Technological Forecasting & Social Change 135 (2018) 208–216

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

The impact of firms' mergers and acquisitions on their performance in emerging economies

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ARTICLE INFO

Keywords:
Merger
Acquisition
Firm performance
Emerging economies

ABSTRACT

This paper explores the relationship between mergers and acquisitions and firm performance by running a partial least squares regression with the data of listed Chinese pharmaceutical firms from 2008 to 2016. The results show that when other conditions are unchanged, value-chain-extension mergers and acquisitions and technology-seeking mergers and acquisitions are positively related to firm performance, and that the correlation between mixed mergers and acquisitions and firm performance is not significant. In addition, this study finds that firm growth ability, firm exclusive assets, firm size, and firm age positively impact firms' performance after their mergers and acquisitions, and that corporate governance, firm property right, and firm solvency have no impact on firm performance after mergers and acquisitions. Implications of the findings are discussed.

1. Introduction

Emerging economies refer to those countries that have low income level but rapid economic growth rate achieved by using economic liberalization as their primary engine of growth (Hoskisson et al., 2000; Xu and Meyer, 2013). In recent years, emerging economies make significant contributions to global GDP (Chen and Chen, 2016; Lebedev et al., 2015; Li, 2013, 2017; Padmanathan et al., 2018; Qiao and Yang, 2015; Sharma and Chanda, 2017; Wekerle et al., 2017). Emerging economies are able to boost their economic performance while many parts of the world economy, including developed economies, stagnated (Alves et al., 2016; Estorilio et al., 2017; Furtado et al., 2017; Nölke et al., 2015; Peng et al., 2016). According to World Economic Outlook Report (The International Monetary Fund, 2016), the growth rate in emerging economies in 2016 is 4.2%, whereas the growth rate in developed economies in 2016 is only 1.6%. This report predicts that emerging economies will make a larger contribution to the growth of world economy than developed economies.

Firms based in emerging economies have been undertaking mergers and acquisitions both inside and outside of their domestic markets (Meyer and Thaijongrak, 2013). Mergers and acquisitions strongly depend on the quality of financial markets, which are shaped by the institutional environment (Lebedev et al., 2015). Find that institutional changes, particularly corporate governance reforms, affect firms' decisions of mergers and acquisitions. In emerging economies, institutions and policies' changes are frequent, and industry concentration is low (Xu and Meyer, 2013). On one hand, firms in emerging economies have to make expansion for surviving in an environment full of fierce competition. Furthermore, they tend to choose mergers and acquisitions for achieving legitimacy (Yang and Hu, 2016). On the other hand, the improved institutions condition in emerging economies drive firms to perform mergers and acquisitions for better development (Cui, 2012).

Prior studies have explored how mergers and acquisitions impact acquirers' performance with inconsistent findings. Both negative acquirer performance (Aybar and Ficici, 2009; Bertrand and Betschinger, 2012) and positive acquirer performance (Bhagat et al., 2011; Bhaumik and Selarka, 2012; Chi et al., 2011; Gubbi et al., 2010; Nicholson and Salaber, 2013) have been found. For target firms, consistent positive returns on acquisitions have been found (Chari et al., 2012; Goddard et al., 2012; Liao and Williams, 2008).

The number of mergers and acquisitions performed by listed Chinese pharmaceutical firms are growing in recent years. Driven by new national policies, high investment return rate, and low industry concentration, listed Chinese pharmaceutical firms are looking for domestic small pharmaceutical firms, hospitals, chain pharmacies, foreign pharmaceutical firms, drug R&D institutions, and medical institutions as their targets of mergers and acquisitions. In addition, the new version of Good Manufacturing Practice (GMP), pharmaceutical circulation planning in China, the reform of drugs review and approval system, control of medical insurance, and the adjustments in medicine catalog

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https://doi.org/10.1016/j.techfore.2018.05.015
Received 12 January 2017; Received in revised form 7 May 2018; Accepted 18 May 2018
Available online 24 May 2018

are the factors that impact listed Chinese pharmaceutical firms' decision of mergers and acquisitions. Given the institutional changes in China and the rising number of mergers and acquisitions performed by listed Chinese pharmaceutical firms, this paper develops a behavior-performance framework for exploring the relationship between firms' strategies of mergers and acquisitions and their performance, specifically price-earnings ratio, by running a partial least squares regression with the data of listed Chinese pharmaceutical firms from 2008 to 2016. The results show that value-chain-extension mergers and acquisitions and technology-seeking mergers and acquisitions are positively related with firms' performance, whereas mixed mergers and acquisitions has no significant correlation with firms' performance. In addition, this study finds that firm growth ability, firm exclusive assets, firm size, and firm age positively impact firms' performance after their mergers and acquisitions, and that corporate governance, firm property right, and firm solvency have no impact on firm performance after mergers and acquisitions. The paper discusses the findings and provides implications for listed Chinese pharmaceutical firms to develop strategic plans regarding mergers and acquisitions.

2. Literature review

Formal institutions, together with informal institutions, act as the "rules of the game" in a society to promote economic exchange and coordination by creating order and reducing uncertainty (North, 1990; Williamson, 1985). Formal institutions provide an incentive structure within which "firms rationally pursue their interests and make choices" (Peng and Khoury, 2008:260). The country-level institutional factors define what is socially or legally appropriate in institutional settings (Scott, 2001) and condition firm strategies, practices, and their outcomes (Van Essen et al., 2012). The constraints and forces in the local environment converge and create isomorphisms, specifically coercive isomorphism, mimetic isomorphism, and normative isomorphism (DiMaggio and Powell, 2000). The institutional context is a key factor that influences firms' decisions and behaviors (Argyres and Liebeskind, 1999). Prior research has demonstrated the power of the country-level institutional environment in shaping how multinational enterprises choose an entry mode (Brouthers, 2002; Delios and Henisz, 2003), perform human resource management (Björkman et al., 2007), and select international joint venture partners (Roy and Oliver, 2009).

