An External Regulatory Perspective on Research Integrity: Practical Drivers and Theoretical Logic of Random Inspections in National Science and Technology Program Projects

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Date: 2022-10-16T10:39:12Z

Abstract

To promote critical improvement of systems related to "external regulations for research integrity" both within and beyond the scientific community, this study examines the practical drivers and theoretical logic underlying the institutional practice of "random inspection of national science and technology plan projects" from the perspective of external regulations for research integrity. The practical drivers are primarily: the global research integrity crisis and institutionalization trend of "external regulations for research integrity" against the backdrop of evolving public cognition and research organization models; the government's rigid demand to ensure the integrity, efficiency, and local benefits of "national science and technology plans"; and the significant deficiencies of over-reliance on reporting, public opinion, and social moral reward-punishment systems. Its theoretical logic originates from moral philosophy, philosophy of science, judicial economics, information economics, and statistical quality management, mainly including: confronting the social attributes of the "research institution," and improving the institutionalized "discipline" of "moral self-discipline"; enhancing the quality of punitive techniques to realize a deterrence mechanism based on "rule-based punishment"; shortening the principal-agent chain of intervention investigations to improve the efficiency of research integrity supervision; and introducing a "statistical sampling + AQL" technical strategy to establish macro-level control of overall research quality. The research conclusions and analytical framework are conducive to deepening stakeholders' empirical understanding of "random inspection of national science and technology plan projects" and "external regulations for research integrity," and provide a more concise and structured analytical framework and cognitive architecture for management decision-making, knowledge dissemination, and theoretical iteration.

Full Text

External Norms of Scientific Research Integrity: The Realistic Drivers and Academic Logic of Sampling National Science and Technology Program Projects

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Abstract

To promote critical reflection and improvement of the institutional framework for "external norms of scientific research integrity" within and beyond the scientific community, this study examines the realistic drivers and academic logic underlying the institutionalized practice of "sampling national science and technology program projects" from the perspective of external research integrity norms. The realistic drivers primarily include: (a) the global crisis of research integrity and the institutionalization trend of "external norms" against the backdrop of evolving public cognition and research organization models; (b) the government's rigid demand to ensure the integrity, efficiency, and local benefits of national science and technology programs; and (c) the significant deficiencies of over-reliance on whistleblowing, public opinion, and social-moral reward-punishment systems. The academic logic derives from moral philosophy, philosophy of science, judicial economics, information economics, and statistical quality management theory, encompassing four main dimensions: (a) acknowledging the social attributes of the "research establishment" to improve the institutionalized "discipline" of moral self-regulation; (b) enhancing the technical quality of punishment to achieve a deterrent mechanism based on "rule-based" penalties; (c) shortening the principal-agent chain in investigative interventions to improve the efficiency of research integrity supervision; and (d) introducing a "statistical sampling + AQL" technical strategy to establish macro-level control over research quality. The research conclusions and analytical framework can deepen empirical understanding of both "sampling of national science and technology program projects" and "external norms of scientific research integrity," while providing a more concise and systematic cognitive architecture for management decision-making, knowledge dissemination, and theoretical iteration.

Keywords: external norms of scientific research integrity; sampling of national science and technology program projects; institutionalization of science; research integrity construction and research system reform; realistic drivers; academic logic

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From 2020 to 2021, the Ministry of Science and Technology, Ministry of Fi-

nance, Ministry of Education, Chinese Academy of Sciences, and National Natural Science Foundation of China formally launched the "Annual Random Sampling of National Science and Technology Program Projects (Special Programs, Funds, etc.)" in accordance with documents such as "Guo Ke Ban Jian [2020] No. 89," "Guo Ke Ban Jian [2021] No. 125," and "Guo Ke Fa Zheng [2015] No. 471" [1, 2]. This represents a stable adjustment of government research supervision policy in the institutionalized practice of "external norms of scientific research integrity," following the establishment of the "Joint Meeting on Research Integrity" system by the Ministry of Science and Technology and multiple ministries in 2007, the creation of the "Department of Science and Technology Supervision and Integrity Construction" in 2018, and the pilot implementation of "random sampling of national science and technology program projects" in 2019. The joint sampling targets "completed projects and those with funds allocated for more than one year," examining fulfillment of project (task) agreements, use of special funds, implementation of institutional responsibilities and internal control systems by host institutions, and implementation of important recent science and technology policy documents. The policy emphasizes principles of "burden reduction" and "practical effectiveness" : (a) not hindering normal project progress; (b) conducting inspections through "unannounced, direct-to-site, lenient-yet-firm, and extend-as-needed" approaches; (c) requiring no prepared reports or materials from inspected projects and institutions; and (d) adhering to a restrained principle of "trust as prerequisite" and a value standard of "zero tolerance for serious violations with integrity as the bottom line" [1, 3]. This policy constitutes a solid step toward "establishing and improving a research integrity system with interactive moral self-discipline and legal regulation" [4], reflecting the government' s admirable value vision, positive effect expectations, and proactive attitude of "respecting research freedom and autonomy while ensuring research integrity and efficiency."

Rational policy serves as crucial support for research integrity construction and research system reform, while systematic theoretical frameworks [5] facilitate consensus-building in policy decision-making and practice. Previously, China has lacked doctrinal explanations permeating research integrity regulation strategies, with theoretical research around policies focusing more on "knowledge updating" and borrowing from international experience [6], often dismissing the "certainty" pointed to by classical academic logic. Consequently, institutional and strategic practices have long suffered from a lack of holistic [7], coherent, and principled observational perspectives and critical approaches, leaving the "last mile"of policy implementation and improvement without systematic synergy [8, 9]. This has spurred current research 热潮 analyzing international research integrity hotspots and the evolution of domestic research integrity policies [6, 9-12], and reflecting on research integrity concepts and institutional supply benefits [8, 13, 14]. In fact, judgments of "realistic situations" and "principled" knowledge can "correct deviations"and "accelerate"practice; once academic logic pointing to "certainty" is understood and mastered by the public, it generates powerful synergy for transforming society, upgrading institutions, and guiding

conscious action. To thoroughly break away from path dependence and institutional lock-in risks, and to promote multi-level criticism and improvement of relevant institutions, technologies, and theories within and beyond the scientific community, we have systematically examined the technical strategies and theoretical foundations for handling research misconduct and preventing research integrity risks in various countries since 2016. We have attempted to introduce multidisciplinary theoretical wisdom to construct a theory of "external norms of scientific research integrity" and have analyzed the purposiveness and regularity of its institutional paradigm [15]. Based on the constructive "interdisciplinary" [16, 17] theoretical perspective encompassed by the concept of "external norms of scientific research integrity," this study systematically organizes the realistic drivers and academic logic of the institutionalized practice of "sampling national science and technology program projects," aiming to provide a more concise and systematic analytical and critical framework and cognitive architecture for management decision-making, knowledge dissemination, and theoretical iteration.

