Crossing the "Mara River" of Scientific and Technological Evaluation: Postprints

Authors: Xu Fang, Li Xiaoxuan, Xiaoxuan Li

Date: 2017-08-21T00:00:00+00:00

Abstract

The issue of science and technology evaluation has become a long-standing challenge that remains difficult to overcome, with academia, government, and society continuously debating and exploring it, much like millions of migrating wildebeest hesitating and attempting before crossing the Mara River. This article analyzes and proposes that the fundamental reason why China's science and technology evaluation problem is difficult to resolve lies in the failure to clarify the relationship between government and science, to properly handle the relationship between overall advancement and key breakthroughs, and to grant special policies and autonomy to institutions at academic highlands, thereby enabling them to play the role of "leading wildebeest" and take the lead in achieving the crossing from "this shore" to "that shore" to establish an evaluation system oriented toward the pursuit of excellence. Based on this, the article attempts to propose the "leading wildebeest" theory for science and technology evaluation reform, namely that effectively playing the role of the "leading wildebeest" constitutes the breakthrough point for reforming science and technology evaluation, and puts forward corresponding policy recommendations in light of China's actual conditions.

Full Text

To Cross the Mara River: Thoughts on Breakthrough Point of Research Evaluation Reform in China

Xu Fang[1],[2], Li Xiaoxuan[1],[2]
[1] Institutes of Science and Development, Chinese Academy of Sciences, Beijing 100190, China
[2] University of Chinese Academy of Sciences, Beijing 100049, China

Abstract
The challenge of research evaluation has become a bastion difficult to breach,

with continuous disputes and explorations among academia, government, and society—much like the wandering and attempts of millions of migrating wildebeest before crossing the Mara River. This paper argues that the fundamental reason why China' s research evaluation problems remain unsolved lies in three critical failures: clarifying the relationship between government and science, balancing overall advancement with key breakthroughs, and granting special policies and autonomy to institutions at academic highlands so they can play the role of "Leading Wildebeest" to achieve the leap from "this shore" to "the other shore" and build an evaluation system oriented toward excellence. Accordingly, this paper proposes the "Leading Wildebeest" theory for research evaluation reform, positing that enabling the Leading Wildebeest to fulfill its role is the breakthrough point for reform, and offers corresponding policy recommendations tailored to China' s context.

Keywords
Research evaluation; Reform; Leading Wildebeest

In September, on the western bank of the Mara River in Africa, millions of wildebeest gather, preparing to cross the river from the Masai Mara grassland to the Serengeti plain in search of lush grass and clean water. The herd has been lingering at the riverbank for days. Some wildebeest have attempted to cross but failed, and the herd grows increasingly anxious. Finally, the leading wildebeest steps forward, leaping from the cliff-like bank into the crocodile-infested waters of the Mara River, completing nature' s great "leap of faith" and successfully reaching the other shore. Subsequently, the entire herd follows, crossing the Mara River and arriving at the "Garden of Eden" of abundant water and grass —the Serengeti plain.

Current State of Research Evaluation: The Wildebeest Herd Lingering at the "Mara River"

China' s research evaluation reform currently stands at a critical juncture of crossing from "this shore" to "the other shore." Discussions and controversies over research evaluation have a long history, and reform has become a key focus and difficult point in the science and technology system. Government agencies, research institutions, and universities have conducted extensive research to find solutions. Yet to this day, China' s research evaluation reform remains in a state of hesitation, the breakthrough point remains elusive, and the "other shore" of an excellence-oriented evaluation system that the scientific community desires has not been reached. The drawbacks of quantitative paper evaluation have become increasingly severe, with waves of opposition to the "paper-only orientation" rising in the scientific community. As in previous years, proposals and suggestions from science and technology delegates at the 2017 Two Sessions expressed widespread dissatisfaction and criticism regarding China' s research evaluation system.