Institutions play a vital role in mergers and acquisitions undertaken between firms in developed economies and emerging economies as well as between firms in different emerging economies (Hoskisson et al., 2013; Luo and Tung, 2007; Meyer and Thaijongrak, 2013; Peng and Parente, 2012; Sun et al., 2015). As Lebedev et al. (2015) point out, significant differences exist in institutional environments, corporate governance practices, and markets between developed economies and emerging economies. Particularly, emerging economies have a greater degree of uncertainty, and lack transparency and contract enforcement (Lebedev et al., 2015). Stronger institutions are a driver of mergers and acquisitions undertaken in emerging economies (Meyer et al., 2009). In terms of the value created by mergers and acquisitions, Li and Qian (2013) argue that the higher level of institutional development provides better protection of shareholders' rights. Seth et al. (2002) find that mergers and acquisitions decrease shareholder value of the acquiring firms. In contrast, some studies find that target shareholders typically gain from the acquisition because of the premium paid by the acquirer (Datta et al., 1992; Hansen and Lott, 1996).

In recent years, the economic performance of mergers and acquisitions in emerging economies has attracted much attention from academia. Some scholars have examined the motivation of mergers and acquisitions. For example, from the perspective of corporate governance, Fu and Wang (2014) investigate the importance of self-motivation in firm management during mergers and acquisitions. Guided by behavioral finance theory, Brown and Sarma (2007) explore the relationship between overconfidence in firm management and firms' mergers and acquisitions. In China, because social transformation and fiscal decentralization are undergoing, studies of mergers and acquisitions mainly focus on government intervention (Fang, 2008; Pan et al., 2008; Zhang et al., 2013). In addition, the impact of asset exclusion and firm ownership on the performance of mergers and acquisitions is examined as well (Li and Wang, 2007; Zhao et al., 2014). In these studies, the motivation of mergers and acquisitions is attributed to one factor only. However, the decision of mergers and acquisitions is complex in firms. As Qiu et al. (2006) point out, when making decision of mergers and acquisitions, firms take into many factors account, including technical factors, scale economy in production or procurement, extending to the downstream & upstream industry value chain to reduce transaction costs, and entering into new markets.

Some scholars study the performance of mergers and acquisitions using diverse methods and different performance metrics standards. For instance, Feng and Wu (2001) study 201 mergers and acquisitions from 1995 to 1998 and find that the performance of listed firms rises right after the mergers and acquisitions and then drops. Jones et al. (2001) study 188 branch companies of multinational firms in the United States and examine their performance, including market competition performance, product innovation performance, and financial performance. They find that technological mergers and acquisitions has a negative impact on firm performance. The finding is confirmed by Qiu et al. (2006), who select data from the pharmaceutical industry. Fan and Yuan (2002) analyze the influence of mergers and acquisitions in the different stages of enterprises lifecycle on firm performance from the perspective of industrial evolution. They find that mergers and acquisitions can promote firm performance when a firm is at the growth stage. By analyzing the impact of intra-industry and cross-industry mergers and acquisitions performed by listed pharmaceutical firms on their performance, Yuan (2011) finds that the effects of different types of mergers and acquisitions on enterprise performance vary. Particularly, intra-industry mergers and acquisitions can improve firm performance, whereas cross-industry mergers and acquisitions has negative impact on firm performance. Moreover, other scholars apply data envelopment analysis to study the efficiency of mergers and acquisitions (Li et al., 2003).

However, findings in studies on the relationship between mergers and acquisitions and firm performance are not consistent. Although some scholars argue that the inconsistence might be caused by agency problems (Jensen, 1986; Wan and Guo, 2009), factors such as market mechanism, development status of capital market, and corporate governance structure should be considered. But these factors play different roles in emerging economies and developed economies. Given the institutional environment in emerging economies, when firms have proper strategies and clear target for mergers and acquisitions, they tend to integrate resources more quickly and more effectively after mergers and acquisitions. In this way, their mergers and acquisitions can be successful. Accordingly, we premise that firms' mergers and acquisitions in emerging economies will positively affect their performance.

3. Research design

3.1. Research model

Based on the existing literature, we develop the following model:

$$PER_i = \alpha_0 + \alpha_1 MA1_i + \alpha_2 MA2_i + \alpha_3 MA3_i + \sum \beta_i X_i + \mu_t + \varepsilon_i \tag{1}$$

where:

PER_i is performance of the i^{th} firm
MA1 is value-chain-extension mergers and acquisitions
MA2 is technology-seeking mergers and acquisitions
MA3 is mixed mergers and acquisitions
X is a controlled variable

μ is a dummy variable of year

ε is idiosyncratic error

The coefficients of three variables, namely *MA1*, *MA2* and *MA3*, are focuses of this paper. If their coefficients are positive, firms' mergers and acquisitions can promote their performance.

3.2. Variables

Market value and profit margins are the two main indicators of firm performance. Therefore, price-earnings ratio (P/E) and return on assets (ROA) are chosen as the dependable variables in this study. For convenience, we use the reciprocal of P/E, namely the ratio of earnings per share and market price per share, as the replacement of P/E. We adopt the method proposed by Liu et al. (2009) to measure ROA. Particularly, we calculate the difference of ROA between the year before the merge/acquisition and the sum of ROA of one year after the merge/acquisition and two years after the merge/acquisition.