1. Realistic Drivers for Sampling National Science and Technology Program Projects

As a practical choice for "management" in the "decentralization, regulation, and service" reform of the research system, "sampling national science and technology program projects" represents an important measure for China to align with the global institutionalization trend of "external norms of scientific research integrity," independently optimize innovation management, improve the research ecosystem, enhance local benefits of "research integrity construction," and implement the spirit of the 19th Central Committee' s fourth and fifth plenary sessions. Its realistic drivers operate at three main levels.

1.1 Driver I: Global Research Integrity Crisis and the Institutionalization Trend of External Norms

Optimizing government management of science and technology in alignment with the global institutionalization trend of "external norms of scientific research integrity" constitutes the deep motivation for national science and technology program sampling.

Since governments began funding scientific research with public finances, the world has experienced three trust crises in the scientific community, forming three successive consensuses: (I) Science' s endogenous "institutional norms" can function to "safeguard research integrity," with the "independence, freedom, and democracy" maintained by "internal norms" holding "meta-value" status for science [18, 19]; (II) Governments have an obligation to fund scientific research but do not naturally possess the authority to manage science [20]—such authority must rely on the knowledge reserves and application capabilities of public decision-making groups in science management; (III) "External norms of scientific research integrity" are both purposive and regular, and governments

bear the responsibility to "ensure the integrity and efficiency of scientific research" [15, 21]. This implies that social demand and institutional supply for research integrity have evolved from "internal norms" to "external norms," and governments are destined to play "external" management and service functions in the norms and normative systems of science.

From a broader historical perspective, the institutionalized practice of "external norms of scientific research integrity" possesses inevitability: (a) The theoretical knowledge construction and public cognition development in management, public management, and science policy studies are transforming the specialized knowledge for developing science and managing research from "tacit"to "explicit" —fundamentally eroding the traditional authority of the "scientific community" to conduct "internal norms" based on implicit knowledge; (b) The "scaled, professionalized development and specialized subdivision" of scientific research is increasingly freeing scientific activities from the "workshop-style" organization model, entering an "industrial-like" organizational era with more detailed division of labor, broader cooperation, greater condition dependency, and more controllable "quality/integrity." Compared to the "workshop" era' s reliance on "guilds and morality" for "integrity and quality" management, the industrial model' s control over "quality and integrity" derives more from scientifically optimized process management and "sampling inspection + Acceptance Quality Limit (AQL)" based on statistical regularities. In short, against the backdrop of evolving public cognition levels and research organization models, government sampling of science and technology program projects fundamentally aligns with the realistic demand for governments to face the future and proactively improve their functions.

1.2 Driver II: Rigid Demand to Ensure Integrity, Efficiency, and Local Benefits of National Science and Technology Programs

Ensuring the integrity, efficiency, and local benefits of "national science and technology programs," and scientifically responding to domestic and international public opinion' s accusations, criticisms, and suggestions regarding China' s responsible research conduct, constitute the main motivation for national sampling.

Ensuring "integrity and efficiency of scientific research" based on local benefits has undoubtedly become a rigid government demand. Since World War II, countries worldwide have promoted social upgrading and development with scientific and technological innovation as the core driving force. Governments have intensively introduced science and technology policies and mobilized public resources to guide and support research programs and knowledge production, thereby enhancing national international competitiveness. Correspondingly, scientific research activities and their actors inevitably involve increasingly public-sensitive domains such as government public fund allocation, social public rights exercise, and public-private interest gaming [22]. Since the 1990s, (a) in emerging scientific centers represented by the United States, a wave of scientific institution-

alization utilizing public power to protect intellectual property rights, evaluate research performance, govern research fraud, and define academic misconduct has been on the rise; (b) academic publication, indexing, and quantitative evaluation were once globally revered as standards for research performance management and talent selection. However, the lack of systematic, fair, and logically rigorous government institutional supply and technical path selection during the institutional "trial-and-error period" rapidly triggered a new round of global research integrity crises characterized by paper fraud and peer questioning, with renowned research institutions and scientists frequently embroiled in academic corruption allegations and research fraud scandals. Government intervention oriented toward local public interests has become an indispensable institutional element of "external norms of scientific research integrity."

Specifically in China, the 1990s marked a crucial time node for vigorously advancing reform and opening up. Government development of science and technology shifted from pure self-reliance or borrowing from Soviet models to actively integrating with European and American academic systems. Encouraging and guiding domestic researchers to publish papers in English in international academic journals was elevated to a strategically important position as "basic quality for participating in the scientific community and international academic society." During the same period, under the era' s demand for benchmarking against European, American, and Japanese science development policies and integrating with the global scientific and technological innovation system, China successively proposed a series of "national science and technology programs"such as the "863 Program," "973 Program," and "National Key R&D Program," establishing the current "national science and technology program system" composed of "basic plans" and "major special projects."

