



Valuing research output: Evidence from a Chinese university

Yuelong Wang^a, Xin Xie^{b,*}, Yongbing Yang^a

^a Jiangxi University of Finance and Economics, Center of Regulation and Competition, China

^b East Tennessee State University, Department of Economics and Finance, 227 Sam Wilson Hall, Johnson City, TN 37614, United States of America

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ABSTRACT

Exploring the economic value of research output is a crucial but neglected issue and thus is worth gaining attention. Using data concerning the promotion from a medium-ranked university in China during 2011–2019, this paper proposes a novel methodology that combines a regression discontinuity design and the theory of “Value of a Statistical Life” to quantify the monetary value of research output. Our findings suggest that each unit of research score is worth \$467 for a promotion to associate professor and \$515 for full professors. Based on the rate for full professors, the computed economic values for a publication in ordinary journals, famous journals, and top journals are around \$1,538, \$5,154, and \$20,615, respectively. Additionally, the economic value of a book publication is approximately \$7,723. These research outputs are significantly undervalued compared to the faculty's own total income, the income of peers in similar sectors, or the income of peers from other countries' higher education. Our analysis provides not only insights for incentive system reform for Chinese higher education but also a methodology that can be universally applicable to any higher institutions that use the scoring system or set implicit research standards in the promotion and merit process.

1. Introduction

How to price an academic work? This question relates to rewarding structure and incentive schemes for higher education institutions. It is generally agreed that economic incentives could motivate researchers' academic productivity and improve their efficiencies. Considerable research has analyzed different types of incentive schemes to promote efficient creation of academic research and concludes that competition conditions (Checchi, De Fraja, & Verzillo, 2020), tenure system (MacLeod & Urquiola, 2021), level of prorotation of authorship credit (Liebowitz, 2014), resources allocation in research positions and lab expansion (Stephan, 2012), and tolerance for early failure and reward for long-term success (Azoulay, Graff Zivin, & Manso, 2011; Ederer & Manso, 2013; Manso, 2011) will influence academic efficiency or creativity.

In present China, with a substantially increasing amount of funds flown to education and scientific research, the obstacle that impedes the development of higher education is the rewarding structure, that is, how to allocate funding to reward academic achievement to incentivize high-end research outputs. Over the past few decades, according to Wei, Xie, and Zhang (2017), China has dramatically increased its research and development spending, from 0.7% of GDP in 1991 to 2.05% of GDP in 2014. With such a significant amount of innovation effort, China has seen remarkable development in scientific research. China's total number of science and engineering articles increased by 20 times from 1990 to 2011, and over the same period, the China versus United States (U.S.) ratio

* Corresponding author.

E-mail addresses: wangyuelong@jxufe.edu.cn (Y. Wang), xiex01@etsu.edu (X. Xie).

of average citation counts rose from 26% to 55% (Xie, Zhang, & Lai, 2014). However, the quality of research lags, and the innovation gap between China and some advanced countries is still distant. A lack of a better incentive system could contribute to such a gap. Zhang (2014) points out that building a high-quality faculty is the key to promoting research productivity in Chinese universities. Over the past decade, China's leading universities have been taking steps to enhance research productivity, but more fundamental reforms are needed. For example, as more Chinese research universities recruit high-profile overseas scholars at high salaries, local faculty feel overlooked.

To better establish an efficient incentive system, institutions must determine the monetary value of academic work, such as a published article or a book. Research outputs produced by universities provide a strong impetus for economic and social development. Jaffe (1989) finds evidence of the importance of geographically mediated commercial spillovers from university research. The findings of Mansfield (1991) suggest that the development of one-tenth of the new products and processes commercialized during 1975–85 in some specific industries results from academic research of that time. South Africa implemented a publication-incentive program in 2005, awarding \$7935 for each additional published article with an aim to foster academic excellence. This program had a significant effect – the yearly number of publications rose from 4063 in 2005 to 25,371 in 2018 but also caused so much debate. Some argue that the rewards make scholars pursue predatory journals and the distribution of funds based on the number of authors discourages collaboration (Hedding, 2019). Nevertheless, while National Research Foundation announced cutting the funding to the program, many criticized this decision, believing that the funding cut discouraged researchers from applying for the rating (Wild, 2017).

In this paper, we aim to estimate the monetary value of research outputs using data from a medium-ranked public university in China during 2011–2019. Such analysis will help us understand the current efforts to incentive research productivity in Chinese universities similar to the one studied in our case.

However, pricing research outputs is such an obscure thing. Just like we do not normally value a person's life, research outputs are not usually priced as they are not for sale in the market. Regardless of priceless life, Schelling (1968) proposes the theory of “Value of a Statistical Life (VSL)” in his article “The Life You Save May Be Your Own.” VSL implies how much individuals are willing to pay to reduce the risk of death. As the example in Greenstone and Nigam (2020), if the average individual is willing to pay \$10,000 to avoid a 0.1% chance of death, the VSL will be \$10 million per statistical life saved. In that vein, we are inspired to follow the theory of VSL to estimate a monetary value for academic work in this paper.

There are just a few studies in the literature that have explored economic values for research outputs. Tuckman and Leahey (1975) estimate lifetime returns to selected article categories by academic rank for full-time male faculty in university economics departments during the academic year 1972–73. Based on a 5% discount rate, they find that returns to the first publication are \$12,340, \$10,256, and \$6958 for an assistant professor, an associate professor, and a full professor, respectively. They also discover that marginal returns decrease rapidly as more publications are added, with such a decrease in returns for book publication being higher than for article publication. For faculty members without published articles, the monetary value for 1.37 books is equal to that for the first-time publishing article. Using the data on economists in the University of California system in 2010, Gibson, Anderson, and Tressler (2014) find that economists without having any articles in any of the Top 5 economics journals face a salary decrease of about 5%–7%. Heckman and Moktan (2020) document evidence that between 1996 and 2010, one more publication in top five economics journals could increase the probability of receiving tenure by as high as 19% in the top 35 economics departments in universities in the United States. Recently, Faria and Mixon (2021) include the marginal impact of an academic publication on total citations to a scholar in their model and find that this variable is associated with a 2.8% to 8.9% increase in the salaries of college faculty.

Most of the studies in the literature either have been conducted in the remote past or mainly focus on estimating economic value for publications in top journals. Additionally, simply by looking at income differential by academic rank, the endogeneity problem may still exist, consequently causing biased results on estimation for the value of research work. To deal with this problem, we suggest a methodology that combines a regression discontinuity (R.D.) design and VSL estimation. In particular, following Jacob and Lefgren (2011), we first utilize an R.D. design to estimate the change in promotion probability, relying upon the fact that promotion is awarded based on observable research scores.¹ Next, in line with VSL estimation, we calculate the economic value for the promotions to associate and full professors by dividing the salary differential for each type of promotion by the corresponding probability change. The threshold research score in the R.D. design is the exerted effort for the applicant to get the promotion, so the division of the economic value for the promotion by the threshold research score is the economic value per unit of research score. Then, this can be used to compute the monetary value for each type of research output while each type has been assigned a fixed amount of research points.

As MacLeod and Urquiola (2021) emphasize, the key to rewarding research is whether the university observes meaningful measures of research output. Generally, Chinese universities have a set of rules to compute research score for each promotion applicant. Thus, the research score is a good measure of research output and serves as the running variable in the R.D. model. The role that research score plays in the analysis is not only to serve to estimate the R.D. model but also to help compute the monetary value for each type of academic research. To our knowledge, apart from Chinese universities, some universities from other countries² use a similar score as an evaluation indicator in the decision to promote.

Based on a sample from a Chinese university, hereafter called University A, our findings suggest that each unit of research score is

¹ In the process of faculty promotion in many Chinese universities, research score is calculated for each applicant based on their research performance and then serves as a measure of reference for reviewers to make voting decision.

² As we check, there are universities using the promotion and merit scoring system in Tennessee, Georgia, and Rhode Island the United States.

worth \$467³ to an associate professor and \$515 to a full professor. Based on the rate for full professors, we compute the economic values for a publication in ordinary journals, famous journals, and top journals,⁴ which are around \$1538, \$5154, and \$20,615, respectively. The economic value for a book publication is approximately \$7723, and a project supported by the national government, the ministry of education, and the provincial government are worth \$20,615, \$7723, and \$2569, respectively. These research outputs are significantly undervalued compared to the faculty's own total income, the income of peers in similar sectors, or the income of peers from other countries' higher education.