The independent variable in this study is merger/acquisition. Existing literatures classify mergers and acquisitions into three categories, namely vertical mergers and acquisitions, horizontal mergers and acquisitions, and comprehensive mergers and acquisitions. Usually, if the two parties involved in a merger/acquisition parties produce the same or similar products, the merger/acquisition is a horizontal one. If the two parties are at different stages of the same industrial chain, the merger/acquisition is a vertical one. If the two parties are from different industries, the merger/acquisition is a comprehensive one.

This paper aims to explore the motivation and pattern of mergers and acquisitions, therefore three dummy variables are set by following Jiang et al. (2008).

1) Value-chain-extension mergers and acquisitions (*MA1*). If the goal of a merger/acquisition is to enter new markets or to expand sale channels, the value of *MA1* is set as 1. Otherwise, its value is set as 0.
2) Technology-seeking mergers and acquisitions (*MA2*). If the goal of a merger/acquisition is to gain new technology, new products, or research and development (R&A), the value of *MA2* is set as 1. Otherwise, its value is set as 0.
3) Mixed mergers and acquisitions (*MA3*). If a merger/acquisition does not fall into the above two categories, it is a mixed one. Its value of MA3 is set as 1. Otherwise, its value is set as 0.

If all coefficients in the regression model are positive, the three strategies for mergers and acquisitions have positive impact on firms' performance.

In addition, the following controlled variables are added into the research model.

(a) Firm growth ability (*Gro*). This paper choses the listed firm's main business growth rate as *Gro*. Usually, the faster a firm grows, the greater demands it has for mergers and acquisitions. In this way, its performance will be improved.
(b) Corporate governance (*Cg*). As a balance mechanism, the independent directors of the listed firms are set to influence mergers and acquisitions as well as the economic consequences of firm corporate (Baghat and Black, 2000; Wei and Zheng, 2009). Thus, this paper takes the proportion of the independent directors as a proxy.
(c) Firm size (*Size*). Total sales, total assets, and the number of employees are usually adopted for measuring firm size. However, sales are easily affected by exogenous events. The number of employees in a firm changes in its stages of development. Because the usage of asset indicators can reduce the impact of labor-intensive or property-intensive firms' feature (Li and Wong, 2003), this paper chooses the logarithm of the total asset of a firms to measure firm size.
(d) Firm exclusive asset (*Ea*). Because mergers and acquisitions are found positively related with asset exclusiveness (Cording et al., 2002), the ratio of intangible assets to total assets is selected to measure firm exclusive asset.
(e) Firm solvency (*Deb*). According to the free cash flow theory (Jensen, 1986), the liability of a firm will inhibit its mergers and acquisitions activities to a certain degree. In addition, due to the tax deduction of debt interest, the debt ratio affects firm performance. Thus, this paper chooses the ratio of total liabilities to total assets to measure firm solvency.
(f) Firm property right (*Pro*). Firm property right plays an important role in mergers and acquisitions. Particularly, domestic mergers and acquisitions are driven by government. Therefore, the impact of firm property right on mergers and acquisitions should be taken into account in the research model. When a firm is a state owned, the value of *Pro* is set as 1. Otherwise, the value is set as 0.
(g) Firm age (*Age*). According to Schumpeterian Innovation, older firms have stronger development abilities because older firms accumulate more resources. Thus, this paper chooses the logarithm of the age of a firm as the proxy.
(h) Time. Time is added to the research model as a dummy variable for controlling the common time trend of financial performance of listed firms.

3.3. Data collection and descriptive statistics

The pharmaceutical industry is an ideal industry for studying enterprise activities (Barney and Hesterly, 2006), because It has intense technological changes, long R&D cycle, and huge investment in R&D. In addition, the pharmaceutical industry is susceptible to policies change (Wu, 2013). Pharmaceutical firms are sensitive to the change of environment, and are greatly affected by technological innovation (Achi et al., 2016; Sachdeva et al., 2016). Because mergers and acquisitions affect firms' innovating ability and ability to adapt to the environment, the development of firms in the pharmaceutical industry is impacted by mergers and acquisitions as well. Only the pharmaceutical industry is selected because the impact of raw materials market and product market on industries can be eliminated. In this way, the results are more reliable and well-directed.

In this study, 148 pharmaceutical firms listed in Shanghai and Shenzhen stock market are selected. Financial statements of these selected firms from 2008 to 2016 are collected. Particularly, total assets and gross profit of these firms are collected. The industry classification standard is based on *A Guide to Listed Company Industry Classification Benchmark* issued by China's Securities Regulatory Commission (CSRC) on October 26, 2012.

Following the method proposed by Han and Chen (2007), the result of mergers and acquisitions in this paper is calculated with financial data of the year before a merger/acquisition, the year of a merger/acquisition, and the first and second year after a merger/acquisition. Some listed pharmaceutical firms are rather new. Data about them are not available. Therefore, these firms are removed. In addition, we exclude those firms whose financial conditions are abnormal. For example, firms with a prefix of *ST or ST have been audited by certified public accountants. They refuse to express their opinions. At the beginning, data of mergers and acquisitions for 127 listed pharmaceutical firms from 2009 to 2014 are collected. For those firms with incomplete data, we manually query their annual financial statements. Then we use Wind Financial Terminal (WFT) to query announcements and annual reports of these 127 firms. Finally, 264 mergers and acquisitions performed by the 127 firms are collected. Each firm has at least one merge/acquisition. Descriptive statistics of the 264 mergers and acquisitions are shown in Table 1.

Table 1
Descriptive statistics of the 264 mergers and acquisitions.