This system undertakes important tasks of solving major scientific and technological problems in social and economic development and achieving rational allocation of scientific and technological resources, involving China' s most cherished research groups and currently being entrusted with more adequate project funding autonomy. However, over the past 30 years, as Chinese scholars have become increasingly familiar with Western peers, gradually integrated into the world scientific system, and achieved paper "productivity" comparable to the United States, institutional borrowing and migration have left China unable to escape the loopholes and pitfalls accompanying foreign "institutional trial-and-error" phases, while also spawning more complex local "Four Only" and "Five Only"interest chains. Particularly under the parallel background of market economy system reforms that "monetize rewards" and "encourage private interests" alongside the planned economy system of state research funding and administrative management of research personnel, irrational practices of "free-riding" by research units at all levels in talent selection, appointment, title evaluation, research assessment, and resource allocation have increasingly manifested negative "Matthew effects," with opportunism, utilitarianism, and refined egoism running rampant. "Scientific research has been adulterated with fake and shoddy components," exhibiting "both the stench of money and the impetuousness of 浮

躁" [23]. International prestigious academic journals such as *Nature* and *Lancet* have published articles specifically blasting Chinese research paper fraud [24], and journals have retracted Chinese scholars' papers en masse [25]. The deteriorating state of research integrity makes it difficult to guarantee the discursive authority of Chinese scholars integrating into the international academic system, while also leaving local enterprises and economic-social development facing numerous "bottleneck" technological dilemmas. Scientifically responding to domestic and international public opinion' s accusations, criticisms, and suggestions regarding China' s research integrity issues clearly requires forceful measures to ensure the integrity, efficiency, and local benefits of "national science and technology programs."

1.3 Driver III: Significant Defects of Over-Reliance on Whistleblowing, Public Opinion, and Social-Moral Rewards and Punishments

Overcoming the inherent defects of over-reliance on whistleblowing, public opinion, and social-moral reward-punishment systems to prevent research integrity risks constitutes the direct motivation for national sampling.

For a long time, peer whistleblowing, media public opinion, and social-moral rewards and punishments have de facto shouldered the "external norm" function of curbing scientific fraud and enhancing knowledge production efficiency and local benefits in the scientific community. Because "scientific autonomy," as the officially selected policy theory and "initial system," has long dominated the bilateral relationship model between "science and politics," theoretical analysis, technological development, and institutional construction around "external norms of scientific research integrity" by government, academia, and intellectual circles have been relatively brief [15]. However, over-reliance on whistleblowing, public opinion, and social-moral reward-punishment systems exhibits several significant loopholes and defects:

First, fairness and effectiveness cannot be guaranteed: (a) External intervention relies on informed whistleblowing, but key informed parties rarely report due to interest collusion, low status, fear of privilege, or retaliation; (b) Due to bystander silence and moral disengagement [26], academically misconduct reports driven by genuine morality are few, while those driven by interest gaming are many; (c) When academic misconduct and research fraud are exposed, both administrative and research institutions tend to first adopt resolution methods for interest damage control (subjectively not necessarily intending to cover up). Once determined to endanger institutional reputation and future interests, pressure is rapidly shifted down to specific researchers, graduate students, or even "temporary staff" to extricate the institution. In short, gaming and weighing of public power and private interests fundamentally constrain the exposure, fair handling, and removal of information constraints on research fraud determination.

Second, information components are not pure—online public opinion and scholar

evaluations surrounding research whistleblowing often accompany public power and private interest demands. Undoubtedly, "social regulations are a shackle that everyone wants to place on others but not on themselves" [27]. Objectively speaking, (a) real-name whistleblowing is legally a typical "dangerous power and obligation" where whistleblowers personally bear risks that may not lead to reasonable handling of the reported subject, thus generally carefully measuring the "power" and "capacity" gap with the reported party to obtain sufficient government, media attention, and online onlookers to achieve fair treatment and the intended reporting purpose. In reality, public opinion and media are generally driven by economic interests and attention levels, and in most cases, the desire of media intellectuals and institutions to meddle with and manipulate public rights and discourse lacks guidance and regulation. Online onlookers exhibit information characteristics of "acting without reasoning or verification" —under increasingly networked and self-media conditions, this not only causes serious psychological and reputational distress for investigated subjects but may also be artificially manipulated or exploited; (b) anonymous whistleblowing helps break information blockades and protects whistleblowers to some extent, but generates large amounts of non-standard, insufficient, and difficult-to-process information in a timely manner, with content authenticity unaccounted for and difficulty in intelligence analysis and punishment governance during investigation. The interference with normal order and harm to public and private rights caused by false accusations, framing, exaggeration, and distortion are difficult to effectively prevent and govern.

Third, extremely high economic and social costs: (a) Driven by public opinion and whistleblowing, governments need to frequently and passively establish various special investigation committees, mobilizing substantial human, material, and administrative resources to respond to social concerns or domestic and international peer questioning. As a passive performance of duties, whistleblowing-driven law enforcement places government supervision in a passive state, detrimental to maintaining government image and authority; (b) The "media + government + expert panel" investigation model cannot achieve opportunity fairness for all researchers, and determinations often require lengthy time and procedures [22]—the uncontrollable fairness scale and unguaranteed evaluation timeliness inevitably involve persons and institutions with unknown degrees of interest association, producing variations in punishment severity and processing speed, presenting phenomena of inconsistent policies and ineffective enforcement, and dissolving public identification with local scientific society and government authority; (c) The "black-or-white" moral judgment and opportunistic association of "severe punishment" consequences trigger intentional avoidance or malicious manipulation by later actors, forming a vulgar "litigation-prone" atmosphere and abnormal competitive ecology at interest-critical innovation frontiers. Especially in the era of post-academic and post-normal science, science and technology research itself is associated with enormous and urgent economic and political interests, ethical value controversies, and public safety or ecological uncertainties [28]. Cross-national research integrity supervision [29]

and "research integrity evaluation" based on different stakeholder needs may be manipulated to serve non-scientific purposes such as peer competition, technological colonization, colonization of scientific and technological systems, and cultivation of various "agents," easily degenerating into an out-of-control discursive authority of "free-riding."

In short, under circumstances of global research fraud proliferation, complex incentives, and inefficient social-moral reward-punishment guidance systems, overreliance on peer whistleblowing, media "scientific morality activists' " "verbal condemnation,"and "societal common concern"is clearly insufficient to guarantee the implementation benefits and management effectiveness of national science and technology program projects. Preventing the evil consequences of selective law enforcement and overcoming the defects of supervision systems dependent on whistleblowing, public opinion, and social-moral rewards and punishments have directly driven the institutionalized practice of national science and technology program sampling.

2. Academic Logic of Sampling National Science and Technology Program Projects

Science policy inevitably involves "social issues and values"and requires multidisciplinary theoretical knowledge including social sciences [30]; only by clarifying academic logic can we uphold integrity while innovating. Academic logic is the academic presentation and theoretical articulation of regular understanding, including the revelation of essence, assessment of current situations, and description of internal evolutionary paths. Under the constructive "interdisciplinary perspective" [16, 17] encompassed by the concept of "external norms of scientific research integrity" [15], the academic logic of "sampling national science and technology program projects" originates from moral philosophy, philosophy of science, judicial economics, information economics, and statistical quality management theory, comprising four aspects.

