Postprint of General Strategic Research on Research Organizations

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Abstract

[Purpose/Significance] This paper aims to apply Porter' s generic competitive strategy theory to analyze and propose the competitive advantages and generic strategies of research organizations, which holds important guiding value for enhancing the core competitiveness of China' s research organizations. [Method/Process] This paper first analyzes and summarizes the basic functions of research organizations as knowledge discovery and knowledge application. Based on this, it proposes that the competitive advantages of research organizations are mainly manifested in systematically and continuously accumulated data/sample repositories, the capability to continuously solve major strategic problems, and the capability to continuously transform knowledge and technology into real productive forces. Then, through a combinational analysis of competitive advantages, it proposes a generic strategic model for research organizations, deduces the generic strategies of research organizations, namely breakthrough strategy, leading strategy, and collaborative strategy, and systematically elaborates on the three strategies. [Results/Conclusions] This paper applies the model to analyze the classification reform plan of institutes under the Chinese Academy of Sciences, finding that the institute classification reform basically conforms to the research conclusions of the generic strategic model for research organizations, but there are inconsistencies. The main reason lies in that the basis for the institute classification reform is the experience-driven benchmarking management principle rather than the rationality-driven strategic management theory for research organizations. Based on this, this paper proposes countermeasures and suggestions for improving and deepening the institute classification reform.

Full Text

A Study on General Strategies of Research Organizations: With a Discussion on the Institute Classification Reform of the Chinese Academy of Sciences

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Abstract:

[**Purpose/Significance**] This paper applies Porter' s theory of generic competitive strategies to analyze and propose competitive advantages and generic strategies for research organizations, offering important guidance for enhancing the core competitiveness of China' s research institutions. [**Method/Process**] The study first analyzes and summarizes the fundamental functions of research organizations as knowledge discovery and knowledge application. Based on this, it identifies three primary forms of competitive advantage: systematic and continuously accumulated databases/sample libraries, sustained capacity to solve major strategic problems, and sustained ability to transform knowledge and technology into real productivity. Through portfolio analysis of these competitive advantages, the paper develops a generic strategy model for research organizations, deriving three generic strategies—breakthrough strategy, leading strategy, and cooperative strategy—and systematically elaborates on each. [**Result/Conclusion**] Applying this model to analyze the CAS institute classification reform reveals that the reform basically aligns with the conclusions of the generic strategy model, yet certain inconsistencies exist. These discrepancies primarily stem from the reform' s reliance on experience-based benchmarking management rather than rationality-based strategic management theory for research organizations. Accordingly, this paper proposes recommendations for improving and deepening the institute classification reform.

Keywords: research organization; strategic management; generic strategy; competitive advantage; classifying reform

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1 Introduction

Research organizations are specialized institutions engaged in scientific research and technological innovation. Empirical evidence demonstrates that successful research organizations—such as Germany' s Max Planck Society, Britain' s Cavendish Laboratory, and the U.S. Department of Energy National Laboratories—have all benefited from correct strategic positioning and implementation. China' s research organizations were established after 1949 based on the So-

viet system. Prior to 1978, national science and technology strategies within the planned economy framework essentially served as strategies for research organizations. Following the 1980s, as market-oriented reforms progressed, most Chinese research organizations adopted changes analogous to the "household responsibility system"in rural reforms, making the research group or PI system the dominant mechanism for scientific activities. This weakened the overall strategic layout and resource allocation capacity of research organizations, rendering strategic management virtually non-existent. Although the Chinese Academy of Sciences (CAS) has recently emphasized strategic management and endeavored to implement it in its affiliated institutes, much of this effort remains superficial. What strategies are available to research organizations? Without theoretical research to support strategic practice, strategic management in research organizations becomes like water without a source.

