Research Policy 47 (2018) 98–107

Contents lists available at ScienceDirect

Research Policy

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

Do university mergers create academic synergy? Evidence from China and the Nordic Countries

Qiaochu Liu[a], Donald Patton[b,*], Martin Kenney[b]

[a] Graduate Student Tsinghua University Beijing, China
[b] Community and Regional Development, University of California, Davis, CA 95616, United States

ARTICLE INFO

Keywords:
University mergers
Chinese universities
Nordic universities
Research performance
Medical schools

ABSTRACT

Since the late 1990s, mergers have been pursued by a large number of national university systems. The mergers have been justified as a way of increasing research performance. This paper examines the impact of mergers on one vital measure of university research performance, the production of publications, for 29 Chinese university mergers and 8 Nordic university mergers. Using Web of Science counts of research articles before and after a merger while controlling for the university inputs of R & D funding and research personnel, it was found that Chinese universities exhibited a small but significant increase in the rate of growth of articles following a merger. The Nordic performance was less clear cut. Our findings support the belief that mergers of similarly sized institutions usually have little impact on research performance. In contrast, mergers between a large comprehensive university and much smaller universities have a positive impact on overall publications. We also show that cases in which the merger was between a comprehensive university and a medical school resulted in significantly improved performance in terms of scholarly publications. We attribute the improvement to synergies between the basic biological research in the comprehensive university and the more practical research undertaken in medical schools. We conclude with suggestions for policy-makers aiming to create synergies through mergers.

1. Introduction

Since the early 1990s, university mergers have occurred in many countries, often because policy makers believed that their higher education systems were inefficient, underperforming, and in need of reorganization (Fielden, 1991; Pruvot et al., 2015a; Yang, 2015). Such university mergers were frequently part of larger reform programs in academia (Harmon and Meek, 2002). Invariably, policy makers and administrators claimed that the mergers would improve academic quality and advance strategic objectives (Pruvot et al., 2015a: 61–62) and that other administrative efficiencies would be achieved. Mergers were also expected to lead to increased competitiveness, usually in international terms and particularly in global ranking; domestic universities, it was believed, are too small to compete against those in the US and, to a lesser degree, the UK (Hazelkorn, 2008).

For the past two decades, institutions of higher education have been buffeted by complex pressures. The drop in their lump-sum funding for research and the concomitant rise in external funding streams, pressure for ranking and comparisons, ongoing globalization and the growing importance of the knowledge-based economy have placed universities at the center of national competitiveness agendas (Sursock and Smidt, 2010). Mergers are a response to these trends, particularly internationally, as policy makers seek to build excellent universities and foster international competitiveness (Salmi, 2009).

In pursuing mergers, larger universities were expected to result in greater recognition (Aula and Tienari, 2011; Salmi, 2009) and have better research performance, especially if specialized faculties (e.g., medical schools) merged with them. Moreover, it was believed that a larger university has a better chance of being considered “world class” in global university-ranking systems. Mergers were expected to yield new institutions that would be more than the sum of their parts (Yuan et al., 2013).

Despite a considerable amount of research on higher education mergers in general, on the rationales of mergers, and on the attributes of successful mergers (Harman and Meek, 2002; Harman and Harman, 2003; Mok, 2005; Skodvin, 1999; Välimaa et al., 2014), less study has been conducted on the impact of mergers on knowledge production, which was the principal goal articulated by policy makers other than operational efficiency (Huang 2015: 208). Following the literature, we distinguish mergers of universities that are roughly equal in size from

* Corresponding author at: Community and Regional Development University of California, Davis, CA 95616, United States.
E-mail address: dfpatton@ucdavis.edu (D. Patton).

http://dx.doi.org/10.1016/j.respol.2017.10.001
Received 2 January 2017; Received in revised form 7 September 2017; Accepted 2 October 2017
Available online 14 October 2017
0048-7333/

those involving mergers of small universities with large ones, and mergers of a larger, more comprehensive university with a specialized faculty, most often a free-standing medical school. Some case studies have been done (Kyvik and Stensaker, 2013; Norgard and Skodvin, 2002) but relatively few quantitative studies. Further, although the wave of mergers has been global, the existing research is limited in terms of individual mergers or specific countries (for a notable exception, see Pinheiro et al. (2016a), which discusses Nordic countries) or uses truncated periods, which are not likely to capture any synergy that might result from a merger.

Clearly universities are enterprises that produce numerous outputs, but our purpose is to examine the impact of mergers on just one vital measure of university research performance, the production of scholarly publications. Our focus on just this one output is driven in part by the recognition that universities around the world are now assessed almost exclusively along this dimension of activity. Global rankings of universities have become commonplace, and although subject to question, are the primary way universities are measured and compared internationally (Hazelkorn 2014). While domestic rankings such as *US News and World Report* have been around since the 1980s, the appearance of Shanghai Jiao Tong University's Academic Ranking of World Universities (ARWU) in 2003 ushered in the era where universities are ranked internationally along quantitative dimensions.

In addition, we were also interested in viewing university mergers as a treatment affecting the research output of universities. The literature on mergers has laid out several observations about the effectiveness of mergers in general which we hypothesized would result in differential impacts upon one research output − publications. Just as ARWU was constructed using research output measures which were quantitative, internationally comparable, and open to all researchers, our interest in publications as an output was also driven by the availability of such data internationally.

We begin in the next section by discussing the previous research on university mergers, and then outline the hypotheses to be tested in Section 3. In Section 4 we describe how we selected our data, and then discuss the variables and the results of our analysis in Section 5. We close with a discussion and then a conclusion.

2. Previous research

The dominant global trend has been to create fewer, larger, and more comprehensive institutions (Harman and Meek, 2002). Merger research is complicated by the fact that national governments often have used mergers and other forms of consolidation as part of a systemic restructuring of higher education (Olsen and Maassen, 2007). Mergers were expected to lead to an increase in university efficiency and effectiveness, deal with "nonviable" institutions and institutional fragmentation, widen student access, increase course diversity, and serve national and regional economic and social objectives (Harman and Meek, 2002; Pruvot et al., 2015b).

In China, Johnes and Yu (2008) found that research performance is greater at comprehensive universities than at specialized institutions, and thus mergers between them should improve performance.[1] Although the rationale or motivation varies, one consistent theme is the belief that mergers will produce economies of scale and scope (Martin and Samels, 1994), but this article of faith is unproven (Fielden, 1991; Rowley, 1997). Unfortunately, cost savings and other fiscal benefits are difficult to quantify and tend to be overestimated (Patterson, 2000).

[1] Johnes and Johnes (2016) deals with the methodological challenges of estimating cost functions of higher education institutions exhibiting multiple outputs and inputs. Specifically, the article addresses the relative advantages and disadvantages of using data envelope analysis (DEA) and stochastic frontier analysis (SFA) in estimating these cost functions, with a particular application to English universities over the 2013–2014 period.

Other studies on economies of scale have had mixed results. Two studies of US universities as multiproduct institutions using a flexible cost quadratic function of three outputs (undergraduate teaching, graduate teaching, and research) and one input (faculty salaries) show that economies of scale do exist (Cohn et al., 1989; De Groot et al., 1991). Brinkman and Leslie (1986) in a literature review found that two- and four-year institutions enjoy economies of scale but that they are most pronounced for smaller universities. The results at research universities are less clear.