2.1 Unity of Moral Philosophy and Philosophy of Science: Acknowledging the Social Attributes of the "Research Establishment" and Improving Institutionalized Discipline for "Moral Self-Regulation"

Self-regulation is the ideal form of scientific norms and the core trait of morality —according to Kant' s classic philosophical assertion, "autonomy of the will" is the sole principle of all "moral laws" and corresponding duties; conversely, any "heteronomy" not only fails to establish any duty but stands in opposition to "the principle of duty" and "the virtue of the will" [31]. In other words, "self-regulation" is humans "legislating for themselves" in practice, "a more positive freedom" [31], obviously more aligned with the fundamental value demand of "responsible research conduct." Undoubtedly, scientific practice possesses traits unsuitable for "heteronomy" : (a) science remains imperfectly institutionalized in society, with exploration of unknown frontiers often lacking "a priori" ethical

standards and rule provisions; (b) infinite subdivision of research specialties inevitably leads to shrinking peer groups and insufficient supervision intensity; (c) "self-regulation" is the mark of a "field' s" existence, while "autonomy" is the prerequisite for the "science field" to host "science" [32].

However, while "self-regulation" aligns with the value and functional demands of scientific practice, it is not the natural social attribute of researchers or the research establishment [33]. Particularly in China, (a) theories of scientific institutionalization and "recognition-reward" mechanisms remain imperfect, with some researchers needing to simultaneously play multiple roles as principals, agents, and supervisors, where the private benefits of engaging in scientific innovation and safeguarding public interests are far lower than the private gains from power rent-seeking and power attachment; (b) the early economic reform' s overcorrection of "encouraging private interests" has led to various forms and degrees of monetized linkage between the "public nature" of research activities and the "private nature" of personal interests, with institutional-level "public power-private interest" loopholes causing universal decline in moral constraints on academic activities, rampant utilitarianism and refined egoism, and spawning speculative groups and cultural atmospheres that covet public resources and authority and endanger academic self-regulation.

Therefore, self-regulation based on "scientific spirit characteristics," "scientist spirit," and researchers' conscience cultivation obviously cannot completely replace institutionalized discipline involving 梳理 guidance, "panopticon" surveillance, and even public punishment. In other words, at the stage where research activities are increasingly professionalized and profoundly influence public discursive authority and political-economic interests, group "self-regulation" is an organizational cultural atmosphere that can only gradually form effectively with strong support from external institutional "heteronomy" [15].

Consequently, "sampling national science and technology program projects" is a scientific institutionalization measure that acknowledges the social attributes of the research establishment and supplements the disciplinary prerequisites for "self-regulation." Compared to early "internal norms of scientific research integrity" and other informal social disciplines, indiscriminate random sampling possesses a series of advantages: (a) it can legitimately achieve fairness in evaluation rules and opportunities, making intervention inspections and potential punishments for research fraud constant and fixed; (b) it can maximally reduce and filter the negative impacts of "whistleblowing-intervention investigation" on specific researchers and institutions, desensitize inappropriate social public opinion, and eliminate management departments' concerns about investigation intervention—for example, if the annual sampling probability for non-whistleblown individuals is 5% while that for whistleblown individuals is 50%, with both proceeding through the conventional form of sampling, the public opinion pressure and social negative effects of intervention investigations will receive maximal "filtering" treatment.

2.2 Utilization of Judicial Economics Principles: Enhancing Punishment Technical Quality and Realizing a Deterrent Mechanism Based on "Rule-Based" Punishment

Although the core goal and main technical approach of research integrity construction is not punishment, establishing a "deterrent mechanism" through sanctions can actively respond to societal concerns outside science and urge researchers to strengthen self-regulation. Most people' s "moral self-regulation" essentially stems from fear and avoidance of losses brought by sanctions— "with awe, one dares not act recklessly, and virtue is thus achieved." Especially in domains involving public interests, "punishment is the existing force that maintains rule existence; if a rule is announced but the state fails to arrange a reasonable and effective punishment structure for it, then the rule practically does not exist at all" [34].

However, we must face the facts: (a) punishment is associated with power and authority prone to rent-seeking and abuse; (b) "deterrence" follows sophisticated economic logic, and "opportunity-based" punishment cannot achieve the actual deterrent effect of "rule-based" punishment. According to law and economics principles, the deterrent effect of punishment (i.e., the expected loss of violators) equals the product of the actual loss from punishment and the probability of being caught; when punishers are unable to maintain high punishment probability, they often ensure sufficient deterrent effect by increasing punishment severity [34]. In fact, information constraints and logical defects in determining research fraud are difficult to ignore, opportunities for different researchers' fraud to be reported, investigated, verified, and punished are extremely unequal, and the probability of certain research fraud represented by QRP [35] being caught and punished even approaches zero. When opportunities for research fraud to be "determined" and "punished" are minimal, "rules" either exist only in certain "normative documents" without generating effective deterrence, or breed power authority that endangers scientific democracy and stifles innovation enthusiasm. Especially in the "post-academic science" era, knowledge production methods are shifting from "Mode I" to "Mode II," increasingly exhibiting characteristics of "collectivization, utilization, industrialization, and bureaucratization," with academia, government, and industry forming an overlapping "triple helix structure" where "science is no longer the internal affair of the scientific community, nor is it a matter between the scientific community and government" [36]. "Severe laws and harsh punishments," indiscriminate punishment, and selective law enforcement that ignore judicial economic benefits and "marginal deterrent effects" inevitably spawn deeper-level power corruption and interest solidification.

