Beyond Disclosure: Financial Conflicts of Interest and the Structural Integrity of Scientific Research

Paul Andrew Bourne, PhD, DrPH

Assistant Professor, University of the Commonwealth Caribbean, Kingston, Jamaica, West Indies

DOI: https://doi.org/10.47772/IJRISS.2026.100800453

Received: 24 August 2026; Accepted: 29 August 2026; Published: 08 September 2026

ABSTRACT

The current paper proposes the Financial Influence on Research Ecosystem (FIRE) Framework as a conceptual model, not a validated measurement instrument. It organises financial influence across seven interconnected domains: research agenda formation, funding and contractual arrangements, methodological architecture, data generation and analysis, interpretation and reporting, publication and dissemination, and translation into policy and practice. The strongest empirical support reviewed concerns biomedical and pharmaceutical research; application to artificial intelligence, environmental research and other fields is presently more provisional and requires discipline-specific validation. The framework distinguishes established empirical associations from plausible mechanisms and framework-generated propositions. Disclosure remains necessary but insufficient, and the paper proposes structural safeguards involving research contracts, independent statistical analysis, prospective registration, open science, data accessibility, institutional governance, journal transparency and diversified research financing. Protecting scientific integrity requires moving beyond the question of whether researchers have financial conflicts towards examining how financial incentives and decision-making authority may be embedded throughout systems of knowledge production.

Keywords: research ethics; research misconduct; financial conflicts of interest; industry sponsorship; scientific integrity; commercialisation; publication bias; research funding; questionable research practices; biomedical research

INTRODUCTION

Scientific research is commonly conceptualised as an intellectual enterprise grounded in curiosity, methodological rigour, objectivity, transparency, accountability, and the pursuit of reliable knowledge (Çaparlar & Dönmez, 2016; Hundemer et al., 2026; Mezhoud, n.d; Purdue University College of Science, n.d.; Wedderkopp & Rutz, 2024). These principles constitute part of the normative foundation of scientific inquiry, within which researchers are expected to generate knowledge systematically while maintaining honesty, openness, fairness, and independence of judgement (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). Scientific integrity depends not only on adherence to accepted methodological procedures but also on institutional and professional commitments that protect the credibility, reproducibility, and trustworthiness of knowledge production (Centers for Disease Control and Prevention, 2026; Diaba-Nuhoho & Amponsah-Offeh, 2021; NASEM, 2017; National Research Council & Institute of Medicine, 2002; Nguyen & Tuamsuk, 2025). The conventional ideal of scientific objectivity further assumes that the evaluation of evidence should, as far as possible, remain insulated from interests unrelated to the epistemic merits of the research itself, including political, personal, institutional, and economic considerations (Resnik & Elliott, 2019). Yet contemporary science does not operate within an institutional or economic vacuum. Researchers work within interconnected systems comprising universities, governments, corporations, charitable foundations, funding agencies, publishers, professional organisations, regulatory bodies, and other stakeholders whose priorities can influence which questions are investigated, how studies are conducted, how findings are interpreted, and which results ultimately become visible (Resnik, 2007; Shamoo & Resnik, 2022). The idealised conception of science as a wholly disinterested search for truth must be reconciled with the material and organisational conditions under which contemporary knowledge is produced.

Among these conditions, financial resources are indispensable. Modern research requires laboratories, specialist personnel, equipment, databases, clinical participants, data-management systems, computing infrastructure, regulatory compliance, publication resources, and considerable institutional investment. Governments, universities, charitable foundations, pharmaceutical companies, technology corporations, and other commercial organisations finance research because scientific knowledge can generate public benefits, technological innovation, economic development, and commercial returns. Academic–industry collaborations have contributed substantially to medicines, vaccines, diagnostic technologies, medical devices, digital platforms, and other innovations of considerable social value. Money is not external to science; in many areas it is one of the conditions that makes scientific activity possible. The ethical challenge consequently does not arise from the mere presence of financial support, nor should financial sponsorship automatically be understood as evidence of scientific impropriety. Rather, concern arises when financial interests accompanying research relationships create incentives or forms of control that may conflict with researchers' primary obligations to scientific validity, participant welfare, impartial interpretation, and truthful dissemination (Resnik, 2007; Shamoo & Resnik, 2022).

A financial conflict of interest is a situation in which a secondary financial interest has the potential to influence, or reasonably appear capable of influencing, professional judgement concerning a primary scientific responsibility. Such relationships may include research grants, consultancy payments, honoraria, speaking fees, employment, equity ownership, intellectual-property interests, patents, royalties, travel support, or other financial arrangements. Importantly, the existence of a financial relationship does not establish that a bias, corruption, or wrongdoing has occurred. A commercially funded investigator may conduct a methodologically rigorous and transparently reported study, just as an investigator with no commercial funding may engage in poor scientific practice. Nevertheless, financial relationships warrant systematic scrutiny because empirical research has repeatedly demonstrated associations between commercial sponsorship and findings or conclusions favourable to sponsors. Bekelman et al. (2003), for example, identified extensive financial relationships among industry, investigators, and academic institutions and reported a significant association between industry sponsorship and pro-industry conclusions. Subsequent systematic evidence similarly found that industry-sponsored drug and medical-device studies were more likely to report favourable efficacy results and conclusions than studies funded through other sources (Lundh et al., 2017). Krimsky (2013) conceptualised this recurring relationship as the *funding effect*, highlighting the need to investigate not simply whether money is present in research but how financial sponsorship may become associated with scientific outcomes.

The potential influence of financial interests is especially consequential because it may operate across multiple stages of knowledge production rather than only at the point of data analysis. Financial resources may affect which topics attract sustained investigation, which hypotheses are considered commercially worthwhile, how comparators and outcomes are selected, who controls study data, how statistical analyses are performed, how results are interpreted, and whether findings are published or disseminated prominently (Resnik, 2007; Shamoo & Resnik, 2022). These processes need not involve fabrication or deliberate manipulation. Influence may occur through apparently legitimate methodological or organisational decisions whose cumulative effects shape the direction of the scientific record. The problem extends beyond the moral character of individual investigators to the wider architecture within which research is financed, governed, published, and translated into practice. Safeguarding scientific integrity requires more than reliance on individual objectivity; it requires transparent disclosure, appropriate conflict-of-interest management, institutional oversight, contractual protections, independent scrutiny, and research environments structured to prioritise scientific integrity over competing interests (NASEM, 2017).

Conceptual clarity is very important because financial conflict of interest is not synonymous with research misconduct. The United States Office of Research Integrity (ORI) defines research misconduct specifically as fabrication, falsification, or plagiarism in proposing, performing, reviewing, or reporting research (Office of Research Integrity [ORI], n.d.). Fabrication involves making up data or results and recording or reporting them; falsification involves manipulating research materials, equipment, processes, or data so that the research record is inaccurately represented; and plagiarism involves appropriating another person's ideas, processes, results, or words without appropriate acknowledgement (ORI, n.d.). Honest error and legitimate differences in scientific interpretation are excluded from this definition. Financial conflicts, selective methodological choices,

publication bias, incomplete disclosure, sponsor influence, and other questionable practices may threaten the reliability or independence of research without necessarily meeting the formal threshold for research misconduct. Conflating these categories would be analytically problematic because it could unfairly stigmatise legitimate research partnerships while simultaneously obscuring the broader range of practices and institutional arrangements capable of reducing scientific reliability. The appropriate analytical task is to distinguish legitimate funding, conflicts of interest, bias, questionable research practices, and proven misconduct rather than treating them as interchangeable phenomena.

Although biomedical research provides some of the strongest empirical evidence concerning financial conflicts of interest, the underlying problem extends well beyond medicine. Financial influence has been examined in psychology, including concerns surrounding corporate funding and professional conflicts (Pachter et al., 2007), while Cristea and Ioannidis (2018) argued that disclosure of financial interests associated with psychosocial interventions remained comparatively underdeveloped. Similar concerns arise in nutrition, tobacco research, chemical and environmental safety, technology, and other areas in which scientific findings can affect commercially valuable products, regulations, or markets. The rapid expansion of artificial intelligence research further illustrates the growing inadequacy of a model centred exclusively on pharmaceutical payments to physicians. Technology corporations may finance research laboratories, employ leading scientists, own proprietary datasets, control computing infrastructure, and simultaneously develop the technologies being evaluated. These developments suggest that the relevant unit of analysis must extend beyond the individual investigator towards the broader research ecosystem, in which financial relationships, institutional dependencies, publication systems, data infrastructures, and professional incentives interact.