The paper contributes to the literature in two ways. First, this analysis provides a novel approach to exploring the monetary evaluation of research work. Our identification strategy allows us to indirectly estimate economic value for different types of research outputs through promotion probability. In line with Faria et al. (2013) finding that the number of academic publications is an important consideration for academic promotion across all types of university settings, research score plays a vital role in determining the promotion probability in our setting. Our proposed method is believed to be applicable to the universities that explicitly adopt a similar scoring system or implicitly set research standards in the faculty promotion process.

Second, the results of our paper imply that faculty promotion and merit system can serve as an essential pathway to increase economic value for research output and thus impel faculty to work more productively on academic work. According to the tournament model by Lazear and Rosen (1981), a more considerable salary increase due to promotion incentivizes faculty to make more significant efforts to gain a promotion. Meanwhile, it is also necessary to increase salaries for all ranks to recruit more outstanding young academics. We also suggest that the promotion and merit system emphasizes research quality rather than quantity. As Besancenot et al. (2009) indicate, the competition among business schools with a large research productivity gap could drive them to do too much research, likely leading to the neglect of teaching quality and inefficient social outcomes. In light of this possibility, our proposal to more value research quality but not quantity will reduce these adverse effects. Further, it could increase the value of research work, which also corresponds to the policy guidelines introduced by the Chinese government in recent years.

The remainder of the paper is organized as follows. Section 2 provides relevant information on the procedure for applying for promotion. The methodology and estimated results are presented in Section 3. In Section 4, we show the results for validity tests of the R.D. design. The estimation results and relevant policy suggestions are discussed in Section 5. Section 6 concludes.

2. Procedure for applying for promotion

2.1. Faculty promotion and merit procedures in Chinese universities

The United Kingdom has a competitive academic structure for faculty promotion, in which there are only limited quotas for faculty to be promoted in British colleges. It is often due to retirement or great inter-university mobility to open a promotion opportunity. By contrast, in universities in the United States, faculty members do not compete for limited merit or promotion opportunities. Many qualified candidates could take six years or even less to get promoted from assistant to tenured associate professor. The extent of competition for faculty promotion in Chinese universities is in some in-between state. According to its number of officially budgeted posts, each public higher education institution must maintain a certain proportion of faculty regulated by the national education department for each appointment level. This proportion varies by institution. For example, "Double-First Class" universities⁵ in Henan province classified as three types - having doctorate, master, and bachelor students - are required to have associate professors and higher rank at 53%, 49%, and 45% at maximum, respectively. Such ratios are as low as less than 10% for higher vocational colleges. By looking through the websites of faculty information of other colleges in China, we find that the ratio of professor rank in province-affiliated universities in other provinces is similar to the above in Henan province. However, this ratio can be up to 80% for the universities directly under the ministry of education.⁶ In the spirit of the related documents,⁷ the faculty promotion and merit system has become more decentralized. Except for some higher vocational colleges, which lack the capacity to evaluate faculty promotion and merit due to weak academic strength, most Chinese colleges conduct an assessment of professional titles for themselves.

The general procedure for reviewing the application for faculty promotion is similar across major Chinese universities. First, the applicants must submit their application files. Universities with the ability to evaluate faculty promotion set their criteria so long as these are consistent with provincial higher education regulations. Faculty can be categorized as teaching-oriented, research-oriented, and a combination of both. Promotion and merit criteria are customized for each category and discipline. Education, academic

³ We use the U.S. dollar to measure the values of promotion and publication throughout the paper.

⁴ In the promotion and merit process in University A, journals are categorized into three groups: ordinary, famous, and top. The ordinary group includes journals indexed by the *Chinese Social Science Citation Index* (CSSCI), the famous group includes top field journals, the rank of which in China is similar to that of the *Journal of Development Economics* internationally in Economics, and the top group includes a few highly top journals, the rank of which in China is similar to that of Top five journals internationally in Economics.

⁵ Chinese authorities released a selected list of universities and colleges, which participate in the country's construction plan of world-class universities and first-class disciplines. They are the so-called "Double-First Class".

⁶ For example, the official website of Peking University reveals that in 2018, there were 3358 faculty members, among which 1486 hold full professor title and 1451 are associate professors.

⁷ The files include "Opinions of the State Council on Deepening the Reforms of team construction for college faculty in an all-round way" and "Opinions on deepening the reforms of simplifying administrative procedures, Delegating Powers and Combination of the Simplification and Delegation and Optimizing Services in the Field of Higher Education"

experiences, teaching loads, publications, and the number and level of projects supported by governments and institutions are considered while the applicant for promotion is reviewed. The discrepancy in the criteria across universities can be significant. Most national key universities require that candidates hold a doctorate, publish several papers in journals from a specified list as first author or corresponding author, and lead research project group(s) at the national level. However, as of 2016, the Chinese government introduced two documents⁸ focusing on adjusting the tendency of only valuing education background, seniority, and published papers. These documents advocate for representative publications as a vital reviewing criterion, with more weight on the quality of research work but less on the quantity. For the same token, it is recommended to bring in a peer evaluation mechanism involving both market and social evaluations.

After knocking out the applicants who fail to meet the basic requirements, the evaluation process will continue for the rest of the applicants because more applicants meet the basic requirements than the quotas for a faculty rank. Each university will set up its assessment system, including three evaluation steps by the college-level faculty promotion committee, discipline assessment group, and university-wide promotion committee. The collegiate promotion committee, consisting of senior faculty members as well as department chairs and college deans, ranks the candidates but only as a reference in the voting process, and no one is struck out in this stage. To some large extent, the candidates are ranked in terms of their seniority and contribution to the college instead of their research accomplishments. Therefore, this ranking has a minimal effect on the final results. The discipline assessment group is composed of experts from inside and outside of the university. The selected experts will conduct a professional evaluation of the candidates according to the classification of disciplines, including natural science, social science, humanities, and engineering science. In this stage, some candidates would be struck out. At last, it is reviewed and voted upon by the university promotion committee members,⁹ who are randomly selected from the discipline assessment group. The candidates who get votes with less than two-thirds of the total will go out.

Some candidates have to go out in the second and third steps in this procedure, which might be caused by the factors such as the quantity and quality of projects, papers, academic books, and awards. Faculty promotion and merit system plays an essential role in leading the development of the discipline and the university. For the convenience of evaluation, each university calculates a research score for each applicant using a formula considering both the quantity and quality of their research work. Then, reviewers mostly vote by the research scores. Each university has a different discipline classification system, in which some fields are favored over others as the leading disciplines because they are considered more central to the mission of the university. As a result, the formula to compute research scores varies significantly across universities. For instance, many national key universities only count publications of the journals from a specified journal ranking list, but those published in other journals are not scored. The research score is the determining indicator for committee members to judge an applicant's qualification while voting. This is mainly because the external members in the discipline assessment group and university-wide promotion committee, who account for a high proportion, do not understand each applicant regarding their teaching, service, and so forth. Thus, research score-based appraisal seems fair and convenient.

2.2. A case from University A

We will focus on the promotion and merit system details using an example of University A in China.¹⁰ University A is not listed in Project 211, Project 985, or Double First-Class initiative,¹¹ but is a national key university that has been authorized to offer doctorate degrees for multiple first-level disciplines¹² and is ranked around 120th in China. In more than 30 provinces of China, only the first batch of students participating in the national college entrance examination can be enrolled in University A. University A is a public regional research university with major disciplines in business and management and other fields in legal law, engineering, art, and science.

We then discuss the flow of promotion and merit system in a University A. Every June, the department of human resources announces the notice to start accepting applications for faculty promotion. The application forms, which should be filled out with applicants' information on teaching and research, are available for download at the university's website. The Provost will approve the forms upon completion, given the provided information. Performance in teaching is usually measured in terms of teaching load. Concerning research, peer-reviewed articles, research grants, and academic books are the main accomplishments. As for peer-reviewed papers, the university has specified a journal directory that includes international and national journals, each assigned a score for the evaluation. More specifically, for the national publications in Chinese, those published in ordinary journals (CSSCI¹³), famous journals

⁸ Including "Opinions on Deepening the Reforms of Professional Titles System" and "Guiding Opinions on Deepening the Reforms of College Faculty Assessment System".

⁹ Typically, there are over 25 members in the promotion committee members and the ratio of experts from outside is higher compared to that from inside.

¹⁰ Only the data of University A are used in the analysis because the information of promotion applicants in each university is confidential and thus hard to acquire. However, one of the important takeaways of the paper is to propose a methodology which can be applied to many universities that have their own research scoring system to evaluate their research work.

¹¹ These titles represent the blueprints for tertiary education policy and part of a long-term plan to improve the quality, capacity, and prestige of China's top 100 or so universities.

