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Complementary Technology and Long-term Shareholder Value of Acquiring Firm in Technology Acquisitions

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Abstract: Prior research on technology acquisitions has not examined the effect of acquiring complementary technology on long-term shareholder value of acquiring firms and the mechanisms of value creation of complementary technology acquired. And most empirical results in previous technology acquisitions are based on data in the USA and UK from mid-1980s to mid-1990s. There is little evidence from emerging market. This study develops a model of complementary technology and long-term shareholder value of acquiring firms in technology related acquisitions that considers the factors associated with value creation of complementary technology. The model is tested using a sample of technology acquisitions from high-tech industries in China. The study finds that complementary technology acquired creates more value for shareholder of acquiring firm than similar technology does in technology acquisitions in the long term. And the percentage of target firm acquired and the ratio of technical employees of acquiring firm have positive moderating effects on the relationship between complementary technology and long-term shareholder value of acquiring firm. The results of the study suggest that firms should increase their technology integration capability to make complementary technology acquired creates value for acquiring firms.

Key words: Complementary technology, shareholder value, technology acquisition, integration capability

INTRODUCTION

There is no question that mergers and acquisitions (M&A) has been and will continue to be a highly popular strategy for firm development (Cartwright and Schoenberg, 2006). There are five waves of M&A in economic history. And it seems that the peak of the sixth wave of M&A has been reached (Cefis, 2010). Within each wave, a review of the evidence suggests that the M&A was driven by a mix of managerial motives (Ravenscraft and Scherer, 1987; Bower, 2001). Over time, managerial motives for M&A have included efficiency gains, market power gains, geographical expansion, resource sharing, horizontal and vertical integration and diversification (Golbe and White, 1993). A primary motive of many M&A has also been the desire to obtain valuable resources, such as technologies and capabilities possessed by the target firms (Chaudhuri and Tabrizi, 1999; Ahuja and Katila, 2001).

Acquiring technologies and capabilities is rarely mentioned as a motive for M&A before late 1980s. In the most recent wave of M&A, this motive appears to have increased in relative importance (Bower, 2001). This is well supported by the dramatically rising number of acquisitions in high-tech industries such as electronics, biotechnology, telecommunications, networking and information services (Ranft and Lord, 2002). New product innovation of firms for achieving competitive advantage is more important when the market competition is ever increasing (Tsai *et al*., 2011). The pace of technological environment change is accelerating and the complexity of technology is increasing (Badawy, 2009), in addition to the product life cycle is shortening, which bring great challenges for firms in high-tech industries (Bannert and Tschirky, 2004). Nowadays, even the largest firms that rely solely on internal R and D efforts can not create sustainable product advantages any more (Rigby and Zook, 2002) and must acquire external technologies to cope with the ever-increasing speed and complexity of new product development (Kim, 2009). Innovation has become an important factor for firms to ensure their survival and performance in the market (Cefis and Marsili, 2006). Paralleling this practical importance, technology acquisitions have received increasing attention in academic literature (for a review see Graebner *et al*., 2010).

In previous literature, the relationship between technology acquisitions and innovative performance of

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acquiring firms is a popular issue researched by scholars in the last decade. The innovative performance of the acquiring firms was usually measured by the number of patents granted to acquiring firms around five years after the M&A (Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002; Cloodt *et al*., 2006; Makri *et al*., 2010). The main empirical results of the research included the inverted U-shaped relationship between relatedness of the acquired knowledge base and innovative performance of the acquiring firm (Ahuja and Katila, 2001; Cloodt *et al*., 2006), the positive effect of technology related M&A on the innovative performance of the acquiring firm (Hagedoorn and Duysters, 2002) and the positive relationship between complementary technology and post-merger innovative performance of acquiring firm in technology acquisitions (Makri *et al*., 2010).