Variable	Mean	Variance	Max	Min
P/E	0.071	0.024	0.227	−0.065
ROA	0.033	0.021	0.243	−0.137
MA1	0.873	0.264	1	0
MA2	0.516	0.237	1	0
MA3	0.794	0.206	1	0
Gro	0.261	0.072	6.438	1.357
Cg	0.257	0.132	0.784	0.096
Size	31.117	10.612	42.337	15.246
Ea	0.443	0.176	0.924	0.189
Deb	0.219	0.154	2.392	0
Pro	0.335	0.428	1	0
Age	8.374	3.129	20	2

3.4. Basic principles and algorithm

3.4.1. Pooled ordinary least squares (POLS)

Panel data has two dimensions: cross-section unit and observation. Cross-section unit is commonly known as group. Pooled regression is a linear panel data model. The following is the basic panel data model.

$$y_{it} = x_{it}\beta + z_i\alpha + \varepsilon_{it} \tag{2}$$

where:

x_{it} is observable explanatory variable, which does not contain constant terms

$z_i\alpha$ is individual effect or heterogeneity

ε_{it} is idiosyncratic errors

z_i contains constant and group variables whose values do not change with time. It may be the observable individual effects, such as race, gender, and location, or unobservable individual effects, such as family characteristics, individual ability and preferences. When POLS is performed on panel data and z_i is observable, model (2) is a normal linear model. Therefore, we can run POLS. In short, model (2) does not contain unobservable individual effects.

3.4.2. Test of regression coefficient significance level

The test of regression coefficient significance level aims to find whether there is a linear relationship between dependent variable Y and independent variable X. Suppose the regression equation is $Y = a + bX$. When the coefficient b does not equal to 0, there is a linear relationship between Y and X. The null hypothesis is H_0: b = 0 and b is the coefficient of independent variables X. When the null hypothesis H_0 cannot be rejected, b equals to 0. In other words, the coefficient of X is 0. This means that there is no linear relationship between Y and X. Thus, X should be removed. When the null hypothesis H_0 is rejected, the independent variable X plays an important role in Y. In this case, the independent variable should be retained.

3.4.3. Multiple collinearity

Multiple collinearity means that high correlations exist among explanatory variables. It will cause distortion or inaccuracy in regression results. There are three methods for diagnosing multiple collinearity. The first one is eigenvalue decomposition method. We can run principal component analysis on independent variables first. If the eigenvalue of a dimension is very close to 0, multiple-collinearity exists among the independent variables. The second approach is condition number method. Condition number is the ratio of the maximum eigenvalue to the minimum eigenvalue of the matrix X^TX. The condition number $k = \frac{\lambda_{max}}{\lambda_{min}}$ characterizes the difference among eigenvalues. If k is smaller than 30 or equal to 30, there is no multiple collinearity. If k is greater than 30 but smaller or equal to 100, a moderate degree of multiple collinearity exists. If k is greater than 100, a high degree of multiple-collinearity exists. The third approach is variance inflation factor method (VIF). The variance expansion factor of an independent variable is calculated with this formula $VIF_i = (1 - R_i^2)^{-1}$. R_i^2 is the coefficient in the regression when we take X_i as the dependent variable and other variables as independent variables. If the VIF value of an independent variable is greater than 10, multiple collinearity exists among the variables.

3.4.4. Variable importance in projection (VIP)

Variable importance in projection is used for measuring the explanatory capability of independent variable X_i to dependent variable Y. If *VIP* is greater than1, a strong explanatory capability exists. If *VIP* is smaller than1, a weak explanatory capability exists. Here is the formula.

$$VIP_i = \sqrt{\left(k\sum_h Rd(y,t_h)w_{hi}^2 / \sum_h Rd(y,t_h)\right.} \tag{3}$$

where $Rd(y, t_h) = r^2(y, t_h)$. It reflects the variable precision of the dependent variable Y when Y is explained by the component t_h. In other words, it represents the explanatory capability of the component t_h to the dependent variable Y. Similarly, $\sum_h Rd(y,t_h)$ represents the total explanatory capability of the component $t_1, t_2, \ldots, t_h$ to the dependent variable Y. w_{hi} is the ith component of the principal axis w_h. It is used for measuring the marginal contribution of the independent variable X_i to the construction of the principal component t_h.

3.4.5. Partial least squares regression (PLSR)

Partial least squares regression is a new multivariate statistical analysis method. It has advantages that ordinary least squares regression (OLSR) and principal component analysis (PCA) have. OLSR or PCA will cause abnormal phenomenon, which will reduce accuracy and reliability of regression model. In practice, multiple collinearity among variables is common. Partial least squares regression can remove multiple collinearity. It only considers the correlation between principal component and independent variables. Partial least squares regression can fix multiple-collinearity problem that OLSR cannot solve. It can also fix the problem generated by the process when PCA extracts principal component.

Assume that $\{Y_1, Y_2, \ldots, Y_q\}$ are dependent variables and $\{X_1, X_2, \ldots, X_p\}$ are independent variables. We extract components t_1 and u_1 from X and Y, respectively. t_1 is the linear combination of $X_1, X_2, \ldots, X_p$ and u_1 is the linear combination of $Y_1, Y_2, \ldots, Y_q$. In order to meet the requirements of running regression analysis, the following two conditions must be met when we extract t_1 and u_1:

1) t_1 and u_1 should carry the variation information of their data as much as possible;
2) The correlation between t_1 and u_1 should reach the maximum value. That is to say, the covariance of t_1 and u_1 reaches the maximum value.