¹² First level disciplines are a family of disciplines in higher education institution.

¹³ CSSCI, abbreviated for Chinese Social Sciences Citation Index, is an interdisciplinary citation base in China that covers about 500 Chinese academic journals of humanities and social sciences.

(top field journals), and top journals (a few top journals) are each assigned 3, 10, and 40 points, respectively. Each publication in an international journal at an ordinary level (SCI/SSCI¹⁴) is assigned 20 points. Top international journals may be given 40, 60, 100, or so. Research grant is an essential factor and is given more or less weight according to the nature of the funding source. For example, a project supported by the National Natural Science Foundation of China (NSFC) or the National Social Science Fund of China (SSFC) could obtain 200, 80, or 40 points based on the types of programs. The national and provincial governments' grants will receive 15 and 5 points, respectively. A book writing is worth 15 points. The above scoring rule is for single authorship. If a paper or book is authored by two, the points should be split with a ratio of 6:4; authored by three, the points should be split with a ratio of 5:3:2; authored by four or more, the first author will get half points, and the other authors will evenly share the other half points. As for research grants, the principal investigator gets 70% of the points, and others will share the rest 30%.

By following the above rules, each applicant's research score can be calculated and serve as the basis for voting. Especially before the policy proposed by the Chinese government aiming to devalue the quantity of research work but to attach importance to representative research work, research score plays a decisive role in faculty promotion.¹⁵ This will be confirmed with the data in the later analysis. The faculty promotion procedure is shown in Fig. 1. First, the department of human resources collects and reviews all application forms according to the requirements on seniority, education, teaching, research, and services to confirm applicants' eligibility for being assessed for the promotion and then send applicants' representative research work (usually three papers) to two external professors for review. With the consent of the external reviewers, the applicants will be qualified as the promotion candidates, and the list of candidates will be posted in October. Next, the promotion and merit procedures will continue with review by the college-level faculty promotion committee, discipline assessment group, and university-wide promotion committee. As discussed before, no one would be struck out in the first step, but all the candidates are ranked through the voting of the committee members. Since the committee members might know the candidates well, their votes are primarily based on their seniority and contributions to the college. It has ever happened that the first-ranked candidate failed to be promoted in University A. In each of the following two steps, 20% of the candidates would be washed out. Research score plays a vital role in these two steps because quite a few committee members are external without knowing the candidates, and thus research score becomes a critical basis they rely on to make judgments.

Tables 1 and 2 provide detailed information on University A's faculty promotion from 2011 through 2019. As shown in Table 1, 413 and 201 have applied for associate professor and full professor, respectively, and among each group, 56.66% and 52.74% have been successfully promoted. Compared to the promotion to associate professor, there are half fewer candidates for the promotion to full professor, and it is also less likely for them to get promoted. This is mainly because the threshold for qualification for being considered for promotion to full professor is relatively higher. The fact that over 50% of the candidates can get promoted to both ranks and over 60% of them may get promoted with no more than two attempts¹⁶ implies that the candidates must compete with others for promotion, but the competition is not that fierce. After all, University A is not a top-tier college in China but ranks about 120th. Taking a closer look at the numbers across the years, the promotion rates for 2011 and 2012 are the lowest, with less than 50%, especially in 2011 the full professor promotion rate was only one-third. The promotion rates have been constantly increasing in the following years, with a breakthrough of 60% in 2016 and 2017, and then falling in 2018 and 2019. The change shall be related to the government's policy in 2016, discussed before in the paper.

As previously stated, research scores are important in the promotion and merit system at University A. To better understand how it would affect the final results, we introduce the concept of promotion threshold for our R.D. design. It is an assigned cutoff for a promotion score above which the promotion will be more likely. Following the method used by Jacob and Lefgren (2011), our threshold is determined on the basis of the number of faculty who got promoted to each rank each year. More specifically, we arrange all the candidates' research scores in descending order for each of the promotion ranks, and then the threshold will be the research score for the last candidate who is awarded a promotion. For example, if there are 40 candidates for the rank of associate professor and 24 of them eventually get promoted, the threshold would be the score for the 24th candidate after sorting all the candidates' scores from the highest to the lowest. For the promotion to associate professor, we group all the candidates into three disciplines: humanities and social science (social), economics and management (econ & mana), and natural science (science), and thus the thresholds are at the discipline-year level. For the promotion to full professor, due to the limited candidates for each discipline each year, we aggregate the data into a single one; thus, the thresholds are yearly. Table 3a displays the total number of candidates whose research scores are above and below the cutoff for the promotion ranks of associate and full professor, respectively, each year. As shown, there is a large variance in cutoff points across years. Despite the cutoffs being determined by all the candidates, no one is able to manipulate the cutoffs. Thus, we regard the cutoffs as exogenous in our setting. Table 3b summarizes our data on promotion rates according to the promotion threshold. It shows that over 70% of those who pass the threshold were promoted, implying that research score is an essential factor that may determine the final results.

Figs. 2 depict the threshold trend from 2011 to 2019 in University A for the promotion to associate and full professor, respectively. Fig. 2a shows that the overall promotion threshold for associate professors in University A fluctuates around 60, with an increasing

¹⁴ SCI and SSCI represent the abbreviations for Science Citation Index and Social Sciences Citation Index, respectively.

¹⁵ In response to the government's reform on professional titles, University A stopped using research scores in the faculty promotion and merit system in 2018 and 2019. Due to the small sample size of our analysis, we still calculate research score for the candidates in 2018 and 2019 so that we can use these two years of data.

¹⁶ Majority of Chinese universities do not limit the number of attempts of applying for faculty promotion and thus it is common for some faculty members to apply more than once. In University A, there are actually 218 and 140 faculty members who have applied for promotion to associate and full professors, respectively, during 2011 and 2019.

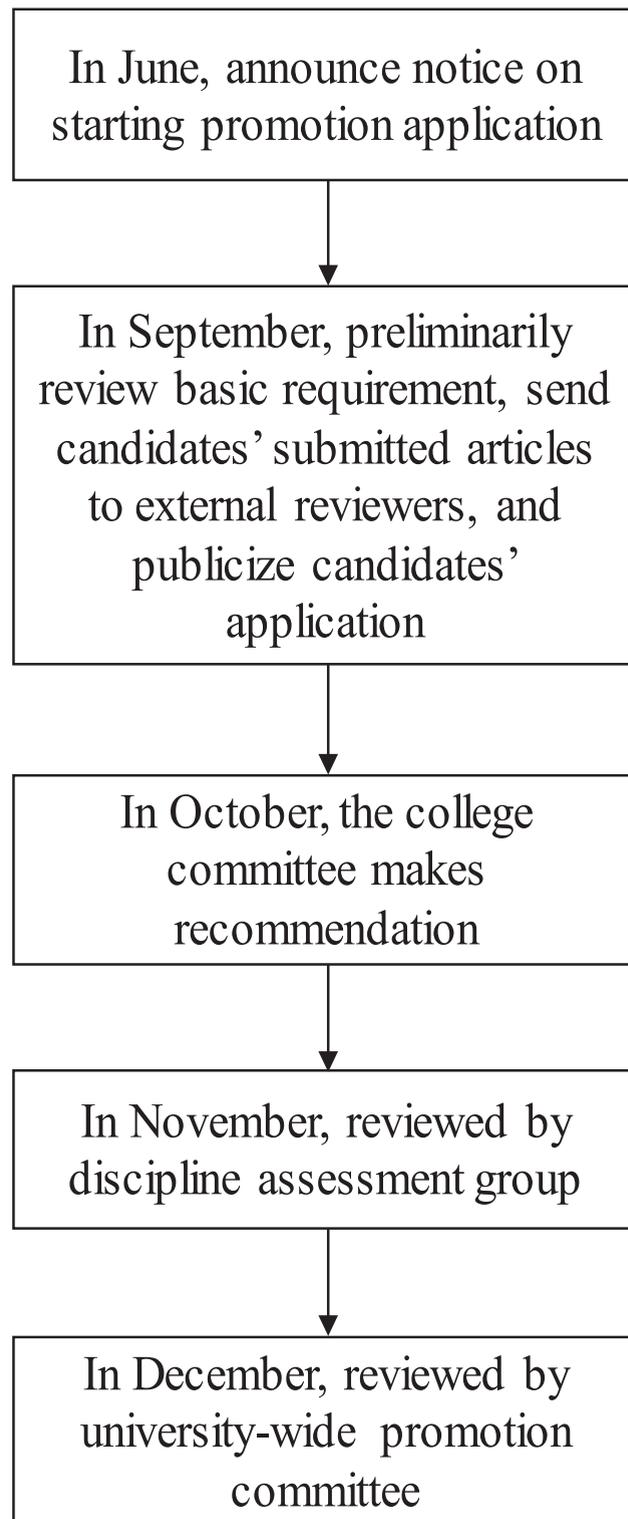


Fig. 1. Promotion flowchart in University A.

trend. Classified by discipline, the average threshold for natural science is the highest, with a majority around 90 but the lowest at 34 in 2019. The thresholds for economics & management and humanities & social science are just around 60. Fig. 2b does not show a certain pattern of threshold trend for the promotion to full professor with a large discrepancy across the years, possibly due to the small sample

Table 1
Promotion information 2011–2019 in University A.