Economies of scale are thought to exist for university research outputs as well as educational outputs, such as number of degrees awarded (Pruvot et al., 2015b). Critical mass is mentioned frequently as one benefit of merging universities, despite the absence of research directly supporting the economies-of-scale hypothesis. In a literature review, Johnston (1994) deduced that most studies found that research had constant returns to scale, and a few discovered economies of scale but only up to a minimum institutional size. Bonaccorsi and Daraio (2005) found no positive relationship between research efficiency, as measured by publications per researcher, and university size and possibly a negative relationship.

Ranking system improvement is another commonly mentioned goal. Some studies have been conducted on the impact of mergers on university rank, in which a belief is expressed that some ranking systems appear to favor large institutions over small ones. For example, in a "what-if" study, Docampo et al. (2015) found that in the Shanghai Jiaotong Academic Ranking of World Universities (AWRU) "the merging of relatively strong universities will, according to ARWU, produce a more highly ranked institution" (p. 189). Thus, beliefs among policy makers about ranking may provide some justification for mergers. The AWRU only began in 2003, however, so we are unable to test this conjecture in this paper.

The final rationale for mergers is that the complementarities that could be created might make it easier for the institutions to compete for grants (Skodvin, 1999). Such gains would presumably be realized from synergies created out of combining disciplines. The merged heterogeneous institutions with different subject portfolios will, it is hoped, create interdisciplinary combinations that will improve research capabilities (Georgiou and Harper, 2015). At the micro level, this intuition is supported, as Ali and Gittelman (2016) found at academic medical centers that the mixing of teams of clinicians and basic biologists can lead to superior innovative results.

In general, the research has been in the form of case studies (Rowley, 1997), in part because obtaining ex ante and ex post time-series data is difficult and results in small sample sizes (Cartwright and Cooper, 1996; Kyvik and Stensaker, 2013). Further, the emphasis is often on implementation, rather than the evaluation of outcomes. For example, a 2002 special edition of *Higher Education* exploring mergers concentrated almost exclusively on the merger process and relied on case studies in all but one instance (Harman and Meek, 2002). More recently, several publications have appeared that focus on international university mergers (Curaj et al., 2015), in Europe (Pruvot et al., 2015b) and in northern Europe (Pinheiro et al., 2016a); these also focused on the process, motivation, and typologies, not on outcomes (Lang, 2003).

Ample disagreement exists about whether mergers have been successful. Rowley (1997) in a survey based study of 30 university mergers in the UK concluded that most of these mergers were a success based on the opinions expressed by university personnel. In contrast, using an ex post questionnaire of two UK universities, Cartwright et al. (2007) concluded that they failed because of mismanagement of human resources. In a case study of Australian institutions merged together in 1988, Gamage (1992) found that the merger was a qualified success but that the expectation of achieving economies of scale was disappointed. Following up on Rowley's (1997) findings, Fielden and Markham (1997) found that merging institutions of higher education did not always result in economies of scale and that unrealistic assumptions by policy-makers were made about the returns.

The few empirical assessments of university mergers have used a variety of methods. Data envelope analysis (DEA) is the most common, as it can provide a measure of the efficiency of institutions, such as universities, that produce more than one output. DEA studies of Chinese universities found that universities in the coastal regions of China were more efficient than those inland, but that universities of specialized faculties were less efficient than those of comprehensive universities (Johnes and Yu, 2008; Ng and Li, 2000). In a study of UK mergers using DEA, Johnes (2014: 485) concluded that they improved research output. Using a sample of 25 Chinese universities that merged in 2000, Hu and Liang (2007) concluded that efficiency increased after the mergers. In another study, Yuan et al. (2013) found that mergers in China increased university knowledge transfer. Mao et al. (2009) used factor analysis in a multiple research output model and concluded that research efficiency increased in the first two of years following the merger but declined later.

University mergers have been studied through the lens of organization theory including resource dependence, structural contingency, and culture-related factors, mainly emphasizing leadership, management, administrative procedures, governance, and human resources (Pinheiro et al., 2016b). The literature addresses the efficacy of mergers based on the type of institutions being merged (Cai, 2007; Lang, 2002; Martin and Samels, 1994) and the type of institution that results from a merger (Harman and Harman, 2003; Kyvik and Stensaker, 2013). Numerous distinctions have been made, primarily on the basis of case studies following the typology laid out by Harman and Meek (2002: 2), and include variables such as the number of institutions participating in a merger (Kyvik and Stensaker, 2013), geographic proximity, the degree to which a merger was voluntary (Skodvin, 1999), and institutional similarity.

3. Hypotheses

The first hypothesis is quite basic and tests whether mergers improve university research output:

H1: University mergers have a positive impact on the growth rate of post-merger university knowledge production, after the research inputs of R & D personnel and expenditure are controlled for.

One crucial distinction found in the literature on mergers, among universities as well as firms, is the relative size of the merger partners. Mergers among institutions of similar size, or consolidations, usually take more effort and time to organize than mergers among institutions of dissimilar size, known as takeovers or acquisitions (Harman and Harman, 2003). Skodvin (1999) argues that, as a general rule, the larger the differences between the institutions involved with regard to size and the programs the institutions offer, the more likely the merger will be successful. Kyvik and Stensaker (2013) in their case study of Norwegian mergers, however, found successful mergers among institutions with a similar size and academic profile.

The costs of merging institutions of a similar size have also been addressed in the literature on mergers and acquisitions among technology firms. Ahuja and Katila (2001) and Cloodt et al. (2006) specifically examine this question, respectively, in chemical industry and high-technology mergers. These studies found that the larger the acquired firm's knowledge base relative to the knowledge base of the acquiring firm, the smaller the subsequent innovation output of the acquired firm, ceteris paribus. This finding shows that absorbing an acquired knowledge base has costs. More recently, Yuan et al. (2013) found that similarity in size had a negative effect on patent applications by Chinese universities following a merger. Although the literature is mixed, the preponderance of the studies suggests that the merger of universities of a similar size may have a negative impact. Therefore, we hypothesize:

H2: After R & D personnel and expenditures are controlled for, mergers of institutions of a similar size, or consolidation mergers, will have a negative impact on the growth rate of post-merger knowledge production.

Our final hypothesis is drawn from the literature that distinguishes between "horizontal" and "vertical" mergers, in which the former have similar academic profiles, while the latter have different academic profiles (e.g., Ljungberg and McKelvey, 2015). Kyvik and Stensaker (2013) observed that if the merged universities have similar academic profiles, then disagreements about the distribution of tasks and roles are likely to emerge after the merger. Vertical mergers result in a more comprehensive university with more diverse academic programs and stronger support services, which results in more choices for students and an increased capacity for organizational flexibility and international competitiveness.

One particular type of university among heterogeneous institutions that is thought to generate synergy is the merger of medical schools with comprehensive universities that do not have an academic medical center (Azziz, 2014). One example of this type of merger is the one between the Medical University of Ohio and the University of Toledo in 2006, which is judged to have strengthened the former medical university and diversified the new University of Toledo (McGinnis, 2007). In another case, the highest-ranked university in Wales, Cardiff University, merged with the country's only medical school to create what one observer termed a "biomedical and health research powerhouse" (Gummett, 2015: 86).

China also had several instances of "medical-comprehensive" mergers in which a medical university was absorbed into a comprehensive university (Yang, 2000). These were undertaken in the belief that the unification of clinical science with basic biological research would strengthen both disciplines (Chen, 2002). For this reason, we hypothesize:

H3: A medical-comprehensive university merger will have a positive impact on the growth rate of post-merger university knowledge production, that is, publication rates grew more rapidly after the merger after the research inputs of R & D personnel and expenditure were controlled for.

