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Does the merger of universities promote their scientific research performance? Evidence from China

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ABSTRACT

University mergers fundamentally aim to enhance the level of higher education and scientific research performance through resource integration by "reorganization". However, whether university mergers achieve the latter goal has been subject to controversy. With the help of the "quasi-experiment" of Chinese colleges and universities merged in the 1990s, this study determines the impact of university mergers on scientific research performance. Panel data of 431 colleges and universities from 1993 to 2013 in *The compilation of scientific and technical statistics of Chinese higher education* and difference in differences method are used. Results show that the merger of colleges and universities exert a significant negative impact on the scientific research performance due to excessive government interventions and difficulties in cultural integration. The merger effect is related to the number of university participants and degree of government intervention. Therefore, university mergers cannot effectively promote the level of scientific research, unable to bring economies of scale and rather lead to diseconomies of scale.

1. Introduction

Universities are one of the important providers of innovation and birthplaces of patents (Belenzon and Schankerman, 2013). Universities have incomparable advantages in basic research and forward-looking topics. Any breakthrough in science and technology cannot be achieved without the support of basic theories. Innovation without basic and original research is unsustainable (Adams, 2002; Salter and Martin, 2001; Toole, 2012). In the United States, universities maintain leading positions in science and technology and are the second largest executors of R&D funds, accounting for 11%–15% of the total annual budget and undertaking over half of basic research tasks[1]. American universities still maintain numerous scientific research outputs. United States Patent and Trademark Office (USPTO) report that the number of patent applications of American universities reached 15,335 in 2017, more than twice that in 2003. Moreover, the number of patent authorizations reached 7459 in 2016, more than twice that in 2008. In 2017, 6050 enterprises were transformed from university scientific and technological innovation. China is regarded as the largest developing country worldwide, and thus the role of its universities in scientific and technological progress cannot be ignored. Chinese universities won approximately 80,000 patents in 2018, accounting for 23.4% of the total patents in the country.

On this basis, the strength of university research ability is of considerable significance to the country's innovation capacity. In theory, the spillover effect of universities on local innovation is widely confirmed (Jaffe, 1989; Jaffe et al., 1993; Hausman, 2012; Belenzon and Schankerman, 2013). The two main ways are as follows: the first is to promote the transformation of innovation through cooperation with enterprises to improve their innovation ability (Hong and Su, 2013), and high-ranking universities have considerably improved the innovation performance of enterprises (Szücs, 2018); the second is to promote innovation by producing high-quality human capital and highly skilled labor force (Valero and Reenen, 2016). In reality, the success of university industrial parks, such as Silicon Valley in the United States, Scientific Town of Tsukuba in Japan, Science City of Novosibirsk in Russia, Carlton High Tech Zone in Canada, Grenoble Science Park in France, and Bangalore in India, prove that universities play an im-

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[1] https://www.nsf.gov/.

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portant role in providing innovation and promoting regional economic development.[2]

Various countries carry out series of reforms in higher education to improve the basic scientific research ability and comprehensive strength of universities. On the one hand, encouraging policies are introduced to continuously increase investment in higher education, such as the *211 Project* and *985 Project* of China, *The Elite University Plan* of Germany, and *5-100 Plan* of Russia[3]. On the other hand, adjustments of management mode and structure of higher education is also in progress. The reorganization and merger of universities are widely applied in the higher educational systems of various countries (Norgard and Skodvin, 2002; Locke, 2007; Kyvik and Stensaker, 2013). The core logic is as follows: the university merger promotes universities to share academic and discipline resources, strengthen academic exchanges, reduce the average operations cost, and increase the average output of scientific research to realize the "scale economy effect" (Norgard and Skodvin, 2002). This approach is not only widespread in developing countries, such as China (Wan and Peterson, 2007) and South Africa (Van Vuuren et al., 2010) but also in developed countries such as the United Kingdom, the Netherlands, Norway, Finland, and Australia[4] (Kyvik, 2002; Cartwright et al., 2007; Ursin et al., 2010; Maassen et al., 2011). For example, Japan merged 42 public universities into 18 in 2003–2005 (Xu, 2007); South Africa merged all 36 universities and reduced the number of public universities nationwide to 23 in 2005 (Gu and Wang, 2007); Norway also merged 98 vocational schools into 26 state comprehensive universities in 1994 (Kyvik, 2002); Australia forced 56 of 74 institutions of higher education to merge by raising the threshold of government funding for education and established a unified higher education system, which has become a model and benchmark for all countries (Goedegebuure, 1992).

An important question is as follows: do university mergers bring economies of scale and promote scientific research performance? Given the data availability, studies often focus on qualitative analysis (Hu and Liang, 2008) and lack rigorous empirical evidence (Chambers, 1987; Goedegebuure, 1992; Mulvey, 1993; Eastman and Lang, 2001; Hu and Liang, 2008). The results are debated even though several studies show that university mergers have merits (Harman, 2000; Wan and Peterson, 2007; Liu et al., 2018)[5]. However, a large number of studies also question the performance of university mergers (Gornitzka et al., 1998; Abbott and Doucouliagos, 2001; Norgard and Skodvin, 2002; Curri, 2002; Hu and Liang, 2008; Wang, 2009). The university scale and its effect on studies on university mergers in China (Hu and Liang, 2008), Norway (Norgard and Skodvin, 2002), and Australia (Abbott and Doucouliagos, 2001) are believed to be obscured.

In general, the main factors that cause the controversy arise from the following aspects. First, existing empirical research is often based on data of cases or a few universities and lack the support of large sample data. External effectiveness is poor and reliability is insufficient. Wan and Peterson (2007) use the case of Sichuan University in China to show that the economies of scale brought by the university merger significantly improves the academic capacity of universities and provides a wide range of educational choices. Hatton (2002) considers that the merger of Stuart University in Britain achieved economic benefits after its efficient bonding of the merged schools; thus, such a merger can be regarded as successful. Second, the research performances before and after the merger are mainly compared, but other policy interferences in the same period are ignored, thereby failing to effectively identify the net merger effect. Abbott and Doucouliagos (2001) use the balance panel data of 31 Australian colleges from 1984 to 1987 to study the changes of Malmquist productivity, technical efficiency, and scale efficiency before and after their incorporation into universities. Hu and Liang (2008) analyze data of 25 Chinese universities merged from 1999 to 2002 and find the obscure scale effect of mergers. Liu et al. (2018) also use 37 mergers in China and Northern Europe and observe that papers published after mergers slightly but significantly increased. Therefore, the effect of university merger needs further exploration.

The answer to this question does not only involve the evaluation of university merger policy but also determining whether the basic innovation ability of the country can improve through the organizational restructuring of scientific research departments. This study uses the empirical evidence of Chinese universities to answer this question. On the one hand, Chinese universities experienced the largest university mergers worldwide. From 1990 to March 2006, 431 mergers were initiated[6] and involved far more students than those of other countries, thereby providing an excellent opportunity to answer the above-mentioned questions. On the other hand, China's public universities have several common characteristics with other countries in the relationship between the government and school, organizational form, and other aspects. The strength of China's university scientific research has considerably progressed in recent years. With less than 10% of the national R&D personnel and 8% of the national R&D funds, China's university scientific research has undertaken over 60% of the national basic research, built 60% of the national key laboratories, obtained over 60% of the national science and technology awards, and published more than 80% of the total scientific papers[7]. This finding provides important intellectual support for China's innovation and economic growth. This study can provide additional guidance and references for other countries, especially developing ones, to improve their innovation capacity

[2] Silicon Valley is a successful high-tech industrial park in the world, and its heart is Stanford University. Silicon Valley relies on eight renowned universities, including Stanford University, University of California, and Santa Clara University. The Tsukuba Science City is centered in the University of Tsukuba, thereby making Tsukuba a comprehensive research city. Novosibirsk Science City is the Siberian Branch of the Russian Academy of Sciences. The institution was founded in 1957 and currently has 30 comprehensive scientific research entities. Approximately 400 universities, scientific research institutions, and high-tech development companies are concentrated in the Carlton high technology zone, which is known as the North Silicon Valley. In France, Grenoble Science Park is one of the well-known university cities and has over 8000 research institutions and enterprises that study and manufacture high-energy physics and electronic products. Bangalore, India is home to 125 universities, including the Indian Institute of Technology and the Indian Institute of Management.