Year	Associate Professor			Full Professor		
	Total applicants	Number of promoted	Chance of being promoted	Total applicants	Number of promoted	Chance of being promoted
2011	51	23	45.1	24	8	33.33
2012	35	17	48.57	15	7	46.67
2013	38	21	55.26	13	7	53.85
2014	59	35	59.32	30	16	53.33
2015	52	31	59.62	24	15	62.5
2016	46	29	63.04	24	13	54.17
2017	45	27	60	17	11	64.71
2018	41	23	56.1	22	12	54.55
2019	46	28	60.87	32	17	53.13
Total	413	234	56.66	201	106	52.74

Table 2
Distribution of the number of attempts for promotion.

Associate Professor			Full Professor		
Total attempts	Number of individuals	Percentage	Total attempts	Number of individuals	Percentage
1	133	32.20	1	64	31.84
2	158	38.26	2	60	29.85
3	48	11.62	3	36	17.91
4	16	3.87	–	–	–
Failed during 2011–2019	58	14.04	Failed during 2011–2019	41	20.40
Total	413	100	Total	201	100

Table 3a
Research cutoffs for sample observations for each year.

	Associate Professor			Full Professor
	Humanities & Social Science	Economics & Management	Natural Science	All disciplines
2011	18	19	12	24
2012	12	13	7	15
2013	17	13	7	13
2014	14	27	8	29
2015	13	23	8	24
2016	9	26	7	24
2017	13	26	4	17
2018	8	20	7	22
2019	12	26	4	32
Total	116	193	64	200

Table 3b
Relationship between research score and being promoted.

	Associate professor				Full professor			
	below threshold research score		Above threshold research score		below threshold research score		Above threshold research score	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Promoted	60	33.52	174	74.36	31	32.63	75	70.75
Failed	119	66.48	60	25.64	64	67.37	31	29.25
Total	179	100	234	100	95	100	112	100

size. However, the threshold for a full professor is higher than that for an associate professor for each discipline, and both the figures show higher thresholds for natural science than for the others. The reason might be that more existing scientific scholarly journals and a shorter review process make it relatively easier to get papers published. Moreover, scientific journals usually have higher impact

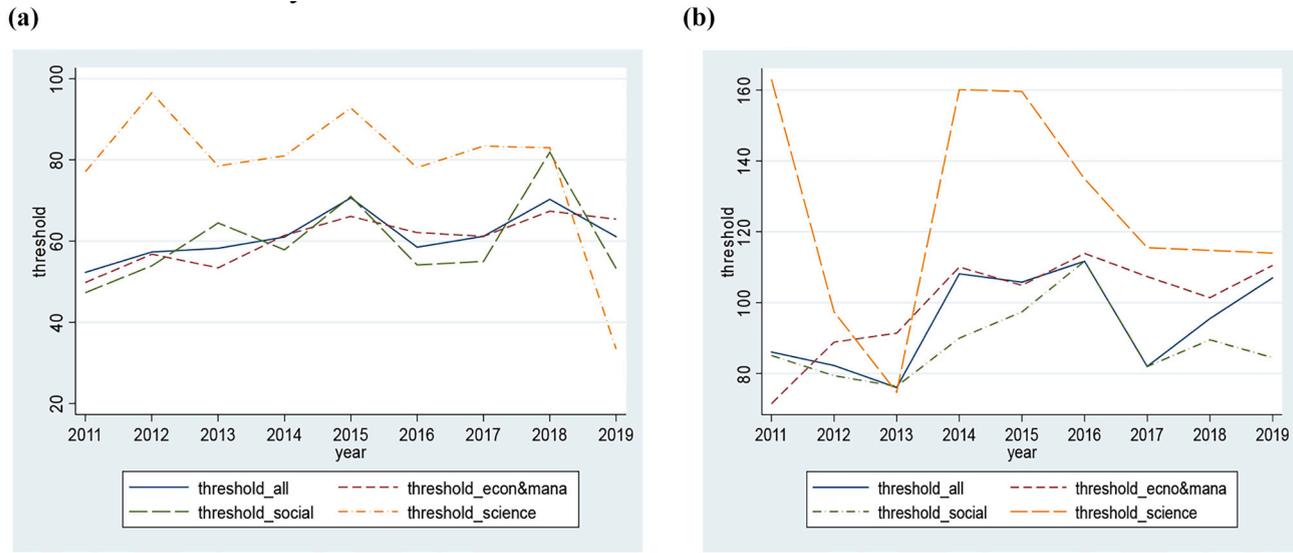


Fig. 2. a Threshold trend for associate professor. b Threshold trend for full professor.

factors and thus raise the promotion threshold.¹⁷ Since 2016, policies regarding the reform of professional titles have been implemented. In response to the central government's call, University A canceled the action of computing research scores in the faculty promotion and merit process and thus led to the decreasing trend of threshold in the most recent years, especially for the natural science subject.

To further evaluate whether research score plays a crucial role in the promotion process of University A, we conduct a regression analysis to estimate the effects of research on successful promotion to associate and full professor, respectively. Table 4 reports a series of OLS estimates. For both promotion ranks, we include progressively more controls – age, gender, education, overseas study experience or not, whether receiving a degree from the school, annual average teaching hours, teaching evaluation, and whether leading national projects. It is evident that research score has a statistically significant effect on both outcomes. Specifically, every one-point increase in research score leads to a 0.8% and 0.5% increase in the probability of successful promotion to associate professor and full professor, respectively. As indicated in Table 1, the likelihood of being promoted to associate and full professor are 57% and 53%, respectively; therefore, a one-point change in research score makes the successful probabilities of promotion change by 1.4% and 0.9% for associate and full professor, respectively. As a result, research score can be a good fit in our R.D. model to estimate the probability of promotion.

2.3. Income situation of faculty in Chinese universities

On account of estimating the economic value of research work, it is imperative to know about the general income situation of faculty in Chinese universities. In current Chinese universities, other than a few high-level professionals subject to annual salaries according to the contracts, most university faculty members have their income composed of these parts: post salary, pay grade wage, basic performance-based salary, awarding performance-based salary, and compensation for teaching and research. Post salary, pay grade wage, and basic performance-based salary are government budgets and do not vary much across regions. The amounts are not affected by the performance of faculty members but are based on their professional ranks and length of work. As time goes by, these amounts will increase accordingly. These three parts account for approximately 70% of the total income and thus play an essential role in determining the wage differential among faculty members. By contrast, awarding performance-based salary and compensation for teaching and research are paid by the university and determined by the actual teaching load and research performance within that year or the employment period. If faculty members finish all the mandated tasks, they will receive the whole amount of awarding performance-based salary; otherwise, just part of it. If they over-complete the required tasks, compensation for extra accomplishment will be paid.

During the period 2011 to 2019, the average annual incomes for a lecturer, associate professor, and full professor in University A were \$18,462, \$23,077, and \$32,308, respectively, based on completing the required teaching load. The required teaching load is 256 teaching hours for every faculty member, and the requirement on research amount as measured by research score is 1, 3, and 7 points for the above three ranks, respectively. One point of research score can substitute for 32 teaching hours, but not vice versa. If we convert teaching hours into research scores to uniformly measure the overall performance of each candidate in the promotion and merit process, the required score for each of the three ranks would be 9, 11, and 15 points. Furthermore, for the one extra point above the requirement, the compensation of University A is \$154. In addition, each project supported by the national government and each publication as the first author in any of the national top or famous journals will be awarded additional compensation, ranging from \$770 to \$23,077. We will discuss this in detail in the following section.