4. Data selection

The initial research plan was to collect data from all European and Asian countries in which university mergers had taken place. We contacted the Ministry of Education in Japan but were told that all such data was secret. In Europe, with the exception of Denmark, Sweden, and Finland, the data were unavailable through any online sources and inquiries to government officials went unanswered or we were told that no such data were available. Data university mergers in China and in Nordic countries from 2000 to 2010 were found in two primary sources: official data in national databases and data extracted from the Web of Science Core Collection. In selecting our population, we limited our selection to mergers for which input data could be collected five years before and after the merger. This meant that we could not use any mergers that occurred after 2010 and that we could only use mergers for which we could obtain data back to 1995. Finally, we required input data in terms of research expenditures and the number of personnel.

Because of our focus on mergers was initiated for the purpose of promoting research competence and fostering academic synergy, in China we only selected mergers with at least one 211 Project university.[2] Complete and consistent data for all participants were available for 29mergers in the *Gaodeng xuexiao keji tongji ziliao huibian*

[2] Since the 1990s China has advanced a series of higher education initiatives aimed at building world class universities. The 211 Project, initiated in 1995, assisted 107 universities and was directed to improve instruction and research. Project 985 was announced in 1998 and provided funding to a total of 39 selected research universities. While more modest in the number of universities assisted, Project 985 was much more ambitious in the level of funding provided than earlier initiatives (Zhang et al., 2013).

1996–2016 (Compilation of University Science and Technology Statistics 1996–2016)[3] (Science and Technology Office, 1996–2016).

For the European countries in which university mergers occurred, the only usable university-level data were from Denmark, Finland, and Sweden. Most of these mergers, however, occurred after 2010, so only eight mergers from these countries were included in our study.

Data for Sweden were downloaded from Statistics Sweden. Two mergers qualified for inclusion in our study: Stockholm University merged with the Stockholm Institute of Education in 2008, and Linnaeus University resulted from the merger of Vaxjo University and Kalmar University in 2010. Data on the Danish mergers were provided by Statistics Denmark. Three mergers, all in 2007, qualified for inclusion: the University of Copenhagen merged with the Royal Veterinary and Agricultural University and the Danish University of Pharmaceutical Science, the Technical University of Denmark absorbed five different research institutions, and Aalborg University merged with the Danish Building Research Institute. Finnish university data came from Statistics Finland's PX-Web databases. Three mergers in 2010 qualified for inclusion: the University of Turku merged with the Turku School of Economics, and Aalto University resulted from the merger of the Helsinki University of Technology, the Helsinki School of Economics, and the University of Art and Design, and the University of Eastern Finland resulted from the merger of the University of Kuopio and the University of Joensuu.

5. Data and analysis

5.1. Variables

The Web of Science is the source of all measures of university research output. The core collection of scholarly articles consists of the Science Citation Index Expanded (SCIE), the Social Sciences Citation Index (SSCI), and the Arts & Humanities Citation Index (AHCI) (Thomson Reuters, 2014). The authors of these articles, and the institutions with which they are affiliated, recorded in these indexes provide the bibliographic data that form the basis of the dependent variable. Table 1 lists and explains all the variables used in the analysis.

5.2. Methodology and basic model

Most previous studies have used data envelope analysis (DEA) to examine the outcome of mergers, a method that is well suited to universities that produce multiple outputs. However, this study relies on a single output, scholarly articles, as a measure of research output. Because the universities in our sample show considerable variation, our statistical methodology measures the impact of mergers, controlling for the differential initial resource endowments.

Our approach in assessing the research benefits of university mergers follows the practice used in bank merger studies that treat the pre-merger entities as if they were a combined entity prior to the merger (Rhoades, 1994: 2). This provides a counterfactual pre-merger entity to which the performance of the post-merger entity can be compared. Therefore, the annual input data on research personnel and research funding of each independent university are added together to produce the input data for a counterfactual pre-merger university, which is then compared to the post-merger university.

The research output variable is the natural log of university articles, producing the following equation, which is estimated through ordinary least squares (OLS).

$$\begin{aligned}\ln articles_{ij} = {} & \beta_1 + \beta_2 rdtotal3_{ij} + \beta_3 realstexp3_{ij} + \beta_4 relativeyear_j \\ & + \beta_5 control_j + \beta_6 dummy2_j + \beta_7 dummy2_j \\ & \times relativeyear_j + \beta_8 university_j + \beta_9 relativeyear_j \\ & \times university_j + \varepsilon_{ij} \end{aligned} \quad (1)$$

where β_1 is the intercept of the equation, β_2 and β_3 are coefficients on the university research inputs of personnel and funding, while β_4 is the coefficient on time, indicating the annual rate of growth in university articles, the measure of research output. β_6 and β_7 are the coefficients on the change in intercept and change in coefficient on relative year that occurs after the merger as dummy2 assumes a value of 1 only after the merger. The coefficients β_8 and β_9 are applied to each individual university considered in Eq. (1) to allow the intercept and slope of each university to assume its own value. β_5 is the coefficient attached to each merger type control, such as project985, used in examining Chinese university mergers, and ε_{it} is an error term.

All hypotheses tested in this study are based on evaluating the change in the growth rate of university research output following the merger, compared to the research growth rate in the five years preceding the merger. The statistical significance of the coefficient β_7 tests the hypotheses operationalized below.

5.3. Results and analysis

Eq. (1) was estimated for all mergers.[4] The coefficients on individual universities for the OLS regressions are excluded from the results presented in Table 2, and the results from three linear mixed models are shown along with the OLS results for the Chinese university mergers.[5] The results suggest support for H1; the growth rate of articles increased following each university's merger at the 0.05 level of significance for the coefficient on dummy2 x relativeyear (see Table 2). This coefficient is the difference in the article growth rate before and after the merger. Although significant, the increase is approximately 2% more than the existing growth rate of nearly 18% prior to the merger, as indicated by the coefficient on relativeyear.

Given the large number of unique university intercepts and slopes, requiring two dummies for each of 29 universities in the OLS estimation of Eq. (1), estimation based on mixed models is reported. The linear mixed-model method assumes that the intercepts and slopes of each university are random deviations from the underlying fixed intercept and slope of the entire population (Rabe-Hesketh and Skrondal, 2008: 141–150). Column 2 reports the results using both rdtotal3 and realstexp3 as independent input variables, and columns 3 and 4 report the estimated coefficients using each of these input variables individually. The estimated coefficients are consistent, increasing our confidence in the results.

The results for the Nordic countries less consistently support H1. Because of the small number of university mergers considered in the Nordic countries, Table 3 shows only OLS estimation results. The input variables rdtotal3 and realstexp3 were highly correlated, so each OLS estimation is made using each variable singly.

The results suggest that mergers resulted in a significant increase in article publication in Denmark, an increase in Finland that was only significant at the 0.10 level, and in the estimation using R & D personnel as an independent input variable. The results from Sweden, by contrast, imply that the growth rate actually declined following mergers.

Our results for Chinese universities extend previous findings (Mao et al., 2009; Yuan et al., 2013) that did not control for the 985 Project, which was a central government initiative that selected a few Chinese universities for a massive influx of research funds meant to move the chosen universities into the top global-class. Several studies have shown that the 985 Project influenced university publications (Zhang et al.,

[3] There were two years data missing, namely, data of 2003 and 2004 could not be found in the *Gaodeng xuexiao keji tongji ziliao huibian 2004–2005*.