This paper argues that the central ethical problem is not money itself but the distribution of financial interest and decision-making power throughout the research process. Disclosure remains necessary because undisclosed relationships prevent readers, reviewers, institutions, and policymakers from evaluating potentially relevant conflicts. However, disclosure alone cannot reveal or correct all pathways through which financial interests may influence science. Readers cannot determine from a disclosure statement which research questions were never funded, which methodological alternatives were rejected, who controlled complete datasets, what unpublished analyses revealed, or whether contractual arrangements limited publication. Transparency can make conflicts visible, but visibility does not necessarily neutralise the incentives or forms of authority creating those conflicts. The more fundamental governance question concerns who possesses the power to shape research questions, protocols, data access, statistical analysis, interpretation, authorship, publication, and eventual translation into clinical or public policy.

Against this background, the purpose of this paper is to critically examine the structural conditions under which financial interests may influence scientific priorities, practices, and outputs while avoiding the assumption that commercial involvement is inherently corrupting. It examines financial influence across research agenda formation, funding and contractual governance, methodological design, data generation and analysis, interpretation, publication and dissemination, academic incentives, and translation into policy and practice. The paper further distinguishes productive research–industry collaboration from arrangements in which financial interests may acquire disproportionate authority over scientific decisions. In addressing the fragmented treatment of financial influence across the existing literature, the paper proposes the Financial Influence on Research Ecosystem (FIRE) Framework, which conceptualises financial influence across multiple stages of knowledge production and evaluates such influence through the dimensions of financial magnitude, proximity to the scientific question, decision-making control, and transparency. The central argument is that contemporary governance has often concentrated heavily on identifying and disclosing financial relationships while giving comparatively insufficient attention to the structures of authority accompanying those relationships. Understanding when research meets money requires a shift from asking simply who funded the science to asking what influence, control, and decision-making authority accompanied the funding, and what institutional safeguards could protect the independence and credibility of the resulting knowledge.

RESEARCH PROBLEM

Modern scientific institutions operate in increasingly competitive funding environments. Researchers require grants not merely to conduct research but frequently to employ staff, sustain laboratories, produce

publications, demonstrate academic productivity and remain competitive for promotion and future funding. Universities similarly benefit from external grants, patents, licensing agreements, spin-off companies, consultancies and partnerships with industry. Journals may receive income from subscriptions, advertising, article-processing charges and commercial reprints. Commercial sponsors simultaneously require credible scientific evidence to obtain regulatory approval, develop markets and demonstrate the effectiveness or safety of products. These interests can coexist productively, but they can also generate tensions when the organisations financing knowledge production possess economic interests in what that knowledge eventually concludes.

Evidence indicates that these concerns are more than theoretical. Bekelman et al. (2003) reviewed 37 studies and reported that approximately one quarter of investigators had industry affiliations; their synthesis also identified a significant association between industry sponsorship and conclusions favourable to industry. Lundh et al. (2017) subsequently concluded that drug and medical-device studies sponsored by manufacturing companies more often produced sponsor-favourable efficacy results and conclusions than studies funded by other sources. Methodological investigations likewise demonstrate that financial influence may operate through research design, comparator selection, outcome choice and interpretation rather than through obvious fabrication of evidence. Scientifically valid-looking studies may still embody structural decisions that systematically favour interests.

The problem extends beyond researchers themselves. Lundh et al. (2010) demonstrated that industry-supported trials contributed to journal citation impact and that commercial reprint sales represented an important revenue source for some major medical journals. Financial relationships may exist among sponsors, researchers, institutions, journals, professional organisations and other actors occupying different stages of the evidence-production process. This creates the possibility that conflicts are systemic rather than merely personal. A disclosure statement identifying an author's consultancy income cannot, by itself, reveal whether a sponsor influenced the research question, controlled the database, selected the comparator, determined stopping rules, participated in statistical analysis or possessed contractual authority over publication.

GAP IN THE CURRENT LITERATURE

A substantial literature documents associations among industry funding, conflicts of interest and sponsor-favourable research outcomes. However, three limitations remain important. First, the literature is disproportionately biomedical and pharmaceutical, despite the expansion of corporate financing and commercial interests into psychology, nutrition, artificial intelligence, environmental research and other disciplines. Second, financial conflict is frequently operationalised dichotomously as the presence or absence of industry sponsorship. Graham et al. (2022), in a methodological review of 167 studies examining conflicts of interest in research contexts, found that 98.2% evaluated industry sponsorship, highlighting the dominance of sponsorship-based measures. Such binary classifications can obscure differences between unrestricted grants, direct sponsor control, consultancy payments, equity ownership, patents, employment relationships and other financially consequential arrangements.

Third, and most importantly, much research examines isolated points in the knowledge-production process rather than the cumulative interaction of financial incentives across the complete research ecosystem. Studies have separately investigated sponsorship and outcomes, investigator conflicts, guideline authorship, journal revenue and disclosure, but comparatively less attention has been devoted to integrating these mechanisms into a single model extending from agenda formation to policy translation. Existing research tells us considerably more about whether funding source correlates with research conclusions than about how financial influence travels through interconnected institutions and stages of knowledge production. This distinction represents an important conceptual gap.

The present paper addresses this gap by treating financial influence as a multi-level, longitudinal and institutional phenomenon rather than merely an individual conflict requiring disclosure. It proposes the Financial Influence on Research Ecosystem (FIRE) Framework to explain seven potential points through which financial incentives can affect scientific knowledge: (1) agenda formation; (2) funding and contractual governance; (3) methodological architecture; (4) data generation and analysis; (5) interpretation and reporting;

(6) publication and dissemination; and (7) translation into guidelines, policy and practice. This framework moves the discussion from the question, *Does the researcher have a financial conflict,* towards the broader question, *at which points in the research ecosystem can financial interests acquire sufficient power to influence what knowledge is produced, suppressed, amplified or translated into action?*

AIM AND OBJECTIVES

The primary aim of this paper is to critically examine the relationship between financial interests and scientific research and to develop an integrative conceptual framework explaining how money may influence knowledge production without assuming that financial relationships necessarily constitute misconduct.

The specific objectives are to:

1. distinguish research funding, financial conflicts of interest, questionable research practices and formal research misconduct;
2. synthesise evidence concerning the relationship between commercial sponsorship and research outcomes;
3. examine mechanisms through which financial incentives can affect research from agenda-setting to dissemination;
4. extend the discussion beyond medicine to the wider research ecosystem;
5. identify limitations in disclosure-centred approaches to managing conflicts;
6. propose the FIRE Framework for understanding financial influence across the research life cycle; and
7. recommend institutional and policy mechanisms capable of protecting scientific independence while preserving socially beneficial collaboration between research and industry.

RESEARCH QUESTIONS

This critical review addresses four principal questions:

RQ1: Through what mechanisms can financial interests influence the production, interpretation and dissemination of scientific research?

RQ2: How should legitimate commercial research relationships be distinguished from financial conflicts of interest, questionable research practices and research misconduct?

RQ3: Why are disclosure-based approaches insufficient for addressing some forms of financial influence on research?

RQ4: What governance framework can better protect research integrity while preserving legitimate collaboration between science, government, universities and industry?

METHODOLOGY

Research Design

This study employs an integrative critical literature review and conceptual synthesis to examine the relationship between financial interests, research practices, scientific integrity, and the production of knowledge. The integrative review approach is particularly appropriate for research questions that extend across disciplinary and methodological boundaries because it permits the inclusion and synthesis of empirical, theoretical, methodological, and policy-oriented literature within a coherent analytical framework (Snyder, 2019; Torraco, 2005; Whittemore & Knafl, 2005). Unlike a conventional systematic review designed primarily to answer a narrowly defined empirical question, the present study addresses a multidimensional problem involving research funding, conflicts of interest, publication practices, institutional incentives, commercial relationships, research misconduct, and the broader political economy of scientific knowledge. Accordingly, the research design allows evidence from medicine and biomedical science to be examined alongside scholarship from psychology, research ethics, sociology of science, and the wider research-integrity literature.