Strategic management theory has developed most extensively in military and business domains. In the 1980s, Harvard professor Michael Porter proposed his renowned competitive strategy theory, identifying three generic competitive strategies for firms based on competitive advantage: cost leadership, differentiation, and focus. This theory quickly gained corporate acceptance, with many firms successfully applying it to guide their strategic practice. However, as non-profit organizations fundamentally different from businesses, research organizations cannot directly apply Porter's theory. The science and technology field requires its own strategic management theory. In this domain, Donald Stokes (1999), former chairman of the Brookings Institution, proposed a research model categorizing scientific activities into pure basic research (Bohr quadrant), pure applied research (Edison quadrant), use-inspired basic research (Pasteur quadrant), and studies of special phenomena. Building on Stokes' work, Ruttan (2001) further clarified the nature of special phenomena research, defining it as "government-funded applied research and technological development" and labeling it the Rickover quadrant (named after Admiral Hyman Rickover, who led the development of nuclear submarines through laboratories at Oak Ridge, Los Alamos, Livermore, Westinghouse, and General Electric). While these models offer reference value for research organization strategic management, they do not constitute strategic frameworks themselves. In 2014, CAS launched its "Pioneer Action"plan, classifying institutes into four types—innovation research institutes, excellence innovation centers, large science research centers, and characteristic institutes—based on strategic positioning. This classification implies strategic thinking but lacks theoretical support from research organization strategic management theory. Consequently, both for enhancing the effectiveness and value realization of scientific activities and for building core competitiveness and competitive advantages, theoretical guidance on generic strategies for research organizations is urgently needed.

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2 The Value and Competitive Advantage of Research Organizations

Porter's competitive strategy theory is grounded in understanding and assessing corporate competitive advantage. As profit-seeking organizations, firms aim to maximize profits through two fundamental approaches: cost leadership (gaining advantage through lower product costs at constant prices) and differentiation (gaining advantage through higher product value at constant costs). Research organizations, as non-profit entities, cannot simply adopt Porter' s theory, though his strategic thinking offers valuable insights. By extension, the purpose of research organization strategy is to maximize value—but how should this value be defined and measured?

Research activities constitute an integral part of human endeavor. From an epistemological perspective, human activities can be summarized as understanding the world and transforming it. Correspondingly, research activities can be categorized as knowledge discovery and knowledge application. Knowledge discovery aims to explore and grasp the laws of nature and human development, while knowledge application seeks to apply discovered knowledge to serve humanity' s transformation of the world. Extended analysis reveals that the value of knowledge discovery lies in comprehensively, systematically, accurately, timely, and efficiently revealing and verifying developmental patterns, whereas the value of knowledge application lies in comprehensively, targeted, innovatively, dynamically, and effectively applying mastered knowledge to propose and optimize solutions for transforming the world. Both knowledge discovery and application can be measured across four dimensions: creativity, effectiveness, priority, and contribution. Creativity refers to the quantity and quality of new knowledge generated in specific research activities. Effectiveness indicates the degree to which particular problems are solved or new knowledge and methods are provided for problem-solving. Priority concerns the sequence of discovering new knowledge or proposing new solutions. Contribution measures the actual value of new knowledge or solutions for humanity' s understanding and transformation of the world. In this sense, generic strategies for research organizations are systematic plans and action schemes that help maximize value across these four dimensions.

The primary purpose of strategic management in research organizations is to cultivate, build, and sustain competitive advantage. Applying strategic management thinking, competitive advantage for research organizations is the combination of resources and capabilities that ensures value maximization. Generally, competitive advantage results from correctly selecting and consistently implementing appropriate generic strategies. Analyzing from the perspective of knowledge discovery, leading the discovery of developmental patterns requires systematic and continuous accumulation of research samples and data, coupled with cultivation of large-sample/big-data analytical capabilities. From the knowledge application perspective, continuously solving major problems in human development hinges on cultivating and enhancing the capacity to solve

major strategic problems and to transfer and transform knowledge and technology, including building knowledge systems, tool-method systems, and innovative talent systems targeting major strategic issues.