[4] The regression equations for Denmark, Finland, and Sweden were run separately because certain data on research personnel and funding were not strictly comparable.

[5] The three mixed models are distinguished by the use of the input independent variables rdtotal3 and realstexp3.

Table 1
Definitions of the Independent, Dependent, and Control Variables.

Name	Dependent variable	Description
$lnarticles_{ij}$	Dependent variable for year *i* and university *j*	The natural log of the count of university *j* articles published by authors affiliated with the university in year *i*.

Name	Independent variables	Description
$relativeyear_j$	Year relative to the date of merger for university *j*	An integer that assumes a value of zero in the year of the merger and takes on negative values before the merger and positive values for years after the merger.
$realstexp3_{ij}$	Three-year moving average of the real, inflation adjusted, value of science, and technology expenditures by university *j* in year *i*.[a]	The total expenditures on science and technology are for each university per year, from all funding sources.
$rdtotal3_{ij}$	Three-year moving average of the number of research and development personnel at university *j* in year *i*.	Personnel consists of all scientists and engineers engaged in teaching, R & D activities, or scientific research services and management.
$dummy2_j$	Binary variable with a value of 1 for one year after university *j*'s merger, 0 otherwise.	–
$university_j$	Binary variable with a value of 1 for university *j*, 0 otherwise.	–

Name	Control variables (Chinese mergers only)	Description
$project985_j$	Binary variable with a value of 1 if university *j* was part of the 985 Project, 0 otherwise.	–
$medical_j$	Binary variable with a value of 1 if one party in the merger was a medical school, 0 otherwise.	–
$consolidation_j$	Binary variable with a value of 1 if the merger is characterized as being a consolidation merger	A merger that occurs among institutions that are of similar size is considered a consolidation merger.[b]

[a] The control variables for S & T expenditures and R & D personnel may affect publication output in later years. In addition, the recorded values of these variables varied from year to year. To account for both a lagged effect and high variability a three-year moving average was used for these independent variables.

[b] A merger is considered a consolidation merger if the surviving university is less than ten times the size of the university, or universities, that are merging with it. In the case of a newly formed university, this size ratio is the ratio of the largest pre-merger university to the other university, or universities, with which it merges. Size is measured by university S & T expenditures the year before the merger. If the difference is larger than 10x, the merger is called an "acquisition".

Table 2
Chinese University Mergers, 2000–2005.

Variables n = 521, 29 mergers	OLS	Mixed models 1	Mixed models 2	Mixed models 3
relativeyear	0.1792786***	0.1761792***	0.1776167***	0.1760577***
	0.0111886	0.0123763	0.0125162	0.123247
dummy2	0.0911883*	0.0879367*	0.0958423**	0.0883065*
	0.0368368	0.0366151	0.0366469	0.0364245
dummy2 x relativeyear	0.0197255†	0.0238524*	0.0226605*	0.0233688*
	0.0113608	0.0111406	0.0111948	0.0100092
project985	2.613062***	2.257537***	2.209545***	2.25587***
	0.1326523	0.3666314	0.361884	0.3660637
medical	2.754142***	0.7771414*	0.7500004†	0.7780519*
	0.1287556	0.3950894	0.3903744	0.3947769
consolidation	2.896279***	0.4440599	0.4243371	0.4448455
	0.1506657	0.3675543	0.3632327	0.3672776
rdtotal3	−0.0000508*	−0.0000516*	–	−0.0000523*
	0.0000235	0.0000224	–	0.000021
realstexp3	0.0000001	−0.0000001	−0.0000001	–
	0.0000001	0.0000001	0.0000001	–
constant	2.299338***	3.004865***	2.985812***	3.004708***
	0.1314347	0.4289499	0.4239748	0.428725

Standard errors are shown below coefficient values. Significance levels: † 0.10, * 0.05, ** 0.01, *** 0.001.

2013) and patent applications (Fisch et al., 2014). For this reason, 985 Project effects can be conflated with those of university mergers, so we estimated Eq. (1) for the mergers in which the post-merger university was part of the 985 Project, and mergers in which the post-merger university was not part of the 985 Project.

To be confident that the findings are not the result of any other phenomena in Chinese academia and not captured in our model specification in Eq. (1), we applied our model to a set of comparable universities that were not subject to either mergers or the effects of the 985 Project. To construct such a set, we selected fourteen 211 universities that were similar in terms of the number of articles produced by the 12 non–985 Project merged universities. The mean value of articles published in 2013 among the 12 non–985 Project universities in our population is 781.7. The mean value of 2013 articles among the 14 matched universities is 783.6. To complete the comparison, we selected a counterfactual merger year for the matched universities. Since 9 of the 12 non–985 Project universities merged in 2000 or 2001, we chose 2000.

The results of the regressions for the two populations of merged universities, both those that are part of the 985 Project and those that are not, and the set of matched universities that were neither merged nor part of the 985 Project are shown in Table 4.

The equation estimates of the 17mergers in which the surviving university was part of the 985 Project in Table 4 indicate little difference in the growth rate of articles before and after a university merger, as the coefficient on dummy x relativeyear is not significant for either the OLS or mixed method estimations.

Universities that were merged but were not part of the 985 Project are in the middle columns of Table 4, and the results suggest that mergers contributed to growth of approximately 4% in university output of research articles. Although both the OLS and mixed method estimates produce consistent estimates of the coefficient on dummy2 x relativeyear, only the OLS estimate is significant at the 0.10 level. These results suggest that mergers as a group may have resulted in an increase in university research output, but this effect seems to be limited to the smaller universities not involved in the 985 Project.

The last two columns of Table 4 show the results of treating the matched set of 14 universities as if they experienced a merger in 2000. The results show that, although these universities as a group produced articles at a rapid rate prior to 2000, around 25%, their rate of growth actually declined 5% after 2000. This strongly implies that there were no system-wide effects in Chinese academia that drove our results showing an increase in university research from mergers among non–985 Project universities.

Table 3
Nordic University Mergers, 2007–2010.

Variables	Denmark		Finland		Sweden	
	n = 39, 3 mergers		n = 33, 3 mergers		n = 32, 2 mergers	
	OLS		OLS		OLS	
relativeyear	0.075404***	0.059006***	0.043423***	0.042265***	−0.0684126*	0.120901***
	0.0185712	0.0120371	0.0073594	0.005851	0.0310809	0.0155582
dummy2	−0.0446526	−0.0313815	0.0393508	0.0439339	−0.1291043	−0.1198385
	0.0474274	0.047333	0.0386388	0.0350647	0.0820965	0.1015343
dummy2 x	0.0355972†	0.048935*	0.011079	0.0213223†	−0.0625501*	−0.08618*
relativeyear	0.0184461	0.0203408	0.0155721	0.0119382	0.1254706	0.0378367
rdtotal3	–	−0.0000397	–	−0.0001267*	–	0.0010025**
	–	0.0000292	–	0.0000549	–	0.000312
realstexp3	−0.0000001	–	−0.0000013	–	0.008108***	–
	0.0000001	–	0.0000012	–	0.0015952	–
constant	8.51371***	8.435131***	7.296434***	7.450582***	2.614167*	6.031812***
	0.4269286	0.1438066	0.1266763	0.1245912	0.9574828	0.4523893

Standard errors are shown below coefficient values. Significance levels: † 0.10, * 0.05, ** 0.01, *** 0.001.

