Research on Issues of Private Capital Promoting the Commercialization of Applied Basic Research Outcomes: A Case Study of the Chinese Academy of Sciences (Postprint)

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Abstract

Science and technology constitute the primary productive force, and the state has demonstrated high-level attention through the introduction of multiple policies to support basic research and enhance original innovation capabilities. Consequently, guiding social capital investment in basic research represents a matter of significant theoretical and practical concern. This article examines three typical institutes of the Chinese Academy of Sciences as case studies and proposes a theoretical analytical framework for guiding social capital to facilitate the transformation of basic research achievements. Through case analysis conducted according to this theoretical framework, the following policy recommendations are advanced: innovating financing models to broaden funding channels for basic research; establishing communication channels between enterprises and research institutes to alter entrepreneurs' short-sighted pursuit of quick profits; and fostering an environment and atmosphere conducive to cultivating the spirit of scientists.

Full Text

Study on Social Funds Promoting Transformation of Applied Basic Research Achievements—Taking Chinese Academy of Sciences as an Example

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Abstract

Science and technology constitute primary productive forces, a principle that receives high-level attention in China through numerous policies supporting basic research and enhancing original innovation capabilities. Guiding social capital investment into basic research thus represents a major theoretical and practical concern. This study examines three typical institutes of the Chinese Academy of Sciences (CAS) and proposes a theoretical analytical framework for channeling social funds to facilitate the transformation of basic research outcomes. Through case analysis guided by this framework, we offer policy recommendations including: innovating financing models to diversify basic research funding channels; establishing communication channels between enterprises and research institutes to counteract entrepreneurs' short-term profit-seeking mentality; and cultivating environments conducive to nurturing the spirit of scientific inquiry.

Keywords: transformation of scientific and technological achievements, basic research, social funds, case studies, behavioral finance

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Main Body

Science and technology are primary productive forces. The 19th Party Congress report articulated comprehensive requirements for accelerating China' s development into an innovative nation, with particular emphasis on strengthening basic research investment. In May 2018, President Xi Jinping emphasized at the Academicians' Conference of the Chinese Academy of Sciences and Chinese Academy of Engineering that "China' s basic scientific research still suffers from prominent weaknesses, enterprises insufficiently value basic research, major original achievements are lacking, underlying foundational technologies and basic process capabilities are inadequate, and the situation where key core technologies are controlled by others has not fundamentally changed." Basic research serves as the wellspring of innovation and is crucial for promoting the transformation of scientific achievements and industrial upgrading. Currently, enterprises show insufficient attention to basic research, and the long-standing pattern of relying primarily on state funding for such research remains unchanged. As Engels observed, "once society develops a technical need, that need will advance science more than ten universities." Therefore, guiding social capital to participate in basic research is essential for addressing major scientific questions, achieving breakthroughs in key generic technologies, and producing major strategic products.

Conceptual Connotation and Research Status

Western economics traditionally divides economic investment actors into a "two-sector" model comprising "public sector" and "private sector." However, China' s classification differs, distinguishing instead between "government sector" and

"social sector" [1]. Accordingly, this paper defines "social funds" as the aggregate of various resources owned and controlled by socio-economic units (excluding government) that can be deployed for investment and reproduction, including capital from enterprises, social organizations, and individuals.

Mainstream approaches to classifying scientific research include: (1) the linear or leverage model [2]; (2) the extended model [3]; and (3) the quadrant model [4]. Other scholars have proposed alternative frameworks, such as the Technology Readiness Level (TRL) classification widely used in Western S&T evaluation, or the distinction between "science-based innovation" and "technology-based innovation" in Chinese scholarship [5-10]. Some researchers have categorized scientific research from the perspective of achievement transformation [11-13]. These perspectives demonstrate that science is not merely basic research, technology cannot be simply reduced to applied scientific knowledge, and basic versus applied research are not strictly separable. This paper focuses on applied basic research—strategic, foundational, and forward-looking research activities driven by both scientific curiosity and industrial needs, exploring fundamental principles and concepts to address major scientific questions, generic key technologies, and socially significant research concerning national welfare, industrial competitiveness, independent innovation capacity, and national security.

Theoretical Basis and Path Mechanism

Basic Research as a Quasi-Public Good Basic research constitutes a quasi-public good, manifesting in two dimensions: (1) **Limited non-excludability**. Basic research can be simultaneously driven by curiosity and utility, with inspiration often emerging instantaneously and discoverable only by individual scientists by chance, thus exhibiting limited non-excludability. The long cycles, high transformation uncertainty, and time lags characteristic of basic research further reinforce this limited non-excludability. (2) **Limited non-rivalry**. Basic research possesses strategic and pioneering attributes, and under intellectual property protection systems, demonstrates limited non-rivalry. For instance, traditional roads are pure public goods, but with breakthroughs in new energy technology, photovoltaic highways can charge electric vehicles, becoming products with limited non-rivalry that attract social capital support.