[3] In China, the 211 Project and 985 Project are university-support policies issued to build a first-class university with world-advanced level. In Germany, *The Elite University Plan* aims to enhance the strength and international competitiveness of universities through funding. From 2012 to 2017, the total funding amount reached 2.7 billion euros, 75% of which is borne by the federal government and 25% by the state where the university is located. In Russia, the *5-100 Plan* aims to enhance the reputation of universities worldwide. The first 21 universities have a total investment of 60.05 billion rubles.

[4] The rest of the country's university mergers are available in literature: United Kingdom (Cartwright et al., 2007; Harman and Harman, 2008), the Netherlands (Van Knippenberg et al., 2006; Maassen et al., 2011), Australia (Goedegebuure, 1992), Finland (Ursin et al., 2010), Canada (Eastman and Lang, 2001), and Norway (Skodvin and Stensaker, 1998; Kyvik, 2002; Kyvik and Stensaker, 2013).

[5] During the merger of the universities in Australia in 1987–1991, Harman (2000) proposed a systematic differentiation according to five dimensions: voluntary, joint or merged, peer or cross level. In addition, whether the number and discipline are complementary to each other are determined. Four criteria were provided for evaluating the merger success, namely, whether improvements occurred in efficiency, academic progress, organizational stability, and participants' sense of identity. From the above-mentioned perspective, the merger of colleges and universities in Australia is successful in most aspects, particularly in adjustments of higher educational structure and the transfer of state investment focus. Hence, the Australian higher education maintained a relatively good momentum of development.

[6] http://www.moe.edu.cn/edoas/website18/58/info19558.htm

[7] http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/201803/t20180301_328254.html.

and long-term economic development using the empirical evidence of China.

The closest to this study is that by Liu et al. (2018), who use the sample of 29 Chinese universities and find that the growth rate of articles published by Chinese universities exhibit a small but significant increase. As an in-depth attempt on this issue, the OLS model is used to open the black box of the Data Envelopment Analysis (DEA) model and other common methods in this field. Then the differences in the number of published university papers are noted. This approach is more specific and intuitive than that of previous research. However, the above-mentioned study still has the following problems. First, the samples are small and the impact of individual heterogeneity cannot be avoided. China has over 2500 universities, and their samples only include 29 universities in the 211 Project, which presents the problem of self-selection. The heterogeneity analysis, which uses eight universities in three Nordic countries, is not convincing. Second, the publications of 37 universities before and after the merger are compared but such simple analysis could not accurately identify the net effect of the merger. Various support policies of Chinese universities in the same period are not controlled, thereby manifesting potential risk of missing variables. Third, the scientific research ability of universities is reflected not only in papers but also in patents, projects, awards, and other aspects. Therefore, observing only papers is slightly insufficient to understand the change of scientific research performance of universities. In summary, the above-mentioned points are also the common problems and source of controversy in this literature. Therefore, the mechanism by which to use optimal data sets and scientific methods to accurately identify the net effect of university mergers remains a problem that is yet to be efficiently solved.

In comparison with existing literature, the main contributions of this study are as follows. First, in terms of sample selection, the sample size of existing literature is relatively small; only the sample sizes of Goedgebuure (1992) and Kyvik (2002) are relatively large with the study of the merger of 74 universities in Australia and 98 universities in Norway, respectively. The present study uses panel data from 431 universities in China from 1993 to 2013, 73 of which are merged. To our knowledge of literature, this number is thus far the largest sample size in this field. In comparison to several studies using transnational data, such as the research by Liu et al. (2018), we can avoid the immeasurable missing variables caused by institutional and cultural aspects in the transnational comparison.

Second, in terms of method and index selection, this paper studies the effect of university mergers under the difference in differences (DID) framework, which can eliminate the interference factors that simultaneously affect all universities. Such a framework can solve the missing variable errors caused by the before–after comparison of Liu et al. (2018) and Kyvik (2002) to obtain the net effect of university mergers. Abbott and Doucouliagos (2001) and Hu and Liang (2008) use the DEA method or Malmquist index to measure the scientific research output of universities. No clear economic meaning in the perspective of quantitative analysis has been formulated. This study uses nine indicators on publications, projects, and awards to measure the academic performance of universities. These indicators are intuitive in economic interpretation.

Third, the main findings indicate that university mergers exert a significant negative impact on scientific research performance and are affected by the number of participants and degree of government intervention. These circumstances are also the common problems of public university mergers in other countries. After a series of robustness tests, the above-mentioned conclusions remain valid, indicating that university mergers cannot effectively promote the scientific research performance of universities. This conclusion leads us to reexamine the existing reform of higher education and provides reference and warning for university mergers in other countries.

2. Institutional background and hypothesis

2.1. Institutional background

In history, Chinese universities follow the Soviet Union model. However, with the deepening of reform and opening up, domestic economic and social breakthroughs strongly impact the original system and mechanism of universities. The mechanisms to improve the quality of higher education and build a high-level university have become a major concern of the Chinese government, which has launched a series of relevant reforms since the early 1990s.

The State Education Commission considers the policy of “co-construction, adjustment, cooperation, and consolidation” as the guideline to instruct the university merger. This initiative is adopted to change the original “fragmented” management system and realize the scale benefit. Moreover, this program is carried out in response to the strategy of “develop the country through science and education” and to achieve the goal of building a number of world-class universities in 21st century. The mergers began in 1992 with the formation of the Yangzhou University and reached its peak in 2000. That year has the highest number of university mergers, with 91 initiations involving 233 colleges and universities. In April, May, and June, 48 universities under the central ministries and commissions merged and formed 19 huge universities. The involvement of numerous domestic first-class universities caused considerable social repercussions (Xie, 2004; Wang, 2009). Table 1 shows the number of university merges in 1990-2006.

After 2003, the pace of university mergers greatly slowed down. Ministry of Education statistics from 1990 to March 2006 indicate that a total of 1086 colleges and universities are merged into 431. To date, China's original university management system has undergone historic and profound changes. The system, which adapted to the planned economic system, has basically come to an end. A new system of management at the central and provincial levels has been formed. Most universities in China are under the management of province government at 72.7%. Joint management of central ministries and local governments account for 15.4%, and 12.0% remain under central ministries (Xie, 2004).

2.2. Hypothesis

A prominent feature in this field is the merger of public universities under governmental intervention. University mergers in fact reflect the government's hope that universities can directly serve economic and social goals (Harman and Meek, 2002), which can often be achieved through direct governmental intervention. From the perspective of the relationship between public universities and the government, the rapid expansion of student size, increasing social demand, continuous increase in educational costs, and shortage of school funding, universities are increasingly reliant on government funding for development. Acceptance of government funding means concurrence to its supervision and management, especially for public universities. The government is often the actual funder and manager of public universities. For example, the government enforced the merger of universities in Australia by raising the threshold of appropriations (Goedgebuure, 1992). However, excessive government intervention for its own motivations often ignores the willingness of the merged universities. For one thing, this situation duplicates the discipline construction and the sharp increase of expenditure. In addition, several merged universities are heterogeneous with large gaps in level, thereby aggravating the difficulty of academic communication.