Although, many issues have been researched in previous literature, there are still some limitations in this area. The high-growth and high-risk characteristics of high-tech industries raise the question about the value creation in technology acquisitions (Kohers and Kohers, 2000). In business practice, estimated failure rates of M&A are typically around 70 percent (Tetenbaum, 1999; Marks *et al*., 2001), especially many technology acquisitions fail to create value (King *et al*., 2008). The innovative performance of technology acquisitions reflects long-term effects of acquisitions (Hagedoorn and Duysters, 2002). But there is much fewer evidence on the relationship between technology acquisitions and long-term shareholder value of acquiring firms (He and Wang, 2013). The research on the relationship between M&A and the market-based performance of the acquiring firm are fruitful in strategic management and finance fields (Lubatkin, 1987; Loughran and Vijh, 1997; Gregory and McCorriston, 2005; Arnold and Parker, 2007), but the researchers either only concluded the relationship between M&A and shareholder value of the acquiring firm (Lubatkin, 1987; Arnold and Parker, 2007) without analyzing the factors associated with M&A performance, or overlooked the technology factors of acquiring and target firms in the analysis of determinants of market-based performance (Loughran and Vijh, 1997; Gregory and McCorriston, 2005). When examining the relationship between technological relatedness of the acquiring and target firms and the post-acquisition innovative performance of the acquiring firm, researchers often divided the sample into technologically related and technologically unrelated acquisitions based on the patents of acquiring and target firms (Hagedoorn and Duysters, 2002; Cloodt *et al*., 2006), which overlooked the difference between similar technology and complementary technology when the acquisition was technologically related. Makri *et al*. (2010) proposed a method of measuring technology similarity and complementarity. But the value of technology complementarity is always much greater than technology similarity using the measures, which makes them can not be used as the benchmark of judging the technologies possessed by target firm are mainly similar or complementary to the technologies of acquiring firm by analyzing the patent information of acquiring and target firms. And in the majority of previous literature, the data were collected from advanced markets such as the USA and UK between mid-1980s and mid-1990s. There is very few evidence on the performance of technology acquisitions based on the data in emerging markets in recent years.

This study tries to explore the effect of complementary technology possessed by target firm on long-term shareholder value of acquiring firm in technology acquisitions, where little evidence is available. In examining the effect of acquiring complementary technology, the factors associated with technology integration of the acquiring firm were tested. The study examined the moderating effects of the percentage of target firm acquired and the ratio of technical employees of the acquiring firm on the relationship of acquiring complementary technology and long-term shareholder value of acquiring firm. Firstly, the cumulative abnormal returns of acquiring firms in technology acquisitions were calculated by standard event study for a three-year event widow after acquisition. Subsequently, acquiring complementary technologies were identified from acquiring similar technologies in technology acquisitions. Finally, the effect of acquiring complementary technology on long-term shareholder value of acquiring firm and the factors having moderating effects on complementary technology were examined.

This study gives some theoretical and managerial implications to M&A. First, the study shows that acquiring complementary technology has a positively effect on long-term shareholder value of acquiring firm. Second, the percentage of target firm acquired and the ratio of technical employees of acquiring firms have positive moderating effects on the relationship between acquiring complementary technology and long-term shareholder value of acquiring firm. Third, the findings of factors having moderating effects on the relationship between acquiring complementary technology and long-term shareholder value of acquiring firm shed light on the way for managers to increase shareholder value of acquiring firm by improving technology integration capability.

THEORY BACKGROUND AND HYPOTHESES

The definition and measurement of relatedness are central issues in strategic management filed (Makri *et al*., 2010). In technology acquisition research, one of important factors is the technology relatedness between acquiring and target firms. Technology relatedness of firms refers to the degree to which firms are active in particular fields of technologies that they share with their (potential) partners in mergers and acquisitions (Hagedoorn and Duysters, 2002). But in most previous literature, researchers often measured technological knowledge relatedness between acquiring and target firms to explore the effect of technology relatedness on innovative performance of acquiring firm in technology acquisitions (Ahuja and Katila, 2001; Cloodt *et al*., 2006). From organizational learning and absorptive capacity perspectives, if the knowledge possessed by target firm is related to that of acquiring firm, it can be evaluated and utilized better than unrelated knowledge (Cohen and Levinthal, 1990). Similar knowledge can facilitate the integration of the knowledge of target firm into the knowledge of acquiring firm (Kogut and Zander, 1992; Grant, 1996). When the firm comes from distant realms of technology, the recipes for conducting research, or the innovation routines of the acquiring and target firms are likely to be different (Kogut and Zander, 1992). In such circumstances, the integration of the knowledge of acquiring and target firms will be resource consuming, or even unproductive because the routines are not inappropriate to adopt either or both knowledge of acquiring and target firms (Haspeslagh and Jemison, 1991; Zollo and Singh, 2004). The positive effect of relatedness in knowledge on the success of technology acquisitions is supported by empirical studies that emphasize the effects of economies of scale and scope of R&D (Gerpott, 1995; Hagedoorn and Duysters, 2002).

