McCormick and Roses, 1994; Sinha and Noble, 2005). Hence, ATM investments are influenced by bank scale, cost efficiency, and deposit structure (Ou et al., 2009).

Since a bank's financial performance is related to its business scale, cost efficiency, and customer satisfaction, these factors should play the role of control variables when examining the relationship between ATM investment and bank financial performance. However, these variables can also influence banks' ATM investment decisions. For example, the Pearson correlation coefficient between ATM investment and total assets is 0.874 in our sample. In order to account for the simultaneity, we construct a simultaneous equations model with two equations. The first equation estimates the deciding factors of ATM investment, including bank scale, cost efficiency, and deposit structure. The second equation estimates the relationship between financial performance and ATM investment. Our simultaneous equations model is as follows:

$$\text{ATM Investment} = f(\text{bank scale}, \text{deposit structure}, \text{operating costs}) \quad (1)$$

$$\text{Financial performance} = g(\text{ATM investment}, \text{prior financial performance}) \quad (2)$$

Four profitability measures are used to proxy for financial performance. These four financial performance measures are return on assets (ROA), return on equity (ROE), operating income ratio (OIR) and net income ratio (NIR) (Hitt and Brynjolfsson, 1996; Irwin et al., 1998; Wu and Wang, 2007). The main independent variable in this paper is the ATM investment, which measures the extent to which a bank invest in ATMs. ATM investment is defined as the natural log value of the number of ATMs (NATM). Since the goal of this paper is to examine whether or not the ATM investment leads to a better financial performance, the measure of ATM investment (NATM) is consequently lagged for one period.

Ou et al. (2009) constructs a framework of determinants of ATM investment. Their framework suggests that the ATM investments are influenced by bank scale, cost efficiency, and deposit structure. Following Ou et al. (2009), three proxy variables of bank scale are the log value of total assets (TA), the number of branches (NB), and the growth in the number of branches (ΔNB). The proxies of deposit structure are the ratio of total deposits to total assets (TD/TA), the ratio of demand deposits to total deposits (DD/TD), and the growth of demand deposits (ΔDD). Finally, operating expenses are measured by the ratio of operating expenses to total deposits (OE/TD), the ratio of salary costs over operating expense (SE/OE), and the growth of operating expenses (ΔOE).

Therefore, the corresponding regression model is as follows:

$$\begin{aligned}\mathrm{NATM}_{t-1} = {} & \beta_0 + \beta_1 \mathrm{TA}_{t-1} + \beta_2 \mathrm{NB}_{t-1} + \beta_3 \Delta\mathrm{NB}_{t-1} + \beta_4 (\mathrm{TD/TA})_{t-1} + \beta_5 (\mathrm{DD/TD})_{t-1} \\ & + \beta_6 \Delta\mathrm{DD}_{t-1} + \beta_7 (\mathrm{OE/TD})_{t-1} + \beta_8 (\mathrm{SE/OE})_{t-1} + \beta_9 \Delta\mathrm{OE}_{t-1} + \varepsilon_{t-1} \end{aligned} \tag{3}$$

$$y_t = \alpha_0 + \alpha_1 \mathrm{NATM}_{t-1} + \alpha_2 y_{t-1} + e_t \tag{4}$$

where the subscription t denotes the period t; y_t denotes a bank's financial performance in period t; e and ε are the error terms. In addition, the Greek letters α_i and β_i represent the coefficients of independent variables in the two equations respectively. This regression model was estimated by the two-stage least squares method (Maddala, 1992). We first estimate Eq. (3) to obtain the predicted value of NATM and then use the predicted NATM in Eq. (4).

The sample and empirical results

In this paper, we examine the banking industry in Taiwan, an important sector in the Greater China economy. According to the Central Bank of Taiwan, the banking industry is composed of eight categories: domestic banks, foreign banks, investment and trust companies, credit cooperative associations, credit departments of farmers and fishermen cooperative associations, bill finance companies, and security finance companies. The sample banks included in this study are Taiwanese domestic banks. The data used in this study are collected from the Bureau of Monetary Affairs, Financial Supervisory Commission of Taiwan. A total of 284 observations are included in the empirical analysis.

Table 1 shows the descriptive statistics. First, the maximum number of branches (NB) is 181 and the minimum number is 12. The mean of NB is 62.55. The number of branches of the largest bank is about 15 times that of the smallest bank. The large variation in the number of branches indicates that both large and small banks are included in our sample. Second, the minimum values of all financial indicators are all negative. Additionally, the minimum value of the growth of branches (ΔNB), the growth of demand deposits (ΔDD), and the growth of operating expenses (ΔOE) are all negative. These numbers show that some banks are in fact suffering from financial difficulty and that some operating scales are shrinking. Thus, the sample banks of this paper include both banks with sound financial positions and those with financial adversities.