Therefore, even "non-violent, mild punishment" as an economic mechanism for depriving rights requires implementing "punishment technical quality" to establish effective deterrence: (a) punishment must be moderate—its severity need only just reach or slightly exceed the point where violators' losses outweigh their gains. Technically, punishment consumes resources while inflicting losses on the

punished; rational punishers should not make punishment costs exceed punishment benefits. Excessive punishment not only consumes excessive resources and energy and scares away potential partners but also destroys punishment' s "marginal deterrent effect," rendering inability to impose more severe punishments when facing more serious consequences to demonstrate fairness [34]; (b) punishment must be timely—the more timely, the more effective. Research shows that punishment' s deterrent effect depends on the urgency and importance of impact on future interests (i.e., the "discount rate" in economics). If a certain punishment' s discount value is fixed with an annual discount rate of 10%, a punishment implemented ten years later has a deterrent effect only equivalent to 0.35 times that of timely punishment [34]; (c) punishers must have the opportunity and capacity to implement punishment [34]. In other words, the most effective way to enhance punishment technical quality and establish deterrence is to eliminate "uncertainty in punishment implementation"and make punishment constant and fixed, i.e., replacing "opportunity-based" punishment with "rule-based" punishment. Only inevitable, timely, fair, and appropriate punishment can truly form deterrence, effectively prevent large-scale deterioration of academic atmosphere and research ecology, and fundamentally establish a benign research order that curbs research fraud.

Therefore, in judicial economics terms, "random sampling of national science and technology program projects" on the one hand provides science and technology supervisors with legitimate opportunities to actively perform duties and implement sanctions, ensuring equal opportunities and identical probabilities for all fraudsters to be investigated and punished, which helps enhance punishment technical quality, exert punishment' s "marginal deterrent effect," and promote self-regulation. On the other hand, it can eliminate the "severe laws and harsh punishments" and "uncertainty" brought by "opportunity-based punishment," reduce the negative impacts of external intervention investigations and "litigation-prone atmosphere" on researchers and the research ecosystem, and prevent deeper-level corruption and interest solidification caused by indiscriminate punishment and selective law enforcement, thereby fostering a "lenient and simple" research management environment.

2.3 Application of Information Economics Principles: Shortening the Principal-Agent Chain in Investigative Interventions to Enhance Research Integrity Supervision Efficiency

Governments' reliance on public finance to develop science and technology inevitably requires various types of "principal-agent" relationships. Particularly in China, despite multiple reforms of the research system, its organization and management still exhibit layered "principal-agent" relationships similar to "public ownership economy" structures—two typical hierarchical systems: (a) a "bottom-up authorization chain" from grassroots members to the highest management committee, and (b) a "top-down authorization chain" from the highest management committee to grassroots members. In this two-way man-

agement "information-rights" chain, each "player" is simultaneously the principal' s agent and the agent' s principal [37]. Correspondingly, in research, academic, and economic establishments, specific research institutions and personnel often simultaneously play multiple roles as principals, agents, and supervisors at different levels, objectively causing overlapping and tangled layers of rights, responsibilities, and interests among government, science and technology management departments, and research institutions. Without whistleblowing and public opinion supervision, research misconduct or academic misconduct involving specific strata often fails to produce "natural consequences."

Undoubtedly, integrity is an obligation-oriented relational category; increased "principal-agent" hierarchy makes supervision less efficient. According to information economics principles, only by shortening the distance from principal to agent and flattening the supervision hierarchy can overall supervision efficiency be improved. Current intervention investigations of research fraud are in fact also based on layered "principal-agent-supervisor" relationships; without external public opinion focus and supervision, the enthusiasm and fairness of trustees in safeguarding public interests are difficult to effectively guarantee. Once academic misconduct and research fraud are reported and exposed, the first casualty is institutional reputation and future interests, leading both administrative and research institutions to tend toward compromise resolution for interest damage control—even if subjectively unwilling to shield the parties involved. Power rent-seeking, power attachment, and gaming/weighing of public power and private interests fundamentally constrain the real-time exposure and fair handling of research fraud.

In this sense, "sampling national science and technology program projects" makes supervision, evaluation, and reward-punishment a public power directly held and exercised by national science and technology development departments, independent of the current research funding and management administrative system. On the one hand, it can shorten the principal-agent chain in intervention investigations and scholar evaluations, improving supervision efficiency; on the other hand, it provides opportunities to clarify conflicts of interest with existing research authority circles, promote specialized division between "athletes" and "referees" in research activities, and nurture specialized "referee technologies," "referee rules," and "referee services," conducive to the self-organizational improvement of the research establishment.

2.4 Applicability of Statistical Quality Management Theory: Introducing "Statistical Sampling + AQL" Technical Strategy to Establish Macro-Level Research Quality Control

Essentially, science and technology development departments organizing researchers and allocating economic-social resources for research activities resembles production activities organized by the state, which theoretically should have quality sampling links and equally apply quality sampling reward-punishment systems.

Undoubtedly, the correlation between product quality and moral integrity is influenced by production organization levels. Under the "workshop-style" production model, product quality depends on whether the "craftsman" personally possesses exquisite skills and good morality, cherishes character and reputation, pursues excellence, and restrains 浮躁 coping mentality. In modern industrial production, however, product quality is systematically controlled through process subdivision, link optimization, fine modeling, quality standards, and sampling rewards/punishments, with each worker on the assembly line completing only one or a few processes at high specialization levels, enabling each production link to stably achieve specific quality standards. The latter' s quality control strategy— "statistical sampling strategy + Acceptance Quality Level (AQL)" —was initially proposed by American statisticians such as Dodge and is currently the globally recognized most reasonable and widely applied quality control method. AQL linked with "rewards-punishments" can not only enhance self-regulation levels of production units but also assist in evaluating management element allocation, workflow, and information flow surrounding production organization. Compared to "workshop-style" production, modern industry' s control over product quality has freed itself from excessive dependence on individual moral standards and integrity levels, making quality system control a technical rather than moral-ethical issue.

Through "national research quality sampling," such as establishing a "National Research Basic Data Supervision and Inspection Center,"with the determination of "burning ships and weighing nails" to conduct sampling verification of certain key technologies, indicators, data, and talents, and gradually fixing and expanding this into conventional rules in the national research field, we can not only shield against interest conflicts and hidden rules that are extremely difficult to avoid in traditional peer review, maximally safeguard researchers' freedom and rights, and promote researcher self-regulation, but also promote management to actively optimize and upgrade research information flow, workflow, and organization management models at minimal cost, liberate and develop researchers' creativity, improve innovation efficiency, promote benign research ecosystem succession, and achieve macro-level control of national research quality.