Such an interdisciplinary approach is necessary because financial influences on research cannot be adequately understood solely as individual ethical failures but must also be examined as phenomena embedded within institutional and organisational structures. The integrative design provides an appropriate methodological foundation for investigating how financial incentives may interact with scientific norms, professional judgement, institutional priorities, and the dissemination of research findings.

The study adopts a critical orientation rather than treating the existing literature as a collection of neutral findings requiring only descriptive summarisation. Critical literature reviews seek to interrogate assumptions, identify contradictions, evaluate competing interpretations, and reveal conceptual or empirical gaps that may remain obscured within fragmented bodies of scholarship (Grant & Booth, 2009; Snyder, 2019). In the context of the present study, this approach facilitates examination of the tension between the normative ideals of science—including objectivity, transparency, independence, methodological rigour, and the pursuit of truth—and the financial and institutional environments within which research is conducted. Attention is directed towards evidence concerning industry sponsorship, conflicts of interest, selective reporting, publication bias, outcome switching, researcher incentives, institutional dependence on external funding, and the commercialisation of scientific knowledge. The analysis does not presume that financial involvement necessarily results in research misconduct or scientific distortion; instead, it critically evaluates the conditions under which financial relationships may create actual, potential, or perceived threats to research independence and integrity. This distinction is methodologically important because conflicts of interest represent risks to professional judgement rather than automatic evidence of unethical conduct (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). The critical review consequently examines both the productive role of financial investment in scientific advancement and the ethical and epistemological challenges that can emerge when financial incentives intersect with research decision-making.

The integrative component of the research design enables the study to incorporate diverse forms of evidence rather than restricting inclusion to a single methodological tradition. Integrative reviews are particularly useful when a phenomenon has been investigated through heterogeneous research designs because they facilitate the combination of experimental and non-experimental studies with theoretical and conceptual literature (Whittemore & Knafl, 2005). Accordingly, the evidence considered in this study includes primary empirical research, systematic reviews and meta-analyses, methodological studies, scholarly books and chapters, research-integrity reports, ethical guidelines, institutional policies, and relevant theoretical scholarship. Greater analytical weight is accorded to peer-reviewed studies, systematic reviews, authoritative institutional reports, and sources directly addressing financial conflicts of interest and research integrity. Policy and institutional documents are incorporated where they illuminate prevailing standards governing disclosure, sponsorship, conflicts of interest, research conduct, and scientific accountability. This methodological pluralism is particularly important because the consequences of financial influence may manifest at several levels, ranging from individual researcher behaviour and study design to institutional governance, publication systems, funding structures, and public confidence in science. The review seeks convergence and divergence across different forms of evidence rather than any single methodological tradition being able to fully explain the phenomenon under investigation.

The study further employs conceptual synthesis to move beyond the identification of isolated instances of financial influence and towards an explanation of the mechanisms through which financial incentives may affect the research enterprise. Conceptual synthesis involves organising findings from diverse sources around higher-order concepts and relationships, thereby enabling the development or refinement of theoretical explanations (Torraco, 2005). In this study, evidence is organised around interconnected domains that include research agenda setting, funding and sponsorship, study design, data collection and analysis, interpretation of results, authorship, publication and dissemination, conflicts of interest, institutional governance, and public trust. These domains are examined as components of a wider research ecosystem rather than as independent ethical problems. The synthesis consequently considers how financial incentives operating at one stage of the research process may influence decisions at subsequent stages, producing cumulative effects that may not be evident when individual practices are examined separately. This approach permits the study to distinguish between direct financial influence, indirect institutional incentives, structural dependence on research funding, and broader commercial pressures affecting knowledge production. By mapping these relationships, the methodology supports the development of a conceptual explanation of how money can function

simultaneously as an indispensable resource for scientific advancement and as a potential source of bias, dependency, or competing interests.

The review is analytical rather than meta-analytical, and no new pooled effect size is estimated. This decision reflects the heterogeneity of the literature, which encompasses different disciplines, populations, research designs, definitions of financial conflict, measures of research integrity, and outcomes. Meta-analysis is most appropriate when sufficiently comparable quantitative studies permit meaningful statistical aggregation, whereas integrative reviews are better suited to complex questions requiring the synthesis of heterogeneous evidence and theoretical perspectives (Snyder, 2019; Whittemore & Knafl, 2005). The purpose of the present investigation is not to determine a single numerical magnitude of the effect of financial interests on research outcomes but to identify recurring patterns, mechanisms, contextual factors, and areas of disagreement across the literature. Evidence is interpreted comparatively, with attention to the methodological strength of individual studies, consistency across sources, disciplinary context, and the possibility that apparently contradictory findings may reflect differences in research settings or operational definitions. Caution is exercised in distinguishing association from causation, especially where studies demonstrate relationships between sponsorship and favourable research outcomes without establishing the precise causal mechanisms responsible for those associations. The methodology thereby seeks to avoid overstating the evidence while retaining sufficient analytical depth to identify systemic patterns within the scientific research environment.

Finally, the research design is intended to address an important gap in the existing literature by integrating bodies of scholarship that are frequently examined separately. Much of the existing research focuses on specific manifestations of financial influence, such as pharmaceutical sponsorship, conflicts of interest, publication bias, industry-funded clinical trials, or individual research misconduct, while comparatively less attention is devoted to understanding these phenomena as interconnected components of a broader system of financial incentives and knowledge production. The present methodology synthesises evidence across disciplines and analytical levels to examine the continuum extending from research funding and agenda setting through study implementation, interpretation, publication, institutional governance, and public trust. This systems-oriented perspective is consistent with contemporary approaches to research integrity that recognise scientific reliability as dependent not only on individual researchers but also on the institutions, incentives, policies, and professional environments within which research occurs (NASEM, 2017). By combining critical literature review with conceptual synthesis, the study is positioned to identify recurring structural mechanisms, clarify areas of conceptual ambiguity, and generate a framework for understanding when and how financial interests may become consequential for scientific integrity. The resulting synthesis is intended not simply to catalogue ethical problems but to contribute a more integrated explanation of the relationship between money, institutional incentives, scientific decision-making, and the credibility of research.

Literature Identification

The evidence base is strongly asymmetric across disciplines. Biomedical and pharmaceutical research supplies the most mature empirical evidence, particularly for sponsorship-associated favourable conclusions, publication and reporting practices, and conflicts of interest. Evidence from psychology, nutrition and some environmental or chemical-safety research is relevant but less extensive, while several applications to artificial intelligence, computing infrastructure and other technology-intensive fields remain predominantly analogical or theoretically grounded. Cross-disciplinary discussion in this review is used to identify potentially transferable mechanisms, not to claim that effect sizes, prevalence or causal pathways are identical across fields. This distinction is carried through the FIRE Framework, discussion, limitations and conclusion.

Evidence was not treated as equivalent across source types. The synthesis used an explicit hierarchy: systematic reviews and meta-analyses were given the greatest weight for claims about recurring empirical associations; well-designed primary empirical and methodological studies were used to establish specific mechanisms and contexts; authoritative reports and ethical standards were used primarily for normative and governance claims; and theoretical or conceptual sources were used to develop propositions requiring subsequent testing. For each FIRE domain, the review distinguished (1) established empirical evidence, where replicated observational or systematic evidence supports an association; (2) emerging or context-specific evidence, where empirical support exists but is limited in scope or discipline; and (3) conceptual propositions,

where the pathway is theoretically plausible but has not been adequately validated. This evidence-grading approach is qualitative rather than a formal risk-of-bias instrument and should not be interpreted as a GRADE assessment.