3. Methodology and results

According to the view of Tuckman and Leahey (1975), the return to article publication may contain direct pay salary increments, career-related option effects, and promotion-related salary increments. The first two types are determined by academic performance and the university's budgetary status and are thus endogenous. We, therefore, utilize the promotion to associate and full professor, which is awarded on the basis of observable research scores to indirectly estimate the monetary worth of academic work. Our analysis depends on the assumption of the theory of VSL. For example, if one would like to spend \$10,000 to reduce 0.1% of fatality, this person's life is worth \$10,000,000. Similarly, in our case, the return to the professional promotion for an applicant represents the worth of her academic work, which is deemed as the effort made by the faculty member. Thus, the economic value of the endeavor on academic work is to be estimated.

We have borrowed the method used by Chen, Shi, and Tang (2019), who estimate the market value of hukou (household registration). In our analysis, we use the research score thresholds previously discussed for promotions to associate and full professor as the cutoffs in an R.D. design to estimate the successful promotion probability changes. With the combination of the income differentials among a lecturer, an associate professor, and a full professor, we will calculate the monetary value of one unit of research score with the formula shown as follows:

¹⁷ Even though University A more specializes in programs related to business and management, some top journals with high impact factors count with more points for promotion. For example, one publication in *Nature* or *Science* can receive 100 points but only 60 points in *American Economic Review*.

Table 4
Regression estimation for being promoted.

Variables:	Associate professor			Full professor		
	(1)	(2)	(3)	(4)	(5)	(6)
Research score	0.007*** (9.631)	0.008*** (10.118)	0.008*** (6.645)	0.005*** (6.668)	0.005*** (6.409)	0.005*** (6.225)
Male	-	-0.013 (-0.233)	0.022 (0.283)	-	-0.021 (-0.237)	0.027 (0.250)
Age	-	-0.009* (-1.697)	-0.006 (-0.913)	-	0.012 (1.478)	0.016* (1.688)
Holding doctorate degree ^a	-	0.147 (1.631)	0.162 (1.140)	-	-	-
Overseas study	-	-	-0.044 (-0.406)	-	-	-0.001 (-0.012)
Whether receiving a degree from the school	-	-	-0.012 (-0.170)	-	-	-0.040 (-0.481)
Average yearly teaching hours	-	-	-0.000 (-0.093)	-	-	0.000 (1.005)
Teaching evaluation	-	-	0.002 (0.100)	-	-	0.029 (0.954)
Whether leading national projects	-	-	0.112 (1.027)	-	-	0.060 (0.743)
Subject F.E.	Yes	Yes		Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Obs. ^b	410	410	222	201	201	160

Notes: Equations are estimated using ordinary least squares. *** statistically significant at 1%; ** statistically significant at 5%; and * statistically significant at 10%. Same for the below.

^a Because every applicant in the sample holds doctorate degree, we fail to estimate the effect of education on being promoted.

^b Due to considerable missing values for some variables, quite a lot of observations are dropped from the regressions.

$$\text{unit value of research score} = \frac{\text{income increase attributable to the promotion}}{\text{promotion threshold} \times \text{increase in promotion probability}} \tag{1}$$

In Eq. (1), the income increase attributable to the promotion has been available, which is \$4615 for the promotion to an associate professor from a lecturer and \$9231 for the promotion to a full professor from an associate professor, and the promotion threshold which can be identified are based on the number of successful candidates. Our task is to estimate the increase in promotion probability.

We implement an R.D. design using the parametric estimation method. Our identification strategy relies on the fact that promotion is awarded based on observable research scores. The logic behind the R.D. design is that candidates whose scores are just above or below the promotion cutoff will not be different in any unobservable determinants of the research output but will experience a significant difference in the likelihood of receiving the promotion. $Score_{ijt}$, representing the research score of candidate i in subject j in year t , is the running variable. As described earlier, we define the $Cutoff_{jt}$ as the score of the last promoted candidate in discipline j in year t . The basic model of parametric estimation is set as Eq. (2) below:

$$Promotion_{ijt} = \beta_0 + \beta_1 Eligibility_{ijt} + f(n_{ijt}) + \mu_j + \gamma_t + \epsilon_{ijt} \tag{2}$$

where $Promotion_{ijt}$ indicates whether candidate i from discipline j in year t was successfully promoted with 1 being yes and otherwise 0, $Eligibility_{ijt}$ is a binary variable that equals 1 when $Score_{ijt} \geq Cutoff_{jt}$, otherwise equals 0. $n_{ijt} = Score_{ijt} - Cutoff_{jt}$ denotes the normalized research score. We also control for the discipline fixed effect μ_j and the year fixed effect γ_t . ϵ_{ijt} is a random error term for candidate i . $f(n_{ijt})$ denotes a polynomial function of the normalized research score, which includes the linear term of n_{ijt} and may include the interaction of this term and the treatment variable $Eligibility_{ijt}$.

Figs. 3 plot the probabilities of being selected for the promotion to associate and full professor, respectively.¹⁸ Both graphs show a significant jump in the vicinity of the cutoff score. The probability of promotion on the right side is 15.3% and 18.3% higher than that on the left side for associate and full professors, respectively. According to Eq. (1), the values for the promotion to associate and full professor are respectively \$30,163 (4615/15.3%) and \$50,442 (\$9231/18.3%), which are higher than the actual annual incomes of the associate and full professors in University A, \$23,077 and \$32,308, respectively. As a matter of fact, the above results are underestimated to a large extent. There are two reasons for this. First, we have implicitly assumed that some candidates whose research scores are in the vicinity of the cutoff point and fail in the promotion will be very likely to be selected in the following year, and thus the income gap due to the promotion could exist for only one year. However, the reality is that the promotion to associate or full professor might not go smoothly because it could take several years for some faculty members to get promoted, and even more time is needed for

¹⁸ We use a bandwidth of 50 points for the RD estimation for the promotion to association professor. However, for the estimation for the promotion to full professor promotion, we use the whole sample with the overall threshold without grouping by subject because the sample size is only 201, which means there are only around 20 candidates by average each year for the entire university.

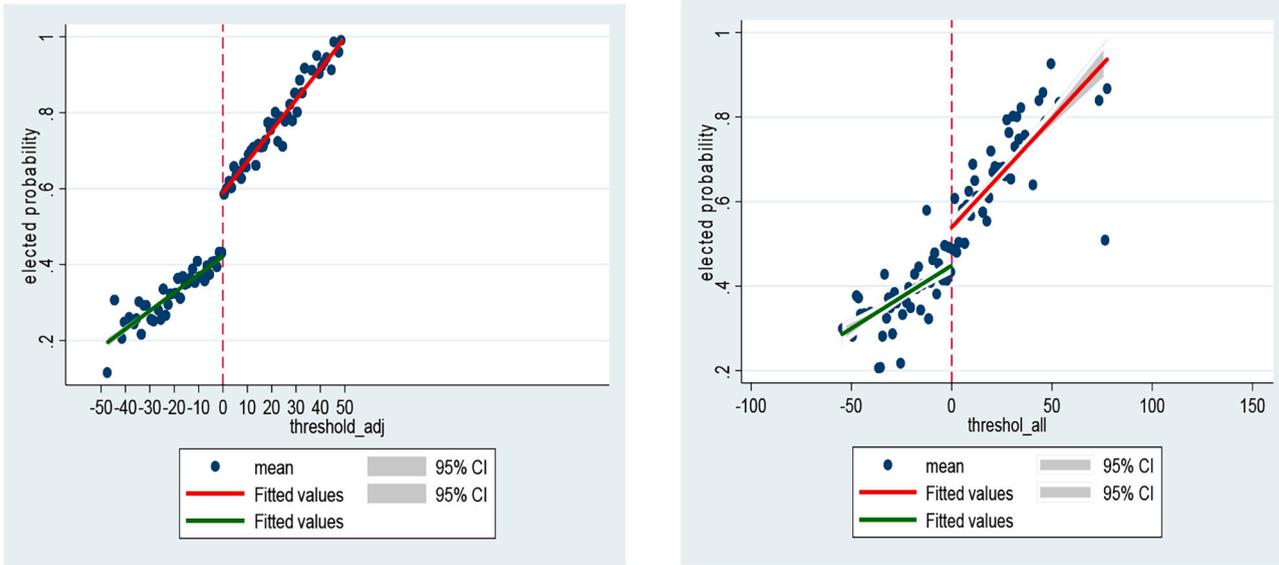


Fig. 3. a R.D. plot for associate professor. b R.D. plot for full professor.

full professors than for associate professors. Second, the above calculation for the value of promotion does not take into account the discounted value of the income gap and ignores the benefits that promotion potentially brings, including more opportunities of being funded for research and attending academic events and career-related option effects as discussed by [Tuckman and Leahey \(1975\)](#). Therefore, we believe that the actual incomes for professors, especially full professors, are lower than the real value of their academic work, proving an argument for the urgency of a raise in salary for Chinese college faculty.