Cultural and organizational conflicts in university mergers also have a profound impact on the merger effect. We first discuss cultural integration. Cai (2006) proposes that the primary goal of university mergers should be the integration of academic values and other cultures. Relevant parties must start from the same core culture and

Table 1
Number of university merges in 1990-2006
Source:Ministry of Education of the People's Republic of China

year	1990	1991	1992	1993	1994	1995	1996	1997	1998
Merge number	29	23	19	9	11	21	17	17	29
Participants	71	72	52	22	29	51	46	78	78
year	1999	2000	2001	2002	2003	2004	2005	2006	Sum
Merge number	31	91	41	44	22	15	9	3	431
Participants	78	231	92	106	60	31	18	8	1086

develop unity on the basis of cultural diversity (Harman, 2002). Before mergers, each university has a long history of operations and forms different schools of thought and campus culture. The differences in school concept, values, campus spirit, management system, and other aspects deepen the phenomenon of "cultural isolation", which is not conducive to realizing the overall strategic goal of the merger school. Second, we discuss personnel integration. The reorganization and allocation of resources are regarded as the core of university integration. The adjustment of interest of relevant members inevitably affects personnel integration; specifically, university scholars exhibit behavioral autonomy and heterogeneity (Dunleavy, 1981). Various concerns increase the uncertainty of the merger results, such as questions on which institutions should be retained; which should be removed; who is the leader of the new institution; and how to arrange redundant cadres. The internal power structure of Chinese university organizations has a high degree of stability, and thus has a natural resistance to organizational restructuring (Li et al., 1996; Wang, 2006). This type of utilitarian merger motivation prompts the original power structure to hinder the reorganization and allocation of resources and directly affect the scientific research communication and platform sharing.

For this reason, we hypothesize that:

H1: University mergers do not improve scientific research performance.

The ultimate purpose of university mergers in China is to achieve economies of scale through university expansion. However, the government provides support policies to merged universities to encourage mergers, thereby reflecting the policy orientation of "who merges, who benefits". Under the long-term Soviet-style school-running system, few comprehensive universities exist. In 1990, among the 1075 universities in China, only 50 were comprehensive universities and accounted for 4.6% (Wang, 2009). Universities are often motivated to merge multiple schools to adapt to the needs of economic and social development for establishing institutions with comprehensive and complete disciplines. Most mergers have two participants, but several have three or more participants; Guangzhou University involves seven participants. However, the transaction costs of university mergers increase with the number of participants.

For this reason, we hypothesize that:

H2: The merger effect is negatively correlated with the number of participants.

The effect of university mergers heavily depends on local government intervention. Chinese universities are heavily dependent on the administrative department in terms of financial resources and construction land, which are essential to university development. Prior to 1998, China's educational system operated at the central, provincial, and city levels. In June 1998, the central government decided to further reform China's higher educational system. The central government retained only a few universities in their control and placed most under provincial management. As of 2015, the central government controlled only 111 universities, 75 of which are directly under the Ministry of Education. These universities do not follow the local government as their superior management department, and rather have strong independence and less interference from local governments during the merger. As such, the merger effect for provincial universities is worse.

For this reason, we hypothesize that:

H3: The merger effect of universities directly under the central government is better than that of provincial universities.

3. Data, variables, and identification strategies

3.1. Data

The availability of data and indicators is one of the difficulties in assessing the scientific performance of merged universities. Since 1994, the Ministry of Education has collected *The compilation of scientific and technical statistics of Chinese higher education* (hereinafter referred to as *Compilation*). The *Compilation* records not only the educational development of each province but also the scientific research input and output data of over 600 Chinese universities. The specific indicators include the following: teaching and research staff; investment funds and other inputs; total scientific and technological projects; projects in a certain year; monographs, academic papers, and foreign and national publications; achievements; contracts signed; awards; national awards; and other scientific research output indicators. These indicators provide a good research material for this study.

However, such data does not indicate the completeness of the *Compilation*. First, over 2500 universities and colleges are established in China, but the *Compilation* only records data from over 600 institutions. In this study, we observe the differences of scientific research performance of universities before and after the merger. However, the universities themselves are integrated as merged participants, which cannot be directly compared with their previous selves. Therefore, we need to add the data of all participants before the merger. Specifically, the data before the merger of new schools are obtained from the sum of all participants, thereby forming a counterfactual control group for the merged universities, which is consistent with Liu et al. (2018). However, part of the merged school's data is unrecorded in the *Compilation*; thus, this part of the "treatment group" sample must be excluded. Second, the data on the input and output of scientific research in the *Compilation* are not entirely continuous, and missing those for the years 1994, 1995, 2003, and 2004. Consequently, we were unable to observe the data of several years.

Fortunately, the absence of the above two types of data did not lead to serious problems in this study. First, although the sample of the treatment group was damaged, the statistics of over 600 colleges and universities are the focus, or the quality of ordinary undergraduate institutions is higher than those of the rest of the universities and colleges. In accordance with the planning of the Ministry of Education, these institutions serve as "teaching and research university" or "research university". The universities that are not counted in the *Compilation* serve as "teaching university", and their function is to "teach" rather than "research". During the evaluation, this study focuses on the research performance to ensure that the removal of such data still allows the treatment (merged) and control (never merged) group to be comparable and consistent with the "parallel trend hypothesis". Second, the lack of scientific research performance data in 1994, 1995, 2003, and 2004 inevitably affect the empirical results. On the one hand, the university input and scientific research output maintain a stable development trend, and the lack of individual years of data do not affect the overall conclusions of this article. On the other hand, we regress through sub-samples by adding a variety of fixed effects and other means to verify the problems caused by missing data and eliminate the resulting issues.

3.2. Variables

(1) Dependent variable. In general, the scientific research performance of universities generally has several forms. The number of projects and funds entrusted by the state ministries, local governments, enterprises, and institutions are related. Commitment to the subject requires strong scientific research strength. With a high number of

projects, the amount of funds is high and the scientific research performance of colleges and universities is strong. Monographs, papers, patents, and other forms of scientific research are common final forms of scientific research products. Achievement awards, especially national rewards, are further confirmation of the final output of the university. Such awards are honorary compliments to existing accomplishments and often represent the cutting-edge scientific research achievement of a university. Therefore, this study chooses nine scientific indicators as explanatory variables, including the total number of science and technology projects, project funds, monographs, academic papers, foreign and national publications, identified results, contracts signed, awards, and national awards.

(2) Core explanatory variable. The dummy variable is whether the university has been merged or started to merge. Merging is equal to one if the university has merged or started to merge, and zero otherwise. Considering the hysteresis of the merger effect, if the merger occurs before June 30, then the current year is set as the start of the merger; if the merger occurs after July 1, then the succeeding year is set as the starting year. The merge type is further subdivided considering the heterogeneity of different types of universities. The number of participating universities *merge_n* is assigned accordingly, while $merge^p$ and $merge^m$ are the core explanatory variables for the mergers of provincial universities and of those under the central government, respectively.

(3) Control variables: We select a series of control variables to monitor other factors. In the 1990s, the state has carried out 211 and 985 Projects to build a number of first-class universities with world-advanced level. Several follow-up policies include the 985 Project Innovation Platform, Project of Characteristic Key Subjects (key subjects), and National Basic Ability Construction Project of Western and Central China (mid-western). These policies directly affect the scientific research performance in each university. We separately control these variables to exclude the impact of such support policies. The number of teaching and research personnel in each school and that of investment funds also affect scientific research performance. Therefore, we control the total number of teaching and research personnel, R&D personnel ratio, and logarithm of investment funds. Table 2 shows the main variables and descriptive statistics.