Without a leading wildebeest, millions of wildebeest cannot cross the Mara River. Without a "Leading Wildebeest"that takes the lead in research evaluation reform, China' s overall research evaluation cannot reach the "other shore" and can only linger at the "Mara River." The author argues that the breakthrough point for China' s research evaluation reform lies in identifying the "Leading Wildebeest," entrusting it with a mission, and enabling it to play its role.

Research Evaluation Reform: An Insurmountable "Mara River" ?

In the mid-1980s, as China' s science and technology system reform launched—with the restoration of the professional title system and science and technology award system and the establishment of competitive research programs—research evaluation rapidly emerged in China. This period' s evaluation relied primarily on peer expert review. However, because China' s overall scientific level was relatively low at the time and human factors influenced peer review, peer evaluation was far from objective and fair. During achievement evaluations, many results were rated as either "internationally advanced" or "domestically leading," with various awards "blooming everywhere" [1]. Research evaluation became distorted and uncontrolled, creating significant negative impacts.

In the late 1980s, the state reformed the award system, retaining a few awards and canceling many others, reducing numerous unreasonable evaluation activities. However, under market economy conditions, research evaluation as an important means of science and technology management is irreplaceable and cannot be diminished. In the early 1990s, Nanjing University first introduced SCI paper metrics into researcher professional title evaluation, and its SCI paper count rapidly rose to first in the nation [2]. Subsequently, SCI paper metrics were widely adopted by domestic universities and research institutions, quickly becoming the "commanding baton" of research evaluation. Simultaneously, the use of SCI paper metrics expanded: in evaluation objects, they were applied not only to individual researchers but also to institution evaluation, project evaluation, and discipline assessment; in evaluation fields, they were used not only in basic research but also in engineering technology and even medical and health fields; in user groups, they were employed not only by the scientific community but also by science and technology management departments and social intermediaries; in evaluation indicators, they included not only SCI paper counts but also journal impact factors and citation frequencies.

Scientific papers are important manifestations of research activities; however, overemphasizing SCI paper quantity rather than academic quality itself is undoubtedly inappropriate. Although in the early period when China' s overall scientific level was relatively low, SCI paper metrics, with their simplicity and objectivity, did play a certain positive role. But in later development, the scientific community became increasingly dependent on quantitative evaluation of SCI papers (as well as projects, funding, patents, talent, awards, etc.), the role of peer review in research evaluation was increasingly weakened, the culture of

pursuing excellence was tarnished, and problems with SCI paper-oriented evaluation became increasingly prominent, even becoming a constraint on China' s scientific and technological innovation development. The recently exposed retraction of 107 papers [3] is a typical case of the drawbacks of SCI paper orientation.

In response to problems with paper-oriented evaluation, the government and scientific community have proposed a series of solutions and measures, but with limited effect. In 2003, the Ministry of Science and Technology, Ministry of Education, Chinese Academy of Sciences (CAS), Chinese Academy of Engineering, and National Natural Science Foundation jointly issued the "Decision on Improving Science and Technology Evaluation Work" (Guo Ke Fa Ji Zi [2003] No. 142). Subsequently, the Ministry of Science and Technology issued China' s first systematic document on research evaluation management—the "Science and Technology Evaluation Measures (Trial)" (Guo Ke Fa Ji Zi [2003] No. 308) —and organized lecture teams to promote it nationwide. In 2016, the Ministry of Education issued the "Guiding Opinions on Deepening the Reform of University Teacher Assessment and Evaluation Systems" (Jiao Shi [2016] No. 7). These measures were necessary, and some were foundational, playing certain roles, but they could not curb the momentum of paper-oriented quantitative evaluation.

The scientific community has also continuously explored research evaluation issues and sought solutions. Taking the CAS Academic Divisions as an example: in 2009, it established the "China' s Science and Technology System and Policy" project (research evaluation being an important component), in 2015 the "Problems and Countermeasures of China' s Science and Technology Evaluation Indicators" project, and in 2015 the "Scientific Value Assessment under Deepening Globalization" project. Although these research efforts accurately understood research evaluation problems and adopted some positive measures—for example, in 2014 the CAS Academic Divisions Presidium issued the "Pursuing Scientific Excellence" declaration [4]—their effectiveness in solving research evaluation problems was limited and could not fundamentally shake the foundation of paper-oriented quantitative evaluation.