Using the discipline-adjusted threshold score for promotion to associate professor, 63.8, the value per unit of research score is \$473 (\$30,163 / 63.8). We can interpret \$473 as the willingness to pay for a faculty in University A to get promoted to associate professor. Similarly, as the threshold for promotion to full professor is 97.9, each unit value of research score is \$515 (\$50,442 / 97.9), which is not so much different from that for associate professor. Our result is inconsistent with [Tuckman and Leahey's \(1975\)](#), which finds that the gap of direct returns to publication between associate and full professors is over 50%, and this gap is widened as the amount of publications is increasing. Our results rest on the reliability of the R.D. design, and thus we will conduct a series of validity tests in the next section.

4. Validity tests for the R.D. design

4.1. Manipulation test

One concern for R.D. design is that the cutoff score might not be random, and candidates can manipulate it as they wish. This is not likely to happen in our setting because the threshold value is not predetermined and constant over the years but rather determined on the basis of the number of candidates and quotas from the education authorities. As we have seen previously ([Figs. 2](#)), the threshold values change over time, and thus it is not easy for candidates to predict the threshold research score for the current year. As such, candidates would do their best to produce as much academic work as possible rather than retain some work for the next promotion application when reaching the threshold. Following the method suggested by [McCrary \(2008\)](#), we examine the density of observation of the normalized research score for both associate and full professor samples. As shown in [Figs. 4](#), the confidence intervals on the two sides of the cutoff overlap greatly and thus show a continuous density function. Therefore, there is no evidence of manipulation of the running variable.

4.2. Robustness test by bandwidth

[Table 5](#) presents the R.D. parametric estimates under the linear function with the bandwidths of no limit, 50, and 45 for the “associate professor sample” and with the bandwidth of no limit for the “full professor sample.” The “associate professor sample” results show that the treatment effects are stable across the three bandwidths. As noted, we chose the bandwidths of 45 and 50 for this sample. The reason is that the analysis is only based on data from one university across nine years, which leads to relatively small sample size. For the same reason, we set no limit to conducting parametric analysis for the “full professor sample.” Therefore, we can conclude that when the research score passes the cutoff core by a little, the likelihood of being promoted to associate professor will increase by around 15%. Column (4) shows the result while controlling for gender, age, and education, and the treatment effect is a little higher than without covariates, which is 17.2%. Without a limit for the bandwidth, the likelihood of promoting to full professor is 18.3%.

The coefficient estimates presented in [Table 5](#) are found to be marginally significant. This may be due to the small sample size of the data used for the analysis, which may result in a limited number of observations available in close proximity to the threshold. To address this issue, we follow the framework proposed by [Cattaneo, Frandsen, and Titiunik \(2015\)](#) to test the sensitivity of the treatment coefficient to the bandwidth choice. Our results indicate that across the bandwidth of 20-50 for the “associate professor sample”, the coefficients fall in the range of 0.3 to 0.35, while for the “full professor sample”, the coefficient estimates sensitive to the bandwidths of 20 to 50 fall within the same range¹⁹. It is worth noting that due to the inability to include confounding variables using this method, there may be a difference between the estimates produced from this approach and those obtained through the model used in our paper. Despite the decrease in statistical significance observed as bandwidth decreases, we believe the results presented in [Table 5](#) are robust.

4.3. Continuity of observable variables

Another possible concern is that the differences in other variables cause the treatment effects in the earlier estimation. As a result, we test whether those who barely pass the treatment cutoff have different characteristics in gender, age, and education. As shown in [Table 6](#), for both associate and full professor samples, the treatment effects for all the variables are not statistically significant, implying these variables are continuous at the cutoff. Therefore, the impact of the threshold on promotion only results from the research score instead of other characteristics of candidates.

¹⁹ Those who are interested in the results can contact the authors by email to request them.

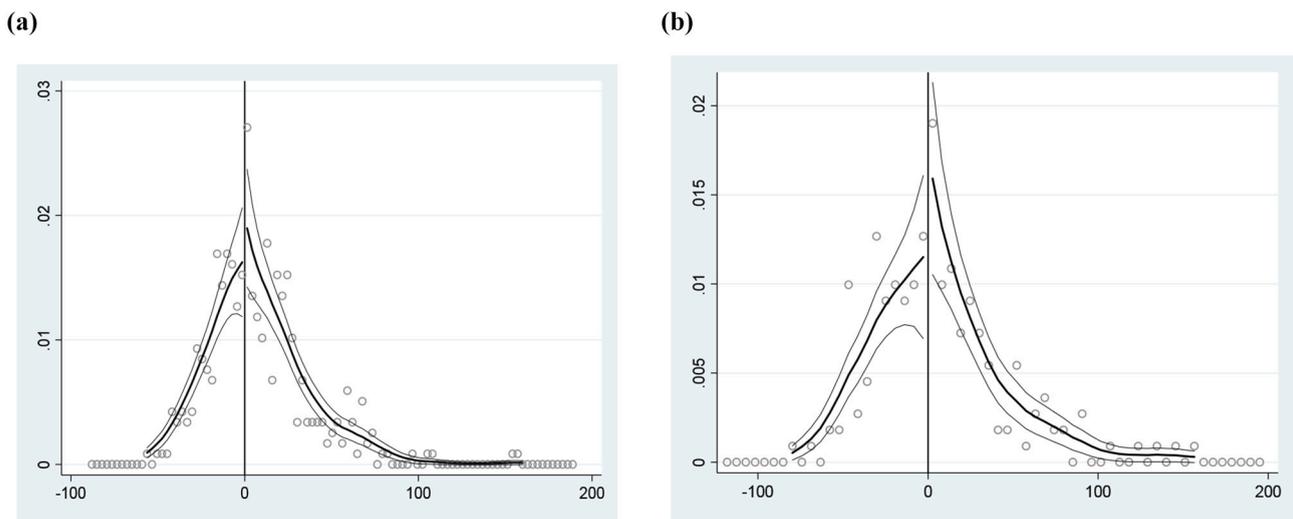


Fig. 4. a Manipulation test plot for associate professor. b Manipulation test plot for full professor.

Table 5
R.D. results with different bandwidths.

Dependent variable:	Associate professor				Full professor	
	No limit (1)	(-50,50) (2)	(-45,45) (3)	(-50,50) (4)	No limit (5)	No limit (6)
Above threshold	0.187** (2.480)	0.153* (1.714)	0.158* (1.720)	0.172* (1.919)	0.183* (1.793)	0.183* (0.795)
Subject F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial function	Linear	Linear	Linear	Linear	Linear	Linear
Interaction between treatment and running variables	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	No	No	No	Yes	No	Yes
Obs.	407	373	366	373	201	201

Table 6
Continuity test for observable variables.

Dependent variable:	Associate professor			Full professor	
	Gender	Age	Education	Gender	Age
	(1)	(2)	(3)	(4)	(5)
Above threshold	0.0235 (0.31)	0.766 (0.88)	-0.060 (-1.39)	0.031 (0.42)	0.092 (0.09)
Subject F.E.	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes
Polynomial function	Linear	Linear	Linear	Linear	Linear
Interaction between treatment and running variables	Yes	Yes	Yes	No	No
Bandwidth	(-50,50)	(-50,50)	(-50,50)	No limit	No limit
Obs.	373	373	373	201	201

4.4. Placebo test

To further confirm that the discontinuity exploited to inform causal impacts of the promotion is highly likely caused by the assignment rule of the research score, we use another two thresholds as the fake cutoffs to perform R.D. analysis. For the observations to be near the fake cutoff but far from the real one, we use the bandwidth of 20 for the “associate professor sample.” As shown in Table 7, when adding 10 and 20 points to the original cutoff for the “associate professor sample,” the treatment effects are not statistically significant as expected. Similarly, when subtracting 10 and 20 points from the original cutoff for the “full professor sample,” the treatment effects reported in Table 7 are not statistically significant either. No jumps occur at placebo thresholds for promotions to associate and full professors, further validating our R.D. design.

4.5. Considering the effect of the new policy

As mentioned earlier in the paper, Chinese authorities have proposed some advice related to the college faculty assessment system in 2016 with the purpose of adjusting the tendency of overvaluing education background, seniority, and published papers and advocating for representative work as an important assessment criterion. This policy aims to weigh more on the quality of research work than on quantity in Chinese universities. As a response, University A eliminated the way research score is used as an assessment criterion in 2018, potentially affecting the estimation results. To test this potential effect, we include the interaction terms between the threshold treatment variable and year dummy variables. The estimated coefficients for these interaction terms reported in Table 8 are

Table 7
R.D. results with falsified cutoffs.