3.3. Identification strategy

Our sample contains universities that have never been merged (control group) and those that have been merged (treatment group) during the sample period. A difference in the merger time of each university remains. Thus, we can use the DID framework to assess the consequences of university mergers. Data before and after the mergers are available for 73 universities, which thus make up our treatment group. The rest that has never been merged constitutes the "control group". We constructed the following model in accordance with Beck et al. (2010).

$$Y_{it} = \beta_0 + \beta_1 merge_{it} + \alpha X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

where Y_{it} is the dependent variable of a series of scientific research indicators used to measure the university research performance; i and t represent the university and year, respectively; γt represents the time fixed effect; and μi represents the university fixed effects, which measure the time trend of the change of scientific research performance. The factors of each university that do not change with time include geographical location and establishment date. Variable X_{it} represents several control variables, including the total number of teaching and research personnel, R&D personnel ratio, school funding per capita, 211 Projects, 985 Projects, 985 Project Innovation Platform, Project of Characteristic Key Subjects, and National Basic Ability Construction Project of Western and Central China. In the above-mentioned model, we focus on β1, which represents the net effect of university mergers on the university research performance. We use the following model to test Hypothesis 2:

$$Y_{it} = \beta_0 + \beta_1 merge\_N_{it} + \alpha X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (2)$$

The core explanatory variable $merge\_N_{it}$ is the number of participants, and the other parameters are consistent with Eq. (1). We use the following model to test Hypothesis 3:

$$Y_{it} = \beta_0 + \beta_k \sum_{k=m,p} merge_{it}^k + \alpha X_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (3)$$

where M and P represent the central and provincial universities, respectively. The other parameters are consistent with Eq. (1).

4. Measurement results and robustness test

4.1. Basic regression

We test three hypotheses in Table 3. All indicators show negative correlation, and six others remain significant in panel A. These findings indicate that the growth rate of scientific research performance declines after the university merger. Rather, the merger does not improve the scientific research performance but may induce a "scale uneconomical effect". This finding confirms the first hypothesis of this paper. In panel B, we replace the core explanatory variable with the number of participating colleges and universities according to Eq. (2). The results show that all variables are negative, among which seven indicators remain

Table 2
Main variables and calculation methods
Source: According to *The compilation of scientific and technical statistics of Chinese higher education*, the digits retain three digits after the decimal point.

Variable meaning	Calculation methods	Sample size	Mean	S.D
Merge	Merge is equal to 1 if the university had merged or started to merge, and 0 if otherwise.	7327	0.123	0.329
211	211 is equal to 1 if the university is in 211project, and 0 if otherwise.	7327	0.164	0.370
985	985 is equal to 1 if the university is in 985project, and 0 if otherwise.	7327	0.051	0.220
985 platform	985 platform is equal to 1 if the university is in 985 platform, and 0 if otherwise.	7327	0.033	0.178
Key subject	Key subject is equal to 1 if the university is in key subjects, and 0 if otherwise.	7327	0.026	0.158
Midwestern	Midwestern is equal to 1 if the university is in midwestern, and 0 if otherwise.	7327	0.019	0.136
Number of teaching and research personnel	Number of teaching staff + research staff	6293	1695.855	2176.573
R&D personnel ratio	Research personnel / Total number of teaching and research staff	6293	0.293	0.107
School funding	The school funding is counted by logarithms	6293	9.457	2.332
Number of science and technology projects	Number of science and technology projects is counted by logarithms	6293	5.228	1.485
Number of project fund	Number of project fund is counted by logarithms	6236	9.009	2.492
Monographs	Number of monographs is counted by logarithms	6293	1.407	1.240
Number of academic papers	Number of academic papers is counted by logarithms	6293	6.043	1.334
Publication of foreign and national publications	Number of publications is counted by logarithms	6293	4.445	1.890
Number of identified results	Number of identified results is counted by logarithms	6293	1.923	1.379
Number of contracts signed	Number of contracts signed is counted by logarithms	6293	1.169	1.498
Number of awards	Number of awards is counted by logarithms	6293	1.671	1.249
Number of national awards	Number of national awards is counted by logarithms	6271	0.227	0.491

Table 3
Basic result

Dependent variable	Logarithm of number of projects	Logarithm of the number of project fund	Logarithm of the number of Monographs	Logarithm of the number of papers	Logarithm of the number of foreign and national publications	Logarithm of the number of identified results	Logarithm of the number of contracts signed	Logarithm of the number of awards	Logarithm of the number of national awards
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Merge	-0.083 (-1.570)	-0.008 (-0.164)	-0.145* (-1.661)	-0.226*** (-4.337)	-0.204** (-2.448)	-0.257** (-2.138)	-0.220* (-1.747)	-0.164* (-1.782)	-0.026 (-0.710)
R-squared	0.265	0.519	0.038	0.083	0.032	0.067	0.008	0.038	0.010
Panel B									
Merge_N	-0.039* (-1.958	-0.008 (-0.485)	-0.064** (-2.049)	-0.096*** (-4.569)	-0.090*** (-3.084)	-0.072* (-1.764)	-0.089* (-1.788)	-0.067** (-2.037)	-0.011 (-0.762)
R-squared	0.266	0.519	0.039	0.084	0.033	0.066	0.007	0.038	0.010
Panel C									
$Merge^m$	-0.071 (-1.010)	-0.004 (-0.055)	-0.129 (-1.059)	-0.380*** (-3.751)	-0.202 (-1.556)	-0.126 (-0.737)	-0.053 (-0.217)	-0.056 (-0.408)	-0.083 (-1.263)
$Merge^p$	-0.089 (-1.312)	-0.010 (-0.176)	-0.153 (-1.421)	-0.143** (-2.348)	-0.204** (-2.066)	-0.327** (-2.316)	-0.311** (-2.461)	-0.222** (-2.136)	0.004 (0.108)
R-squared	0.265	0.519	0.038	0.084	0.032	0.098	0.007	0.039	0.011
Observations	6292	6204	6292	6292	6292	6292	6292	6292	6270
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:(1) t-statistics are presented in parentheses;(2) *,**,***denote significance at the 10%,5% and 1% levels, respectively.(3)All the regression uses the cluster-robust standard error at university level.

significant. This finding indicates that the cost of cultural and organizational integration is high when the number of participants is also high; thus, the merger effect is worse and confirms the second hypothesis. In panel C, we regress according to Eq. (3). The first and second lines are the merger performance of the central and provincial universities, respectively, which are significantly negative in terms of the number of papers. The figures for central universities are insignificant in terms of publication, achievement, contract, and achievement award; however, those for provincial universities are significantly negative. The results show that the merging effect of provincial universities is worse than that of central universities, thereby verifying Hypothesis 3.

Among the control variables, the numbers of teaching and research personnel and of investment funds have a significant positive effect on scientific research performance, thereby indicating the importance of research investment. This finding is consistent with the general intuition. The 985 and 211 projects have little effect on the scientific research performance of universities, which is inconsistent with the conclusion of existing literature (Zhang et al., 2013). This result is attributed to the data regarding the sum of all participants before the university mergers, according to the processing method in this study. Accordingly, the scales of funds and personnel before the merger are higher. Another possible reason is that the investments of universities that are not selected for the 211 and 985 Projects also increase in the same period with the competition among universities. This circumstance reduces the gap among universities in the 211 and 985 Projects. Such results are not shown here due to limited space.