These two conditions mean that t_1 and u_1 should contain as much information as possible provided by the dependent variable Y and independent variable X, and that the independent variable's component t_1 has the strongest explanatory capability to the dependent variable's component u_1.

After extracting the first group of components t_1 and u_1, we run regression analysis of t_1 on X and t_1 on Y, respectively. If the fitting accuracy of the regression equation reaches the predetermined precision, the calculation is suspended. Otherwise, we will use the residual information after X and Y is explained by t_1 to run the second round of component extraction. We repeat this process until the fitting accuracy of the regression equation reaches a predetermined precision. Assume that we extract the components $t_1, t_2, \ldots, t_m$ from X. PLSR will be applied on the regression of $t_1, t_2, \ldots, t_m$ for Y. Finally, we get regression equation of independent variable $X_1, X_2, \ldots, X_p$ for Y.

Here are the steps for running PLSR.

Step 1: Data standardization

Assume that there are q dependent variables $\{Y_1, Y_2, \ldots\ldots, Y_q\}$ and p independent variables $\{X_1, X_2, \ldots\ldots, X_p\}$ and that the sample size is n. We convert independent variables into matrix $X = [X_1, X_2, \ldots\ldots, X_p]_{nxk}$ and convert dependent variables into matrix $Y = [Y_1, Y_2, \ldots\ldots, Y_q]_{nxp}$. Each value in matrix X and Y is normalized to obtain the independent variable matrix E_0 and the dependent variable matrix F_0. Here is the normalization formula:

$$x_{ij}^* = \frac{x_{ij} - \bar{x}}{s_j},\ y_i^* = \frac{y_i - \bar{y}}{s_y}\ \ (i = 1, 2, \ldots\ldots, q; j = 1, 2, \ldots\ldots p)$$

where:

$\bar{x}$ is the mean of X_i

s_j is standard deviation of X_i

$\bar{y}$ is the mean of Y_i

s_y is standard deviation of Y_i

Step 2: Components extraction

We extract a component t_1 from E_0, $t_1 = E_0w_1$, and $w_1 = E_0{}^TF_0/\|E_0{}^TF_0\|$. w_1 is the first principle axis of E_0. It is the unit eigenvector corresponding to the maximum eigenvalue of matrix $E_0{}^TF_0F_0{}^TE_o$. Next, we extract a component u_1 from F_0, $u_1 = F_0c_1$. c_1 is the first principle axis of F_0. it is the unit eigenvector corresponding to the maximum eigenvalue of matrix $F_0{}^TE_oE_0{}^TF_0$.

Step 3: Implementation of the first round of regression

We then run the regression of t_1 on E_0 and F_0, respectively:

$$E_0 = p_1^Tt_1 + E_1$$

$$F_0 = r_1^Tt_1 + F_1$$

where:

$p_1{}^T$ is regression coefficient of t_1, $p_1 = E_0{}^Tt_1/\|t_1\|^{2.}$

$r_1{}^T$ is regression coefficient of t_1, $r_1 = F_0{}^Tt_1/\|t_1\|^2$

E_1 is residual error matrix of E_0

F_1 is residual error matrix of F_0

The residual error matrix represents the remainder of the original matrix that cannot be explained by the component t_1.

Step 4: Termination criteria of component extraction

When extracting each component, we determine whether there are enough components by running cross validity analysis. Here is the procedure. Extract a new component first. Then, eliminate the i^{th} sample point. Use the data of remaining p-1 sample points to develop regression equation. Load the data of the i^{th} sample point into the regression. At the end, we get predictive value $\hat{y}_{(i)j}(h)$ of Y_j with the data of the i^{th} sample point. Therefore, the forecasting error square sum (FESS) of Y is:

$$FESS(h) = \sum_{j=1}^{q} \sum_{i=1}^{p} (y_{ij} - \hat{y}_{(i)j}(h))^2$$

Then, use the data of all sample points to run the regression of the component that extracted for Y. Load the data of the 1th sample point into this regression equation. We then get predictive value $\hat{y}_{ij}(h)$ of the 2nd sample point. The formula for calculating the sum of squared errors (SSE)of Y is:

$$SSE(h) = \sum_{j=1}^{q} \sum_{i=1}^{p} (y_{ij} - \hat{y}_{ij}(h))$$

The cross validity of the h^{th} component is defined as below:

$$Q_h^2 = 1 - FESS(h)/SSE(h-1)$$

After we extract the h^{th} component t_h, we do the following comparison. If $Q_h{}^2$ is smaller than $1–0.95^2 = 0.0975$, the model meets the requirement of accuracy. The extraction stops. If $Q_h{}^2$ is greater than or equal to 0.0975, the marginal contribution of the h^{th} component on Y is significant. This means that we should continue to extract the $(h+1)^{th}$ component.

Step 5: Determination of PLSR equation

Assume that the regression equation meets the predetermined precision after extracting m components $t_1, t_2, \ldots, t_m$. We run the regression of $t_1, t_2, \ldots, t_m$ on F_0, and obtain the regression equation:

$$F_0 = r_1^Tt_1 + r_2^Tt_2 + \ldots + r_m^Tt_m \tag{4}$$

Then load $t_i = E_{i-1}w_i = E_0w_i{}^*$, i = 1, 2, ……, m into Eq. (4). We get the regression equation of E_0 on F_0:

$$F_0 = E_ow_1^*r_1^T + E_ow_2^*r_2^T + \ldots + E_ow_m^*r_m^T$$

where:

$w_i{}^* = \prod_{k=1}^{i-1}(I - w_kp_k{}^T)w_i$, i = 1,2,……,m

I is identity matrix

Finally, we get the following equation by reversely normalizing E_0 and F_0.

$$y = a_1x_1 + a_2x_2 + \ldots + a_qx_q \tag{5}$$

Eq. (5) is the final regression equation achieved by applying PLSR.