Continuous exploration and reform attempts have failed to resolve the problem of quantitative evaluation-oriented research evaluation, making it a "Mara River" that is difficult to cross. At the 2016 "Three Science and Technology Conferences," General Secretary Xi Jinping issued a call to "reform the science and technology evaluation system, establish a classified evaluation system oriented toward the quality, contribution, and performance of scientific and technological innovation, and correctly evaluate the scientific, technical, economic, social, and cultural value of scientific and technological innovation achievements" [5], pointing out the direction for research evaluation reform and depicting the proper vision for research evaluation. The key to implementing the General Secretary' s call is to find the breakthrough point for reform. Where exactly is this breakthrough point?

The "Leading Wildebeest" as the Breakthrough Point for Research Evaluation Reform

The author argues that the reason previous research evaluation reforms in China have not been effective is the exclusive adoption of an overall advancement reform model, without properly handling the relationship between overall advancement and key breakthroughs, which does not align with the inherent laws of science and China's national conditions. From the perspective of sociology of science, science is an activity of a few elites, presenting a typical pyramid structure where a minority of elite personnel and research institutions are at the top while the majority are at the base [6,7]. Even in the United States, the gap in research level and quality among different research institutions is large, with research universities comprising only a small fraction of all universities. China has a vast and widely distributed scientific workforce and research institutions with enormous differences in research level and activities. Some research institutions and universities have already assembled outstanding researchers and reached certain heights in research level. At the same time, many other institutions remain at relatively low research levels. Incongruously, in a series of policies promoting research evaluation reform, there has been no distinction between pyramid-top institutions and base institutions; instead, universal policies or overall advancement models have been adopted—the so-called "one-size-fits-all" approach.

Does the government always adopt overall advancement models in science and technology management? Not necessarily. For example, CAS's "Knowledge Innovation Program," the Ministry of Education's "985" and "211" projects, and various talent programs in recent years all belong to key breakthrough models. However, this key-point management model is mainly reflected in focused support for resource allocation. China's transition from a planned economy to a market economy is not yet complete; major research forces such as research institutions and universities are almost all government-owned with strong administrative characteristics and weak scientific community influence. In material aspects such as funding input and infrastructure construction, personalized and differentiated management of institutions by the government is relatively easy, representing government power. However, in value orientation, it is difficult to accommodate institutional personalization and differentiation needs. This is why research evaluation reform has not adopted a key breakthrough model. Under a "one-size-fits-all" value orientation, horizontal ranking comparisons and quantitative evaluation are easy, eliminating institutional individuality and characteristics, and preventing top-tier institutions from playing their proper role in research evaluation reform. This is also the fundamental reason why, since entering paper-oriented quantitative evaluation in the 1990s, scientific value-oriented evaluation has not naturally developed over more than 20 years.

Therefore, the author argues that the breakthrough point for research evaluation reform lies in finding the "Leading Wildebeest," entrusting it with a mission and autonomy, and encouraging it to explore and establish an evaluation system

oriented toward excellence. Institutions at the pyramid' s top are the needed "Leading Wildebeest." Only when these "Leading Wildebeest" institutions fully play their leading role, successfully cross the "Mara River," and reach the "other shore" can they drive other institutions to cross together, thereby building a reasonable academic ecology.