However, if the knowledge of target firm is too similar to the knowledge of acquiring firm, it may also contribute little to subsequent innovative performance of acquiring firm. From an absorptive capacity perspective, the knowledge of target firms can help improve performance of acquiring firms through two effects. Firstly, the knowledge from target firms can provide a cross-fertilization effect as old problems can be addressed through new approaches (Cohen and Levinthal, 1990). Secondly, new knowledge from target firms can serve as the basis for absorbing additional stimuli and information from the external environment (Ahuja and Katila, 2001). If the knowledge of the target firm is too related to the knowledge of the acquiring firm, the benefits mentioned above might be limited. This effect of relatedness of knowledge is supported by empirical studies that proposed the inverse U-shaped relationship between the knowledge acquired and innovative performance of acquiring firm (Ahuja and Katila, 2001; Cloodt *et al*., 2006). One of the most fundamental studies is what types of acquisitions can create value for acquiring firms in strategic management field (Kim and Finkelstein, 2009). One of the most common answers is focused on the positive effects of relatedness for many years. Researchers in strategic management and finance fields have done a lot of studies of the effects of relatedness on performance of acquiring firms (Elgers and Clark, 1980; Lubatkin, 1987; Seth, 1990; Kaplan and Weisbach, 1992; Flanagan, 1996). The resources of firms in related business have similarities such as administrative processes, culture and management style. These similarities enable acquiring firms to effectively leverage their resources and capabilities to merging the relevant resources of the target firms (Robins and Wiersema, 1995; Palich *et al*., 2000). Similarities between acquiring and target firms are the main source of strategic fit which can improve the performance of acquiring firms. But the evidence is less conclusive from previous literature. The results that related acquisitions outperform unrelated acquisitions (Anand and Singh, 1997; Walker, 2000), do not outperform unrelated acquisitions (Seth, 1990; Matsusaka, 1993) and there exists a nonlinear relationship between relatedness and performance of acquiring firms (Ahuja and Katila, 2001), are all supported by empirical studies.

Based on the resource based theory, some scholars have argued that complementarities between the acquiring and target firms are very important to acquisition success (Harrison *et al*., 1991; Capron *et al*., 1998; Wang and Zajac, 2007). Complementarities of resources might be a promising theoretical foundation for continued acquisition research and is recognized as an under-researched topic (Harrison *et al*., 2001; King *et al*., 2003). Complementarities between acquiring and target firms can offer opportunities for value-enhancing resource redeployment (Kim and Finkelstein, 2009). Harrison *et al*. (1991) found performance improvements for acquiring firms when there are complementarities rather than similarities of resources between the acquiring and target firms. Although, studies of complementary resources did not exist in quantities sufficient for the present meta-analyses, both theory and initial empirical studies suggest that complementarities of resources may help explain observed acquisition activities and predict performance of acquiring firm (Barney, 1988; Capron *et al*., 1998; Capron and Pistre, 2002; King *et al*., 2003).