4. Results and analysis

4.1. Impact of mergers and acquisitions on firm performance

The data we collected for this study is unbalanced panel data because the time span of data for listed pharmaceutical firms are different. Therefore, we run POLS in this study. We examine whether multiple collinearity and heteroscedasticity exist among variables. The results of multiple collinearity test are listed in Table 2. If the values of VIF for all variables are smaller than 10, no eigenvalue is close to 0, and the condition number K (4.451/0.304 = 14.64) is smaller than 30, we can reach the conclusion that no multiple collinearity exists.

In order to reduce heteroscedasticity, we apply heteroscedasticity consistent covariance matrix derived by White (1980) to revise the standard error and statistics of the regression results. This process can make the results generated by POLS more robust and reliable, and eliminate heteroscedasticity to a certain degree. The results are shown in Table 3. $P/E[-1,2]$ is firms' average performance from the year before a merger/acquisition to the second year after the merger/acquisition. $P/E[-1,0]$ is firms' average performance from the year before a merger/acquisition to the year of the merger/acquisition. P/E [1,2] is firms' average performance from the first year after a merger/acquisition to the second year after a merger/acquisition. The parameters allow us to study firms' performance during the whole research period as well as in a certain time period.

It can be seen from Table 3 that when firm growth ability, corporate governance, firm size, firm exclusive asset, firm solvency, firm property right, and firm age are controlled, value-chain-extension mergers and acquisitions and technology-seeking mergers and acquisitions are positively related to price-earnings ratio and return on assets. Their coefficients and significance show considerable robustness. Although

Table 2
Results of multiple collinearity test.

Variable	*Cons*	*MA1*	*MA2*	*MA3*	*Gro*	*Cg*	*Size*	*Ea*	*Deb*	*Pro*	*Age*
VIF		1.447	1.856	1.762	1.022	1.937	1.651	2.558	1.014	2.371	1.812
Dimension	1	2	3	4	5	6	7	8	9	10	11
Eigenvalue	4.451	3.667	3.024	2.057	1.972	1.547	1.398	0.952	0.841	0.726	0.304

Table 3
Results of regression between mergers and acquisitions and firms' performance.

	P/E[−1,2]	*ROA*[−1,2]	*P/E*[−1,0]	*ROA*[−1,0]	*P/E*[1,2]	*ROA*[1,2]
MA1	0.039***	0.034***	0.015*	0.014*	0.018*	0.020*
	(4.65)	(3.92)	(1.66)	(1.75)	(1.67)	(1.84)
MA2	0.072*	0.091**	0.058*	0.016***	0.074***	0.026***
	(1.91)	(2.27)	(1.68)	(3.19)	(2.63)	(3.20)
MA3	0.087**	0.229**	0.143*	0.138	0.072**	0.011
	(2.25)	(2.19)	(1.71)	(1.17)	(2.29)	(1.65)
Gro			0.662***	0.574***	0.618***	0.031***
			(6.06)	(5.77)	(3.31)	(2.76)
Cg			0.134	0.158*	0.267	0.107
			(0.47)	(1.18)	(0.46)	(0.07)
Size			0.009**	0.018*	0.009**	0.013*
			(2.09)	(2.05)	(2.27)	(1.89)
Ea			0.060*	0.076*	0.043*	0.054**
			(1.78)	(1.91)	(2.16)	(2.59)
Deb			0.253	0.237	0.098	0.170
			(0.95)	(0.77)	(0.86)	(0.18)
Pro			0.521	0.435*	0.216	0.022
			(1.14)	(1.83)	(0.63)	(1.01)
Age			0.472**	0.847*	0.405*	0.508*
			(2.98)	(1.87)	(1.91)	(1.73)
Year	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Cons	0.137***	0.124***	0.072***	0.087***	0.052***	0.070***
	(17.68)	(16.90)	(4.87)	(4.63)	(4.25)	(3.24)
Adj.R^2	0.03	0.05	0.14	0.16	0.37	0.37
Obs	264	264	264	264	264	264

Note: the values in the brackets are t statistical, ***, **, * represents 1%, 5%, 10% significant level, respectively.

the coefficient of mixed mergers and acquisitions is positive, the result is not robust.

Results of regression between mergers and acquisitions and firms' performance show that when pharmaceutical firms selects value-chain-extension mergers and acquisitions and technology-seeking mergers and acquisitions, their price-earnings ratio and return on assets are significantly improved. This is possible because pharmaceutical industry in China is technology intensive and capital intensive. If firms want to obtain competitive advantages, they need to invest more on R&D and continue the development of new drugs. Most pharmaceutical firms in China are small in size with weak R&D capability and low innovation ability. In order to obtain competitive advantages, some pharmaceutical firms in China perform mergers and acquisitions. Through mergers and acquisitions, they reorganize competitors that produce similar products, get access to sales and raw materials supply, and gain strong R&D capability. In addition, firms expand their market shares and realize economies of scale through mergers and acquisitions.

For mixed mergers and acquisitions, the effect of *MA3* on *ROA* is significantly positive at 5% level when no controlled variables are added into the regression model. When controlled variables are added, the coefficients of *MA3* is not significant. The possible reason is that the return on assets is impacted by many factors. For example, after a merger\acquisition, production business expands. However, the integration of management and marketing of the two parties of a merger \acquisition is not enough. This causes that the influence of mixed mergers and acquisitions is not significant. Thus, pharmaceutical firms need to pay more attention to mergers and acquisitions strategy, motivation of mergers and acquisitions, and integration after mergers and acquisitions.