Of course, China' s research evaluation reform is far more complex than wildebeest crossing the Mara River in nature, but the principle of leveraging the "Leading Wildebeest" is similar. From the perspective of complexity, China' s current research evaluation problems involve not only government management issues but also the scientific community' s own issues—including research institutions, researchers, and academic organizations—as well as social environmental issues. For instance, non-academic interference in research evaluation is prevalent in China' s cultural environment, which is an important reason why quantitative evaluation is so popular. After more than 30 years of reform and opening up, China' s overall scientific level has greatly improved. Compared with the 1980s, China now has a group of scientists with high academic capability and vision who can undertake peer review responsibilities, especially in some top-tier institutions. Therefore, the author believes the main contradiction in current research evaluation reform is to properly handle the relationship between government and science, grant a group of academic highland institutions the status of "Leading Wildebeest," and delegate autonomy to them. Only under this premise can the scientific community' s own problems be gradually explored, improved, and resolved in practice– "one cannot learn to swim while standing on the shore."

The Dilemma of "Leading Wildebeest" in Research Evaluation Reform

Who then is the "Leading Wildebeest" in research evaluation reform? The author believes that the "Leading Wildebeest"in research evaluation reform must first itself be at an academic highland—a gathering place for high-level talent and high-level research outputs—and second, have significant influence in the scientific community and society to serve as a role model. By this standard, in basic research fields, CAS and top domestic universities such as "985"universities can be regarded as the main force of "Leading Wildebeest."China's best research results mainly come from these institutions, and important research tasks are primarily undertaken by them. In fact, these institutions have continuously attempted beneficial explorations in research evaluation reform.

CAS has been developing and improving its institute evaluation system [8,9]. After the conclusion of the "Knowledge Innovation Program" in 2011, CAS issued the "Decision on Reforming Science and Technology Evaluation and Establishing a Major Output-Oriented Institute Evaluation System" (Ke Fa Gui Zi [2012] No. 40), guiding institutes to produce major achievements "oriented toward world science and technology frontiers, economic main battlefields, and major national needs." It constructed a "two links and one foundation" insti-

tute evaluation system: acceptance evaluation and expert diagnostic evaluation, with quantitative data monitoring as the foundation; it clarified the types and standards of major scientific and technological achievements. In the expert diagnostic evaluation link, international evaluation is used as much as possible for research work that can be evaluated internationally. International experts typically focus on the quality and level of the scientific research itself rather than quantitative indicators such as paper counts or talent "labels." The major output-oriented evaluation system has produced good results in "adjusting value orientation, abandoning quantitative evaluation and pure paper orientation, and highlighting research quality and actual contribution" [10].

In recent years, Nanjing University has implemented the "Science and Technology Innovation Ten-Hundred-Thousand Project," selecting ten, hundred, and thousand key research questions at the department, school, and university levels respectively, guiding academic backbones to focus on key problems and strive for breakthroughs at scientific frontiers. The project' s essence is research evaluation reform—replacing the previous paper orientation with problem orientation [11]. Shanghai Jiao Tong University, to eliminate "point-scoring" and "number-padding" phenomena in university research evaluation, relatively early explored international evaluation at the department level, inviting renowned international experts for on-site visits, reports, and discussions. International experts conduct comprehensive evaluations of departments' positioning, development status, development speed, and potential, identifying gaps and providing development recommendations [12]. Peking University, Tsinghua University, and the University of Science and Technology of China have drawn on the tenure-track system to pioneer personnel system reform [13]. After 5-6 years of tenure-track, researchers who pass evaluation are incorporated into the formal establishment, with the focus on the frontier and international influence of representative research achievements rather than SCI paper counts.

However, these explorations and practices in research evaluation reform are only isolated sparks that have not touched the overall research evaluation system. Even within these institutions, the paper-oriented quantitative evaluation orientation has not been fundamentally reversed. To completely reverse the paper orientation, relying solely on institutions' spontaneous exploration is far from sufficient; there must be special policy support and guidance at the national level. Currently, the state' s inducement power in research evaluation is extremely strong, and no institution can remain unaffected. Taking government science and technology awards and talent programs as examples: the award system at all levels is very large, with nearly 300 national science and technology awards annually. Governments at all levels have established numerous talent programs, "talent 'hats' fly everywhere, and the names of major rivers, great rivers, and big mountains have almost been used up" [14]. Internationally, few countries have as many awards and talent "labels" as China, creating such great disturbance to the scientific community. Some university presidents have reflected that the ideal state for universities should be unaffected by these paper rankings, awards, and talent "hats" quantitative indicators, focusing wholeheart-

edly on research to produce outstanding original achievements. However, in this atmosphere, leadership departments, faculty and students, and the public are all paying attention, and evaluation results are linked to resource allocation in various forms—who can remain unaffected?