We first estimate the determinants of ATM investment and report the empirical results in Table 2. The adjusted R-square of this regression model is 0.83. The coefficients of the two scale measures, total assets (TA) and number of branches (NB), are significantly positive, suggesting that larger banks invest more in ATMs than smaller banks do. The coefficients of $(\mathrm{TD/TA})_{t-1}$ and $(\mathrm{DD/TD})_{t-1}$ are significantly positive, indicating that banks with higher customer demand for deposit services and demand deposit services tend to invest more on ATMs. The significantly positive coefficients of $(\mathrm{OE/TD})_{t-1}$ and $\Delta\mathrm{OE}_{t-1}$

Table 1
Descriptive statistics of variables.

Variables	Mean	Std. Dev.	Min.	Max.
NATM	5.184	0.897	3.296	8.198
TA	19.559	0.812	17.548	21.185
NB	62.599	40.891	12.000	181.000
ΔNB	3.042	10.725	−103.000	75.000
TD/TA	0.805	0.096	0.219	0.980
DD/TD	0.140	0.070	0.019	0.329
ΔDD	5,780,813	21,581,940	−196,314,697	123,930,959
OE/TD	0.017	0.005	0.009	0.032
SE/OE	0.497	0.095	0.2556	0.682
ΔOE	336,875	975,618	−8,184,751	5,072,030
ROA	0.134	1.175	−8.250	2.350
ROE	1.548	19.991	−171.820	131.460
NIR	1.436	21.903	−157.710	35.920
OIR	2.190	24.700	−151.720	46.060

Note: NIR (%)=(net income)/(net sales)×100, OIR (%)=(operating income)/(net sales)×100.

Table 2
The determinants of ATMs investment.

Variable	Coefficient	*T*-value
Intercept	−14.292***	−10.69
TA	0.894***	14.57
NB	0.003***	2.64
ΔNB_{t-1}	−0.003	−0.98
$(TD/TA)_{t-1}$	1.619***	5.38
$(DD/TD)_{t-1}$	1.299***	3.26
ΔDD_{t-1}	−1.07E−9	−0.80
$(OE/TD)_{t-1}$	30.708***	5.10
$(SE/OE)_{t-1}$	−0.406	−1.26
ΔOE_{t-1}	1.01E−7***	2.86
Adj-R^2=0.838, *P*-value<0.0001		

Note: The values in parentheses are *t*-value. *, ** and *** represent the significant level 0.1, 0.05 and 0.01, respectively.

suggest that banks with higher operating expense burdens invest in more ATMs in an attempt to reduce their cost burdens. In general, the results suggest that banks invest in ATMs to satisfy customers' needs for deposit related services and to improve cost performance.

We then estimate the effects of ATM investment on banks' financial performance. The empirical results of Eq. (4) are presented in Table 3. The coefficients of $NATM_{t-1}$ are 0.215, 3.088, 3.523, and 3.301 for the four financial performance measures, ROA, ROE, OIR, and NIR, respectively. All of these coefficients are significantly positive. Contrary to some prior studies suggesting ATMs are not profitable for banks (Stavins, 2000; Florian et al., 2004) and the hypothesis that ATMs have no positive impact on financial performance, our empirical results show that higher investment in ATMs is associated with better financial performance in the subsequent period.

In addition, all of the coefficients of financial ratio (lag 1 period) are positive and significantly different from zero, except the coefficient of ROE. These coefficients indicate that banks with better

Table 3
ATM investment (lag 1 period) and financial performance.

Financial ratio	Intercept	Estimated $NATM_{t-1}$	Financial ratio (lag 1 period)	Adjusted R^2
ROA	−1.020 (−2.46)***	0.215 (2.68)***	0.341 (6.04)***	0.158
ROE	−14.202 (−1.90)*	3.088 (2.15)**	0.024 (0.39)	0.011
NIR	−17.161 (−2.16)**	3.523 (2.31)**	0.301 (5.27)***	0.117
OIR	−15.407 (−1.73)*	3.301 (1.93)*	0.292 (5.09)***	0.102

Note: Values in parentheses are *t*-values. *, ** and *** represent the significant level of 0.1, 0.05, and 0.01, respectively.

Table 4
ATMs investments (lag 2 period) and financial performance.