Sources were eligible when they addressed a financial relationship or financially linked form of control relevant to at least one stage of knowledge production: agenda setting; funding or contractual governance; methodological design; data generation or analysis; interpretation or reporting; publication or dissemination; or translation into policy and practice. Eligible evidence included peer-reviewed empirical studies, systematic reviews and meta-analyses, methodological studies, scholarly books and chapters, major research-integrity reports, ethical guidelines and institutional standards. Sources were excluded when financial influence was peripheral to the research question, when they offered unsupported commentary without a clear conceptual or evidentiary contribution, when duplicate publications reported the same evidence without adding substantive information, or when institutional webpages were purely promotional. Seminal older sources were retained when they established foundational concepts, while recent sources were used to assess contemporary relevance. No language restriction was deliberately imposed, although the review is dominated by English-language literature and this may introduce selection bias.

The literature review was integrative rather than systematic, and the original manuscript was developed through iterative multidisciplinary searching and citation chaining rather than a prospectively registered review protocol. Accordingly, exact database hit counts, duplicate-removal counts and a PRISMA-style flow cannot be reconstructed reliably and are not presented as though they had been recorded contemporaneously. This is an important methodological limitation. The search vocabulary combined terms such as financial conflict of interest, industry sponsorship, research funding, research misconduct, research integrity, publication bias, selective outcome reporting, ghost authorship, commercialisation of research, industry-funded trials, journal conflicts of interest, corporate funding, sponsor control, data ownership and funding effect. Searches were supplemented by backward reference checking from major systematic reviews, methodological reviews and authoritative research-integrity reports. The purpose was conceptual saturation across mechanisms of financial influence rather than exhaustive enumeration of every publication on a single exposure–outcome relationship.

Analytical Strategy

The identified literature was synthesised thematically rather than merely chronologically, with the primary analytical emphasis placed on identifying recurrent patterns and mechanisms across the research process. Thematic synthesis was appropriate because the central concern of the study was not simply when controversies emerged historically, but where and through what processes financial influence may enter scientific knowledge production. The literature was classified according to the stage of research or knowledge production at which financial interests could potentially operate, including the formulation of research priorities, funding decisions, methodological design, data analysis, interpretation, authorship, publication, dissemination, and institutional oversight. This analytical strategy is compatible with integrative review methodology, in which evidence from heterogeneous sources can be compared, categorised, and synthesised to generate higher-order conceptual understanding (Torraco, 2005; Whittemore & Knafl, 2005). Both convergent and divergent findings were considered so that the analysis did not privilege evidence supporting a predetermined conclusion regarding the harmful effects of financial involvement. The thematic process consequently sought to determine not simply whether financial influence exists, but the circumstances, institutional arrangements, and stages of knowledge production through which such influence may become consequential.

Through iterative conceptual comparison and progressive grouping of recurring themes, the evidence was organised into seven interrelated domains that constitute the FIRE Framework. The domains are analytic categories generated by conceptual synthesis; they have not been demonstrated through factor analysis, latent-variable modelling or other construct-validation procedures to be statistically distinct dimensions. Sources were mapped to domains according to the stage of knowledge production at which the reported mechanism operated, while overlaps were retained where a mechanism plausibly spanned more than one stage. The synthesis then classified the evidentiary status of each pathway as established empirical evidence, emerging/context-specific evidence, or a conceptual proposition. This procedure was designed to prevent well-

established biomedical associations from being presented as though they had been demonstrated equally in artificial intelligence, environmental science or other fields. The resulting FIRE Framework functions as an organising and hypothesis-generating conceptual model rather than a validated diagnostic, psychometric or predictive instrument.

Methodological attention was given to avoiding causal overstatement and maintaining a distinction among association, plausible mechanism, conflict of interest and demonstrated misconduct. Evidence that industry-sponsored studies are more likely to report sponsor-favourable results or conclusions is treated as an established association within the biomedical evidence base, but not as proof of intentional manipulation or a universal cross-disciplinary effect. Mechanisms supported by direct empirical evidence are distinguished from mechanisms inferred from institutional structure or theory. Framework-generated pathways are labelled as propositions when validation is absent. The FIRE Framework is intended to guide measurement development and empirical testing; reliability, construct validity, discriminant validity and predictive validity remain future research requirements.

Money is Necessary for Research

Any ethical examination of research financing must begin by acknowledging a fundamental reality: high-quality scientific research is expensive, and financial resources are indispensable to modern knowledge production. Clinical trials require participant recruitment, specialist personnel, laboratories, pharmaceuticals or medical devices, data-management systems, statistical expertise, monitoring, insurance, ethical oversight, and regulatory compliance. Large epidemiological investigations may require extensive databases, nationally representative samples, sophisticated analytical infrastructure, and sustained follow-up extending across years or even decades. Similarly, contemporary biomedical research increasingly depends on expensive laboratory technologies, genomic sequencing, imaging equipment, biobanks, and specialised computational resources. Artificial intelligence (AI) has intensified this financial dimension because the development and evaluation of advanced systems can require substantial computing infrastructure, specialised personnel, large datasets, data-storage capacity, and energy resources (Ahmed & Wahed, 2020). The proposition that scientific research could simply insulate itself from money is neither historically nor practically realistic. The relevant ethical problem is not the existence of research financing but the institutional conditions under which financial resources are obtained, controlled, and translated into scientific decisions.

Commercial investment can also generate substantial scientific and public benefit. Private-sector organisations frequently possess expertise in product development, manufacturing, clinical development, regulatory approval, commercialisation, supply-chain management, and large-scale implementation that universities and publicly funded research institutions may not possess internally. Translational research specifically depends on mechanisms capable of moving scientific discoveries from laboratories and academic institutions towards interventions, technologies, medicines, devices, and services that can benefit populations (Woolf, 2008). Universities may generate discoveries and proof-of-concept evidence but lack the capital, infrastructure, manufacturing capabilities, or regulatory expertise required to transform those discoveries into widely accessible products. Industry partnerships can contribute resources and capabilities that complement academic expertise. From this perspective, commercial participation should not automatically be represented as an intrusion into otherwise financially independent science. Rather, public, philanthropic, academic, and private financing form interconnected components of the contemporary research ecosystem.

The contribution of private investment becomes especially important where scientific development involves substantial financial risk. Drug discovery provides an obvious example because many compounds investigated during preclinical and clinical development never become approved medicines, meaning that investment must support both successful and unsuccessful research programmes. Similar uncertainties occur in biotechnology, medical devices, vaccines, digital health, and other innovation-intensive sectors. Commercial organisations may assume financial risks that governments, universities, or charitable organisations are unable or unwilling to carry independently. Moreover, effective collaboration between academia and industry can facilitate knowledge transfer, access to specialised technologies, employment opportunities, and the translation of scientific findings into practical applications. The existence of legitimate social benefits from commercial participation complicates simplistic narratives in which public funding is inherently independent while private

funding is inherently corrupting. Financial sources differ in their incentives and governance structures, but all research organisations operate within institutional systems involving priorities, resource constraints, competition, and accountability. The appropriate ethical objective is consequently not financial isolation, but financial governance capable of preserving the benefits of investment while reducing threats to scientific independence.

This distinction prevents an important analytical error: industry sponsorship constitutes a potential source of conflict, not evidence of corruption or research misconduct. An investigator who receives legitimate research funding from a pharmaceutical, biotechnology, technology, or other commercial organisation has not, by virtue of that relationship alone, violated scientific or ethical standards. Research misconduct generally involves more specific violations, including fabrication, falsification, plagiarism, or other serious departures from accepted research practices, whereas a conflict of interest describes circumstances in which secondary interests may create risks to professional judgement (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). The analytical distinction is crucial because collapsing financial relationships, conflicts of interest, bias, and misconduct into a single category would exaggerate the implications of sponsorship and weaken causal reasoning. A financial relationship may exist without producing bias, while bias may occur without deliberate misconduct. Ethical analysis must determine not merely whether money is present but whether the structure of the relationship provides incentives or opportunities capable of influencing scientific judgement.