Therefore, without the state entrusting these institutions with the mission of "Leading Wildebeest," without granting corresponding freedom and autonomy, these institutions' explorations in research evaluation reform cannot truly succeed. What kind of policy support and guidance should the state provide to these institutions to ensure they truly play the role of "Leading Wildebeest"?

Delegating Autonomy to Enable the "Leading Wildebeest" to Play Its Role

Innovation-driven development is China's major strategic choice. As an important value orientation, research evaluation plays a crucial role in implementing this strategy, and the "Leading Wildebeest" is the breakthrough point for research evaluation reform. We have lingered at "this shore" for too long; time waits for no one. Only by identifying the "Leading Wildebeest" and entrusting it with a mission and corresponding conditions can we complete the feat of crossing the "Mara River." Enabling the "Leading Wildebeest" to play its role means granting a group of pioneering institutions "special zone" status, just like Shenzhen's development back then, providing them with differentiated special policy support. The core lies in granting them the autonomy to build an evaluation system oriented toward excellence.

However, we must also recognize that crossing the "Mara River" is considerably difficult and challenging, and cannot be accomplished overnight. In China's current situation, this great crossing has two dimensions: (1) from paper-oriented quantitative evaluation (including other quantitative orientations represented by papers, such as projects, funding, patents, talent, and awards) to academic quality orientation; (2) from pure academic quality orientation to academic contribution and impact orientation. Compared with scientifically advanced countries, China's problem with the first dimension of paper-oriented quantitative evaluation is much more severe, and a culture of pursuing scientific excellence has not yet formed. From international developments and trends, scientifically advanced countries also have certain tendencies and problems with paper-oriented quantitative evaluation, leading to initiatives like the San Francisco Declaration aimed at curbing the use of journal impact factors to evaluate academic quality [15]. However, for scientifically advanced countries, due to their deep accumulation of scientific culture, they are currently mainly undergoing the second dimension of crossing. It is worth anticipating that for China, the crossings of these two dimensions can proceed in parallel, and if we can achieve this, we have hope of taking a leading position in research evaluation.

Achieving these crossings depends on two key aspects: (1) selecting appropriate "Leading Wildebeest," and (2) providing special policy guarantees for the

"Leading Wildebeest." These two tasks are not starting from a blank slate; there are certain foundations and resources that can be utilized and integrated: (1) they can be linked to existing national programs for the "Leading Wildebeest," such as CAS' s "Pioneer Initiative," the Ministry of Education' s "Double First-Class" construction; (2) they can be linked to national science and technology system reforms, such as establishing modern institute systems and delegating institutional autonomy.

In selecting appropriate "Leading Wildebeest," besides considering academic highland and influence, other relevant factors may need consideration, including institutional initiative, disciplinary distribution, and appropriate scale. The paper-oriented quantitative evaluation problem mainly originates from basic research fields but has expanded to other fields and industries. Therefore, prioritizing the selection of "Leading Wildebeest" in basic research fields to achieve crossing may be a solution that addresses the root cause. From the perspective of existing national support for basic research fields, the state has supported CAS to pioneer the "Knowledge Innovation Program" and is currently supporting CAS to implement the "Pioneer Initiative" plan. For universities, the state has implemented the "985" project and is currently launching the "Double First-Class" construction. These institutions should undoubtedly be key considerations when selecting "Leading Wildebeest."