Financial ratio	Intercept	Estimated ATM_{t-2}	Financial ratio (lag 1 period)	Adjusted R^2
ROA	−0.836 (−1.88)*	0.182 (2.14)**	0.336 (5.87)***	0.158
ROE	−11.201 (−1.34)	2.461 (1.55)	0.019 (0.30)	0.003
NIR	−16.300 (−1.86)*	3.373 (2.02)**	0.296 (4.99)***	0.115
OIR	−14.338 (−1.46)*	3.123 (1.68)*	0.288 (4.86)***	0.101

Note: Values in parentheses are *t*-values. *, ** and *** represent the significant level of 0.1, 0.05, and 0.01, respectively.

performance in the prior year gain superior performance in the following year. ROE can be decomposed into return on assets (ROA) and a measure of financial leverage (Palepu et al., 2007, p. 200)[1]. The decomposition suggests that a company's ROE is affected by two factors: how profitably a firm employs its assets and how big a firm's assets are relative to its shareholder equity. Therefore, ROE is influenced both by a firm's profitability and its capital structure. The influence of capital structure on ROE may cause the coefficient of ROE becomes insignificant.

Kivijarvi and Saarinen (1995) argue that IT investment is not related to superior financial performance in the short term, but will pay off in the long run. In order to examine if the relationship between ATM investment and financial performance will last for more than one year, we next use the ATM investment that is lagged for two periods ($NATM_{t-2}$) and re-estimate Eq. (4). As reported in Table 4, the results of the lagged two-period model are similar to those of the lagged one-period model. The estimated $NATM_{t-2}$ is positively and significantly associated with ROA, NIR, and OIR. With respect to ROE, the coefficient of estimated $NATM_{t-2}$ is positive, but not significant. As mentioned above, ROE is influenced by a firm's financial leverage and thus varies with the fluctuation of capital markets. Table 4 shows that the positive impact of ATM investment on financial performance can last for more than one year.

Further analysis

In this section, we conduct a sensitivity analysis by employing two alternative measures of financial performance to examine the robustness of our empirical results. The first alternative financial performance measure is the expense ratio (ER), which is defined as: (operating expenses + finance costs)/(net sales) × 100%. The second alternative measure is the gross margin ratio (GMR), which is defined as: (gross margin/net sales) × 100%. As shown in Table 5, the results indicate that ATM investments are associated with lower expense ratios and higher gross margin ratios. These empirical results are consistent with the findings reported in both Tables 3 and 4. Overall, the empirical results indicate that ATM investment can improve financial performance.

Some earlier studies also examined the impacts of IT on growth performance and discovered that IT investments are positively related to growth measures. For instance, Weill (1992) examined the contribution of IT investments to the growth of sales. In this study, few use four alternative growth measures, including growth ratio of sales (GRS), growth ratio of net income (GRNI), growth ratio of operating income (GROI), and growth ratio of return on assets (GRROA). The results of ATM investments on growth performance are reported in Table 6. The empirical results show that ATM investments are not always positively related to growth ratios. No coefficient of $NATM_{t-1}$ in Table 6 is significantly different from zero. The coefficient of $NATM_{t-1}$ is negative when the dependent variable is GRS. Based on these findings, we conclude that ATM investments have no significant impact on growth performance.

This interesting finding indicates that the contributions of ATMs to banks are more operationally oriented toward improving financial performance, rather than strategically oriented in pursuing growth for the future. According to Porter's five forces analysis, there are three potential sources of competition in an industry: (1) rivalry between existing firms, (2) threat of entry of new firms, and (3) threat of substitute products or services (Palepu et al., 2007, p. 45). Banks deploy more ATMs can serve

[1] ROE = (net profit shareholder's equity) = (net profit assets) × (assets shareholder's equity) = ROA × financial leverage.

Table 5
Sensitivity analysis results.

Financial ratio	Intercept	Estimated $NATM_{t-1}$	Estimated ATM_{t-2}	Financial ratio (lag 1 period)	Adjusted R^2
GMR	−86.074 (−7.71)***	−3.299 (−1.94)*		0.292 (5.12)***	0.102
GMR	−0.797 (−0.09)	3.802 (2.25)**		0.282 (4.92)***	0.100
GMR	−85.533 (6.69)***		−3.123 (−1.68)*	0.288 (4.86)***	0.100
GMR	5.806 (0.60)		2.610 (1.40)	0.285 (4.78)***	0.09

Note: (1) Values in parentheses are *t*-values. *, ** and *** represent the significant level of 0.1, 0.05 and 0.01, respectively. (2) ER (%)=(operating expenses+finance costs)/(net sales) × 100; GMR (%)=(gross margin/net sales) × 100.