Behavioral Motivation and Model Analysis Since basic research is a quasi-public rather than pure public good, it theoretically can attract social capital participation. This section analyzes models for guiding social capital to promote basic research transformation by examining the behavioral motivations of scientists and entrepreneurs.

Integrating prospect theory [29,30] and mental accounting theory [31,32], entrepreneurs' motivations for engaging in basic research include: (1) **Leading motivation**. For industry-leading entrepreneurs, the loss of losing leadership exceeds the gain from maintaining it—they fear losing their position more than

they value keeping it. Consequently, they seek ways to preserve leadership, and investing in basic or generic technology research can provide direction and accumulate technological advantages. (2) **Strategic motivation**. Some entrepreneurs pursue strategic visions, guiding their enterprises according to formulated plans. They combine sunk costs with current expenditures when evaluating decisions and mentally separate strategic imperatives from profit-making activities, often deciding based on partial accounts. Thus, they continue investing in strategically beneficial activities regardless of immediate profitability. (3) **Speculative motivation**. Entrepreneurs seek to maximize returns, gaining reputational benefits from policy responsiveness while profiting through capital market asset allocation.

Scientists' motivations similarly include: (1) **Leading motivation**. Leading scientists fear losing their position more than they value maintaining it, so they seek to preserve leadership through basic or generic technology research that accumulates advantages at the source. (2) **Strategic motivation**. Scientists mentally separate research strategy from publication output, guiding their work according to strategic plans. "Boundedly rational" scientists decide based on partial accounts: basic research helps achieve strategic goals but carries risks like slower promotion and fewer publications. (3) **Speculative motivation**. This primarily stems from imperfect talent recruitment, unscientific funding mechanisms, and inappropriate evaluation systems.

Scientists with speculative motivation make poor partners, as they may breach agreements post-investment, creating moral hazard. Combining the remaining motivations yields basic research transformation models (Table 1):

Models for Guiding Social Capital to Support Basic Research

The **leading model** involves world-frontier social capital investment in basic research, pairing leading-motivation scientists with leading-motivation entrepreneurs. The **strategic model** responds to national strategic needs, combining strategic-motivation scientists with leading-motivation entrepreneurs, strategic-motivation entrepreneurs with leading-motivation scientists, or strategic-motivation scientists with entrepreneurs. The **profit model** caters to market demand, pairing speculative-motivation entrepreneurs with leading- or strategic-motivation scientists. The speculative model (speculative-motivation scientists and entrepreneurs) is undesirable and unsuccessful due to information asymmetry and moral hazard, and is not discussed further.

Path Mechanism Previous transformation mechanism research focused on applied research with capital at the core. This paper examines basic research transformation, which, given its quasi-public nature, must center on achievements themselves. The resulting path mechanism is illustrated in Figure 1 [Figure 1: see original paper].

Overall, social capital promotion of basic research transformation involves two stages: (1) **Achievement formation** ("capital to results"), where long cycles

and high risks necessitate social capital investment to produce valuable outcomes. Guided by goals of world-frontier leadership, national strategy response, or market demand, appropriate capital introduction methods are selected based on leading, strategic, or profit models. (2) **Achievement commercialization** ("results to capital"), requiring intermediary risk assessment and industrial fund-type social capital to drive productization, commercialization, and industrialization, ultimately generating social-economic benefits. Critically, this mechanism extracts a portion of cooperative benefits as returns while reinvesting remaining capital as seed funds into the formation stage, creating a virtuous cycle consistent with Marx' s capital circulation theory.

Case Studies

From 2016-2017, our team investigated 12 CAS institutes, three prominent investment firms, and two macro-level government decision-making departments. Analyzing CAS' s Dalian Institute of Chemical Physics, Institute of Computing Technology, and Shanghai Institute of Materia Medica reveals major progress in guiding social capital investment in basic research.

Leading Model: Dalian Institute of Chemical Physics The Dalian Institute of Chemical Physics (DICP) pioneered the leading model by establishing shareholding enterprises to implement innovation-driven development and promote achievement transformation. Beginning in 2004, DICP explored social capital cooperation on methanol-to-olefins (DMTO) technology, achieving substantive progress by 2010. In 2015, DICP restructured its operating asset management committee, established the wholly-owned asset management company Zhongke Huawu (Dalian) Technology Development Co., Ltd., and optimized its asset management office functions. The leading model produced major changes: (1) breakthroughs in key technologies and major achievements; (2) complementary institute-enterprise advantages and improved micro-governance; (3) independent intellectual property generating sustained returns; and (4) continuous social-economic benefits forming a virtuous cycle.