Dependent variable:	Associate professor		Full professor	
	(1)	(2)	(3)	(4)
Above threshold	-0.119 (-0.933)	-0.0093 (0.662)	0.118 (1.194)	0.139 (1.194)
Subject F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Polynomial function	Linear	Linear	Linear	Linear
Interaction between treatment and running variables	Yes	Yes	No	No
Covariates	No	No	No	No
Cutoff	Original +10	Original +20	Original -10	Original -20
Bandwidth	(-20,20)	(-20,20)	No limit	No limit
Obs.	227	167	201	201

Table 8
Effect of the new policy.

Dependent variable:	Associate professor		Full professor	
	(1)	(2)	(3)	(4)
Above threshold	0.131 (1.372)	0.131 (1.361)	0.184 (1.582)	0.180 (1.55)
Above threshold × whether 2017	0.171 (1.210)	–	0.617*** (6.783)	–
Above threshold × whether 2018	0.044 (0.241)	–	–0.280 (–1.203)	–
Above threshold × whether 2019	–0.017 (–0.103)	–	–0.098 (–0.481)	–
Above threshold × whether since 2017	–	0.068 (0.662)	–	0.008 (0.052)
Subject F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Polynomial function	Linear	Linear	Linear	Linear
Interaction between treatment and running variables	Yes	Yes	No	No
Covariates	No	No	No	No
Bandwidth	(–50,50)	(–50,50)	No limit	No limit
Obs.	373	373	201	201

statistically insignificant, suggesting that it is difficult to eliminate the common practice of valuing research quantity that has been formed for a lengthy period in University A. Therefore, we believe the R.D. estimation is credible with the data spanning from 2011 to 2019.

5. Discussion

5.1. Implications for the findings

Based on the estimated academic value per unit of research score, we calculate the monetary values for different types of research outputs for lecturers and associate professors, shown in Table 9.

As the monetary value gap of unit research score between lecturers and associate professors is small, the economic value for each research output through our conversion is small. Extra research reward is far less than the value of research output, and particularly extra research reward for most types of research output is close to zero except for the publication in top national journals and the grant from the national government. As such, extra research reward has little effect on the income difference between lecturers and associate professors, as calculated based on the difference in post salary, pay grade wage, and basic performance-based salary. University A has fully rewarded the projects supported by the national government. Thus, it has stayed ahead in terms of the number of such type of projects among the universities in the same specialized fields both province-wide and nationwide and ranks higher in government-supported projects than in other types of research achievements. This fact implies that increasing rewards' intensity could be an effective way to produce more corresponding research work. According to our estimates, the economic values for a publication in ordinary national journals (CSSCI), famous national journals, and top national journals are around \$1538, \$5154, and \$20,615, respectively. The economic value for writing a book is about \$7723, and a project supported by the national government, the ministry of education, and the provincial government is worth \$20,615, \$7723, and \$2569, respectively.

To better assess the above-estimated values of research outputs relative to the one in a system related to University A, we have conducted several comparisons. First, we compare the estimated value of research achievement with the annual income the faculty can

Table 9
Estimated monetary values for different types of academic research.

Types of work	Research points	Extra research reward	Economic values for lecturer	Economic values for associate professor
Top national journals	40	\$15,384	\$18,923	\$20,615
SSCI & SCI	20	\$1231	\$9462	\$10,308
Famous national journals	10	\$769	\$4723	\$5154
CSSCI	3	\$0	\$1415	\$1538
Book	15	\$0	\$7077	\$7723
Project supported by the national government	40	\$23,077	\$18,923	\$20,615
Project supported by the ministry of education	15	\$0	\$7076	\$7723
Project supported by the provincial government	5	\$0	\$2369	\$2569

Note: The currency we use to measure the value of academic research is the U.S. dollar.

receive at University A. As stated earlier, apart from teaching loads of 256 teaching hours, a lecturer and an associate professor need to finish research work worth 1 and 3 points, respectively, in terms of research score, which is equivalent to 1/3 and 1 publication on CSSCI journals. Based on the estimates, the monetary values for these research works are worth \$462 and \$1538, respectively; however, the annual incomes for a lecturer and an associate professor are \$18,461 and \$23,077, respectively. The value of research work only makes up 2.5% and 6.7% of the total income for a lecturer and an associate professor, respectively, and even completing 256 teaching hours can contribute to their income maintenance. Therefore, it is cost-ineffective to engage in research work for faculty in the current resource allocation system at University A.

Next, we compare the estimated value of research outputs with the average labor income in similar sectors. According to China labor statistical yearbook, the average monthly income in the labor sector of scientific research and technical services between 2011 and 2019 was \$1341. Assuming that similar works within the same periods have the same values, to equate the value of research work in University A with \$1341, it would take 1.2 months to complete a paper that can be published in a CSSCI journal, 4 months for an article in a famous national journal, 6 months for a book, and 14 months to complete a project supported by the national government. It normally takes at least three years to finish a nationally-funded project, during which several articles at CSSCI level or higher and at least one book are required to be published. Accordingly, a faculty member can hardly finish a CSSCI article within 1.2 months or a book within a half year and then wrap up the project within a year and a half. Compared with the incomes of peers in a similar industry, the academic value has been seriously undervalued. If the sectors in the comparison are high-pay industries, such as financial and information technology fields, there are even more considerable differences in income level.

Last, we will compare the values of research outputs in University A to that in universities in other countries. Heckman and Muktan (2020) find evidence that between 1996 and 2010, one more publication in top economics journals could increase the probability of receiving tenure by as high as 19% in the top 35 economics departments in U.S. universities. According to AEA 2020–2021 Universal Academic Questionnaire Summary Statistics (Scott and John, 2021), the income gap between Assistant Professor and Associate Professor from the Tier 3 Ph.D. granting universities (ranks 16–30) is \$29,204. Using the method in the current paper to calculate the value of research scores, the value for a Top five economic paper is about \$153,705. This value is about five times as much as \$30,769 – the value of the same level of publication (*American Economic Review*) in University A, and 7.5 times as much as \$20,615 – the value of a publication in a Chinese national top journal. The significant difference in the economic value of research work between China and the U.S. is the embodiment of the difference in the degree to which the countries attach great importance to scientific research, thus possibly causing China to be left behind in science and technology.

What we have examined in the paper is to quantify the indirect payoff from promotion attributable to research publication, while other scholars have estimated the direct payoff to publication (Faria & Mixon, 2021; Gibson et al., 2014; Tuckman & Leahey, 1975). By using the data of economists in the University of California system in 2010, Gibson et al. (2014) find that economists without having any articles in any of the Top five economics journals face a salary decrease of about 5%–7%. Instead of focusing on short-term returns to publication, Tuckman and Leahey (1975) use the data from a national cross-section of university economists to compute lifetime returns for selected article categories by academic rank. They find that returns to the first publication are \$12,340, \$10,256, and \$6958 for an assistant professor, an associate professor, and a full professor, respectively, based on a 5% discount rate. If measured in the constant year 2015 dollars with the consumer price index for inflating, the values for these returns are \$60,000, \$50,000, and \$35,000, respectively. They also find that the marginal returns decrease rapidly with more publications. In addition, such a decrease in returns for book publication is higher than for article publication. For faculty members without articles published, the monetary value for 1.37 book is equal to that for a first-time publishing article. This result is contrary to ours, possibly reflecting some issues in the Chinese higher education system.

In our setting, one gains more research points by publishing a book than by an article because a book is usually several times the size of a paper. Our result reveals that the value of a book is equivalent to that of 5 CSSCI articles. Compared with universities in other countries, Chinese higher institutions put substantially more weight on book writing while evaluating the worth of scientific research. We believe this relates to the difference between the scholars' perceptions of a book project from China and other countries. In other countries, academic books are usually written by authors who have been researching in their fields for many years and would like to write books to review their lifetime research achievements. Thus many scholars only have one or two academic books published. On the contrary, many young scholars working in Chinese universities are more willing to write books. Compared with publishing articles, which requires strict peer review, it is much easier to publish books because publishers do not require peer review. As long as the publication fees, which usually cost around \$4615, are paid, many publishers are willing to publish the book. In University A, for example, a young associate professor has published nine books that give him/her an enormously high research score. This issue is worth pondering in academia in China.