In essence, three concrete forms of competitive advantage emerge for research organizations: systematically and continuously accumulated databases/sample libraries, sustained capacity to solve major strategic problems, and sustained ability to transform knowledge and technology into real productivity. With competitive advantages clearly defined, we can now explore generic strategies.

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3 Generic Strategy Model for Research Organizations

The basic activities of research organizations include identifying scientific problems, planning projects, acquiring resources, exploring principles, proposing hypotheses, designing and conducting experiments, verifying and discovering new knowledge, forming technical solutions, conducting technological innovation, promoting technology transfer and transformation, implementing product innovation, and providing technical services. All these activities, when organized according to the laws of scientific and technological development, constitute the value chain of scientific and technological innovation. These activities can be broadly categorized into knowledge discovery and knowledge application. Competitive advantage emerges from the unique, inimitable resources and capabilities accumulated through these two activity streams. Excluding the particularities of specific organizations, the fundamental purpose of research organization strategy is to build unique competitive advantage. Due to resource constraints and capability limitations, research organizations typically cannot establish advantages across the entire innovation value chain. Instead, they focus on specific segments, concentrating superior resources around defined strategic positioning to cultivate competitive advantage.

Based on the combination of these two basic activity types, this paper derives four basic strategies (see Figure 1 [Figure 1: see original paper]). However, since imitation strategy merely represents a default option rather than a deliberate choice, it can hardly be considered a true strategy. Therefore, research organizations effectively have only three generic strategies.

Figure 1 Generic Strategy Model for Research Organizations

3.1 Breakthrough Strategy

As shown in Quadrant I of Figure 1, the breakthrough strategy primarily aims to achieve breakthroughs in knowledge discovery, corresponding to research organizations focused on basic scientific research. Germany' s Max Planck Society exemplifies this strategy. The recently established "Breakthrough Prize" funded by Russian and other international billionaires, including China' s Jack Ma, targets precisely such organizations and scientists. Key characteristics include:

(1) Breakthrough strategy emphasizes original innovation and focuses on international scientific frontiers, aiming to discover the essence and laws of nature and human society. (2) Its competitive advantage manifests primarily in the quantity and quality of systematically and continuously accumulated data/samples—the more comprehensive the data/sample collection, the longer the time span, and the more advanced the processing methods, the higher the probability of pioneering and breakthrough discoveries. (3) Success hinges on cultivating and retaining innovative leading talent who demonstrate deep interest in research, pursue scientific discovery as a lifelong career, possess broad knowledge foundations about specific objects or problems, exhibit philosophical thinking and strategic leadership abilities, and resist external temptations. Such leaders can grasp scientific trends and correctly select research directions and priorities. (4) This strategy requires a tolerant and free innovation culture with stable support for researchers, avoiding strict and frequent quantitative evaluations. Creativity and priority are typically the most suitable evaluation variables. (5) Risks include inherent uncertainty in scientific development, potential entertainment-oriented research (overemphasizing personal interest at the expense of fundamental research purposes), and professionalization of research (loss of creative passion, treating research merely as a livelihood).

3.2 Leading Strategy

As shown in Quadrant II of Figure 1, the leading strategy balances knowledge discovery and application, emphasizing not just discovering new knowledge but transforming it into new products, tools, or engineering projects that lead economic and social development. NASA exemplifies this strategy. Leading strategy typically covers the entire innovation value chain, either through a powerful research organization or alliance implementing complex large-scale scientific and technological projects, or through coordinated division of labor where different organizations handle specific value chain activities. Key characteristics include:

(1) Leading strategy emphasizes both new knowledge discovery and its systematic application. Generally focusing on national strategic needs, it can lead a country' s socio-economic development at the strategic level. Due to the exclusive and closed nature of national strategic scientific activities and achievements, even when one country has discovered and transformed new knowledge into competitiveness, other nations' strategic research organizations must independently discover and transform knowledge, making leading strategy particularly effective. (2) Competitive advantage manifests primarily as sustained capacity to solve major national strategic problems, requiring stable and orderly renewal of strategic innovation teams that continuously forecast changes in national strategic domains and technological needs, concentrate superior resources for advance deployment, and cultivate strategic innovation capabilities around core requirements.