Operating Mechanism: The leading model pairs field-leading research teams with industry-leading enterprises—optimal partners for basic research. Leading enterprises seeking breakthroughs in major achievements or generic technologies require top research teams, while leading teams need abundant, non-return-seeking industrial capital to accelerate innovation. For example, DICP's DMTO team, a field leader with technological advantages, partnered with Sinopec, an industry leader with capital strength. Their cooperation mechanism is shown in Figure 2 [Figure 2: see original paper].

Strategic Model: Institute of Computing Technology Since the Knowledge Innovation Project, the Institute of Computing Technology (ICT) has invested nearly 150 million yuan in intangible assets, attracted over 880 million yuan in social capital, and incubated more than 30 enterprises, with Dawning,

Blue Whale, Loongson, and Jingshang achieving large-scale industrialization. In 2017, ICT established a development fund providing 4 billion yuan in targeted support, enabling better strategic deployment of information industry computing technology. These measures produced tangible changes: (1) social capital investment in basic research generated substantial applied research and derived basic research; (2) upgraded institute micro-governance, institutionally integrating basic and applied research; (3) transformed basic achievements into new science and technology with economic benefits; and (4) accelerated transformation through stable social capital support.

Operating Mechanism: The strategic model pairs leading research teams with well-known enterprises based on strategic alignment. Both parties share basic research goals: enterprises seek breakthroughs for corporate strategy, while teams need targeted strategic capital to accelerate achievements. The mechanism is shown in Figure 3 [Figure 3: see original paper].

Profit Model: Shanghai Institute of Materia Medica The Shanghai Institute of Materia Medica introduced Tonghua Capital to provide 2 billion yuan for basic research using the profit model, achieving substantive progress: (1) transformed the participant structure from single research units to collaborative research-enterprise partnerships with complementary advantages and improved risk-bearing; (2) enhanced micro-governance and capital management through subsidiary trusteeship and investment committee decision-making; and (3) successfully introduced sufficient social capital into multiple basic research transformation projects.

Operating Mechanism: The profit model pairs research teams with return-seeking investment enterprises. Teams with significant but financially unsupported achievements require investment, while drug research—high-risk, long-term, and capital-intensive (typically 10+ years from target to production)—offers venture capital high-return opportunities. The cooperation mechanism is shown in Figure 4 [Figure 4: see original paper].

Policy Recommendations

Building on theoretical exploration and empirical case analysis, this paper proposes the following recommendations:

Innovating Financing Models to Broaden Funding Channels

(1) **Establish basic research achievement transformation funds**. Concentrate resources to build a fund system including guidance funds, seed funds, strategic investment funds, and transformation funds.

(2) **Pilot innovative mechanisms at CAS institutes**. Select pilot units for social capital promotion of basic research transformation, implementing novel incentive, supervision, and evaluation mechanisms. Replicate

successful practices, focusing on achievements with major impact potential within 5-10 years. Use "post-subsidy" support to guide research team-enterprise R&D consortia. Pilot civil servant-equivalent salaries for researchers alongside equity rewards, stock options, and profit-sharing. Establish replicable, promotable technology transfer systems with classified acceptance management.

(3) **Promote major achievement transformation**. Concentrate resources to create smooth channels from basic research to social-economic benefits. Reserve major generic achievements, conduct promising basic research, advance frontier-leading studies, and transform achievements addressing major economic and social concerns.

Establishing Communication Channels and Changing Entrepreneurial Mentality

(1) **Build training and regular communication mechanisms**. Through intermediaries, establish entrepreneur training by leading scientists on research frontiers. Create seminars and practical courses integrating science and economy, enabling researcher-entrepreneur interaction. Provide research teams opportunities for in-depth enterprise investigation to align research with market practice.

(2) **Foster entrepreneurial spirit [18,19]**. Encourage basic research investment by enhancing entrepreneurs' sense of honor and mission in responding to major national S&T programs and generic key technologies. Guide entrepreneurs away from short-term profit-seeking mentalities toward stronger basic research investment and improved transformation systems.

Creating Environments for Nurturing Scientific Spirit

(1) **Cultivate favorable research atmospheres**. Innovate management models by evaluating achievements through long-term transformation benefits. Trial dual evaluation by academic value and social-economic impact. Implement third-party evaluation based on academic communities with stakeholder participation from government, enterprises, social organizations, and the public.

(2) **Establish error-tolerance mechanisms**. Improve incentive systems to encourage high-quality basic research outputs. Create error-tolerance mechanisms that motivate scientists to produce high-quality achievements and actively transform them into social-economic benefits.

References

1. 万劲波, 赵兰香. 政府和社会资本合作推进科技创新的机制研究. 中国科学院院刊, 2016, 31(4): 467-476.