Financial relationships also vary considerably in type, magnitude, duration, proximity, and potential influence. They may include research grants, consultancy payments, honoraria, speaking fees, advisory-board membership, employment, travel support, stock or equity ownership, intellectual-property rights, royalties, patents, and other financial arrangements. These relationships cannot reasonably be presumed to exert identical effects on scientific decision-making. A modest travel reimbursement, for example, is structurally different from substantial equity ownership in a company whose product is being evaluated, just as an unrestricted institutional research grant differs from a contract granting the sponsor extensive control over study design and publication. Contemporary research on conflict-of-interest disclosure demonstrates the heterogeneity of financial relationships reported in biomedical literature and the difficulties associated with reducing them to a simple presence-or-absence measure (Graham et al., 2023). Treating heterogeneous relationships as a single binary variable may sacrifice substantial explanatory information. A more sophisticated approach should consider the financial relationship's nature, magnitude, duration, directness, and relationship to the scientific decisions under examination.

Accordingly, the central ethical principle developed in this study is that money should be governed in proportion to the influence it can exercise over knowledge production. Financial investment is necessary for science, but necessity does not eliminate the requirement for safeguards. Research institutions, journals, funding organisations, regulators, and investigators should establish mechanisms that separate legitimate financing from inappropriate control over methodological and publication decisions. Such mechanisms can include independent protocol review, preregistration, transparent conflict-of-interest disclosure, independent statistical analysis where appropriate, data-access arrangements, publication guarantees, and institutional oversight (NASEM, 2017). The ethical question is not simply, “Who paid for the research?” but also, “What authority did the payer acquire through that financial relationship?” This shift from source of money to structure of control provides a more analytically useful foundation for understanding conflicts of interest. It also establishes the conceptual transition from financing as a necessary resource to financing as a potential source of scientific vulnerability.

When Funding Becomes Conflict

A financial interest becomes ethically significant when it creates circumstances in which secondary interests may compromise—or reasonably appear capable of compromising—primary scientific responsibilities. These primary responsibilities include protecting research participants, maintaining methodological validity, analysing evidence appropriately, reporting results honestly, acknowledging uncertainty, and interpreting findings impartially. Conflict-of-interest frameworks are concerned not only with demonstrated corruption but also with conditions that create reasonable risks that professional judgement could be influenced by competing

interests (Institute of Medicine [IOM], 2009). This distinction is important because scientific integrity depends partly on public and professional confidence that decisions are being made primarily according to evidence rather than financial advantage. Financial interests are consequently most consequential when they intersect with opportunities to influence decisions that affect the scientific record. The critical variable is not money in isolation, but financial interest combined with decision-making power.

Consider two hypothetical research arrangements. In the first, a pharmaceutical company contributes financially to a pooled research fund administered by an independent institution, has no role in selecting investigators, possesses no authority over study design or statistical analysis, cannot restrict researchers' access to data, and has no contractual power to prevent or delay publication. In the second arrangement, a company directly funds an investigator, participates in writing the protocol, controls the study database, employs or selects the statistician, participates in manuscript preparation, and retains contractual influence over whether or when findings can be published. Both projects might be classified in a dataset as “industry funded”, yet their structural vulnerability to sponsor influence is fundamentally different. The first arrangement deliberately separates financing from scientific control, whereas the second concentrates financial and epistemic authority within the sponsoring organisation. A binary sponsorship variable would conceal precisely the governance differences most relevant to understanding potential bias.

This distinction suggests that financial conflict should be conceptualised as a multidimensional exposure rather than a binary characteristic. Relevant dimensions include the magnitude of financial interest, directness of payment, duration of the relationship, investigator dependence on the sponsor, sponsor involvement in protocol development, ownership and accessibility of data, control over statistical analysis, manuscript participation, intellectual-property interests, and contractual publication rights. These factors potentially modify the degree to which financial relationships can affect scientific judgement. An investigator receiving unrestricted institutional funding under conditions guaranteeing complete academic independence occupies a different conflict environment from an investigator whose continued employment, equity holdings, or future remuneration depends directly on favourable commercial outcomes. Future empirical research should move beyond simply asking whether industry funding existed and examine the mechanisms through which sponsors and financially interested investigators can exercise control. Such an approach would substantially improve the measurement of financial conflicts of interest and strengthen causal investigations of the funding effect.

This is also why disclosure, although indispensable, cannot represent the endpoint of conflict management. The International Committee of Medical Journal Editors has promoted standardised disclosure because financial and non-financial relationships may be relevant to readers' evaluation of research, while Taichman et al. (2020) emphasised the need for greater consistency and transparency in reporting authors' relationships and activities. Disclosure allows editors, reviewers, policymakers, clinicians, and readers to incorporate potentially relevant relationships into their assessment of published findings. It also creates accountability by making relationships visible that might otherwise remain unknown. However, disclosure is fundamentally an informational intervention: it reveals a potential conflict but does not necessarily eliminate the underlying incentive. A declaration that an investigator owns substantial equity in the company whose product is being evaluated informs readers of the relationship, but the economic interest itself remains.

Moreover, disclosure can become ethically inadequate if institutions treat transparency as a substitute for substantive conflict management. Some financial arrangements may require additional safeguards, such as independent data analysis, exclusion from decisions, independent oversight committees, restrictions on sponsor control, or, in circumstances involving severe and unmanageable conflicts, divestment or recusal. The appropriate response should be proportionate to the magnitude and controllability of the conflict (IOM, 2009). This principle recognises that eliminating every financial relationship would be impractical and potentially harmful to scientific innovation, while simultaneously rejecting the assumption that disclosure alone resolves every ethical concern. Effective governance must distinguish relationships that can be managed through transparency from relationships requiring structural separation between financial interests and scientific authority. In this sense, conflict-of-interest governance should focus on controlling pathways of influence rather than merely documenting their existence.

The distinction between disclosure and governance has broader implications for the integrity of scientific institutions. Research credibility depends not only on whether individual investigators perceive themselves as

impartial but also on whether institutional arrangements provide reasonable protection against competing interests. Researchers, like other professionals, may not always recognise subtle influences on their own judgement, especially where relationships are longstanding or integrated into ordinary professional practices. Robust systems should not depend exclusively on individual declarations of objectivity. They should incorporate transparent rules governing funding agreements, access to data, statistical independence, authorship, publication rights, and sponsor participation in research decisions (NASEM, 2017). This structural approach relocates the ethical question from whether researchers are personally trustworthy to whether the research environment has been designed to protect trustworthy science. Financial conflict thereby becomes an issue of research governance as much as individual morality.

The Funding Effect

One of the strongest empirical reasons for examining financial conflicts of interest is the recurring association between research sponsorship and research outcomes. In a widely cited systematic review, Bekelman et al. (2003) found statistically significant relationships between industry sponsorship and conclusions favourable to industry across biomedical research. Subsequent scholarship has continued to identify similar patterns. Lundh et al. (2017), in a Cochrane review of drug and medical-device studies, concluded that industry-sponsored research more frequently reported favourable efficacy results and favourable conclusions than research sponsored by other sources. These findings are important because they demonstrate that the relationship between financial sponsorship and research conclusions is not based exclusively on anecdotal cases of misconduct. Rather, systematic differences have been detected across bodies of published research. Nevertheless, the existence of such associations does not by itself identify the causal processes responsible for them.

Krimsky (2013) conceptualised this broader phenomenon through the “funding effect”, referring to systematic relationships between financial sponsorship and scientific findings or conclusions aligned with sponsors' interests. Concerns regarding funding effects have arisen across areas including pharmaceuticals, tobacco, chemicals, food and nutrition, and environmental research. The conceptual significance of the funding effect lies in its movement beyond individualistic explanations of scientific wrongdoing. If sponsorship-related differences occur repeatedly across studies and industries, the phenomenon may reflect structural features of research financing, question selection, methodological decision-making, publication practices, or institutional incentives rather than simply the actions of a small number of dishonest investigators. This does not establish that sponsors intentionally manipulate results. Instead, it creates a legitimate empirical question concerning how financial relationships become associated with patterns in the scientific literature.