How to provide special policies to ensure that "Leading Wildebeest" enjoy the autonomy to build an excellence-oriented evaluation system? First, there must be full recognition of its significance. Scientific research is a highly creative and innovative activity with strong randomness, contingency, and unpredictability. As Premier Li Keqiang stated, "Major scientific discoveries by humanity are not 'planned' " [16]. Scientific research needs to respect researchers' exploratory interests and allow them long-term focused dedication. We must let outstanding researchers have greater autonomy in the scientific research process, not only in independently selecting research questions but also in not letting evaluation orientation influence and interfere with their research work. Therefore, we need to grant corresponding autonomy to institutions where outstanding scientists work, enabling them to formulate personalized and differentiated policies that align with their scientists' groups in research management and evaluation. This essentially means properly handling the relationship between government and science, letting "God' s be God' s and Caesar' s be Caesar' s."

In the management of U.S. national laboratories, the initial "Government Owned - Government Operated" (GOGO) model gradually transitioned to a "Government Owned - Contractor Operated" (GOCO) model, aiming to give scientists greater autonomy, improve efficiency, and promote healthy development. Currently, 16 of the Department of Energy' s 17 national laboratories use the GOCO model, entrusted to universities or non-profit research institutions [17]. In May 2017, the UK just passed the Higher Education and Research Bill, in which the government made concessions on many provisions that concerned scientists, adding measures to safeguard university autonomy [18].

Specifically, to create a policy environment that guarantees the "Leading Wildebeest" can play its role: (1) Clean up evaluation policies for the "Leading Wildebeest," retaining those necessary and conducive to their crossing while canceling those that are not, including excessive and overly broad awards and excessive and 泛滥 talent programs. For necessary project evaluations, improve and optimize evaluation methods. (2) According to crossing needs, research and formulate special policies conducive to ensuring the "Leading Wildebeest" can play its role. Build institutional governance systems that give scientists a role in institutional governance, ensuring institutions can handle autonomy after government delegation. Implement rule-of-law requirements, formulate scientific and reasonable institutional charters, and guarantee institutional autonomy through charters. (3) According to crossing needs, adjust original resource allocation policies, talent and personnel management policies related to evaluation, give these institutions certain resource allocation advantages, ensure they do not suffer resource allocation losses due to being entrusted with the "Leading Wildebeest" mission, and provide relatively stable funding support for excellent teams to reduce competitive project disturbances.

Ultimately, through these policies, various institutional ranking comparisons will be canceled, various talent program "hats" and various awards will be greatly reduced, governance systems safeguarding institutional autonomy will be established, allowing the "Leading Wildebeest" to set out lightly, gradually cultivating a deep culture of pursuing excellence, crossing the "Mara River," and forging a path in research evaluation that suits their own characteristics. Conversely, if the government cannot break the "one-size-fits-all" management model, does not delegate autonomy to these "Leading Wildebeest," or if after delegation the "Leading Wildebeest" cannot shoulder their historical mission, establish reasonable institutional governance and evaluation systems, and build an excellence-oriented scientific culture and environment, the "Mara River" will be difficult to cross, and we will remain trapped on the dry grassland, unable to reach the lush Serengeti plain.

Author Biographies

Xu Fang is an associate professor at the Institutes of Science and Development, Chinese Academy of Sciences (CAS). After receiving her Ph.D. in Management Science from the University of Kent, UK in 2011, she joined the Management Innovation and Research Evaluation Center at CAS. Her research interests include research management and evaluation to support S&T decision-making. She has undertaken more than 10 research evaluation and policy study projects from the National Natural Science Foundation of China, Ministry of Science and Technology, Ministry of Human Resources and Social Security, and other departments. She has published over 20 papers in *European Journal of Operational Research*, *Omega*, and other international and domestic journals. E-mail: xufang@casipm.ac.cn