2. Bush V. Science: The endless frontier. Transactions of the Kansas Academy of Science, 1945, 48(3): 231-264.
3. 经济合作与发展组织. 弗拉斯卡蒂手册: 研究与试验发展调查实施标准（第 2 版）. 北京: 科学技术文献出版社, 2010.
4. Stokes D E. Pasteur' s quadrant: Basic science and technological innovation. Washington DC: Brookings Institution Press, 2011.
5. 陈劲. 创新管理及未来展望. 技术经济, 2013, 32(6): 1-9.
6. 林苞, 雷家骕. 基于科学的创新模式与动态——对青霉素和晶体管案例的重新分析. 科学学研究, 2013, 31(10): 1463-1463.
7. 林苞, 雷家骕. 基于科学的创新与基于技术的创新——兼论科学-技术关系的 "部门" 模式. 科学学研究, 2014, 32(9): 1289-1298.
8. 张鹏, 雷家骕. 基于科学的创新与产业: 相关概念探究与典型产业识别. 科学学研究, 2015 (9): 1313-1323, 1356.
9. 张庆芝, 段勇倩, 雷家骕. 基于科学的创新研究——以诺贝尔奖科学成果到商业产品为例. 科学学研究, 2015, 33(12): 1770-1778.
10. 苏屹, 姜雪松, 雷家骕, 等. 区域创新系统协同演进研究. 中国软科学, 2016, (3): 44-61.
11. 聂常虹, 武香婷. 股权激励促进科技成果转化——基于中国科学院研究所案例分析. 管理评论, 2017, 29(4): 264-272.
12. 聂常虹, 王子铭, 冀朝旭. 科技成果转化联盟模式研究——以中国科学院的全域科研院所科技成果转化联盟为案例. 管理现代化, 2018, 38(2): 38-40.
13. 聂常虹, 肖尤丹. 促进财政性科技成果转化的制度创新研究. 科技促进发展, 2015, (4): 423-427.
14. Audretsch D B, Lehmann E E, Paleari S, et al. Entrepreneurial finance and technology transfer. Journal of Technology Transfer, 2016, (41): 1-9.
15. Cattaneo M, Meoli M, Signori A. Performance-based funding and university research productivity: the moderating effect of knowledge transfer offices: an analysis of the world' s top-ranked universities. Journal of Technology Transfer, 2016, 41(1): 132-151.
16. Fisch C O, Block J H, Sandner P G. Chinese university patents: quantity, quality, and the role of subsidy programs. Journal of Technology Transfer, 2016, 41(1): 60-84.
17. Audretsch D B, Lehmann E E, Paleari S, et al. Entrepreneurial finance and technology transfer. Journal of Technology Transfer, 2016, (41): 1-9.
18. 聂常虹. 实体经济发展需企业家精神. 人民法治, 2016, (1): 66-67.
19. 聂常虹, 李慧聪. 企业家精神驱动实体经济发展的作用机制研究. 全球化, 2016, (6): 96-106.
20. Kahneman D, Tversky A. Judgment under uncertainty: Heuristics and biases. Science, 1974, 185(4157): 1124-1131.
21. Brescia F, Colombo G, Landoni P. Organizational structures of Knowledge Transfer Offices: an analysis of the world's top-ranked universities. Journal of Technology Transfer, 2016, 41(1): 132-151.
22. Colombo G, Landoni P. Public–private partnerships and national R&D structure and the moderating role of public–private cooperation. Journal of Technology Transfer, 2016, 41(1): 152-172.
23. Brescia F, Colombo G, Landoni P. Organizational structures of Knowledge Transfer Offices: an analysis of the world's top-ranked universities. Journal

of Technology Transfer, 2016, 41(1): 132-151.
24. Cumming D, Johan S, Zhang M. The role of due diligence in venture capitalists' decision-making: a behavioral finance perspective. Journal of Technology Transfer, 2016, 41(1): 105-131.
25. 房汉廷. 科技金融的兴起与发展. 北京: 经济管理出版社, 2011.
26. 房汉廷. 加快建立科技金融创新的三大机制. 高科技与产业化, 2012, (4): 97-97.
27. 聂常虹, 冀朝旭. 财政性资金与社会资金相结合促进科技创新研究. 财政研究, 2017, (11): 47-59.
28. 聂常虹, 冀朝旭. 财政性资金与社会资金相结合促进科技创新研究. 财政研究, 2017, (11): 47-59.
29. Kahneman D, Tversky A. Prospect theory: An analysis of decision under risk. Handbook of the Fundamentals of Financial Decision Making: Part I. Singapore: World Scientific Publishing, 2013: 99-127.
30. Kahneman D, Tversky A. Judgment under uncertainty: Heuristics and biases. Science, 1974, 185(4157): 1124-1131.
31. Thaler R. Toward a positive theory of consumer choice. Journal of Economic Behavior & Organization, 1980, 1(1): 39-60.
32. Thaler R. Mental accounting matters. Journal of Behavioral Decision Making, 1999, 12(3): 183-206.

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