Results to this point lead us to conclude that H1 is supported for some university mergers, but not all. This observation is consistent with the literature on mergers that stresses the importance of the merger process and emphasizes the uniqueness of each merger, as it depends so critically on the particular characteristics of the institutions involved in the merger and the process used in implementation of the merger (Harman and Harman, 2003; Skodvin, 1999).

Although the success of a merger depends on characteristics unique to the universities involved and the process followed in implementing the merger, the type of merger also plays a role in its success. H2 and H3 test this proposition for the impact of differences in size and scope, respectively. The test of H2 relies on comparing two populations, the first, in which the universities are similar in size, and the second, in which the universities differ in size. All Chinese mergers are categorized by the binary variable consolidation, which assumes a value of 1 if the merger was a consolidation, and a value of 0 if it was an acquisition (see Table 1). This distinction separates the 29 Chinese mergers into two groups; 17 consolidation mergers of universities of similar size and 12 acquisition mergers of universities of different sizes. The results in Table 5 compare these two merger types. The coefficients on dummy x relativeyear for both the OLS and mixed method results indicate little difference in the growth rate of articles after the merger of universities that are similar in size. At the 0.05 level of significance, though, the results for the acquisition mergers indicate a higher growth rate of articles in the years after the merger, which supports H2.

Finally, we test H3. Mergers involving institutions with potentially complementary knowledge bases are expected to create interdisciplinary combinations that will improve research (Georghiou and Harper, 2015; Yuan et al., 2013). Because of our sample population, the only mergers of this type were for medical schools. This distinction separates the Chinese merger population into 18mergers involving medical schools and 11mergers that do not involve medical schools. Drawing on previous literature, we hypothesized that medical schools, in particular, have a highly complementary fit with comprehensive universities that have biology departments. The results in Table 6 provide clear support for H3. At the 0.001 level of significance, both the OLS and mixed method indicate that the growth rate of articles increased by around 5% following a merger with a medical school, while no change in article growth rate followed a merger of schools that did not involve a medical school.

Given the support found for H2 and H3, we can revisit the results on Nordic university mergers found in Table 3. If the eight Nordic mergers are divided into acquisition mergers and vertical mergers, these results become clearer. In Table 7 the regression results of all eight Nordic mergers are presented by country, indicating the estimated change in the growth rate of articles following the merger.

According to H3, mergers among universities that have dissimilar profiles are more successful than those with similar ones. All three Danish mergers were vertical, while only two of three Finnish, and one of two Swedish mergers were vertical. This alone implies that the mergers in Denmark should do better than those in Finland, which in

Table 4
OLS and Mixed Method Results for Project 985, non–Project 985, and Matched Universities.

Variables	985 Project merged universities (17 mergers)		Non–985 Project merged universities (12 mergers)		Matched set of non–985 Project and non-merged universities (14 universities)	
	OLS	Mixed Method	OLS	Mixed Method	OLS	Mixed Method
relativeyear	0.105621***	0.161181***	0.176898***	0.196392***	0.261493***	0.241427***
	0.0101473	0.0116041	0.0254498	0.0235119	0.0195889	0.0207695
dummy2	0.104051***	0.104316***	0.0607733	0.0677638	0.220731***	0.219829***
	0.0310712	0.0307744	0.0815946	0.0798136	0.0603894	0.0598733
dummy2 x	0.0053927	0.0047867	0.0408468†	0.0373089	−0.0488712**	−0.0505069**
relativeyear	0.0101162	0.0099189	0.024737	0.0236561	0.0168912	0.0166978
rdtotal3	−0.000059***	−0.000060***	0.0000531	0.0000683	0.0000377	0.000082
	0.0000164	0.0000157	0.0000945	0.0000894	0.0001045	0.0001013
realstexp3	0.0000002†	0.0000002*	−0.0000005	−0.0000003	−0.0000002	−0.0000002
	0.0000001	0.0000001	0.0000008	0.0000007	0.0000004	0.0000004
constant	7.309744***	6.088568***	4.946092***	3.511536***	4.378262***	3.71311***
	0.0585883	0.1919986	0.1344419	0.3441757	0.1336214	0.2612441

Standard errors are below coefficient values. Significance levels: † 0.10, * 0.05, ** 0.01, *** 0.001.

Table 5
OLS and Mixed Method Results for Different Types of Mergers.

Consolidation Mergers			Acquisition Mergers		
Variables	OLS	Mixed Method	Variables	OLS	Mixed Method
relativeyear	0.1063477***	0.1797781***	relativeyear	0.1660121***	0.1728817***
	0.0154692	0.0144199		0.0188942	0.0218118
dummy2	0.0947758*	0.091176*	dummy2	0.0904133	0.0909144
	0.0426361	0.0422738		0.0654087	0.064539
dummy2 x	0.0027466	0.0065767	dummy2 x	0.0482185*	0.0481353*
relativeyear	0.0131676	0.0128357	relativeyear	0.020511	0.0196914
rdtotal3	−0.0000115	−0.0000168	rdtotal3	−0.0001421**	−0.0001162**
	0.000025	0.0000241		0.0000494	0.0000451
realstexp3	0.0000001	0.0000001	realstexp3	0.0000001	−0.0000001
	0.0000001	0.0000001		0.0000001	0.0000003
constant	7.212867***	4.973035***	constant	5.088351***	5.230615***
	0.0852766	0.3451793		0.0912521	0.514922

Standard errors are shown below coefficient values. Significance levels: † 0.10, * 0.05, ** 0.01, *** 0.001.

Table 6
OLS and Mixed Method Results for Mergers with and without a Medical School.

Mergers with Medical School			Mergers without Medical School		
Variables	OLS	Mixed Method	Variables	OLS	Mixed Method
relativeyear	0.1711394***	0.1519793***	relativeyear	0.2098833***	0.2145567***
	0.0123948	0.0126724		0.0231923	0.0221729
dummy2	−0.0120816	−0.0089675	dummy2	0.2136801**	0.2134956***
	0.04066	0.0400992		0.0678039	0.0670061
dummy2 x	0.0513382***	0.0513569***	dummy2 x	−0.0203354	−0.0178228
relativeyear	0.0125687	0.0121185	relativeyear	0.0221338	0.0208004
rdtotal3	−0.0000978***	−0.0000843***	rdtotal3	0.0000462	0.0000633
	0.0000239	0.0000224		0.0000729	0.000069
realstexp3	−0.0000001	−0.0000001	realstexp3	0.0000006	0.0000005
	0.0000002	0.0000001		0.0000004	0.0000003
constant	5.087534***	5.694434***	constant	5.053613***	3.995045***
	0.0607439	0.3705347		0.1239356	0.332454

Standard errors are below coefficient values. Significance levels: † 0.10, * 0.05, ** 0.01, *** 0.001.

turn should be more successful, as measured by growth in post-merger articles, than the Swedish university mergers, as is shown in Table 3. In addition, ranking all eight universities by their increase in the article growth rate after the merger matches the ranking implied by their classifications according to H2 and H3. H2 and H3 predict that Aalborg University in Denmark and Stockholm University in Sweden should be the most successful of the Nordic mergers as they are both acquisition and vertical mergers and that the University of Eastern Finland and Linnaeus University in Sweden should be less successful, as they are consolidation and horizontal mergers. The results in Table 7 confirm these predictions. Although based on a small number of mergers, the Nordic results provide additional support for H2 and H3.