3. Discussion and Recommendations

3.1 On the Interpretation, Criticism, and Academic Construction of the "External Norms of Scientific Research Integrity Perspective" and Science Policy

As a classic issue in science policy, the social demand and institutional supply for research integrity have undergone ethical 转向 and model evolution from "internal norms" to "external norms" [15], providing new space for society' s active participation in regulating research. Correspondingly, promoting scientific policy decision-making [5] urgently requires guiding the cognitive level of public decision-making groups to 升华 from "partial perceptual understanding" to "holistic rational understanding." This requires not only disciplinary systems,

theoretical frameworks, and methods such as "science of science policy" [5, 38] to promote specialization and systematization of policy research, but also the theoretical perspective defined by the concept of "external norms of scientific research integrity" [15] to 统领, integrate multidisciplinary and multi-domain knowledge to meet the needs of "interdisciplinary" theoretical innovation [16, 17] and even academic construction. Undoubtedly, (a) institutions are syntheses of norms, and the transformation of "normative paradigms" from "internal norms" to "external norms" implies profound changes in institutional paradigms, ideologies, and their academic logic. Interdisciplinary research pointing to theoretical innovation [16, 17] can only correctly interpret and rationally guide the institutionalized practice of "external norms of scientific research integrity" by 与时俱进 seeking academic logic around it; (b) concepts are abstract summaries of essential characteristics of things, and refining concepts to 统领 material organization, value judgment, and logical reasoning to make tacit knowledge explicit and fragmented knowledge systematic is the necessary path for human cognitive thinking to ascend from "perceptual understanding" to "rational understanding." "External norms of scientific research integrity" is precisely an essentialized abstract summary of the new institutional paradigm, multiple technical paths, and their ideology in the science policy domain of "ensuring research integrity and output efficiency" [21]. Compared to concepts such as "research integrity governance" or "research misconduct governance" that emphasize or limit government responsibilities and obligations, the new concept' s defined "external norms of scientific research integrity perspective"focuses more on the "normative" essence of institutions and holistic optimization of "institutions and strategies," advocating making tacit knowledge around "technical supply and institutional supply" explicit and fragmented knowledge systematic, advocating interpretation, criticism, and construction of government "decentralization, regulation, and service" content boundaries from the policy decision-making level, and promoting organic collaborative integration of technology, organization, market, strategy, and other elements.

3.2 On the Institutionalized Realization of "Sampling National Science and Technology Program Projects" and "External Norms of Scientific Research Integrity"

The collapse of the government "governing by non-action" institutional paradigm means "institutional competition" around the new institutional paradigm of "external norms of scientific research integrity" is inevitable. Especially in the contemporary era where computers continuously expand human brain functions and research frontiers, the global information revolution and information technology development-triggered upgrades in productivity and production relations and "changes in science-society operation logic" [15] are fundamentally determining a nation' s academic ecosystem succession, innovation-entrepreneurship order, "endogenous economic growth," and even international discursive authority through the efficiency, effectiveness, and benefits of "external norms of scientific research integrity." However, against the background of scandals driv-

ing theoretical 转向 in science policy, academic and intellectual circles' doctrinal discussions on "external norms of scientific research integrity" are insufficient, and the exploration, trial-and-error, and reflection processes around theoretical construction and institutional supply value are relatively brief [15]. "Path dependence" and "information cocoons" in policy decision-making fields accompany "institutional lock-in" and "cognitive stagnation," where "a considerable number of people intentionally or unintentionally ignore the expedient and limited nature of current choices, lacking profound cognition of the necessity, legitimacy, and rationality sources" [15].

Objectively speaking, under the institutional paradigm of "external norms of scientific research integrity," the use of public power and public punishment has its necessity: (a) Institutions can constrain individual behavior only on the premise of their "enforceability" ; without "coercive power" as guarantee, rule provisions easily become dead letters, and institutions' "enforceability" such as regulation and adjustment cannot be realized. The technical path of "active punishment," as a feedback technical strategy, directly eliminates or inhibits the "inappropriate gain" sense of "misconduct" individuals by presenting "aversive stimuli" or eliminating "pleasant stimuli," making opportunists' "gains" not worth their "losses" and transmitting strong signals that deter similar potential behaviors, conforming to both physiological psychology and law and economics principles; (b) Scientific research itself is a "collective practice" with "public nature," and its order and social cooperation 实然 face the "dilemma of collective action" [39], requiring "public authority deterrence and punishment" to guarantee group action goals "consistent with collective interests," as "private punishment is weak, transaction costs for multilateral contracts are too high, and there are always those attempting to free-ride" [34]; (c) Beyond strictly defined "acquaintance societies," "private monitoring and punishment between individuals" cannot completely replace law and public punishment, even if sometimes "the social control function played by official punishment is merely marginal" [34]. In other words, punishment relying on public power most intuitively represents "coercive power," clearly demonstrating the authority and legitimacy of institutions maintained by "coercive power."

However, irrational simple reliance on public power and public punishment in "external norms of scientific research integrity" is non-rational. According to principal-agent theory, public power is essentially a "universally shared power" that obviously cannot be exercised jointly by all citizens in reality, but can only be exercised by trustees (agency staff) on behalf, 同样需要 establishing "principal-agent" relationships between the state and private individuals. Therefore, formal research integrity management relying on public power essentially introduces one or more new sets of "principal-agent" relationships "with moral risk" to prevent "integrity risk" in existing "principal-agent" relationships between government and researchers. Undoubtedly, this new principal-agent relationship, like the original one, cannot be immune to the natural moral hazard in "principal-agent" relationships. Moreover, research integrity management relying on public power also needs to be constrained by economic laws of cost-payment and ben-

efit accounting—the lower the marginal benefit and higher the marginal cost of supervision and law enforcement, the lower the principal' s enthusiasm for supervision and law enforcement. Additionally, supervision and law enforcement behavior representing public authority, also based on "principal-agent" relationships, inevitably faces the "principal-agent allocation" question of "who should be principal and who should be agent" inside and outside the scientific system, potentially even triggering "politicized" power struggles and turf division. "Opportunity-based" intervention investigation associated with "severe punishment" consequences implies uncertain interest gaming and devastating punishment, creating objective divisions difficult to bridge in subjective identification of the scientificity, conclusion authority, and institutional rationality of "research integrity" evaluation by all parties—deepening empirical cognition and optimizing top-level design from essential and principled levels is imperative.