(3) Success depends on innovation quality control. Since this strategy ultimately transforms scientific knowledge into specific products or services, strict quality management must be implemented across every innovation value chain link, including theoretical innovation, as minor errors can cause major project failures (e.g., the Challenger disaster resulted from a single gasket failure). (4) This strategy requires rigorous, meticulous, standardized, and collaborative innovation culture, emphasizing national interests above all, focusing on team innovation and cooperation, and adopting results-oriented evaluation and incentive systems. Creativity, effectiveness, and contribution are typically the most suitable evaluation variables. (5) Risks include advantage weakening (inability to concentrate resources due to multiple simultaneous innovation activities), management simplification (technical experts underestimating management needs despite major projects requiring high-level management), and high costs (national strategic orientation causing overemphasis on results at the expense of cost control).

3.3 Cooperative Strategy

As shown in Quadrant III of Figure 1, the cooperative strategy emphasizes knowledge application without necessarily requiring transformation of the organization' s own discoveries. Instead, it focuses on product innovation needs from the demand side and collaborative innovation with enterprises. Taiwan' s Industrial Technology Research Institute exemplifies this strategy. Key characteristics include:

(1) Cooperative strategy emphasizes rapid application of discovered knowledge to support changing enterprise market demands. Whether the knowledge originates from the organization itself or others is irrelevant; the goal is transforming more scientific achievements into innovative products that meet evolving customer needs. (2) Competitive advantage manifests primarily as the ability to rapidly transform scientific achievements into real productivity, with core capabilities being precise customer needs analysis and independent development or improvement of platforms/devices for technology engineering, industrialization, and commercialization. (3) Success depends on cultivating and assembling diverse innovation teams comprising not only technological innovators but also engineering, industrialization, and commercialization talent who must collaborate to facilitate transformation into commercial technologies. (4) This strategy requires inclusive, collaborative, practical, and adaptive integrated innovation culture, emphasizing customer priority, market effects of technology, and intellectual property protection, with incentives like equity, options, and revenue sharing. Effectiveness and contribution are typically the most suitable evaluation variables. (5) Risks include innovation deviating from market needs, researchers prematurely transferring immature technologies to enterprises, and serious opportunistic behavior in organization-enterprise

collaboration.

3.4 Imitation Strategy

Strictly speaking, imitation strategy is not a true strategy but rather the result of simply copying other organizations or making no strategic choice. As shown in Quadrant IV of Figure 1, imitation strategy neither pursues pioneering knowledge discovery nor transformation of discovered knowledge into productivity. Such organizations focus primarily on completing quantitative research metrics like publishing SCI papers or obtaining patents, regardless of whether these contribute new knowledge or enhance corporate competitiveness. Consequently, many research organizations' strategies fall into this quadrant. Key characteristics include:

(1) Imitation strategy focuses on completing quantitative research performance indicators while neglecting organizational mission and social value. (2) It provides a research platform where any researcher capable of securing funding and delivering quantitative performance metrics can conduct research, regardless of whether activities align with organizational positioning and strategy. (3) This strategy offers no competitive advantage. Lacking clear strategic positioning and guidance, it easily leads to strategic confusion and falls into Porter' s "stuck in the middle" trap. (4) The culture is typically performance-oriented, overemphasizing direct links between income and quantitative metrics, creating risks of short-termism, unsustainable practices, integrity deficits, and excessive calculation, ultimately causing loss of competitiveness or even existential crises.

In summary, research organizations have three main generic strategies. Any organization must explicitly select and consistently implement one strategy to succeed. The main features of these three strategies are summarized in Table 1 .