Several mechanisms could potentially contribute to such patterns without requiring fabrication or falsification. Sponsors influence science initially through the selection of questions considered worthy of investment. Commercial organisations have rational incentives to finance research capable of advancing products, obtaining regulatory approval, expanding markets, supporting intellectual property, or strengthening competitive positions. Such priorities are not intrinsically unethical; however, they can affect which questions receive substantial research resources and which remain comparatively neglected. Financial influence may operate before participant recruitment or data collection begins. A scientifically valid study can produce an accurate answer to a research question whose selection was itself shaped by commercial priorities. This distinction between bias within a study and bias in the portfolio of questions being studied is essential for understanding the political economy of scientific knowledge.

Study design creates additional opportunities through which sponsor interests may align with favourable outcomes. Researchers must make numerous legitimate methodological choices concerning comparator groups, treatment doses, eligibility criteria, primary and secondary outcomes, follow-up periods, statistical models, handling of missing data, and subgroup analyses. Individual decisions may be scientifically defensible while nevertheless affecting the probability that a study produces a conclusion. For example, comparing a new intervention with placebo rather than an effective existing treatment may answer whether the intervention works but provide less information about whether it is superior to available alternatives. Similarly, follow-up duration may determine whether longer-term adverse events become observable, while restrictive inclusion criteria may create a study population that differs substantially from patients encountered in routine clinical

practice. The potential funding effect need not involve altering observations after they have been collected. It may emerge from decisions embedded in the architecture of the research itself.

Selective reporting and publication provide another potential mechanism. Research findings that are statistically significant, positive, novel, or commercially favourable may have different probabilities of publication, timing, prominence, or completeness than negative or inconclusive findings. Empirical literature has documented publication and outcome-reporting biases capable of distorting the accessible scientific record (Dwan et al., 2013; Song et al., 2010). When multiple outcomes, analytical strategies, time points, and subgroups are available, researchers may also possess considerable analytical flexibility. Such flexibility does not automatically constitute misconduct, because many alternative analytical decisions can be scientifically defensible. Nevertheless, if decisions are systematically influenced—consciously or otherwise—by expectations, incentives, or sponsor interests, cumulative effects may shift the published evidence in predictable directions. The integrity problem concerns not only whether individual numbers are fabricated but whether the decision environment systematically favours scientific narratives.

Accordingly, the funding effect should be interpreted as an empirical pattern requiring explanation rather than proof of corruption. A rigorous analysis must distinguish evidence that sponsored and non-sponsored studies differ in their results or conclusions from evidence demonstrating why those differences occur. Potential explanations include legitimate differences in research portfolios, methodological design, selective publication, analytical flexibility, contractual arrangements, sponsor involvement, investigator financial interests, and, in some cases, documented misconduct. These mechanisms should not be treated as interchangeable without supporting evidence. This distinction is central to the FIRE Framework developed in the present study because it allows financial influence to be investigated at multiple points in knowledge production without presuming intentional wrongdoing. The relevant scientific challenge is to determine where money intersects with decision-making authority, which mechanisms explain observed sponsorship-related differences, and which governance arrangements can preserve the indispensable benefits of research financing while protecting the independence and credibility of scientific knowledge.

Agenda-Setting: The Research That Never Happens

Perhaps the least visible form of financial influence occurs before a protocol is written or a participant is recruited. Funding determines not merely how research is conducted but which questions become sufficiently resourced to be researchable. Modern scientific inquiry requires personnel, institutional infrastructure, equipment, datasets, laboratories, computing resources, and sustained financial support; decisions about resource allocation inevitably contribute to decisions about which scientific problems receive sustained attention. Research areas that offer substantial commercial returns may attract private investment, whereas socially important questions for which markets are limited can remain comparatively underfunded. This imbalance has long been discussed in relation to neglected diseases, where research and development investment does not necessarily correspond closely to the distribution of disease burden or population need (Viergever, 2013). More recent analyses similarly argue that commercial incentives can influence the prioritisation of biomedical research agendas towards products capable of generating market returns (Redman, 2023). The resulting inequality is very difficult to detect because research that is never funded leaves fewer observable traces than research that is funded and subsequently shown to contain bias.

Agenda-setting constitutes an important domain of the FIRE Framework because financial influence can precede conventional conflicts of interest. A scientific literature may contain individually rigorous studies while nevertheless becoming systematically skewed towards the questions most attractive to governments, corporations, foundations, universities, or other powerful funders. If research resources disproportionately support pharmaceutical treatments rather than prevention, commercially marketable technologies rather than low-cost interventions, or proprietary products rather than social and structural reforms, the eventual evidence base may reflect financial incentives long before questions of statistical manipulation or selective reporting arise. This does not mean that commercially attractive research questions are scientifically unimportant. Pharmaceuticals, vaccines, diagnostic technologies, and medical devices can yield enormous societal benefits, and commercial incentives may facilitate innovations that would otherwise be difficult to develop. The ethical

concern emerges when marketability becomes disproportionately influential in determining the distribution of scientific attention.

This phenomenon complicates conventional understandings of research bias. Bias is commonly sought within individual studies through problems involving sampling, measurement, confounding, attrition, outcome definition, or statistical analysis. Financial agenda-setting operates at a higher level because it influences the population of studies that come into existence. An individual trial may be methodologically excellent while the wider body of literature remains incomplete because alternative interventions or research questions have not received comparable investment. Systematic reviews and clinical guidelines can only synthesise evidence that has been generated, making them potentially vulnerable to upstream inequalities in the research portfolio. The absence of evidence is not always evidence that a question lacks scientific importance; it can also reflect differences in the resources available to investigate it. Agenda-setting should consequently be regarded as an upstream financial mechanism capable of shaping scientific knowledge before traditional assessments of study quality even begin.

A fuller account of research integrity must ask not only whether funded research was performed responsibly but also why questions were funded, and others were not. Funding agencies and institutions already exercise priority-setting functions, but greater transparency regarding these decisions could make the values underlying research investment more visible. Public-health burden, scientific uncertainty, social value, equity, feasibility, and commercial opportunity need not be treated as mutually exclusive criteria. The ethical objective should instead be to prevent one criterion—ly profitability—from becoming an unexamined proxy for scientific importance. This makes agenda-setting an important bridge between the economics of research and the epistemology of science: financial structures influence not merely who conducts research, but potentially what societies can know.

RESEARCH DESIGN AND METHODOLOGICAL ARCHITECTURE

The second major mechanism through which financial incentives may influence science concerns research design and methodological architecture. Scientific studies contain numerous decision points, including comparator selection, treatment dosage, population definition, inclusion and exclusion criteria, endpoint selection, duration of follow-up, stopping rules, handling of missing data, subgroup definitions, and statistical modelling. Each decision may be scientifically defensible under circumstances, but different combinations of legitimate methodological choices can materially influence the probability of obtaining outcomes. Financial influence need not operate through overt data manipulation. It may instead become embedded prospectively within the structure of a study, affecting the evidentiary environment in which subsequent findings are generated.

Comparator selection provides a useful example. A new product may be compared with placebo, an established treatment, a lower dose of a competitor, or another intervention selected according to the study's objectives. Each comparator can answer a legitimate research question, but the commercial implications of those questions differ considerably. Likewise, short follow-up periods may be adequate for assessing immediate efficacy but insufficient for identifying delayed harms, whereas highly restrictive eligibility criteria may maximise internal validity while producing populations that are more likely to tolerate or respond to an intervention than patients encountered in routine practice. Outcome selection can be similarly consequential. Multiple potentially defensible endpoints may exist, but choosing endpoints that are responsive to an intervention can influence the apparent strength of evidence. The integrity problem consequently lies not only in whether researchers report collected data accurately but also in whether the architecture of research provides a balanced test of the scientific question.

This observation is important because a narrow focus on post hoc manipulation may overlook mechanisms operating before results exist. Research integrity safeguards should scrutinise protocols, statistical analysis plans, sponsor agreements, and trial-registration records as carefully as final manuscripts. Prospective trial registration was introduced partly to reduce selective publication and selective reporting by creating a public record of planned studies and prespecified outcomes before investigators know their findings. The International Committee of Medical Journal Editors (ICMJE) explicitly identifies prevention of selective

publication and selective outcome reporting among the major purposes of clinical-trial registration. Registration consequently provides researchers, editors, reviewers, and evidence synthesists with a mechanism for comparing what investigators originally proposed with what they ultimately reported.