Relatedness has commonly been defined in broad terms, often using similarity and complementarity interchangeably (Davis *et al*., 1992; Farjoun, 1998); others have provided incomplete or tautological definitions of complementarity (Mowery *et al*., 1998) and a few have ignored it (Lane and Lubatkin, 1998; Ahuja and Katila, 2001). Knowledge is the primary resource for high-technology firms to create competitive advantage. Based on knowledge relatedness redefined Makri *et al*. (2010) proposed the definitions of technology similarity and technology complementarity and examined the effects of complementary technologies and similar technologies on the invention outcomes of acquiring firms in high technology M&A. In their research, they found that complementary technology contributed to innovative performance of acquiring firms and similar technology had a negative effect on invention quantity. When there are complementarities in technological knowledge between acquiring and target firms, the common technological knowledge stocks they have facilitate communication and coordination between the units from them after acquisition. In practice, big deals such as the combination of Ciba-Geigy and Sandoz to form Novartis, were attempts to combine two firms' complementary technologies and capabilities (Fisher, 1998). Integrating complementary technology from external sources to the acquiring firms can increase the number of related new products introduced to the market (Rothaermel *et al*., 2006). And new product introductions create opportunities for differentiation and competitive advantage. Announcements of new product introductions are generally associated with a positive economic impact on shareholder value of announcing firms (Chaney *et al*., 1991; Kelm *et al*., 1995; Chen and Ho, 1997; Chen *et al*., 2002). High level similar technology creates path dependency and harms new product invention of acquiring firm (Makri *et al*., 2010). The arguments above lead to the following hypothesis:

H1: Comparing with similar technology, complementary technology acquired creates more value for acquiring firms in technology acquisitions in the long term

From an economic perspective, the motive for acquiring another firm is to create value for shareholders of acquiring and target firms. There is a growing recognition that 'all value creation takes place after the acquisition' (Haspeslagh and Jemison, 1991) and that integration design is very important to the success or failure of an acquisition (Pablo, 1994). Based on the premises above, postacquisition integration has received increasing research attention in recent years. From an organizational perspective, acquiring firms need to integrate the target firms in order to further develop and commercialize their technologies. In order to keep their innovative capabilities, the acquiring firms should preserve the organizational autonomy of the target firms in the same time (Ranft and Lord, 2002; Schweizer, 2005; Puranam *et al*., 2006). Schweizer (2005) argued for the value of hybrid integration strategies that integrate different parts of the target firm value chain to different degrees based on his five case studies of pharmaceutical firms acquiring biotechnology firms. He suggests that by providing autonomy to upstream R&D units while integrating downstream non-R&D activities such as sales and regulatory approval, acquirers can meet both short-term goals of adding to their pipeline and preserving the target's capabilities at generating innovation in the long term. Besides providing autonomy like structural separation, structural integration is often used after acquisitions. Structural integration enhances the acquiring firm's efforts to leverage the technical knowledge embedded in the human capital of target firm employees. Through structural integration, the coordination mechanisms of programming, hierarchy and feedback can be effectively used to enable knowledge transfer and coordination (Gulati *et al*., 2005; Puranam and Srikanth, 2007). The positive relationship between structural integration and the success of acquiring firms at leveraging the existing knowledge of target firms in technology acquisitions is supported by empirical studies (Puranam and Srikanth, 2007).

Either structural integrating the whole target firm or providing autonomy to the R&D unit of target firm through structural separation or a hybrid approach after acquisitions, the power of controlling the target firm is an important factor having influence on the postacquisition integration success in technology acquisitions. For technology that are not too related to the technology of the acquiring firm, like complementary technology, it is not enough for the acquiring firm to simply buy a technology. The complementary technology must be integrated throughout the postacquisition integration process and combined with the existing technology of acquiring firm to create value. The percentage of target firm acquired is a direct indicator for the control power, which is often used as an explanatory variable in empirical study on M&A (Kennedy *et al*., 2002). The more percentage of the target firm is acquired, as the control power increased, the better the complementary technology can be integrated into the acquiring firm to create value. The power of controlling the target firm with

complementary technology after technology acquisition may have a moderating effect on the value creation of acquiring firm in the long term. The arguments above lead to the following hypothesis:

H2: Percentage of target firm acquired has a positive moderating effect on value creation of acquiring firm after acquiring the target firm with complementary technology in the long term

The human side of M&A is frequently neglected in previous research (Al-Laham *et al*., 2010). Increased turnover among key managers (Cannella and Hambrick, 1993) or key R&D people (Ranft and Lord, 2000) following an acquisition results in the loss of their knowledge and expertise which, in turn, limits knowledge transfer and technology integration after technology acquisitions, especially for acquisitions of complementary technology. Acquiring firms with high ratio of technical employees can facilitate the process of knowledge transfer and technology integration in technology acquisitions. The arguments above lead to the following hypothesis:

H3: The ratio of technical employees of acquiring firm has a positive moderating effect on value creation of acquiring firm after acquiring the target firm with complementary technology in the long term

DATA AND METHODOLOGY

Data: This study tested the hypotheses using a sample of 91 technology acquisitions collected from high-tech industries in China from 2004 to 2008. The information on mergers and acquisitions was collected from China Securities Journal, Shanghai Securities News, Securities Times, the official websites of Shanghai Stock Exchange and Shenzhen Stock Exchange, RESSET Financial Research Database provided by Beijing Gildata RESSET Data Tech Co., Ltd. The information about the acquiring firms was collected from annual reports of the firms and RESSET Financial Research Database. The monthly rate of return of acquiring firm and equally weighted index in the stock market were collected from RESSET Financial Research Database. The information on patents of acquiring and target firms was collected from The China Patent Inquiry System provide by the State Intellectual Property Office of P. R. China. The sample was constructed in five steps as follows.

First, using RESSET Financial Research Database, 642 acquisition transactions (excluding related-party transactions) were found between 2004 and 2008 in four industries in China: Electronics (SIC-code C5), pharmaceuticals and biotechnology (SIC-code C8), machinery, equipment and instrument (SIC-code C7) and information technology (SIC-code G). The four industries above cover the majority of high-tech industries listed in the High-tech Industries Statistical Classification Directory issued by the National Bureau of Statistics of China, which includes pharmaceuticals, biotechnology, medical and other general and special equipment and instrument, aerospace, telecommunication, computer and office machine, electronics, *et al*.

Second, technology acquisition was distinguished from all other acquisitions. In keeping with prior literature, the criteria used in this study were the same as Ahuja and Katila (2001) did which were cited broadly in research on technology acquisitions (Cloodt *et al*., 2006; Puranam *et al*., 2006; Puranam and Srikanth, 2007). Firstly, the news stories were examined to establish if the acquiring firm reported technology as a motive factor for the acquisition or if technology was a part of the transferred assets. Secondly, the acquisition was classified as technology acquisition if the target firm had been granted any patent or had applied any patent which was granted later in the 5 years preceding the acquisition. Of the 642 acquisitions on which the information can be collected, 206 met at least one of the two above criteria and were classified as technology acquisition.

Third, the acquisitions that technologies of target firms were unrelated to technologies of acquiring firms were distinguished from all other technology acquisitions and were excluded. This made the technologies in the acquisitions left were related between acquiring and target firms. The criteria of unrelated technologies are that the target firm has not been granted any patent with the same class IPC code as the patent of the acquiring firm, or has no product with the technology acquired in the same value chain as the product of acquiring firm.

Fourth, considering the usability of the sample for the study, some acquisitions were cut off as follows. The information on the transaction date of an acquisition can not be found. Acquiring firm has not issued A shares to be traded on Shanghai/Shenzhen Stock Exchange. Acquiring firm was listed on the Shanghai/Shenzhen Stock Exchange less than 40 months prior to the technology acquisition. The acquiring firm is bidding for less than 5% of the target firm and can not become the holding company after the transaction. The acquisition is terminated before its completion or the acquiring firm is acquired by another firm within three years after the transaction.

Fifth, only the transaction with largest trading volume was kept when the acquiring firm was bidding for the target firm from its different shareholders within three months. For avoiding confounding effects, acquisition was excluded if it followed or was followed by another acquisition or other events having significant effects on the acquiring firm within three months such as restructuring, investment, sale of assets, etc. These procedures can make a relative clean data sampling ensure that the technology acquisition is isolated event and the parameters estimated for the market model in the study reflect only the influence of a single acquisition (Elgers and Clark, 1980; Choi and Philippatos, 1983).

Finally, the sample of 91 technology acquisitions consists of 66 acquiring firms of which 9 (13.64%) operate in the electronics industry, 30 (45.45%) are found in machinery, equipment and instrument industry, 17 (25.76%) are active in pharmaceutical and biotechnological industry and 10 (15.15%) operate in information technology industry.