6. Robustness checks

A number of robustness checks were conducted to ensure the reliability of the results. First, to test for the existence of a time lag before the impact of a certain merger was seen in publication performance, we varied the date of variable $dummy2_j$ from t + 1 to t + 5, but varying the year to measure the effect had no impact. To ensure that the

Table 7
OLS Results for Individual Nordic Mergers.

Merged Universities by Country	Acquisition merger (dissimilar size)	Vertical merger (dissimilar profile)	% Δ in articles after merger. (rdtotal3 as the input variable)	% Δ in articles after merger. (realrdexp3 as the input variable)
Danish Universities:				
Aalborg University	Yes	Yes	11.8*	7.3
University of Copenhagen	No	Yes	2.3	2.5*
Technical Univ. of Denmark	No	Yes	−2.4	−6.5
Finnish Universities:				
University of Turku	No	Yes	1.8	3.4†
Aalto University	No	Yes	3.0	6.0
University of Eastern Finland	No	No	−2.4	−1.6
Swedish Universities:				
Stockholm University	Yes	Yes	10.5***	6.5†
Linnaeus University	No	No	−10.1*	−10.0

Significance levels for the coefficient on dummy2 x relativeyear, indicating the percentage change in the growth of articles following the merger: † 0.10, * 0.05, ** 0.01, *** 0.001.

increase in publication was not an artifact of decreased quality, we also examined whether the proportion of articles included in the top 10% and top 1% most-cited articles changed, but we found no significance for this measure in any of our regression equations. We were also concerned that using only articles published in English-language journals might skew our results for Chinese authors. Therefore, we also downloaded the publications in the Index of Chinese Core Journals (Science and Technology Office, 1996–2016). This alternative measure had no impact on our results.

Finally, due to the importance of the 985 Project, the variables in Eq. (1) concerning merger timing were altered to the year in which a university joined the 985 Project. We found that the 985 Project did increase the growth rate of university articles by 1% or 2%. This result was significant at the 0.05 level for the OLS estimation, but this had no impact on any other results.

7. Discussion

Since the 1990s, in an effort to create world-class universities in their country, various ministries of education have considered university mergers as a way of improving research performance. Our results suggest that mergers have resulted in research performance improvements, but only in certain instances. In China, the universities experienced a small but significant increase in the rate of growth of articles in the years after a merger. However, this result is found to be significant only among universities that were not part of the 985 Project. Among the 985 Project universities, mergers did not result in a significant increase in the growth rate of articles. Our results improve upon previous research, such as Mao et al. (2009) and Yuan et al. (2013), as they did not control for the overwhelming impact of the 985 Project. The increase in research by 985 Project universities in the first decade of the twenty-first century was influenced far more by the 985 Project funding than by university mergers. By using a matched set of universities that did not merge and were not involved in the 985 Project, we demonstrated that the positive impact of mergers on universities not involved in the 985 Project was not the result of other factors.

Our findings provide empirical support for the intuition that mergers of similar-size institutions, while offering both advantages and difficulties, are usually less successful in generating synergy (Harmon and Harmon, 2003). Previous research found that, on balance, acquisition mergers between different-size institutions are more likely to be successful relative to consolidation mergers (Pinheiro et al., 2016b: 7; Skodvin, 1999). Our results are consistent with these findings.

Why might this be the case? We expect that the costs associated with merging two similar sized universities are due in large part with the difficulties of eliminating redundancies that are likely to arise in mergers of this type. In addition, as Harman and Harman (2003) emphasize, mergers among institutions of similar size, or consolidations, usually take more effort and time to organize while mergers among institutions of dissimilar size, or acquisitions, are comparatively simpler. The benefits from merging two similar sized institutions are limited to economies of scale as such institutions will likely offer courses in the same disciplines, and so synergies do not play a role. We conclude that the costs from consolidation mergers, in agreement with observations made in the education literature, outweigh the benefits. This does not, though, appear to be the case of mergers of heterogeneous institutions.

The most intriguing result from our research was our quantitative confirmation of the qualitative findings by Kyvik and Stensaker (2013) that mergers of institutions that may have complementary knowledge could lead to productive synergies. This is evidenced by the fact that mergers of universities in which one of the merger parties was a medical school resulted in significantly increased publication rates after the merger. This suggests that these sorts of mergers produce synergies between the two complementary institutions. These types of mergers were common in China,[6] as the Chinese government used the US university system, in which most elite universities have a medical school, as a template for its university reforms (General Office of the State Council, (2000); People's Daily, 2016; Xinhuanet, 2001, 2005, 2016; Yang, 2015).

In the U.S., the melding of academic medical centers (medical schools and their clinical enterprises) with nonmedical universities are seen to have produced research synergies. (Azziz, 2014). In addition, such mergers do not have the costs associated with eliminating redundancy among institutions having the same range of research capabilities. We conclude that the combination of heterogeneous institutions with dissimilar research portfolios creates the possibility of interdisciplinary research, otherwise known as synergies.

These synergies arise in an academic medical setting from the interaction between the basic research pursued by universities and the clinical research conducted by research hospitals. Nelson et al. (2011) argue that advances in medical knowledge are based on the interaction of three different kinds of learning; learning from basic biomedical research, the application of technological advances, and the knowledge obtained from clinical practice. Comprehensive universities combined with research hospitals pull these types of learning together producing synergies that manifest themselves in greater research output.

These results provide support for several general conjectures about successful university mergers found in the literature regarding the relative size of the institutions that are merged and the similarity of their academic profiles. Our contribution is that we find support for these conjectures empirically, rather than through a case study.

8. Conclusion

Governments have repeatedly stated their commitment to improving national research capabilities and believe that university mergers yield positive results. We have shown that positive research results occur only in certain types of mergers. For policy makers, our results are comforting in that mergers do not appear to have any negative effects on research productivity. Yet, for countries plagued by a fragmented system of higher education having difficulty in achieving global visibility, we find that a merger of institutions of similar size is unlikely to improve performance. However, we also do not find any diminution of research performance—in other words, the impact is additive. In contrast, the merger of smaller institutions into a much larger one does appear to have a positive impact. The reasons for this are unclear. Perhaps the “acquired” university’s faculty acquires access to the facilities and resources of the larger institution, thereby allowing them to become more productive. Often, the larger institution is more highly ranked and better recognized than the smaller one, and a merger increases the pressure for excellence at the smaller university and thereby better motivates the staff. For policy makers, this result suggests that continuing to support these acquisition-like mergers is likely to be worthwhile.

The results for mergers of medical colleges with comprehensive universities clearly suggest that the clinical and research synergies that Ali and Gittelman (2016) discovered in terms of inventions may also exist at the institutional level. For policy makers confronted with a system of higher education that, for historical or other reasons, has narrowly specialized institutions that have analogues in a local

[6] Some of the most notable ones were: Shanghai Medical University merged with Fudan University as Fudan University Shanghai Medical College in April 2000; Beijing Medical University merged with Peking University to become the Peking University Health Science Center in April 2000; West China University of Medical Science merged with Sichuan University as the West China Center of Medical Sciences, Sichuan University, in September 2000; Zhongshan Medical University merged with Sun Yat-sen University as Sun Yat-sen University Zhongshan School of Medicine in October 2001; and Shanghai Second Medical University merged with Shanghai Jiaotong University as Shanghai Jiaotong University School of Medicine in July 2005.

comprehensive university, mergers may be a way to increase overall productivity. Although we could measure this only for medical schools, it is interesting to speculate whether similar synergies would occur for mergers of other specialized institutions with their local comprehensive universities. For example, would a merger between the Medical Research Council Laboratory of Molecular Biology in Cambridge and the University of Cambridge yield synergies?