In fact, as a "collective practice" with "public nature," the norms and normative systems of scientific research possess both "publicness" and "functionality." The rational goal of government institutionalized practice of "external norms of scientific research integrity" should be to prevent "bad money driving out good" and ensure the "quality and efficiency" of research activities with minimal "social risk" and "institutional cost." Prevailing "whistleblowing, litigation, and punishment" winds inevitably lead to internal friction and idling of the national research system, obviously not conducive to a research ecosystem and institutional atmosphere beneficial to healthy competition in the scientific community. Because scholarship requires not only resources, funding, and time but also a quiet environment and pure mindset. A relaxed environment and reasonable order are two necessary conditions for nurturing researchers' free souls, unfettered thinking, and high-quality scientific and technological innovation. Moreover, the professionalism of research activities themselves, special dependence on high-level talent groups, tacit knowledge, and highly personal characteristics such as intellectual passion, natural talent, chance encounters, and freedom of thought, also determine that intervention constraints and adjustments by "external norms" must respect the trial-and-error tolerance needs of scientific research itself [40] and judicial economics logic. "If laws are extremely precise but supervision is not strict and comprehensive verification is not achieved, they ultimately become empty words, instead increasing troubles and disturbances."

The current institutionalized practice of "random sampling of national science and technology program projects" through indiscriminate random sampling inspection can theoretically guarantee equal opportunities for intervention investigation and punishment, help exert the "marginal deterrent effect" of external supervision, implement punishment technical quality, maximally improve the judicial economic benefits of intervention investigation, promote researcher self-regulation, and reduce negative impacts of public opinion on reported individuals and the research ecosystem. This represents important progress in lenient and simple institutionalized "discipline" for research integrity and constitutes an indispensable implementation element for institutionalized practice of "external norms of scientific research integrity." Objectively speaking, "in-

tegrity" has no unidirectional value scale of subject, "research integrity" is not a practical category divorced from the connotation and extension of "integrity," and researchers are not emotionless, low-social-cost "leeks" —facing dual value standards of "internal sincerity" and "external trust," brilliant institutions lie in fairness, leniency, and teaching without words, while rational policies lie in promoting benefits and eliminating drawbacks with simplicity and ease of implementation. Correspondingly, in Confucian management thought that takes "making sincere" (making it "sincere") as the value goal and technical approach, "leniency and simplicity" are the general principle of governance— "without leniency, authority orders are strict; without simplicity, regulations are dense," and "using the strictest laws to govern the densest matters is called tyrannical and abusive governance."

3.3 Recommendations for Enhancing Practical Benefits of "Sampling National Science and Technology Program Projects" Based on Academic Logic

High-quality research depends on both researchers' integrity self-regulation and talent utilization, value guidance, and process control. Therefore, "sampling national science and technology program projects" oriented toward "external norms of scientific research integrity" should not be limited to investigating negligence and fraud in the research process but should also summarize and 梳理 research system loopholes, emphasizing the following goals:

First, 梳理 eliminate opportunity monopolies, information constraints, and information asymmetries associated with opportunistic behaviors such as "shirking" and "sloppy work,"and remove opportunists and uncertain factors from the scientific power system. Only in this way can we form a virtuous interaction between institutions and effects, immediately and significantly improve atmosphere, and prevent work from falling into an endless "Sisyphean predicament."

Second, liberate and develop human creativity, safeguard idea generation freedom and rights during non-document dissemination stages, and promote healthy, fair evaluation relationships and rules among people in the research establishment, enabling talented individuals to stand out and matching human talent with human responsibility. Establish rule buffers and system redundancy based on "probationary" deterrence of punishment for researchers in trial-and-error periods, carefully distinguishing subjective malice to promote researcher 重塑 and self-renewal. Only in this way can we establish and apply differentiated punishment rules, promote peer supervision, and prevent interest monopolies and solidification caused by research fraud.

Third, attach extreme importance to the local interests and benefits targeted by national science and technology program projects, carefully examine the benefits and pros/cons of certain achievements without intellectual property protection participating in international academic society exchange in the form of publications, coordinate and promote consideration of both domestic and international

interests, break the paper-only evaluation tendency from the funding system level, and advocate systematic 攻关 around local benefits.

Fourth, promote the elimination of unnecessary "workshop-style" research and upgrade research information flow and workflow. Although the "workshop-style" research organization model fully utilizes the mutational role of human and human-brain functions in research idea generation, 兼顾 professional talent cultivation, specialized skill inheritance, and intellectual property protection in research activities, for the state-funded research system it simultaneously has the following drawbacks: (a) non-unified and non-standardized research data production and reproducibility standards make inter-researcher data sharing and large-scale collaborative research difficult to achieve, and data fraud difficult to assess and discover; (b) repeated allocation of instruments and equipment resources between research groups creates enormous waste; (c) individual researchers often must complete all related processes from idea innovation, proposal writing, funding application, experimental equipment and material inquiry and procurement, to data processing and paper submission, with all bureaucratic red tape in the process first occupying substantial time and energy of grassroots researchers; (d) actual research links are limited to existing material conditions such as "in-workshop" equipment resources and personal knowledge reserves, with "single-handed" work under time constraints inevitably unable to guarantee the rationality, systematicity, precision, and depth that scientific research should extremely value; (e) "workshop-style" "rule-by-man" research management, 脱胎 from ancient "master-apprentice" workshop traditions, easily leads to absolute authority, breeds blind obedience, and generates power corruption.