Dependent variables: Cumulative Abnormal Returns (CAR) are often calculated as the measure of change of shareholder value of acquiring firm in M&A research (Lubatkin, 1987; Kohers and Kohers, 2000; Arnold and Parker, 2007). In this study, the CAR was calculated by estimating a market model for each firm as scholars did in previous studies (Anand and Singh, 1997; Kohers and Kohers, 2000; Arnold and Parker, 2007).

The abnormal returns were estimated as:

$$AR_{it} = R_{it} - (a_i + b_i R_{mt}) \quad (1)$$

In this study, R_{it} is the monthly rate of return on the shares of firm i in month t, R_{mt} is the equally weighted monthly rate of return on a market portfolio of stocks in month t, a_i and b_i are the Ordinary Least Squares (OLS) parameter estimates obtained from the regression of R_{it} on R_{mt} over an estimation period of 36 months (-40, -5) beginning 40 months prior to the acquisition announcement month. AR_{it} was calculated over a three-year event window (+3, +38) beginning 3 months following the acquisition announcement month. Similar as Lubatkin (1987) did, the 6 months of data surrounding the transaction month were excluded to eliminate possible temporary non-stationarities in the regression coefficients.

The CAR for event window was calculated by summing the monthly abnormal returns:

$$CAR_{iT} = \sum_{0}^{T} AR_{it} \quad (2)$$

where, CAR_{iT} is the cumulative abnormal returns on the shares of firm i over event window T.

Independent variables

Complementary technology: This is a dummy variable. It was coded 1 if the technologies were complementary between technologies of acquiring and target firms. When the technologies were similar between technologies of acquiring and target firms, it was coded 0.

When analyzing technology complementarity and technology similarity between technologies of acquiring and target firms, the measures proposed by He and Wang (2013) based on the measures of Makri *et al.* (2010) were used in this study, which used the International Patent Classification (IPC) code to define the measures of technology similarity and complementarity. The measure of technology similarity is calculated as degree of patent overlap between the target and acquirer, weighted by the importance of each patent subclass for the acquirer:

$$\frac{\text{Overlap all patent subclasses}}{\text{Total patent A\&T}} \times \frac{\text{Total acquirer patent in common subclasses}}{\text{Total acquirer patents}}$$

Technology complementarity is operationalized as the overlap in patents in the same class but in a different subclass.

$$\frac{\text{Overlap all patent classes}}{\text{Total patent A\&T}} \times \frac{\text{Total acquirer patent in common classes}}{\text{Total acquirer patents}} - \frac{\text{Overlap all patent subclasses}}{\text{Total patents A\&T}} \times \frac{\text{Total acquirer patent in common subclasses}}{\text{Total acquirer patents}}$$

When the value of technology complementarity is greater than technology similarity, the technologies between acquiring and target firms are complementary and vice versa. When the patent information of target and acquiring firms are not available to calculate technology similarities and complementarities, e.g., technologies are not patented or the patents of target firm are registered by their parents firms, another criterion is used. If the news stories like acquisition announcement reported the motive of the acquisition is enhancing the current technology or improving current products of acquiring firm, technologies of target and acquiring firms are similar. If the motive of the acquisition is reported for accessing the technology of target firm to develop a complementary product or business, technologies of target and acquiring firms are complementary.

Percentage of target firm acquired: The percentage of target firm acquired is calculated as the sum of the percentage of target firm's shares acquired in the transaction plus the percentage of target firm's shares

owned by acquiring firm prior to the transaction. The information on the percentage of target firm acquired was collected from the annual report and acquisition announcement of acquiring firm and RESSET Financial Research Database.

Ratio of technical employees: The ratio of technical employees is calculated by dividing the number of acquiring firm's technical employees by the number of all acquiring firm's employees. The information on the employees was collected from the annual report of acquiring firm.

Control variables

Firm size: The size of acquiring firm was calculated same to Ragozzino (2006) as the log of the acquiring firm's total assets at the end of the year prior to the transaction. The logarithmic transformation was used to remedy the significant skewness exhibited by the untransformed variable. The data for the assets of acquiring firm was collected from the RESSET Financial Research Database.