Our study has limitations. The first limitation is that the data are only from four countries and thirty-seven universities, which may limit its generalizability to other national experiences or future higher-education planning. An additional limitation is that we are unable to control for all possible influences on university publication output over time. This would include the transition from manuscript to article-based doctoral dissertations in many fields in the Nordic countries and in China. Such a transition would increase the number of publications affiliated with a university in the absence of any other change in university operations.

The comparison of universities cross-nationally is severely limited by the lack of available data. It seems certain that administrative data on employment and research funding is collected by the various Ministries of Education, however we found securing this data was, for all intents and purposes, impossible. Because both Japan and France have undertaken significant university merger programs, we were optimistic that we could gain access to such basic data, but despite repeated enquiries to the Japanese Ministry of Education and French statistical agencies no data was forthcoming. In this sense, we were surprised that China made more basic data available than did many liberal democracies. For scholars interested in science policy, it is important to urge our respective nations to make such basic data available so the policies aimed at improving university performance can be objectively evaluated.

Given the increasing desire among governments everywhere to improve the research performance of their public research institutions, mergers undoubtedly will continue. Our results show that mergers of equals and consolidation types of mergers do not appear to have any significant impacts on research performance. However, merging specialty universities with comprehensive universities, which, in our sample, was confined to medical schools and comprehensive universities can yield measurable research synergies. Future research with larger datasets could further explore whether these benefits also occur when merging engineering institutes and comprehensive universities, e.g., Max Planck institutes and local universities. Real opportunities to capture synergies from mergers exist but are most likely to emerge in a merger of two institutions that are home to related but different ways of thinking about specific phenomena, such as biology and medicine.

Acknowledgments

The authors thank Petri Rouvinen of ETLA for introducing us to Ilkka Turunen at the Finnish Ministry of Education, who provided useful data. We are grateful to Isabelle Soder at Statistics Sweden, Ari Leppälahti at Statistics Finland, and Jens Brodersen and Caspar Larsen at Statistics Denmark for their assistance. Qiaochu Liu acknowledges the support of Tsinghua University under Grant No. 20141081191.

References

Ahuja, G., Katila, R., 2001. Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. Strateg. Manage. J. 22, 197–220.
Ali, A., Gittelman, M., 2016. Research paradigms and useful inventions in medicine: patents and licensing by teams of clinical and basic scientists in Academic Medical Centers. Res. Policy 45 (8), 1499–1511.
Aula, H.M., Tienari, J., 2011. Becoming world-class? Reputation-building in a university merger. Crit. Perspect. Int. Bus. 7 (1), 7–29.
Azziz, R., 2014. What is the value and role of academic medicine in the life of its university? Acad. Med. 89 (2), 208–211.
Bonaccorsi, A., Daraio, C., 2005. Exploring size and agglomeration effects on public research productivity. Scientometrics 63 (1), 87–120.
Brinkman, P.T., Leslie, L.L., 1986. Economies of scale in higher education: sixty years of research. Rev. Higher Educ. 10 (1), 1–28.
Cai, Y., 2007. Academic Staff Integration in Chinese Post-merger Chinese Higher Education Institutions. University of Tampere, Tampere (Unpublished paper).
Cartwright, S., Cooper, C.L., 1996. Managing Mergers, Acquisitions and Strategic Alliances: Integrating People and Cultures. Butterworth Heinemann, Oxford.
Cartwright, S., Tytherleigh, M., Robertson, S., 2007. Are mergers always stressful? Some evidence from the higher education sector. Eur. J. Work Organ. Psychol. 16 (4), 456–478.
Chen, D.Y., 2002. A study on the amalgamation of Chinese higher educational institutions. Asia Pacific Educ. Rev. 3 (1), 48–55.
Cloodt, M., Hagedoorn, J., Kranenburg, H.V., 2006. Merger and acquisitions: their effect on the innovative performance of companies in high-tech industries. Res. Policy 35 (5), 642–654.
Cohn, E., Rhine, S.L.W., Santos, M.C., 1989. Institutions of higher education as multiproduct firms: economies of scale and scope. Rev. Econ. Stat. 71 (2), 284–290.
Curaj, A., Georghiou, L., Harper, J.C., Egron-Polak, E. (Eds.), 2015. Mergers and Alliances in Higher Education: International Practice and Emerging Opportunities. Springer, Heidelberg.
De Groot, H., McMahon, W.W., Volkwein, J.F., 1991. The cost structure of American research universities. Rev. Econ. Stat. 73 (3), 424–431.
Docampo, D., Egret, D., Cram, L., 2015. The effect of university mergers on the Shanghai ranking. Scientometrics 104, 175–191.
Fielden, J., Markham, L., 1997. Learning Lessons from Mergers in Higher Education, CHEMS, Paper, No. 17. (accessed December 2016). http://www.lifesciences.no/statisk/fusjonsprosessen/dokumenter/lessons_learning.pdf.
Fielden, J., 1991. Resource implications of mergers: are there any economies? Higher Educ. Q. 45 (2), 158–166.
Fisch, C.O., Block, J.H., Sandner, P.G., 2014. Chinese university patents: quantity, quality, and the role of subsidy programs. J. Technol. Trans. 41 (1), 60–84.
Gamage, D.T., 1992. Recent reforms in Australian higher education with particular reference to institutional amalgamations. Higher Educ. 24 (1), 77–91.
General Office of the State Council, 2000. Plans on Adjusting the Management System and Layout Structure of Colleges and Universities Affiliated to Departments of the State Council. ([in Chinese], accessed December 2016). http://www.gov.cn/gongbao/content/2000/content_60667.htm.
Georghiou, L., Harper, J.C., 2015. Mergers and alliances in context. In: Curaj, A., Georghiou, L., Harper, J.C., Egron-Polak, E. (Eds.), Mergers and Alliances in Higher Education: International Practice and Emerging Opportunities. Springer, Heidelberg, pp. 1–14.
Gummett, P., 2015. Reorganising the Welsh university system. In: Curaj, A., Georghiou, L., Harper, J.C., Egron-Polak, E. (Eds.), Mergers and Alliances in Higher Education: International Practice and Emerging Opportunities. Springer, Heidelberg, pp. 81–103.
Harman, G., Harman, K., 2003. Institutional mergers in higher education: lessons from international experience. Tert. Educ. Manage. 9 (1), 29–44.
Harman, K., Meek, V.L., 2002. Merger revisited: international perspectives on mergers in higher education. Higher Educ. 44 (1), 1–4.
Hazelkorn, E., 2008. Rankings and the battle for world class excellence: institutional strategies and policy choices. In: Paper for the Institutional Management in Higher Education (IMHE) General Conference. September 8–10, 2008, Paris, France.
Hazelkorn, E., 2014. Reflections on a Decade of Global Rankings: what we've learned and outstanding issues. Eur. J. Educ. 49 (1), 12–28.
Hu, Y., Liang, W., 2007. The impact of institutional merge in scientific research productivity in higher education: a Malmquist index analysis. Tsinghua J. Educ. 28 (1), 62–70 (in Chinese).
Huang, F., 2015. Building the world-class research universities: a case study of China. Higher Educ. 70, 203–215.
Johnes, G., Johnes, J., 2016. Costs, efficiency, and economies of scope and scale in the English higher education sector. Oxford Rev. Econ. Policy 32 (4), 596–614.
Johnes, J., Yu, L., 2008. Measuring the research performance of Chinese higher education institutions using data envelopment analysis. China Econ. Rev. 19, 679–696.
Johnes, J., 2014. Efficiency and mergers in English higher education 1996/97 to 2008/9: Parametric and non-parametric estimation of the multi-input multi-output distance function. Manchester School 82 (4), 465–487.
Johnston, R., 1994. Effects of resource concentration on research performance. Higher Educ. 28 (1), 25–37.
Kyvik, S., Stensaker, B., 2013. Factors affecting the decision to merge: the case of strategic mergers in Norwegian higher education. Tert. Educ. Manage. 19 (4), 323–337.
Lang, D.W., 2002. A lexicon of inter-institutional cooperation. Higher Educ. 44 (1), 153–183.
Lang, D.W., 2003. The future of merger–what do we want mergers to do: efficiency or diversity? Can. J. Higher Educ. 33 (3), 19–46.
Ljungberg, D., McKelvey, M., 2015. Collaborations between universities. In: Curaj, A., Georghiou, L., Harper, J.C., Egron-Polak, E. (Eds.), Mergers and Alliances in Higher Education: International Practice and Emerging Opportunities. Springer, Heidelberg, pp. 57–79.
Mao, Y.-q., Du, Y., Liu, J.-j., 2009. The effects of university mergers in China since 1990: From the perspective of knowledge production. Int. J. Educ. Manage. 23 (1), 19–33.
Martin, J., Samels, J.E., 1994. Achieving academic excellence through strategic mergers: a new approach. In: Martin, J., Samels, J.E., Associates (Eds.), Merging Colleges for Mutual Growth. Johns Hopkins University Press, Baltimore, pp. 3–21.
McGinnis, R.A., 2007. Merging two universities: the medical university of ohio and the university of toledo. Acad. Med. 82 (12), 1187–1195.
Mok, K.H., 2005. Globalization and educational restructuring: university merging and changing governance in China. Higher Educ. 50 (1), 57–88.