Table 1 Main Features of Three Generic Strategies in Research Organizations

Strategic Focus	Breakthrough Strategy	Leading Strategy	Cooperative Strategy
Innovation Model	Original innovation, seeking breakthroughs in knowledge discovery	Systematic innovation, seeking knowledge breakthroughs with full-process application	Integrated innovation, applying existing knowledge to solve problems

Strategic Focus	Breakthrough Strategy	Leading Strategy	Cooperative Strategy
Competitive Advantage	Systematic/continuous accumulation of data/samples	Sustained capacity to solve major strategic problems	Rapid transformation of knowledge into productivity
Key Success Factor	Innovative leading talent	Innovation quality control	Demand insight
Innovation Culture	Tolerant and free	Rigorous, meticulous, standardized, and collaborative	Inclusive, collaborative, practical, and adaptive
Primary Risks	Uncertainty; entertainment-oriented research; professionalization	Advantage weakening; management simplification; cost escalation	Deviation from demand; premature transfer; opportunism

Because these generic strategies have different boundary conditions and potential conflicts, attempting to simultaneously adopt two strategies or failing to choose leads to a "stuck in the middle" dilemma. For instance, if an institute simultaneously pursues breakthrough and cooperative strategies, fundamental differences in value orientation, capability requirements, evaluation criteria, and incentive mechanisms would cause confusion among researchers, ultimately resulting in innovation failure. It should be noted that generic strategy research examines general patterns; specific organizations should adapt these strategies to their particular circumstances to develop suitable strategic models through implementation.

4 Analysis of CAS Institute Classification Reform

In 2014, CAS launched its "Pioneer Action" plan for 2030, aiming to achieve General Secretary Xi Jinping's "four pioneers": pioneering scientific and technological development, pioneering national innovation talent development, pioneering national high-level science and technology think tank construction, and pioneering international first-class research institution development. The core component is institute classification reform, which divides CAS institutes into four types based on research development patterns and international best practices: innovation research institutes, excellence innovation centers, large science research centers, and characteristic institutes. By 2020, the reform aimed to 基本完成分类定位和分类管理的体制机制设计、开展四类科研机构建设试点; by 2030, it

seeks to establish a relatively mature, dynamically adjustable modern research organization governance system with Chinese characteristics, creating numerous internationally influential, attractive, and competitive first-class research institutions. Essentially, the reform requires each institute to re-examine its competitive advantages and reposition strategically, following the principle of "doing some things and not others" to highlight key domains and directions, optimize research layouts, integrate superior scientific resources, organize scientific 攻关与协同创新, and achieve leapfrog scientific development. The main features of these four institute types are summarized in Table 2 (compiled from CAS "Pioneer Action" reports).

Table 2 Main Features of Four Institute Types in CAS Classification Reform Scheme

Institute Type	Excellence Innovation Center	Innovation Research Institute	Large Science Research Center	Characteristic Institute
Strategic Positioning	World-class basic research	National and industrial major needs	Large scientific facilities	Characteristic disciplines serving regional/industrial development
Support Method	Selective and stable support	National missions and market resources	National special support	National and local support
Evaluation Method	International peer review	Application departments and market users	Expert review	Peer, industry, and local government review

Applying the proposed generic strategy model reveals that CAS' s classification basically aligns with the model's requirements: excellence innovation centers correspond to breakthrough strategy, innovation research institutes correspond to leading strategy, and characteristic institutes correspond to cooperative strategy. Regarding the fourth category—large science research centers—scientific classification principles suggest they belong to a different plane. More accurately, they are not derived from the same classification standard as the other three types. The basis for large science research centers as a category is large scientific facilities, yet 依托大科学装置 can develop into excellence innovation centers, innovation research institutes, or characteristic institutes. For example, the National Astronomical Observatories represent a typical large science research center, where the space science research group joined the innovation research institute of the Space Science Center, the astronomy research group co-established

an education-research integrated excellence innovation center with UCAS, and groups providing astronomical data services via the Beidou system function like characteristic institutes. Therefore, large science research centers should not be 并列 with the other three types. The correct positioning is to promote collaboration between large science research centers and the three other types based on their nature and development status.