Although the DID method can clearly identify the net effect of university mergers on scientific research performance, the treatment and control groups must meet the pre-parallel trend hypothesis. Specifically, the development trends before the university mergers must be consistent. We generated a dummy year variable (i.e., five years before and ten years after, resulting in 16 years in total) as an explanatory variable to check whether such hypothesis is supported.

The reform dummy variables are insignificantly negative within five years before the merger. Several dependent variables are even significantly positive. The results show that the scientific research performance of the universities in the treatment group has an increasing trend before the merger. Nevertheless, this situation does not prevent us from using the DID method. Our dependent variables are insignificant after the merger, thereby indicating that the university merger has no significant effect on the university research performance. The coefficients of the nine dependent variables of 16 years are separately plotted in Figs. 1–9 to visually present the pre-parallel trend test and the dynamic effects.

4.2. Robustness tests

The above-mentioned data show the basic results of the university merger and scientific research performance. Our conclusions also require further validation, for which we have conduct a series of robustness tests.

4.2.1. Control the universities–year joint fixed effects

In our basic regression, we control the time fixed effect to monitor the time trend of the change of scientific research performance. Similarly, we monitor the university fixed effect to control the impact of the geographical location, establishment time, and other factors that do not change with time. In addition, we exclude the impact of time-varying factors of each university on its scientific research performance. However, only the impact of factors that change with time in each province are excluded due to the degrees of freedom. The logic behind this is that the intervention and the support intensities for higher education differ due to the heterogeneity of each province. For example, only several provinces issue a support policy for all of their universities. Accordingly, the scientific research performance of such

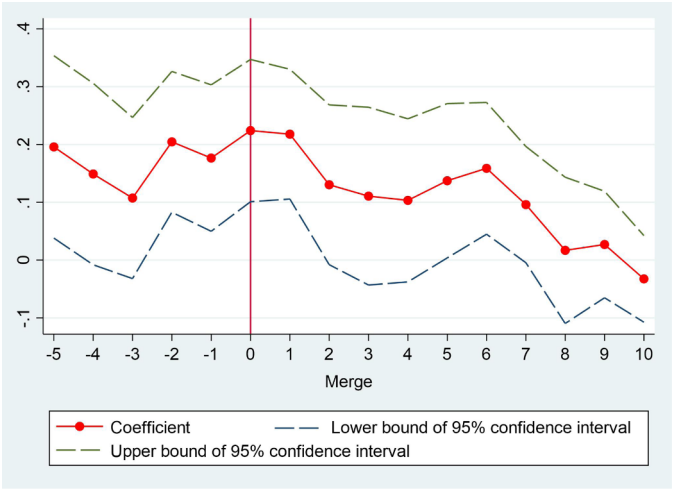

Fig. 1. Parallel trend test of logarithm of number of projects

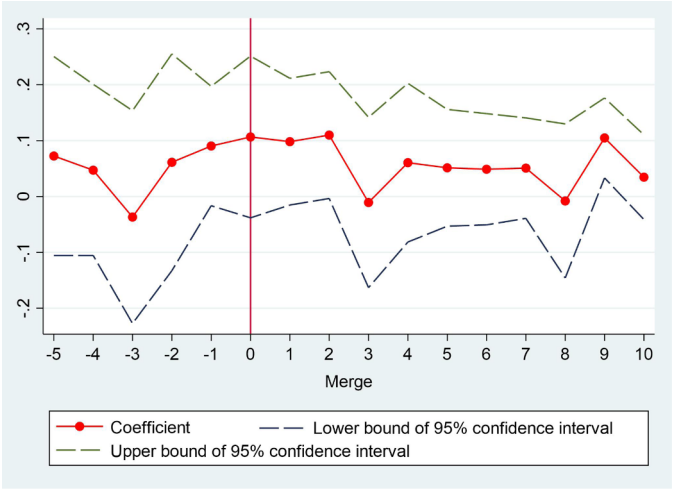

Fig. 2. Parallel trend test of logarithm of the number of project fund

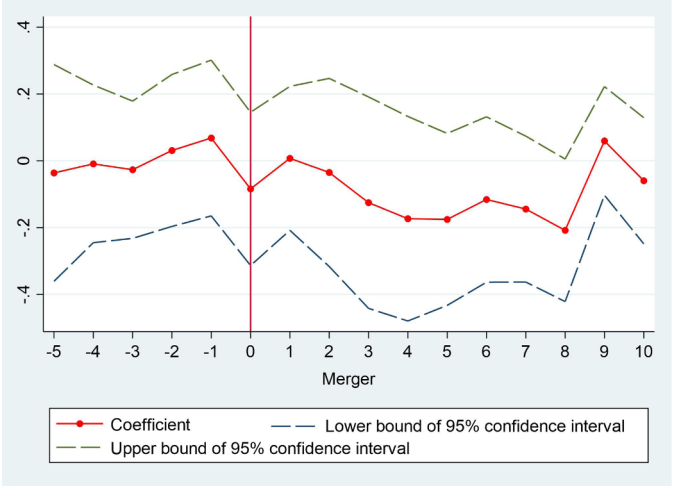

Fig. 3. Parallel trend test of logarithm of the number of monographs

universities improved. If this policy is not controlled, then its effect can reflect in our core explanatory variables and result in overestimation. Therefore, we add the province–year joint fixed effects to the regression. Table 4 shows the results, with no significant difference from Table 3.

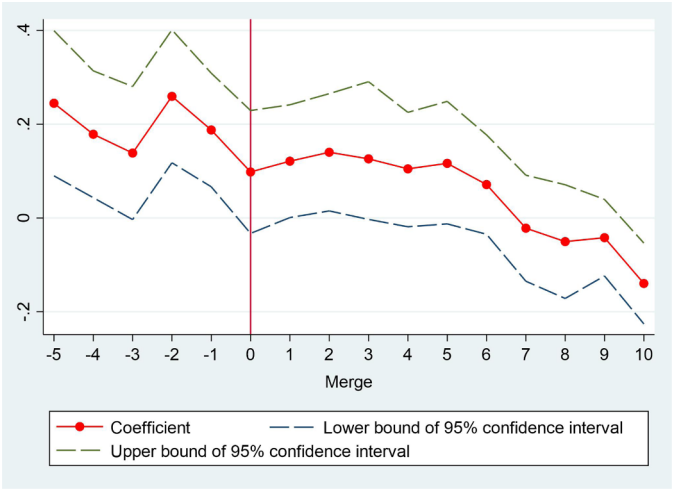

Fig. 4. Parallel trend test of logarithm of number of papers

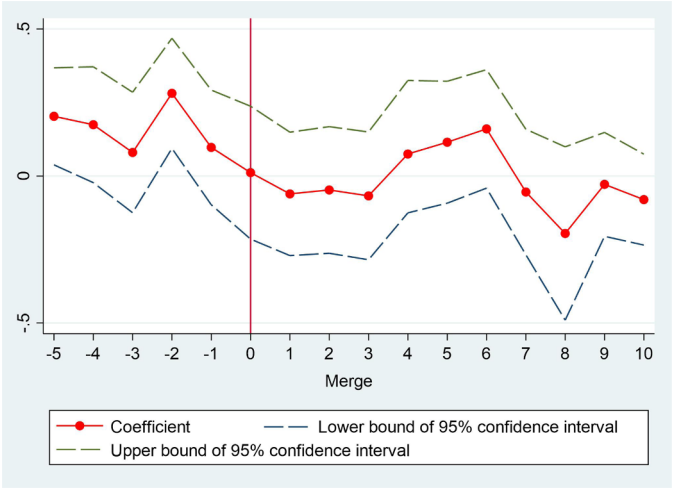

Fig. 5. Parallel trend test of logarithm of number of foreign and national publications