Nelson, R.R., Buterbaugh, K., Perl, M., Gelijns, A., 2011. How medical know-how progresses. Res. Policy 40 (10), 1339–1344.
Ng, Y.C., Li, S.K., 2000. Measuring the research performance of Chinese higher education institutions: an application of data envelopment analysis. Educ. Econ. 8 (2), 139–156.
Norgard, J.D., Skodvin, O.-J., 2002. The importance of geography and culture in mergers: a Norwegian institutional case study. Higher Educ. 44 (1), 73–90.
Olsen, J.P., Maassen, P., 2007. European debates on the knowledge institution: the modernization of the university at the european level. In: Maassen, P., Olsen, J.P. (Eds.), University Dynamics and European Integration. Springer, Dordrecht.
Patterson, G., 2000. Findings on economies of scale in higher education: implications for strategies of merger and alliance. Tert. Educ. Manage. 6, 259–269.
People's Daily, 2016. Educational Observation: Gains and Losses of Medical Education After University Mergers. August 26. ([in Chinese], accessed December 2016). http://edu.people.com.cn/n1/2016/0826/c1053-28668519. html.
Pinheiro, R., Geschwind, L., Aarrevaara, T. (Eds.), 2016. Mergers in Higher Education: The Experience from Northern Europe. Springer, Heidelberg.
Pinheiro, R., Geschwind, L., Aarrevaara, T., 2016b. A world full of mergers: the Nordic countries in a global context. In: Pinheiro, R., Geschwind, L., Aarrevaara, T. (Eds.), Mergers in Higher Education: The Experience from Northern Europe. Springer, Heidelberg, pp. 3–25.
Pruvot, E.B., Claeys-Kulik, A.-L., Estermann, T., 2015a. Designing Strategies for Efficient Funding of Universities in Europe. European University Association, Brussels.
Pruvot, E.B., Estermann, T., Mason, P., 2015b. Define Thematic Report: University Mergers in Europe. European University Association, Brussels, Belgium.
Rabe-Hesketh, S., Skrondal, A., 2008. Multilevel and Longitudinal Modeling Using Stata, second edition. Stata Press, College Station, TX.
Rhoades, S.A., 1989. A Summary of Merger Performance Studies in Banking,1989-93, and an Assessment of the Operating Performance and Event Studies Methodologies. Federal Reserve Staff Study 167. (accessed December 2016). http://www.federalreserve.gov/pubs/staffstudies/1990-99/ss167. pdf.
Rowley, G., 1997. Strategic alliances: united we stand: a strategic analysis of mergers in higher education. Public Money Manage. 17 (4), 7–12.
Salmi, J., 2009. The Challenge of Establishing World-Class Universities. World Bank, Washington, DC.
Science and Technology Office, 2016. 1996-2016 Gaodeng Xuexiao Keji Tongji Ziliao Huibian (Compilation of University Science and Technology Statistics). Office of the Ministry of Education, China, Beijing, China.
Skodvin, O.J., 1999. Mergers in higher education: success or failure? Tert. Educ. Manage. 5, 65–80.
Sursock, A., Smidt, H., 2010. Trends 2010 a Decade of Change in European Higher Education. EUA Publications, European University Association, Brussels.
Thomson Reuters, 2014. InCites Indicator Handbook. (Accessed December 2016). http://researchanalytics.thomsonreuters.com/m/pdfs/indicators-handbook.pdf.
Välimaa, J., Aittola, H., Ursin, J., 2014. University mergers in Finland: mediating global competition. New Directions Higher Educ. 168, 41–53.
Xinhuanet, 2001. Zhongshan Medical University Merged into Sun Yat-sen University. (October 29, 2001)[in Chinese], accessed December 2016. http://news.xinhuanet.com/zhengfu/20011029/938840. htm.
Xinhuanet, 2005. Shanghai Jiaotong University Merged with Shanghai Second Medical University on July 18. [in Chinese],(July 18, 2005)accessed December 2016.. http://news.xinhuanet.com/newscenter/2005-07/18/content_3235160. htm.
Xinhuanet, 2016. Magnificent Mergers in Sichuan University over 120 Years of Development. [in Chinese], accessed December(September 5, 2016). http://www.sc.xinhuanet.com/content/2016-09/05/c_1119512069. htm.
Yang, R., 2000. Tensions between the global and the local: a comparative illustration of the reorganisation of China's higher education in the 1950 and 1990. Higher Educ. 39, 319–337.
Yang, R., 2015. Institutional mergers in Chinese higher education. In: Curaj, A., Georghiou, L., Harper, J.C., Egron-Polak, E. (Eds.), Mergers and Alliances in Higher Education: International Practice and Emerging Opportunities. Springer, Heidelberg, pp. 123–144.
Yuan, C., Sun, H., Fang, K., 2013. The effects of institutional change on university knowledge transfer during the transition period: evidence from the university mergers in China. Chin. J. Manage. 10 (3), 451–457 (in Chinese).
Zhang, H., Patton, D., Kenney, M., 2013. Building global-class universities: assessing the impact of the 985 Project. Res. Policy 42, 765–775.