Table 6
The empirical results of ATM investments and growth ratios.

Financial ratio	Intercept	Estimated $NATM_{t-1}$	Financial ratio (lag 1 period)	Adjusted R^2
GRS	14.698 (1.89)*	−2.132 (−1.45)	0.432 (7.76)***	0.196
GRNI	−298.279 (−0.55)	34.575 (0.33)	−0.040 (−0.67)	−0.005
GROI	−299.374 (−0.55)	34.835 (0.34)	−0.040 (−0.67)	−0.005
GROR	−0.327 (−0.72)	0.060 (0.69)	−0.330 (−5.83)***	0.103

Note: Values in parentheses are *t*-values. *, ** and *** represent the significant level 0.1, 0.05, and 0.01, respectively.

more customers and may get some vantage point in rivalry. But deploying ATMs cannot be the barrier to the new entrants or substitute services. These attributes of ATMs may help banks gain profit rather spur bank's growth.

To provide more theoretical implications of this finding, it would be helpful to discuss more about the following three perspectives in this subject area. From the strategic perspective, there are basically two generic strategies available and they are product differentiation and cost leadership strategies. From IT perspective, there are also two kinds of ITs which include innovative ITs and non-innovative ITs. As to the performance perspective, there are two types of performance drivers: cost-based drivers and revenue-based drivers. Existing literature and/or works have traditionally placed more focus on the studies of adopting innovative ITs and investigating their effects onto firm's performance. Generally speaking, innovative ITs are more suitable for firms to adopt product differentiation strategy to increase the resulting sales revenue. This is so-called growth effects. However, there were rather limited studies in this subject area to emphasize on the examination of the non-innovative ITs and their subsequent effects. In this study, the authors examine the effects of one type of SSTs, a non-innovative IT (i.e., ATM), onto the bank's financial performance. The empirical result shows that ATMs, as one type of SSTs, have a significant and positive relationship onto profitability, but have no association with growth performance. This finding suggests that there are certainly much business values by deploying non-innovative ITs such as ATM. The managerial implication of this obtained result may suggest that a non-innovative IT such as ATM is in fact a cost-based performance driver, rather than a revenue-based performance driver. In addition, it is noted that a non-innovative IT is particularly suitable for those firms that are adopting a cost leadership strategy. From the discussion above, it comes no surprise that the firms should integrate these aforementioned strategic, IT, and performance perspectives while formulating and/or revising their IT investment strategies.

The above contribution is important in three primary ways. For academic researchers, this research may provide a new direction to perform future studies about the impacts of and related factors about non-innovative ITs. As to the companies and businesses, the decision makers can actually use the findings obtained from this study to carefully analyze and formulate the best investment plans and/or strategy to match with their operating objective – to create a better product differentiation advantage or to be a more effective costs leader in the market. Finally, IT vendors should also pay future attention to the technological advancement of the capabilities, functions, and features offered by their products. To meet with the dynamic challenges, IT vendors/suppliers must strive their best to improve their products to gain a competitive advantage.

Conclusion

Since China joined the WTO in 2002, foreign banks and financial institutions have been permitted to access to one of the fastest growing financial markets in the world. The restrictions on foreign banks' operations and businesses in China have been gradually removed. This paper uses the actual operating and financial data of Taiwanese banks to examine the impacts of ATM investment on financial and growth performance. The research results of this paper can provide some insights to those foreign banks that intend to enter and expand their banking businesses in Greater China.

The main objective of this paper is to examine the relationship between self-service technology investment and financial performance. Our results demonstrate that ATMs are significantly and positively associated with financial performance. In addition, the sensitivity analysis shows that the influence of ATM investments on bank financial performance can last for more than one year.

This paper highlights both positive and negative effects of ATMs. The empirical results indicate that ATM investment is profitable, but also that it has no significant impact on growth performance. This interesting finding suggests that banks can invest self-service technology, such ATMs, to improve their financial performance, but they cannot use self-service technology to enhance their growth in the future. In other words, some other means, rather than simply investing in self-service technology alone, have to be employed in order to improve growth performance.

Every industry has its own way of taking advantage of information technology. Since the banking industry is a service industry, the results of this paper may not be applicable to manufacturing industries. Furthermore, the banking industry is highly regulated regarding its operations, and the generalization of the results in this paper towards other industries, even to other service industries, should be made with caution.

In addition to ATMs, several kinds of self-service technologies, such as telephone banking, internet banking and mobile banking, have been utilized to deliver their services by the banking industry. The impacts of these alternative SSTs and their interacting effects remain unknown and deserve further examination.

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