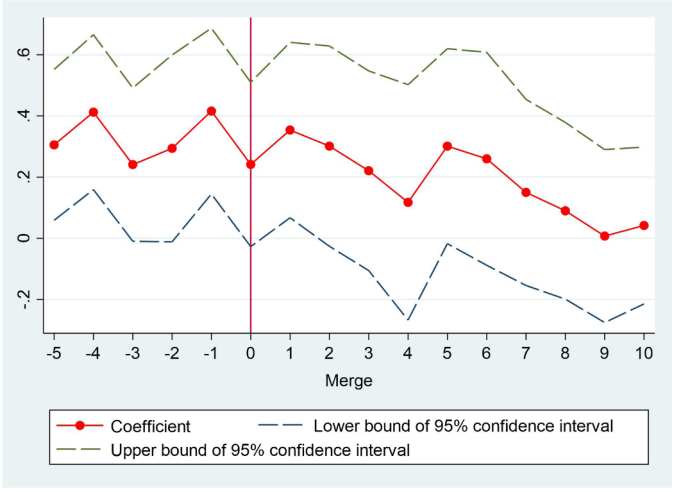

Fig. 6. Parallel trend test of logarithm of number of identified results

4.2.2. Eliminate the effect of outliers

Given that this paper is based on panel data of 431 universities in China from 1993 to 2013, the level gap between sample schools is large. The Quacquarelli Symonds World University Rankings in 2019–2020

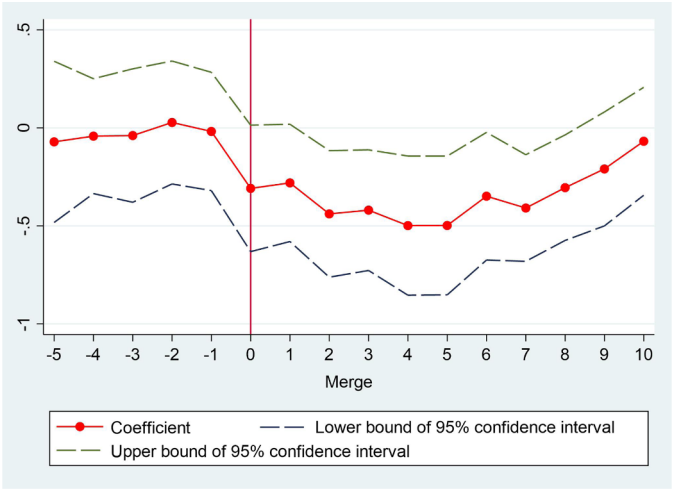

Fig. 7. Parallel trend test of logarithm of number of contracts signed

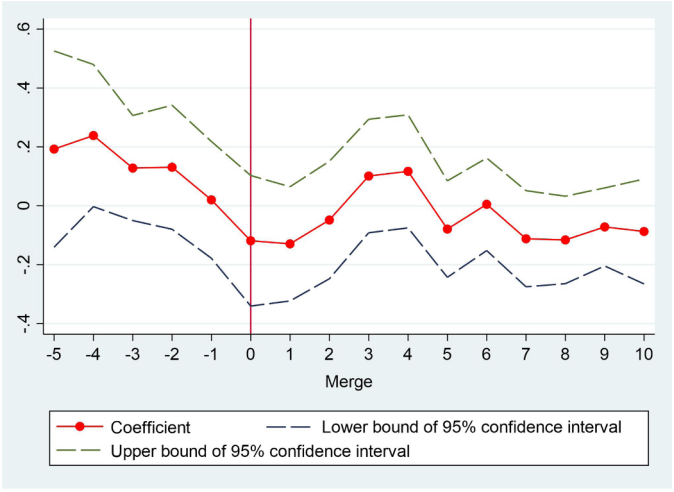

Fig. 8. Parallel trend test of logarithm of number of awards

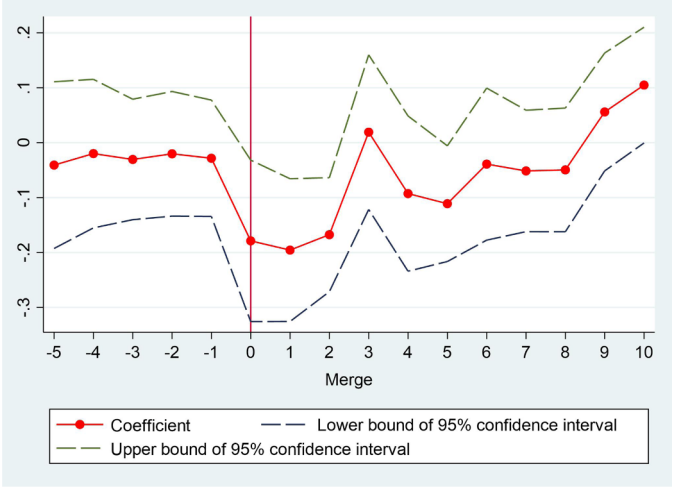

Fig. 9. Parallel trend test of logarithm of number of national awards

indicates that 45 universities in the top 1000 are in Mainland China, 6 of which are in the top 100, and 5 are merged. We regress all dependent variables via 1% winsorization to eliminate the interference of the top and the lowest universities on our computations. Table 5 presents the results, which support that our three hypotheses are still valid after

Table 4
Added the universities–year joint fixed effects

Dependent variable	Logarithm of number of projects	Logarithm of the number of project fund	Logarithm of the number of Monographs	Logarithm of the number of papers	Logarithm of the number of foreign and national publications	Logarithm of the number of identified results	Logarithm of the number of contracts signed	Logarithm of the number of awards	Logarithm of the number of national awards
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Merge	-0.098* (-1.664)	-0.046 (-0.989)	-0.163* (-1.695)	-0.281*** (-4.369)	-0.198** (-2.043)	-0.274** (-2.542)	-16.219 (-1.053)	-0.180* (-1.940)	-0.029 (-0.778)
R-squared	0.254	0.505	0.034	0.082	0.025	0.060	0.010	0.037	0.007
Panel B									
Merge_N	-0.046** (-2.135)	-0.028* (-1.708)	-0.060* (-1.713)	-0.116*** (-4.571)	-0.096*** (-2.661)	-0.089** (-2.330)	-0.116** (-2.172)	-0.066* (-1.845)	-0.010 (-0.664)
R-squared	0.254	0.505	0.034	0.082	0.025	0.060	0.010	0.037	0.007
Panel C									
Merge^{m}	-0.140* (-1.860)	-0.089 (-1.316)	-0.163 (-1.058)	-0.443*** (-3.976)	-0.247 (-1.567)	-0.211 (-1.303)	-0.175 (-0.679)	-0.055 (-0.352)	-0.068 (-0.972)
Merge^{p}	-0.073 (-0.954)	-0.020 (-0.354)	-0.163 (-1.374)	-0.187** (-2.471)	-0.170 (-1.450)	-0.311** (-2.439)	-0.382*** (-2.867)	-0.253** (-2.523)	-0.006 (-0.166)
R-squared	0.254	0.505	0.034	0.082	0.025	0.060	0.010	0.037	0.007
Observations	6285	6202	6285	6285	6285	6285	6285	6285	6263
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:(1) t-statistics are presented in parentheses;(2) *, **, ***denote significance at the 10%,5% and 1% levels, respectively.(3)All the regression uses the cluster-robust standard error at university level.