References

[1] Ministry of Science and Technology. Notice on Launching the 2021 Annual Random Sampling of National Science and Technology Program Projects [Z]//People' s Republic of China Ministry of Science and Technology. 2021
[2] Ministry of Science and Technology. Notice on Launching the 2020 Annual Random Sampling of National Science and Technology Program Projects [Z]//People' s Republic of China Ministry of Science and Technology. 2020
[3] Liu Yin. Five Ministries Launch 2020 Annual Random Sampling of National Science and Technology Program Projects [N]. Science and Technology Daily, 2020-.
[4] Tang Zhuang, Nie Peiqin. Establishing and Improving a Research Integrity System with Interactive Moral Self-Discipline and Legal Regulation [J]. Science Research Management, 2008, (S1): 4.
[5] Zhou Huadong, Wang Haiyan, Hao Junchao. Promoting Scientific Decision-Making in Science Policy—Interpreting the Construction of Science of Science Policy in the United States [J]. Studies in Science of Science, 2012, 30(11): 1601-6.
[6] Wang Yang. The Institutional Logic of the Evolution of U.S. Research Integrity Construction and China' s Reference [J]. Studies in Dialectics of Nature,

2020, (07 vol 36): 52-8.
[7] Wei Huai' an, Wei Bin. Holistic Governance of Research Integrity Issues [J]. Science & Technology Progress and Policy, 2019, 36(21): 6.
[8] Yin Bo. Perfection, Inheritance, and Pragmatism: Value Criteria for Formulating Norms for Handling Research Misconduct Cases [J]. Science and Society, 2020, (04 vol 10): 85-101.
[9] Yu Liping, Zhou Mengmeng, Su Guangyao. Research on the Evolution Characteristics of China' s Research Integrity Policy—Based on Policy Text Analysis from 1981-2020 [J]. Information Science, 2022, (05 vol 40): 51-8+64.
[10] Jiang Chunlin. Comparison of Domestic and International Research Integrity Research: Themes, Hotspots, and Trends [J]. Journal of Southwest Minzu University (Humanities and Social Science), 2020, (08 vol 41): 226-33.
[11] Wang Anyi, Hu Liyun. Historical Evolution and Countermeasure Research of Chinese Government Research Integrity Norms [J]. Science Research Management, 2021, (09 vol 42): 10-6.
[12] Yang Rui, Yang Liang, Li Liangqiang, et al. Characteristics and Evolution Logic of China' s Research Integrity Policy—Based on Text Mining Method [J]. Science & Technology Progress and Policy, 2020, (20 vol 37): 89-98.
[13] Wu Guanjun. Research Integrity and Academic Reputation—Thinking Based on Political Philosophy and Game Theory [J]. Journal of East China Normal University (Educational Sciences), 2020, (07 vol 38): 75-86.
[14] LI T. Five ways China must cultivate research integrity [J]. Nature, 2019, 575(7784): 589-
[15] Liu Shengli, Pan Yuntao, Zhao Xiaoyuan. Theoretical Analysis of the Purposiveness and Regularity of External Norms of Scientific Research Integrity [J]. Modern Information, 2020, 40(9): 7.
[16] Luo Weidong. Interdisciplinary Social Science Research: A New Path for Theoretical Innovation [J]. Zhejiang Social Sciences, 2007, (02): 35-41.
[17] Zou Nongjian. Interdisciplinary Research: The Inevitable Choice for Social Science Research [J]. Zhejiang Social Sciences, 2009, (1): 6.
[18] R. Merton, Lin Juren. The Normative Structure of Science [J]. World Philosophy, 2000, (3): 56-60.
[19] POLANYI M, POLANYI M. The Republic of science [J]. Minerva, 1962, 1(1): 54-73.
[20] BUSH V. Science, the endless frontier: a report to the President on a program for postwar scientific research [M]. National Science Foundation, 1945.
[21] David Guston, Gong Xu. Between Politics and Science: Ensuring the Integrity and Productivity of Scientific Research [M]. Science Press,
[22] Liu Shengli, Pan Yuntao, Zhao Xiaoyuan. Macro Considerations on Practical Intelligence Strategies and Technologies for Determining Research Data Fraud [J]. Modern Information, 2017, 37(12).
[23] Science and Technology Community: Corruption Concerns [J]. Procuratorial 风云, 2007, (03): 12.
[24] LANCET T. Scientific fraud: action needed in China [J]. Lancet, 2010, 375(9709): 94-.
[25] Li Aidang, Zhang Xi, Liang Bing. Analysis of Retraction Phenomenon of

International Scientific and Technological Papers Published by Chinese Scholars [J]. Chinese Journal of Scientific and Technical Periodicals, 2019, 30(10): 5.
[26] Chen Yinfei. Moral Disengagement, Bystander Silence, and Academic Misconduct [J]. Studies in Science of Science, 2013, 31(12): 8.
[27] Rousseau. The Social Contract [M]. Beijing: The Commercial Press, 2018.
[28] Liao Miao. Social Contract of Science and Post-Normal Science [J]. Studies in Dialectics of Nature, 2014, (10): 54-9.
[29] MACILWAIN C. Scientific misconduct: more cops, more robbers? [J]. Cell, 2012, 149(7):
[30] Cohen, Brooks, Zhang Butian trans. Social Science, Natural Science and Public Policy—Dialogue Between Bernard Cohen and Harvey Brooks [J]. Science & Culture Review, 2016, (2): 26.
[31] Kant. Critique of Practical Reason [M]. Beijing: The Commercial Press, 2016.
[32] BOURDIEU P. Science of Science and Reflexivity [M]. Polity Press, 2004.
[33] Michael Mulkay, Lin Juren et al. trans. Theories and Methods of the Sociology of Science [M]. Beijing: The Commercial Press, 2006.
[34] Sang Benqian. Private Monitoring and Punishment Between Individuals: An Economic Approach [M]. Shandong People' s Publishing House, 2005.
[35] Cao Nanyan. QRP—The Gray Area in Scientific Research—Small Evils Unstopped, Great Disasters Immediately Arrive [J]. Hechi University Journal, 2007, 27(3): 4.
[36] Gong Xu. Science Policy and Peer Review [M]. Hangzhou: Zhejiang University Press, 2009.
[37] Zhang Weiying. Principal-Agent Relationships in Public Ownership Economy: Theoretical Analysis and Policy Implications [J]. Economic Research Journal, 1995, (4): 31-3.
[38] FEALING K. The science of science policy: a handbook [M]. Stanford University Press, 2011.
[39] Chen Tan. The Dilemma of Collective Action: Theoretical Interpretation and Empirical Analysis—Public Management Crisis and Its Resolution Under Non-Cooperative Game [J]. China Soft Science, 2003, 000(009): 139-44.
[40] Hu Zhibin. Research on Legal Regulation of Academic Misconduct [M]. China Legal Publishing House, 2014.

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