The institute classification reform scheme also shows inconsistencies with the generic strategy model, particularly in overlapping positioning between innovation research institutes and characteristic institutes, with the latter being relatively ambiguous. The primary reason is that the classification reform employs "benchmarking" rather than scientifically classifying institutes based on their value, resulting in non-uniform classification standards, overlaps between different institute types, and characteristic institutes becoming a catch-all category. Therefore, the CAS institute classification reform can be adjusted and corrected using the generic strategy model. After all, classification is not the end goal; the main purpose is to help CAS institutes clarify strategic positioning, select appropriate strategies, promote consistent strategy execution, build core competitiveness around chosen strategies, and ultimately achieve excellence and greater contributions.

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5 Conclusions and Recommendations

Inspired by renowned strategic management scholar Professor Porter' s generic competitive strategies, this paper proposes a theoretical framework for research organizations. Based on analysis of two fundamental research activities—knowledge discovery and knowledge application—and their value, it introduces a four-dimensional evaluation standard for research value: creativity, effectiveness, priority, and contribution. The paper conceptualizes research organization competitive advantage as three concrete capabilities: systematic and continuous accumulation of databases/sample libraries, sustained capacity to solve major strategic problems, and sustained ability to transform knowledge and technology into real productivity. Through portfolio analysis using the two research value dimensions as axes, it proposes three generic strategies for research organizations and systematically elaborates their characteristics. Applying this model to analyze CAS' s institute classification reform demonstrates that the generic strategy model can provide theoretical support and guidance for CAS reform practice. Based on these conclusions, the following recommendations are offered for CAS institute classification reform:

First, we recommend applying the generic strategy model and theory to systematically re-examine the classification reform logic, redefining institute types according to generic strategies, and clarifying the essential connotations and boundaries between different institute types to provide strong theoretical guidance for reform implementation.

Second, regarding large science research centers, we recommend not treating them as a separate institute type. Alternative approaches include: requiring large science research centers to make strategic choices and develop into excellence innovation centers, innovation research institutes, or characteristic institutes based on large scientific facilities; promoting collaboration between large science research centers and corresponding institutes; or developing them into professional organizations that operate large scientific facilities and provide specialized services to other institutes.

Third, we recommend redefining the connotation of "characteristic institutes," clarifying that they should face the main economic battlefield, focus on industry 对接, conduct industrial common technology research, and serve industrial development and regional economic society. Consider renaming "characteristic institutes" as "industrial innovation institutes" or "technology innovation institutes." Simultaneously, distinguish among current characteristic institutes: those primarily conducting disciplinary theoretical research should be reoriented toward excellence innovation centers.

Fourth, we recommend establishing an institute strategic management expert team to provide strategic diagnosis and consulting services for CAS institutes' strategic positioning, selection, and implementation. This would help institutes truly understand the significance of classification reform, assist them in completing strategic transformation, select the most suitable generic strategy, and restructure accordingly to thoroughly avoid "old wine in new bottles."

Fifth, we recommend implementing a long-term strategic tracking evaluation and service mechanism for pilot institutes in the classification reform series. The strategic evaluation system should be developed based on generic strategy theory, with continuous dynamic tracking and evaluation of pilot institutes to identify and resolve implementation problems, propose targeted solutions, and ensure institutes gradually develop into strategy-driven research organizations.

This paper' s conclusions and recommendations are built upon deductive strategic management theory, representing an application of strategic management theory to research organizations. Their validity awaits testing through strategic practice in research organizations. We hope relevant research organizations will conduct exploration and refinement based on their own practice. If the generic strategy theory for research organizations proves valid, then following these strategies in institute practice will inevitably maximize research organization value and continuously cultivate and enhance competitive advantage.

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