Li Xiaoxuan is a professor at the Institutes of Science and Development, CAS, and director of the Management Innovation and Research Evaluation Center at CAS. He received his Ph.D. in Psychology from Peking University in 1999. His research interests include scientific research management, covering research evaluation, human resource management, and research funding management. He has long been engaged in decision-support research on government S&T management and policy, undertaking numerous projects from CAS, Ministry of Science and Technology, National Natural Science Foundation of China, Chinese Academy of Engineering, China Association for Science and Technology, Ministry of Human Resources and Social Security, and State Intellectual Property Office. He has published over 50 papers in domestic and international journals, including *Research Policy*, *Research Evaluation*, and *Omega*. E-mail: xiaoxuan@casipm.ac.cn

---

References

1. Li Zhenzhen. How to evaluate basic scientific research? *China University Technology Market*, 2001, (9): 20-21.
2. Gong Fang, Qu Mingfeng. The Nanjing University case: Impact of SCI introduction into evaluation systems on basic research in mainland Chinese universities. *Higher Science Education*, 2010, 1(3): 4-17.
3. ScienceNet. 107 papers retracted: Both sides are reflecting. [2017-08-11]. http://news.sciencenet.cn/htmlnews/2017/4/374226.shtm.
4. Presidium of CAS Academic Divisions. Pursuing scientific excellence. [2017-08-11]. http://www.cas.cn/xw/zyxw/yw/201405/t20140525_{4126367}.shtml.
5. Xi Jinping. Speech at the National Conference on Science and Technology Innovation, Academician Conference of the Two Academies, and the Ninth National Congress of the China Association for Science and Technology. *Science and Technology Management Research*, 2016, 36(12): 1-7.
6. Harriet Zuckerman. *Scientific Elite: Nobel Laureates in the United States*. Beijing: The Commercial Press, 1979.
7. Jonathan Cole, Stephen Cole. *Social Stratification in Science*. Translated by Zhao Jiaquan et al. Beijing: Huaxia Publishing House, 1989.
8. Chinese Academy of Sciences. *Successful Practice in Building a National Innovation System with Chinese Characteristics: Evaluation Report of the Knowledge Innovation Program (1998-2010)*. Beijing: Science Press, 2012.
9. Xu F, Li X. The changing role of metrics in research institute evaluations undertaken by the Chinese Academy of Sciences (CAS). *Palgrave Communications*, 2016, 2: 16078. DOI: 10.1057/palcomms.2016.78.
10. Bai Chunli. Reforming research evaluation with major output orientation. *Bulletin of Chinese Academy of Sciences*, 2012, 27(4): 407-410.
11. Nanjing University. President Chen Jun discusses higher education reform and innovative development during the Two Sessions. [2017-08-11]. https://xgc.nju.edu.cn/65/bd/c1519a91581/page.htm.
12. Zhang Jie. Reflections on mid- to long-term international evaluation of

departments. [2017-08-11]. http://plan.sjtu.edu.cn/info/1004/1004.htm.
13. Department of Physics, Tsinghua University. Tenure-track system activates the faculty. [2017-08-11]. http://www.tsinghua.edu.cn/publish/thunews/9914/2011/2011111108475
14. National People' s Congress of China. CAS Academician Guo Lei: Reasonable incentives can fully release scientific and technological potential. [2017-08-11]. http://www.npc.gov.cn/npc/dbdhhy/12_5/2017-03/08/content_{2013388}.htm.
15. Fathi S. San Francisco declaration on Research Assessment. *Journal of Experimental Biology*, 2013, 216(12): 533-534.
16. Government of China. Speech by Li Keqiang at the National Science and Technology Innovation Conference and the Academician Conference of the Two Academies. [2017-08-11]. http://www.gov.cn/guowuyuan/2017-07/13/content_{5210217}.htm.
17. U.S. Department of Energy. National Laboratory governance. [2017-08-11]. https://www.energy.gov/national-laboratories/national-laboratory-governance.
18. ScienceNet. UK research reform completed amid controversy. [2017-08-11]. http://news.sciencenet.cn/htmlnews/2017/5/375008.shtm.

Note: Figure translations are in progress. See original paper for figures.