Results of regression between mergers and acquisitions and firms' performance show that firms' growth ability is positively related to their price-earnings ratio and their return on assets. This is not consistent with the results achieved by existing research. The reason might be that the listed pharmaceutical firms are in the rising stage of their lifecycle. They have better performance even not performing mergers and acquisitions. Listed pharmaceutical firms are particularly active in mergers and acquisitions in recent years. Moreover, with the continuous reform of pharmaceutical management system in China, the development level of pharmaceutical firms and the industry concentration are increasing. Accordingly, the positive role of firm growth on firm performance is strengthened.

The results of the regression show that coefficient of corporate governance is positive but not significant. This is consistent with the conclusions reached by Wei and Zheng (2009). There is no significant positive correlation between the independent director in listed pharmaceutical firms and their performance. Independent directors in listed pharmaceutical firms are called vases because they fail to improve the management in the firms. This indicates that the policy of corporate governance in the listed pharmaceutical firms in China needs improvement so that the independent directors can play their roles.

The results of the regression show that coefficient of firm size is positive at the level of 10%. This indicates that listed pharmaceutical firms in China have economies of scale. in the future, mergers and acquisitions will promote the overall income of pharmaceutical industry in China.

Firm exclusive asset is positively related with firms' performance. The higher the level of enterprise exclusive asset, the more firm unique strategic resource. Acquirers should integrate better with target firms. In this way, performance of acquirers and target firms can be improved.

The results of the regression show that significant positive correlation exists between firm age and firm performance. Compared with young firms, firms established earlier have more manpower, material, and financial resources, so that they can invest more resources in mergers and acquisitions. Firms can optimize the allocation of their resources to improve their performance.

The coefficients for firm property right and firm solvency are positive but not significant. The reasons need to be further analyzed.

4.2. Robustness test

It is necessary to further examine whether the results remain the same with changes of parameters. We perform robustness test by following the steps shown below.

First, we choose capital-labor (KL) ratio as the dependent variable. Then we use the ratio of total fixed assets to the number of employees to measure capital-labor (KL) ratio. The performance of listed Chinese

Table 4
Results of robustness test of the impact of mergers and acquisitions on firm performance.

	KL[−1,2]	*P/E*[−1,2]	*ROA*[−1,2]
MA1	0.171***	0.106*	0.003**
	(3.20)	(1.72)	(2.09)
MA2	0.143*	0.204***	0.025***
	(1.64)	(3.18)	(4.62)
MA3	0.094**	0.009	0.035
	(2.02)	(0.14)	(1.68)
Gro	0.479***	1.072**	1.007***
	(3.17)	(2.08)	(4.01)
Cg	0.020**	0.153	0.312
	(2.51)	(1.65)	(1.92)
Size	0.001*	0.003*	0.38*
	(1.92)	(1.70)	(1.93)
$Size^2$		−0.015**	−0.028***
		(−2.21)	(−5.34)
Ea	0.635*	0.504**	0.207
	(1.78)	(2.36)	(1.08)
Deb	0.027	0.229*	0.015
	(0.11)	(1.92)	(0.45)
Pro	0.073	1.237	0.122
	(0.35)	(0.02)	(1.47)
Age	0.078***	0.205*	0.012*
	(2.38)	(1.76)	(1.95)
Age^2		−0.023**	−0.024**
		(−2.37)	(−2.16)
Year	Uncontrolled	Controlled	Controlled
Cons	2.374***	0.225***	0.191***
	(19.92)	(3.94)	(2.27)
Adj.R^2	0.17	0.27	0.35
Obs	264	264	264

Note: the values in the brackets are the results of t statistical. ***, **, * represents 1%, 5%, 10% significant level, respectively.

pharmaceutical firms is related with their capital size that is condensed in their production equipment (Zhang, 2009). Therefore, the effect of capital owned by firms should be taken into account. Moreover, the influence of firm size and firm age on firm performance may be a nonlinear (Tang and Song, 2008). Thus, the square of firm size and the square of firm age are added into the regression model. The results of robustness test are shown in Table 4. It can be seen that coefficients and the significance of mergers and acquisitions do not change substantially. Accordingly, we can reach the conclusion that the performance of listed Chinese pharmaceutical firms is related to their mergers and acquisitions significantly.

4.3. The explanatory power of variables to price-earnings ratio

The explanatory power of variables to price-earnings ratio is examined by following three steps. First, the significance of coefficients for each variable is tested. Variables with coefficients at a significance level lower than 10% are retained. Otherwise, they are removed. Second, a partial least squares model is developed based on the retained variables. Third, according to the results achieved by running the partial least squares model, the variable importance in projection (VIP) of selected variables is calculated. With the results of the calculation, the explanatory power of selected variables to price-earnings ratio can be determined.

4.3.1. Variable selection

The reciprocal of the price-earnings ratio is set as the dependent variable. Each variable is loaded into formula (3), respectively. The results significance of each variable are shown in Table 5.

The results show that *MA1*, *MA2*, *MA3*, *Gro*, *Size* and *Ea* pass the significant test of coefficients. In other words, these variables are linear with the price-earnings ratio. Accordingly, they are chosen as independent variables in the partial least square regression model.

Table 5
Results of significance tests for the coefficient of each variable.