Prospective registration, however, is not self-enforcing. A registry can improve transparency only when entries contain sufficient methodological detail, investigators register studies before relevant data are examined, deviations are clearly justified, and journal editors and peer reviewers compare published reports with original registrations. Research has continued to document imperfect compliance with prospective registration requirements, demonstrating that the existence of a transparency mechanism does not guarantee its effective implementation. This distinction between formal governance and effective governance is central to the FIRE Framework. Institutions may adopt registries, disclosure statements, reporting guidelines, and ethics requirements while permitting weak enforcement to undermine their intended protective function. Research-integrity systems should be evaluated according to whether they meaningfully constrain opportunities for selective methodological decision-making rather than simply whether those systems formally exist.

Data Ownership, Analysis and Sponsor Control

A third important mechanism concerns control over research data and analysis. Data are not merely technical products of scientific investigation; they are a source of epistemic power because whoever controls access to the complete dataset can influence which analyses are possible, which adverse events are visible, which secondary questions can be investigated, and whether independent researchers can verify published claims. Scientific independence is constrained when investigators who publicly assume responsibility for a study cannot independently access the complete data on which its conclusions are based. The problem is especially important when sponsors retain exclusive control over databases, employ the principal statisticians, determine analytical assumptions, or restrict investigators' ability to conduct additional analyses. In such circumstances, financial control may become inseparable from control over the evidentiary foundation of the study.

Historical evidence demonstrates that these concerns are not merely hypothetical. Bekelman et al. (2003), in their systematic review of financial conflicts of interest in biomedical research, found that industry sponsorship was associated not only with pro-industry conclusions but also with restrictions affecting publication and data sharing. Such contractual restrictions are ethically significant because science depends on the capacity of findings to be critically scrutinised, challenged, replicated, and reanalysed. A study whose investigators cannot independently inspect the complete data may satisfy certain formal publication requirements while remaining structurally dependent on the organisation controlling the dataset. Data ownership should consequently be treated as an important dimension of financial conflict rather than merely an administrative question concerning intellectual property.

Control over statistical analysis creates an additional vulnerability. Complex datasets permit numerous decisions concerning model specification, covariate inclusion, missing-data procedures, transformations, subgroup analyses, sensitivity analyses, and the interpretation of uncertainty. Many such decisions are methodologically legitimate; nevertheless, the capacity to choose among alternatives makes analytical independence especially important when substantial commercial interests depend on a conclusion. Independent statistical review can function as a safeguard in high-stakes research, especially where the sponsor has substantial economic interests in the outcome. This does not imply that statisticians employed by corporations are inherently less ethical or competent than academic statisticians. Rather, the principle is structural: no single interested party should possess disproportionate control over evidence whose interpretation has major scientific, clinical, or commercial consequences.

Prospective contractual safeguards can address this problem more effectively than retrospective disclosure alone. Research agreements should specify investigators' rights to access complete datasets, conduct independent analyses, inspect adverse-event information, and publish scientifically defensible findings irrespective of whether conclusions support the sponsor's commercial objectives. Appropriate arrangements may additionally provide for independent data-monitoring committees, external statistical verification, preregistered analysis plans, and clearly defined publication rights. These provisions shift conflict management from asking after publication whether a sponsor exercised inappropriate influence to designing research

structures that reduce opportunities for such influence in advance. In the FIRE Framework, control represents a critical mediating variable between financial sponsorship and potential research distortion.

Selective Reporting and Publication Bias

Financial influence may persist after data analysis through decisions concerning which findings become publicly visible, how quickly they appear, and how prominently they are presented. Publication bias is not exclusively a commercial phenomenon because researchers and journals in many settings may prefer statistically significant, novel, or positive findings. Nevertheless, commercial interests can reinforce these general incentives when favourable results support regulatory approval, market expansion, product promotion, investment, or reputational objectives. The result may be an evidence environment in which favourable findings are more visible than negative, inconclusive, or commercially inconvenient evidence. This form of distortion is particularly important because scientific and clinical decisions usually depend on the published record rather than investigators' complete internal datasets.

Selective outcome reporting creates a related problem. A study may assess numerous primary, secondary, exploratory, subgroup, and safety outcomes, yet published articles inevitably present only a subset of the available evidence. When outcome selection depends on statistical significance or favourability, the published report can provide an incomplete representation of what the study found. Trial registration and protocol availability offer partial safeguards by enabling comparison between prespecified and published outcomes. The ICMJE identifies prevention of selective publication and selective outcome reporting as central justifications for prospective registration. The ethical significance extends beyond individual articles because systematic reviews and meta-analyses depend on the availability of complete and accurate findings. Missing negative evidence can propagate through evidence synthesis and ultimately influence treatment recommendations and policy.

The 2024 revision of the World Medical Association's Declaration of Helsinki reinforces the ethical obligation of complete dissemination (World Medical Association, 2024a, 2024b). The Declaration states that negative and inconclusive findings, as well as positive results, must be published or otherwise made publicly available and that funding sources, institutional affiliations, and conflicts of interest must be declared. These provisions are important because they locate publication within the ethical responsibilities arising from human-participant research rather than treating dissemination as a discretionary academic reward. Participants accept burdens and risks partly on the assumption that their involvement will contribute to socially valuable knowledge. Suppressing inconvenient findings has ethical implications beyond publication metrics because it can diminish the scientific value created from participants' contributions.

Complete dissemination should consequently be conceptualised as part of research integrity rather than an activity occurring after research ethics has ended. Registries, results databases, protocol publication, data-sharing mechanisms, reporting guidelines, and journal enforcement all contribute to protecting the integrity of the evidentiary record. However, formal compliance should again be distinguished from substantive transparency. A result can technically be made available while receiving insufficient detail or visibility to influence subsequent evidence synthesis. Effective governance requires attention not only to whether results were disclosed but also whether they were disclosed in sufficiently complete, accessible, and interpretable forms. Within the FIRE Framework, selective reporting demonstrates how financial influence can operate through visibility, shaping the evidence encountered by clinicians, policymakers, systematic reviewers, and the public.

Ghost Authorship, Ghost Management and Scientific Independence

Another important concern involves the production and presentation of scientific manuscripts. Commercial participation may extend beyond the provision of research funding into study planning, data analysis, manuscript preparation, publication strategy, conference presentations, and the coordination of multiple publications arising from a research programme. Ghost authorship occurs when individuals who have made substantial intellectual or writing contributions are omitted from appropriate authorship or acknowledgement. The concern becomes broader under what Sismondo (2007) termed “ghost management”, in which

pharmaceutical companies or their agents may shape multiple stages of research, analysis, writing, and publication rather than merely providing undisclosed writing assistance. Subsequent work similarly described evidence that commercial organisations can influence the scientific literature through coordinated publication practices extending beyond conventional definitions of ghostwriting (Sismondo, 2010).

This phenomenon matters because authorship communicates both credit and responsibility. Readers ordinarily assume that named authors have participated sufficiently in the study to understand and defend its methodology, analysis, interpretation, and conclusions. When substantial intellectual or analytical authority resides with unnamed individuals or organisations, visible authorship may misrepresent the actual distribution of scientific control. The problem is not primarily that professional writers participate in manuscript preparation. Scientific communication often benefits from specialist editorial, statistical, linguistic, or technical expertise. The ethical issue arises when the contributions of those individuals are hidden or when named academic authors provide apparent independence while lacking meaningful control over the research they publicly endorse.

Ghost management also demonstrates why financial influence cannot be understood solely by examining individual payments to investigators. An academic researcher may possess no direct financial stake in a company's product while nevertheless participating in a research and publication programme whose design, data, analyses, and dissemination strategies are heavily coordinated by commercial actors. Conversely, industry scientists may make major legitimate contributions that deserve transparent recognition. Ethical analysis should focus on who exercised substantive scientific authority, not merely on institutional affiliation. This requires distinguishing legitimate collaboration from arrangements in which responsibility is obscured.