5.2. Implications for the future policies

The scoring system in the promotion procedure might receive criticism because the computed score is vital in determining one applicant's promotion probability. Some Chinese scholars believe that the future direction will be peer review for promotion instead of the current one, in which both the quantity and quality of publications are assessed in a standardized scoring system. However, peer review for promotion mainly relies on the impartial judgment of those renowned acknowledged experts in the field. This promotion system might be more suitable for top universities like Harvard University. Due to the lack of top professional experts in each area, the scoring system for promotion is still imperative in most developing countries. Yet, the key is how to score research work reasonably. We believe an appropriate scoring mechanism should involve a journal directory that internationally conforms to the mainstream academic evaluation system and essentially differentiates various ranks of journals to lead academicians to produce high-quality

research work.

Our findings convey the reality that academic research at University A has been undervalued, whether it is compared with the faculty's own total income, the income of peers in similar sectors, or peers from other countries' higher education. Therefore, enhancing the values of research work becomes imperative to incentivize Chinese scholars in a promotion system like that in University A. Based on Eq. (1), we can propose some policy recommendations in the following three regards.

First, salary differentials between academic ranks could be further widened on the basis of increasing salaries for all the ranks. Our results show that the actual incomes of faculty members, especially full professors, in University A are undervalued. According to the compensation schemes by Lazear and Rosen (1981), more considerable differences in wages between ranks induce a more efficient allocation of resources because employees would like to make greater efforts to gain a promotion. By the same logic, the higher income level for associate and full professors will play a role in incentivizing those who are lecturers and associate professors to work harder for the promotion. To establish an effective incentive scheme, an organization should have two characteristics of payment structure: income gap and income level. While full professor is the highest professional rank in Chinese universities, many faculty members might feel sort of loss of their spiritual pursuit once they get to the full professor rank. Thus, material rewards are believed to inspire their working enthusiasm. In many circumstances, only after receiving a promotion to associate professor, can one be eligible to get promoted to full professor. Therefore, even with a relatively lower wage raise for associate professors than for full professors, many lecturers still have an incentive to work hard to be able to be qualified to receive promotion to full professor eventually. At the same time, there is also an urgent need to increase salaries for all ranks to recruit more outstanding young academics, especially when they face many choices at graduation.

Second, the promotion and merit system should place particular emphasis on research quality rather than quantity, as Zhang (2014) proposes. Our data show that research score nearly becomes the only determinant for faculty promotion in University A. The overemphasis on research scores could lead to a fickle academic atmosphere in which more academics engage in research that yields short and fast results, which makes them focus on research quantity instead of quality. As a result, an academic bubble or even corruption could emerge. As suggested by Besancenot et al. (2009), the competition among business schools with an extensive research productivity gap could drive them to do too much research, likely leading to the neglect of teaching quality and inefficient social outcomes. A similar concern has been raised by Hedding (2019). He criticizes that a subsidy scheme launched in South Africa in 2005 has pushed academics towards predatory journals and thus suggests stopping paying professors by the number of papers. Recently, University A has realized the downside of using research score as the key criterion in the evaluation process and thus eliminated it in the review process for the promotion to full professor in 2018 and for the promotion to associate professor in 2020. Instead, applicants are asked to list their three representative publications. Due to the small sample and relatively short amount of time since the policy comes out, a significant effect has not emerged and research score still plays its role to some extent. If we convert three representative publications into a research score based on the previous rule, threshold scores are supposed to be significantly reduced, and thus the role of research scores in the faculty promotion process is expected to diminish. In particular, the requirement to list applicants' best three publications would discourage applicants from pursuing short-term low-quality publications and make them more committed to improving research quality. This expectation is in line with Azoulay et al. (2011), finding that selection into the funding program which encourages intellectual experimentation and rewards long-term success more likely produce higher levels of breakthrough innovation, compared with the funding program characterized by short review cycles and renewal policies unforgiving of failure. Similar results are also found by Ederer and Manso (2013) and Manso (2011). With faculty aiming to enhance their research capability, economic value for research achievement will be increased.

Last, we suggest that Chinese universities bring up competitive mechanisms among full professors as a pathway for them to get further promotions. As an interesting finding yielded by Tuckman and Leahey (1975), the returns to publication diminish with age and research output, which might explain why faculty publish less as they age. With the title of the full professor being the highest rank in the current faculty structure, many Chinese universities add some more senior titles for those with outstanding accomplishments in scientific research, such as "chair professor" and "second-level professor of the State."²⁰ These higher-ranked professors will obtain not only more income but also a more incredible honor. Checchi et al. (2020) found that more capable researchers respond to increasing incentives in the promotion system in more competitive situations. In the process of review for these higher ranks, with research score being a criterion, research quality should be given more weight, and in particular, seniority and administrative position should not be considered.²¹ That way, not only are full professors incentivized on research productivity but also the widened salary gap between the lowest and the highest ranks forms a higher incentive for lower-ranked faculty members. Therefore, the competitive mechanism will bring about more research outputs with high quality, resulting in higher economic values of academic research.

6. Conclusions

Our paper sheds empirical light on evaluating the research output of college faculty. Employing the data from a medium-ranked university in China, we utilize an R.D. design in which promotion thresholds are used as cutoffs to estimate the economic values for research work. Our paper finds that each unit of research score in University A is worth \$467 for a promotion to an associate professor

²⁰ Changjiang distinguished professorship and distinguished young scientist are two examples of elite titles. Candidates have to be recommended by their universities first and then participate the final review process nation-wide.

²¹ The fact is that most second-level professors are those who are college chairs or hold higher administrative position, and this exist more often in the lower ranked colleges.

and \$515 for a full professor. Based on the rate for full professor, we compute the economic values for a publication in an ordinary journal, famous national journal, and top national journal, which are around \$1538, \$5154, and \$20,615, respectively. The economic value for a book publication is approximately \$7723, and a project supported by the national government, the ministry of education, and the provincial government is worth \$20,615, \$7723, and \$2569, respectively. These research outputs are significantly undervalued compared with the faculty's own total income, the income of peers in similar sectors, or the income of peers from other countries' higher education. In addition, after controlling for the new policy aiming to advocate for valuing the quality of research work instead of quantity, we discover no noticeable effect of the policy on the probability of receiving a promotion.

There are several limitations of the study that need to be acknowledged. First, with the small sample size, which could lead to a lack of representation, one might urge caution in drawing conclusions from this study. However, the scoring system in our setting is very common in the faculty promotion process in most Chinese universities. For example, the Chinese university studied by Song and Wu (2020) to examine the impacts of university promotion on faculty performance adopts a similar scoring system in the faculty promotion process. With University A being a medium-ranked research and teaching-oriented university in China and specializing in Economics and Management, our conclusion better applies to similar higher institutions in China. Second, our estimation is based on some simplification of the actual situation. For example, we do not consider the nonmonetary rewards such as good reputations that promotion might bring in as well as career-related option effects. In addition, one assumption in our analysis is that failed candidates near the threshold will receive promotion next year might not necessarily happen. Thus, only one year's salary gap could underestimate the true gap. Therefore, our estimates just imply the lower bounds for the economic value of research output.

However, the main takeaway of this paper is to propose a methodology that incorporates an R.D. design and VSL theory to estimate the economic value of research output. To the best of our knowledge, like most Chinese universities, some universities around the world use a similar scoring system in the decision during a faculty promotion process. While computing research scores in the promotion and merit procedure is not typical for most universities across western countries, candidates' research quality and quantity, in addition to their teaching and service, are reviewed and voted upon by the department's faculty and college- and campus-wide committee members. In this process, the exact numbers of article and book publications at various rating levels can be generally regarded as an equivalence of research scores. Therefore, we believe our proposed methodology can be universally applied to the universities that base their promotion and merit results on candidates' research performance to some extent. For a few top universities, such as Harvard University, the peer review for each promotion candidate's research performance is focused on evaluating the real contribution devoted to the papers and research area, not only based on the count of publications. Nevertheless, the ability of a university to assess individuals' research contributions without considering the quantity and quality of publications is not widespread. Thus, our approach has a general application worldwide.

In conclusion, a well-designed promotion and merit procedure for universities can be an effective vehicle to enhance the economic value of academic research output and thus incentivize faculty with productive academic work, which then improves the comprehensive level of a university. Considering the essential role of promotion criterion in leading the direction for the development of the discipline and the university, it should promote high-quality research by formulating a set of rules in which journal lists are reasonably chosen and assigned appropriate weight. Furthermore, facing the situation recognized in University A, we propose a mechanism in which, on the basis of raising all faculty members' salaries, salary gaps between academic ranks need to be further widened, and research quality should be given more weight relative to quantity, with the purpose to enhance the economic research value. This is believed to help boost scholars' research productivity, which is the significance of this paper.

Data availability

The authors do not have permission to share data.

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