Variable	Coefficient	t	Sig.
MA1	0.026**	2.57	0.981
MA2	0.071***	2.15	0.992
MA3	0.069*	1.61	0.937
Gro	0.654***	2.97	0.994
Cg	0.341	0.48	0.742
Size	0.029*	1.53	0.926
Ea	0.178**	2.21	0.983
Deb	0.582	0.85	0.430
Pro	0.176	0.63	0.328
Age	0.447	0.94	0.682
Year	Uncontrolled		
Cons	0.104		
AdJ.R^2	0.37		
Obs	264		

Note: ***, **, * represents 1%, 5%, 10% significant level respectively.

4.3.2. Analysis of variable importance in projection index

Partial least squares regression has been applied to test multiple collinearity earlier in this paper. We run partial least squares regression again by loading the results we get from the regression in the previous section into formula (4). The goal is to make sure that the results we get from the regression in the previous section have better fitting and stronger ability to explain dependent variables. Table 6 shows the variable importance in projection of MA1, MA2, MA3, Gro, Size and Ea.

The VIP value of *MA2* is larger than that of *MA1*. This shows that *MA2* is stronger than *MA1* in explaining the *P/E* ratio. In Tables 3 and 4, the coefficients of *MA2* are greater than those of *MA1*. However, Table 1 shows that the mean and variance of *MA2* are smaller than those of *MA1*. This indicates that although firms can achieve a higher performance level via technology-seeking mergers and acquisitions than value-chain-extension ones, listed Chinese pharmaceutical firms tend to choose the latter. The reason might be that the continuous improvements of the institution and market environment in China have not significantly affected firms' choice of mergers and acquisitions. For example, in the past ten years, Chinese pharmaceutical industry has experienced intense and rapid institutional evolution and environmental changes. For instance, a better approval management system is established. A new version of GMP is released. More supports for new drugs R&D are highlighted in the 11th Five-Year Plan and the 12th Five-Year Plan. The approval process for new drug is updated. The pharmaceutical industry counts on science and technology. Even though the factor of long R&D cycle for drugs is considered, listed Chinese pharmaceutical firms do not adjust their strategies of mergers and acquisitions by following the changes of institution and market environment. During the period of Chinese economy transition, many successful firms are service oriented or sales oriented ones (Zhou et al., 2005). Why has the ongoing improvement of institution led to more technology-seeking mergers and acquisitions by high-tech firms in China? Why do Chinese

Table 6
Results of partial least squares regression.

Variable	Coefficient	VIP	t	Sig.
MA1	0.042**	1.348	2.24	0.976
MA2	0.085***	1.688	2.55	0.995
MA3	0.051*	0.502	1.62	0.933
Gro	0.712**	0.491	2.37	0.981
Size	0.018*	0.763	1.47	0.919
Ea	0.074**	0.615	2.28	0.982
Year	Uncontrolled			
Cons	0.131			
AdJ.R^2	0.39			
Obs	264			

Note: ***, **, * represents 1%, 5%, 10% significant level respectively.

firms still prefer to choose value-chain-extension mergers and acquisitions? The answers to these questions rely on the consideration of the pressure caused by firms' external environment, the amount of firms' internal resource, as well as how firms use their internal resources. Another explanation is that the Inchworm Effect might exist when firms choose strategies for mergers and acquisitions in emerging economies. According to Qin (2009), the Inchworm Effect exists in the reform of China. No matter how an inchworm moves, it moves in one direction only. Specifically, innovation drives firms to choose technology-seeking mergers and acquisitions. Meanwhile, the domestic economic environment drives firms to choose value-chain-extension mergers and acquisitions. The two forces affect firms' strategies of mergers and acquisitions simultaneously.

5. Conclusions

This paper explores the relationship between mergers and acquisitions and firm performance by running a partial least squares regression with the data of listed Chinese pharmaceutical firms from 2008 to 2016. The results show that when other conditions are unchanged, value-chain-extension mergers and acquisitions and technology-seeking mergers and acquisitions are positively related to firm performance. The correlation between mixed mergers and acquisitions and firm performance is not significant. This finding indicates that pharmaceutical firms should not only carefully develop strategies for their mergers and acquisitions, but also pay attention to the resource integration after their mergers and acquisitions. In addition, this study finds that firm growth ability, firm exclusive assets, firm size, and firm age positively impact firms' performance after their mergers and acquisitions. This indicates that Chinese pharmaceutical firms at their growth stage can improve their performance by increasing industry concentration and firm scale. Finally, this study finds that corporate governance, firm property right, and firm solvency have no impact on firm performance after mergers and acquisitions.

Here are the implications from this study. First, a merger/acquisition is a double-edged sword. When firms make strategies for mergers and acquisitions, they should fully consider their available resources. Before performing a merger/acquisition, firms should evaluate the target firm. After a merger/acquisition, firms should integrate and restructure their resources. Second, Chinese pharmaceutical industry is still in the early stage of its lifecycle. The competitiveness of pharmaceutical firms should by increased by a higher industry concentration, better resource allocation, and larger firm size. Third, because uncertainty exists in mergers and acquisitions, preparation is required before a merger/acquisition, such as improvement of firm governance structure and development of planning strategies. Fourth, a merger/acquisition is a business activity. Thus, government should not be involved. Fifth, more supports from government and financial institutions for R&D of pharmaceutical firms are required. The patent system for drugs should be improved. R&D of new drugs is time-consuming and requires large investment. Given the high risks of developing new drugs, economic benefits for pharmaceutical firms must be generated by linking R&D of new drugs with patents. Technology seeking mergers and acquisitions by pharmaceutical firms should be promoted by the supports of government and financial institutions along with a well-developed drug patent system. On in this way, can pharmaceutical firms be driven to invest more human power and resources in R&D. So that the demands generated by population growth, aging population, two-children policy, and the upgrade of consumption in China can be met.

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