Table 5
Winsorization test

Dependent variable	Logarithm of number of projects (1)	Logarithm of the number of project fund (2)	Logarithm of the number of Monographs (3)	Logarithm of the number of papers (4)	Logarithm of the number of foreign and national publications (5)	Logarithm of the number of identified results (6)	Logarithm of the number of contracts signed (7)	Logarithm of the number of awards (8)	Logarithm of the number of national awards (9)
Panel A									
Merge	-0.090* (-1.734)	-0.003 (-0.072)	-0.139 (-1.621)	-0.224*** (-4.462)	-0.219*** (-2.656)	-0.264** (-2.234)	-0.226* (-1.825)	-0.139 (-1.539)	-0.023 (-0.631)
R-squared	0.238	0.463	0.043	0.085	0.029	0.068	0.008	0.037	0.007
Panel B									
Merge_N	-0.041** (-2.133)	-0.006 (-0.351)	-0.062** (-2.021)	-0.094*** (-4.719)	-0.095*** (-3.271)	-0.075* (-1.870)	-0.090* (-1.831)	-0.054* (-1.676)	-0.010 (-0.748)
R-squared	0.238	0.463	0.043	0.087	0.030	0.067	0.008	0.037	0.007
Panel C									
Mergem	-0.098 (-1.434)	-0.010 (-0.156)	-0.127 (-1.064)	-0.384*** (-4.619)	-0.244* (-1.931)	-0.132 (-0.782)	-0.068 (-0.288)	-0.010 (-0.076)	-0.075 (-1.206)
Mergep	-0.086 (-1.260)	0.000 (0.002)	-0.146 (-1.361)	-0.137** (-2.329)	-0.205** (-2.076)	-0.336** (-2.416)	-0.311** (-2.484)	-0.208** (-2.057)	0.005 (0.141)
R-squared	0.238	0.463	0.043	0.087	0.029	0.069	0.008	0.038	0.007
Observations	6292	6204	6292	6292	6292	6292	6292	6292	6270
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:(1) t-statistics are presented in parentheses;(2) *,**,***denote significance at the 10%,5% and 1% levels, respectively.(3)All the regression uses the cluster-robust standard error at university level.

winsorization. We also regress all dependent variables via 2% and 5% winsorization, and obtain the same results. The results are not shown here due to the limited space.

4.2.3. Remove samples from special areas

China's universities are unevenly distributed. High-level universities are mainly distributed in the eastern coastal developed provinces. A number of high-level universities are concentrated in Beijing and Shanghai, which are China's political, economic, and cultural centers. Of the 112 universities of the “211 Project”, Beijing has 26 and Shanghai has 9; of the 39 universities of the “985 Project”, Beijing has 7 and Shanghai has 3. We excluded the samples from Beijing and Shanghai to regress and eliminate the particularity of these two cities and the aggregation effect. Table 6 lists the regression results, which remain robust. The results are not shown here due to the limited space.

The data used in this study starts from 1993. The interference to the results caused by the universities that merged before 1993 may be questioned. However, among the 431 colleges and universities in the *Compilation*, only Yangzhou University, Qingdao University, and Tongren College merged before 1993. Thus, this aspect has little effect on our results.

4.2.4. Distinguish the types of university merger

We observe whether the university mergers differ due to the strength of participants. All of the universities are divided into key and general universities according to the *Compilation*. In this study, the key and general universities are defined as strong and weak ones, respectively[8], and divided into three types, namely, strong–strong, strong–-weak, and weak–weak. We examine whether the merger performance differs among the various types of mergers. The results show that all the three types exhibit not a promotion but a decline of scientific research in panel A of Table 7. Five indicators are significantly negative in the strong–strong and strong–weak types. This finding shows that after mergers, strong universities do not help weak ones enhance the level of scientific research. However, strong universities are negatively affected by weak ones. The effect of the strong–strong merger is relatively poor, possibly due to the concept that “two tigers cannot live on the same mountain”. Such circumstance lead to difficulties of efficient merging and breed internal contradictions, thereby reducing the scientific research performance and administrative efficiency.

After distinguishing the strength type of university mergers, we divide them into four types according to Wang (2009). The first type is comprehensive class / science and engineering colleges + medical school. These universities merge because the original colleges and universities have no medical schools. Through the merger, these universities can fill medical professional vacancies and become a comprehensive institution with complete disciplines. Examples of these mergers are Peking University and Beijing Medical University or Fudan University and Shanghai Medical University. The second type is comprehensive / engineering universities + normal / financial / liberal arts universities. These universities merge to enrich the types of disciplines and achieve complementary advantages. Examples of such mergers are Hunan University and Hunan University of Finance and Economics or Xi'an Jiaotong University and Shaanxi University of Finance and Economics. The third type is comprehensive universities / science and engineering universities + science and engineering universities. This merger aims to further improve the competitiveness of disciplines and scientific research strength and achieve megamerger. For example, Wuhan University of Technology, Wuhan Automotive Industry University, and Wuhan University of Transportation Science and Technology merge into Wuhan University of Technology. Similarly, Xi'an

[8] In this study, “strong” and “weak” are used to represent the “key universities” and “non-key universities” to facilitate their distinction; no other meanings are intended.

Table 6
Remove the samples of Beijing and Shanghai

Dependent variable	Logarithm of number of projects	Logarithm of the number of project fund	Logarithm of the number of Monographs	Logarithm of the number of papers	Logarithm of the number of foreign and national publications	Logarithm of the number of identified results	Logarithm of the number of contracts signed	Logarithm of the number of awards	Logarithm of the number of national awards
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A									
Merge	-0.034 (-0.652)	0.028 (0.604)	-0.121 (-1.358)	-0.211*** (-4.043)	-0.138 (-1.629)	-0.208 (-1.636)	-0.255** (-1.986)	-0.206** (-2.175)	-0.023 (-0.606)
R-squared	0.274	0.534	0.041	0.090	0.031	0.072	0.005	0.040	0.013
Panel B									
Merge_N	-0.023 (-1.128)	0.003 (0.160)	-0.056* (-1.773)	-0.090*** (-4.263)	-0.070** (-2.379)	-0.054 (-1.274)	-0.106** (-2.149)	-0.083** (-2.507)	-0.011 (-0.745)
R-squared	0.275	0.534	0.041	0.090	0.031	0.071	0.006	0.041	0.013
Panel C									
Mergem	0.038 (0.599)	0.058 (0.957)	-0.074 (-0.630)	-0.326*** (-3.026)	-0.069 (-0.564)	0.031 (0.163)	-0.131 (-0.513)	-0.097 (-0.657)	-0.073 (-1.070)
Mergep	-0.068 (-1.018)	0.013 (0.236)	-0.143 (-1.287)	-0.156** (-2.561)	-0.170* (-1.662)	-0.320** (-2.248)	-0.313** (-2.418)	-0.257** (-2.486)	0.001 (0.025)
R-squared	0.275	0.534	0.041	0.090	0.031	0.073	0.006	0.041	0.013
Observations	5879	5796	5879	5879	5879	5879	5879	5879	5857
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:(1) t-statistics are presented in parentheses;(2) *,**,***denote significance at the 10%,5% and 1% levels, respectively.(3)All the regression uses the cluster-robust standard error at university level.

Highway Jiaotong University, Northwest Institute of Architectural Engineering, and Xi'an Engineering College merge into Chang'an University. The fourth type is the liberal arts + liberal arts / medical + medical. Local colleges and medical institutions merge to expand their school size and enhance the universities' grades.

The above four types are labeled as types 1 to 4, and panel B of Table 7 shows the regression results. No type of mergers has a positive impact on the scientific research performance. The ineffectiveness of the university merger is found as a systematic conclusion from the perspective of raising the level of scientific research. The results remain the same after distinguishing between the merger type and the object, further supporting the logic of the preceding text.