Acquisition experience: Although, the relationship between acquisition experience and postacquisition performance is inconclusive (King *et al*., 2004; Puranam and Srikanth, 2007), there is evidence that routines developed through experience can help acquiring firms to better identify, value and integrate target firms (Bruton *et al*., 1994; Vermeulen and Barkema, 2001). And Hitt *et al*. (2001) caution that 'the importance of the link between managerial experience and M&A success should not be underestimated'. The acquisition experience of acquiring firm was controlled and measured similar to Hayward (2002) as the sum of the number of acquisitions that the acquiring firm completed three years prior to the transaction.

Ownership concentration: The ownership concentration may have significant effect on firm performance, which has been studied in previous literature (Shinn, 1999; Gugler *et al*., 2008). The ownership concentration of acquiring firm was controlled and measured as the percentage of shares owned by the top five shareholders of the acquiring firm.

RESULTS

Descriptive statistics: Table 1 presents means and standard deviations for the variables in the analyses for acquiring firms in technology acquisitions from high-tech industries in China. In the three-year event window after acquisition, the average cumulative abnormal returns for acquiring firms are -4.27%. On average, the acquiring firm owns nearly 70% of target firm's shares after technology acquisition. And there are nearly one fifth technical employees in the acquiring firms. The acquisition experience of the firms in the study is 3.81 on average, which means the acquiring firms in the study made a M&A transaction at least once a year in three years period before the technology acquisition. There are frequent M&A activities in high-tech industries in China. And the top five shareholders own over half of the shares of the acquiring firms.

Examining the correlations displayed in Table 1, there is correlation between the two independent variables and the dependent variable in the study. This suggests that acquiring complementary technology and the percentage of the target firm acquired have effects on the long-term shareholder value of acquiring firm. There is also correlation between the acquisition experience of control variables and dependent variable. The positive relationship between acquisition experience and long-term shareholder value of acquiring firm is supported in the regression analysis in Table 2. The correlations between the three independent variables do not suggest any obvious concerns about collinearity.

Hypothesis testing: The regression results of factors associated with long-term shareholder value of acquiring firms in the hypotheses are presented in Table 2. In Hypothesis 1, the study predicted that complementary technology acquired could create more value for acquiring firms compared with acquiring similar technology in technology acquisitions. From Model 1 in Table 2, it is found that the coefficient for complementary technology is positive and significant ($p<0.05$). Hence, the Hypothesis 1 is supported.

In Hypothesis 2, the study predicted a positive moderating effect of percentage of target firm acquired on

Table 1: Descriptive statistics and correlations of variables

Variable	Mean	SD	1	2	3	4	5	6
CAR	-4.27%	0.75						
Complementary technology	0.42	0.50	0.19*					
Percentage of target firm acquired	69.82%	0.25	-0.17*	-0.17				
Ratio of technical employees	17.61%	0.15	-0.11	-0.01	-0.10			
Firm size	21.49	1.06	-0.06	0.32***	0.03	-0.17		
Acquisition experience	3.81	4.09	0.18*	0.27**	0.05	-0.21**	0.29***	
Ownership concentration	53.84%	0.14	-0.07	0.21**	-0.03	-0.002	0.05	0.27***

CAR: Stands for the cumulative abnormal returns, SD: Stands for the standard deviations, N: 91. * $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 2: Regression results of factors associated with long-term shareholder value of acquiring firms

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	2.999*	3.056*	3.098*	3.223**	3.661	6.390**	0.319
Complementary technology	0.346**	0.289*	0.342**	0.540***	-0.034	0.736***	-0.108
Percentage of target firm acquired		-0.566*		-0.388	-1.043*		
Percentage of target firm acquired×complementary technology		0.168**		0.118	0.215		
Ratio of technical employees			-0.298			-0.336	-0.687
Ratio of technical employees×complementary technology			0.152*			0.200	0.203**
Firm size	-0.133*	-0.115	-0.139*	-0.145*	-0.118	-0.298**	-0.008
Acquisition experience	0.039*	0.047**	0.038*	0.059**	0.044	0.065**	0.031
Ownership concentration	-0.887	-0.932	-0.711	-0.652	-0.965	-1.215	-0.058
Adjusted R^2	0.063	0.116	0.089	0.210	0.053	0.171	0.077
F	2.503**	2.970**	2.467**	2.997**	1.409	2.552**	1.616

Independent variable is the cumulative abnormal returns for each firm, *p<0.10, **p<0.05, ***p<0.01

value creation of complementary technology acquired by acquiring firm in the long term. From Model 2, it is found that the coefficient for complementary technology is positive but the level of significance (p<0.10) is lower than the level in Model 1. And the coefficient for the interaction term is positive and significant (p<0.05). In Model 6, the dependent variable is the CAR of acquiring firms with the percentage of target firm acquired greater than the median of this independent variable in the sample. And in Model 7, the dependent variable is the CAR of acquiring firms with the percentage of target firm acquired smaller than the median of this independent variable in the sample. In Model 6, the coefficient for complementary technology is positive and the level of significance (p<0.01) is higher than the level in Model 1. And in Model 7, the coefficient for complementary technology is insignificant negative. Hence, the Hypothesis 2 is supported.

In Hypothesis 3, the study predicted a positive moderating effect of the ratio of technical employees of acquiring firm on value creation of complementary technology acquired by acquiring firm in the long term. From Model 3, it is found that the coefficient for the interaction term of complementary technology and ratio of technical employees is positive and significant (p<0.10). In Model 4, the dependent variable is the CAR of acquiring firms with the ratio of technical employees of acquiring firm greater than the median of this independent variable in the sample. And in Model 5, the dependent variable is the CAR of acquiring firms with the ratio of technical employees of acquiring firm smaller than the median of this independent variable in the sample. In Model 4, the coefficient for complementary technology is positive and the level of significance (p<0.01) is higher than the level in Model 1. And in Model 5, the coefficient for complementary technology is insignificant negative. Hence, the Hypothesis 3 is supported.

CONCLUSION

The objective of the study is to investigate the effect of complementary technology on long-term shareholder value of acquiring firm and the factors associated with the value creation of complementary technology acquired in technology acquisitions. The sample used in the study is collected from the high-tech industries in China from 2004 to 2008, which adds a new evidence of the performance of technology acquisitions from emerging market. The results show that acquiring complementary technologies created more value for shareholder of acquiring firms than acquiring similar technologies in technology acquisitions in the long term. This finding is consistent with the positive effect of complementary resources on the post-acquisition performance of acquiring firm in previous literature (Kim and Finkelstein, 2009; Makri *et al*., 2010). The results also show that the percentage of target firm acquired and the ratio of technical employees of acquiring firm have positive moderating effects on the relationship between complementary technology and long-term shareholder value of acquiring firm. The more the shares of target firm with complementary technologies are owned by acquiring firm, the more value is created for shareholder of acquiring firm in the long term. And the complementary technology creates more value for shareholder of acquiring firm when the acquiring firm has a high ratio of technical employees.

The empirical results have important implications for theory and practice. The performance of technology acquisitions has received only limited attention (Ahuja and Katila, 2001; Hagedoorn and Duysters, 2002; Cloodt *et al*., 2006; Makri *et al*., 2010; He and Wang, 2013). There is little evidence on mechanism of value creation in technology acquisitions. Both the percentage of target firm acquired and the ratio of technical employees of acquiring firm are related to the integration issue in M&A research. It allows future research to extend and enrich the prior research on the relationship between technology acquisitions and performance of acquiring firms. It also provides an enhanced understanding of the absorptive capacity and factors associated with the success of post-M&A integration.

This study suggests that managers and shareholders of firms should better evaluate the value creation potential

by focusing on technology complementarities and similarities between technologies of acquiring and target firms. Further, it suggests firms to increase their technology integration capability by increasing the control of the firms acquired and increasing R&D expenditure like hiring more R&D people. Although, complementary technology creates more value than similar technology in the long term, firms with weak technology integration capability are more likely to fail in creating value after acquiring target firms with complementary technology than with similar technology. This is supported by the empirical results of previous research (He and Wang, 2013), which indicated that firms in high-tech industries in China may have lower technology integration capability than firms in the USA.

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