5. Discussion

In the past 30 years, university mergers have been widely applied worldwide as a policy tool to improve university competitiveness. Several countries, such as China, Australia, Norway, Japan, and South Africa, have completed the nationwide university merger under the leadership of the government. Typical facts of the existing university mergers show that most occur in public universities, which are regarded as an important part of the higher educational system in many countries. In 2017, 161 higher educational institutions in the United Kingdom had independent degree granting rights; only six were private universities. The top ones, such as Oxford and Cambridge, were public universities. Germany has 115 comprehensive universities, only 34 of which are private. All 11 universities of the first "*The Elite University Plan*" in Germany are public. Meanwhile, among the 764 universities in Japan, 169 are public universities, thereby accounting for 22%. The United States, which is famous for its private universities, has nearly 1700 public universities, accounting for 47%.

From a global perspective, most public universities rely on government funding to maintain their operations. These universities are subject to greater government intervention than private ones; thus, the problems discussed in this paper are likely to arise in their mergers. The present findings show that public universities have difficulty improving their scientific research performance through mergers. If mergers cannot be avoided, then the role of the government and the mechanism by which to respect the wishes of participants first require consideration, rather than solely relying on external government forces. Second, mergers are a fierce organizational restructuring for such a highly specialized department, such as universities. The cultural and personnel integration problem between participants needs solutions. On the one hand, the merged universities must have similar historical origins and campus culture to considerably reduce the transaction cost of cultural integration after the merger. On the other hand, the personnel must balance multiple interests, needing not only certain management wisdom but also sacrifices. For example, the University of New England in Australia has even adjusted the proportion of scientific research in the Professional Title Evaluation to care for the staff of the merged school (Pick, 2003), even if such step is not beneficial to the long-term scientific research performance.

The problems existing in the mergers of Chinese universities also exist in other countries. The first one is governmental intervention. Several countries, such as Australia, Germany, Hungary, and Japan, force their universities to merge through laws, such as the *White Paper Policy Statement on Higher Education* issued by Australia in 1988, the *Reform Act of Higher Education Structure* issued by Hungary in June 1999, and the *Reform Policy of University Structure* issued by Japan in June 2001. In Australia, the government does not fully control mergers, but guide universities in choosing and signing agreements with each other, which is the key to the merger success. The second problem is the integration after mergers. In the 1970s, university mergers in Germany failed because of the fierce conflict between personnel from different participants and the original university teachers (Liu, 2003). This conflict became an important lesson in the country. Therefore, the

Table 7
Distinguish the types of university merger: further robustness test

Dependent variable	Logarithm of number of projects	Logarithm of the number of project fund	Logarithm of the number of Monographs	Logarithm of the number of papers	Logarithm of the number of foreign and national publications	Logarithm of the number of identified results	Logarithm of the number of contracts signed	Logarithm of the number of awards	Logarithm of the number of national awards
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Panel A Distinguish the types of university Merger: strong and weak								
$Merge^{ww}$	-0.036 (-0.514)	0.035 (0.613)	-0.007 (-0.068)	-0.148** (-2.320)	-0.225** (-2.267)	-0.153 (-0.995)	-0.090 (-0.719)	-0.058 (-0.485)	0.053 (1.270)
$Merge^{sw}$	-0.141* (-1.951)	-0.077 (-0.976)	-0.410*** (-3.194)	-0.312*** (-4.719)	-0.150 (-1.018)	-0.451** (-2.460)	-0.298 (-1.037)	-0.338*** (-2.770)	-0.076 (-1.314)
$Merge^{ss}$	-0.262** (-2.368)	-0.093 (-0.747)	-0.289 (-1.588)	-0.524** (-2.566)	-0.197 (-1.061)	-0.249 (-0.761)	-0.746** (-2.255)	-0.349** (-1.987)	-0.481*** (-6.077)
Observations	6292	6204	6292	6292	6292	6292	6292	6292	6270
R-squared	0.0.266	0.520	0.040	0.084	0.032	0.068	0.008	0.039	0.019
	Panel B Distinguish the way of university merger								
Mergetype1	-0.123 (-1.395)	-0.008 (-0.110)	-0.149 (-0.878)	-0.330*** (-3.548)	-0.148 (-0.962)	-0.104 (-0.388)	-0.346* (-1.825)	-0.270** (-2.281)	-0.126* (-1.651)
Mergetype2	0.044 (0.296)	-0.002 (-0.024)	-0.348 (-1.248)	-0.198 (-1.102)	-0.258 (-1.020)	-0.137 (-0.391)	-0.151 (-0.452)	-0.008 (-0.024)	0.093 (1.070)
Mergetype3	-0.063 (-0.903)	0.017 (0.294)	-0.141 (-1.505)	-0.157** (-2.399)	-0.076 (-0.860)	-0.341** (-2.565)	-0.073 (-0.346)	-0.069 (-0.611)	0.038 (0.647)
Mergetype4	-0.158 (-1.105)	-0.123 (-0.680)	0.006 (0.030)	-0.251*** (-2.781)	-0.573*** (-3.236)	-0.429 (-1.567)	-0.693** (-2.435)	-0.540*** (-3.292)	-0.110*** (-2.839)
Observations	6292	6204	6292	6292	6292	6292	6292	6292	6270
R-squared	0.266	0.520	0.039	0.083	0.033	0.068	0.009	0.041	0.013
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:(1) t-statistics are presented in parentheses;(2) *,**,***denote significance at the 10%,5% and 1% levels, respectively.(3) All the regression uses the cluster-robust standard error at university level.

above-mentioned two points are worthy of attention in university mergers in other countries.

Although our conclusion confirms several doubts on the performance of university mergers (Curri, 2002; Norgard and Skodvin, 2002; Hu and Liang, 2008), the findings come from a sample in China, where the higher educational system has specific characteristics. Hence, the conclusion may not be fully extended to other countries and problems in external validity may occur. For example, other countries may not the same a hierarchical university management system as in China. The administrative level of Chinese universities results in their complex relationship with the government. However, the problems determined in this paper are common and deserve the attention of all countries.

6. Conclusion

At present, the government increases their investments in higher education because universities play a crucial role in improving the innovation ability of a country (Jaffe, 1989; Hausman, 2012). The university itself is not only an organization of production innovation but can likewise improve the innovation capacity of the whole society through school–enterprise cooperation (Hong and Su, 2013) and the provision of high-quality labor force (Toivanen and Väänänen, 2016). With the increasingly fierce competition in science and technology, the fundamental scientific research activities provided by universities becomes increasingly important, and the support and reform for universities continue. University mergers are a cost-effective means of reform, and can improve the scientific research level of universities through economies of scale and will undoubtedly continue to occur in other countries.

This study determines the impact of university mergers with the help of the large-scale “merger” and “reorganization” of universities in China since the 1990s. Panel data of 431 colleges and universities from 1993 to 2013 and the DID method to test the scientific research performance after university mergers. The results show that university mergers exert a significant negative impact on the scientific research performance due to excessive governmental intervention and cultural integration difficulties. Further tests show that when the number of involved participants is high, the scientific research performance after the merger is low. In addition, the merger effect of provincial universities is lower than that of central ones. The above-mentioned conclusions remain valid after a series of robustness tests. We hope that this study provides a guiding role in the future merger of colleges and universities.

7. Credit author statement

Yankun Kang: Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing, Visualization, Investigation, Software and Validation. **Ruiming Liu**: Supervision, Conceptualization, Methodology, Software, Project administration, Funding acquisition, Writing- Reviewing and Editing.

Declaration of Competing Interest

None.

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