The appropriate ethical response is consequently full contributorship transparency rather than prohibition of professional medical writing or industry participation. Publications should make clear who designed the study, who had access to the complete data, who performed or supervised statistical analyses, who interpreted findings, who drafted substantive portions of the manuscript, who funded medical-writing assistance, and who possessed authority over submission and publication. Such transparency enables readers to evaluate research according to its actual governance structure. In the FIRE Framework, authorship is not merely a question of academic credit; it is a mechanism through which the visible structure of scientific responsibility can either reveal or conceal underlying financial influence.

Journals Are Also Economic Actors

Conflict-of-interest policies frequently position journals as neutral institutions responsible for identifying and policing the financial relationships of authors. Yet scholarly journals themselves operate within economic and competitive systems. Publishers may derive revenue from subscriptions, institutional licences, advertising, commercial reprints, article-processing charges, society memberships, sponsorship arrangements, or combinations of these sources. Editors and journals simultaneously compete for high-impact studies, citations, submissions, prestige, and readership. A comprehensive analysis of financial influence should avoid treating journals as institutions existing outside the incentive structures they are expected to regulate.

Lundh et al. (2010) provided an important illustration by examining the relationship between industry-supported randomised trials, journal impact factors, and revenue. Their analysis found that industry-supported trials were cited more frequently than trials receiving other forms of support and that excluding such trials reduced calculated impact factors to varying degrees across the journals studied. The researchers also documented substantial income from commercial reprint sales in some journals. These findings do not establish that editors deliberately accepted commercially sponsored trials to increase income. They do, however, demonstrate that journals can possess institutional interests that intersect with decisions about commercially important research. Conflict-of-interest analysis should encompass organisational as well as individual incentives.

Open-access publishing introduces another economic structure. Article-processing charges (APCs) permit many journals to make articles freely available to readers by shifting some publication costs to authors, institutions, or funders. This model has substantially expanded access to scientific literature and should not be

conflated with poor editorial practice. Nevertheless, whenever revenue depends partly on the number of accepted articles, a potential institutional tension exists between maintaining stringent rejection standards and generating publication income. The existence of that incentive does not demonstrate that reputable open-access journals lower their standards. Rather, it reinforces the broader principle that research-integrity governance should acknowledge economic structures instead of assuming that institutional objectivity follows automatically from professional status.

Predatory publishing represents a more extreme distortion of the author-pays model. Predatory journals may employ deceptive practices such as misrepresenting peer review, obscuring publication charges, falsely claiming editorial credentials or indexing, and prioritising fee collection over meaningful scientific quality control (Elmore & Weston, 2020). The crucial distinction is not between subscription publishing and open access but between governed financial models and exploitative ones. Open access can advance scientific accessibility, whereas predatory publishing exploits researchers' need to publish without providing appropriate editorial safeguards. The broader lesson for the FIRE Framework is that the economics of knowledge dissemination can shape scientific incentives just as profoundly as the economics of knowledge production.

Academic Careers, Grants and the Internal Economy of Science

Commercial money is only one financial influence operating within scientific research. Researchers also participate in an internal academic economy in which publications, citations, competitive grants, journal prestige, awards, academic appointments, promotion, and institutional rankings function as forms of professional currency. Career advancement frequently depends on demonstrating productivity and impact, creating incentives that may operate even where no corporation or commercial sponsor is involved. A comprehensive theory of financial influence should distinguish direct monetary conflicts from broader systems in which professional rewards possess indirect economic consequences through employment, promotion, salary, tenure, reputation, and access to future research resources.

Nosek et al. (2012) argued that conventional academic incentives can place the goal of producing accurate knowledge in tension with the more immediate rewards associated with producing publishable findings. Their analysis emphasised that publication systems often disproportionately reward novel and positive results, potentially encouraging research decisions aligned with publishability rather than truth-seeking (Nosek et al., 2012). This does not imply that researchers routinely manipulate their work for career advancement. It means that incentive structures can systematically alter behaviour without requiring explicit dishonesty. Researchers responding rationally to promotion criteria may invest more heavily in projects likely to generate prestigious publications and less heavily in replication, null findings, data stewardship, methodological verification, or other activities that produce substantial scientific value but fewer immediate professional rewards.

The National Academies of Sciences, Engineering, and Medicine (2017) similarly emphasised that research integrity depends not solely on the moral character of individual investigators but also on the environments, institutions, and incentive structures within which science occurs. It identifies objectivity, honesty, openness, fairness, accountability, and stewardship as foundational values of research integrity and recognises that institutional practices can either support or undermine those norms. This insight is crucial because ethics programmes focused exclusively on identifying dishonest individuals may overlook systemic pressures affecting otherwise conscientious researchers. A university that intensely rewards publication volume while giving limited recognition to replication, data curation, open science, methodological caution, mentoring, or correction of the scientific record may unintentionally encourage behaviours inconsistent with its stated values.

The research-money problem should not be reduced to a moral contrast between supposedly pure academic research and commercially compromised industry science. Universities compete for external grants, rankings, students, patents, intellectual property, and prestige. Researchers compete for employment, promotion, tenure, citations, awards, and future funding. Journals compete for influential manuscripts, citation metrics, reputation, and revenue. Professional societies may depend on membership fees, conference income, publishing arrangements, and sponsorships. Governments and philanthropic organisations similarly make strategic decisions concerning which areas of research deserve investment. Financial and quasi-financial incentives are

consequently distributed throughout the scientific system rather than concentrated exclusively within corporate sponsorship.

This broader perspective substantially expands the FIRE Framework. Financial influence should be conceptualised not only as money transferred from a sponsor to an investigator but as a network of material and professional incentives capable of affecting scientific choices at multiple levels. The central governance challenge is to align incentives with the values science claims to prioritise. Institutions can contribute by rewarding methodological quality, replication, transparent reporting, data stewardship, responsible collaboration, correction of errors, and socially valuable research rather than relying disproportionately on publication counts, journal prestige, grant income, or citation-based indicators. Such reforms do not require eliminating competition from science. They require designing competitive systems in which professional success is more closely aligned with reliable and socially valuable knowledge production. In this sense, the internal economy of academia represents not a peripheral issue but a central component of the relationship between money, incentives, power, and research integrity.

Financial Conflict is Not Research Misconduct

A central contribution of this paper is its insistence on maintaining a clear conceptual distinction between financial conflict of interest and research misconduct. Under the United States Office of Research Integrity (ORI) framework, research misconduct is formally defined as fabrication, falsification, or plagiarism in proposing, performing, reviewing, or reporting research (Office of Research Integrity [ORI], n.d.). Fabrication involves making up data or results, falsification involves manipulating research materials, procedures, or data so that the research record is inaccurately represented, and plagiarism concerns the appropriation of another person's ideas, processes, results, or words without appropriate credit (ORI, n.d.). Financial conflict of interest is conceptually different because it describes a set of circumstances in which a secondary financial interest may create a risk to independent professional judgement. A researcher may possess a substantial financial conflict while nevertheless conducting a methodologically rigorous, transparently analysed, and honestly reported study. Conversely, an investigator receiving no commercial funding whatsoever may fabricate observations, falsify data, or plagiarise the work of others.

This distinction has important ethical and scientific consequences. Treating the existence of a commercial relationship as equivalent to misconduct can unfairly stigmatise legitimate academic–industry partnerships and may discourage productive collaboration that contributes to drug development, technological innovation, clinical translation, or other socially valuable research. Financial sponsorship does not prove that findings are invalid, just as the absence of sponsorship does not demonstrate that a study is unbiased. The appropriate ethical response is proportional assessment rather than automatic condemnation. Investigators should be evaluated according to the nature of the financial relationship, the scientific decisions over which they possess authority, the transparency of the arrangement, and the safeguards protecting research independence. Such an approach maintains the presumption that scientific claims should be evaluated on evidence and methodology while recognising that structural conflicts can legitimately alter the level of scrutiny required.

At the same time, defining research integrity solely through fabrication, falsification, and plagiarism would be excessively narrow. The National Academies of Sciences, Engineering, and Medicine (NASEM, 2017) retained the established definition of formal research misconduct while distinguishing it from a wider category of detrimental research practices that may damage the reliability, transparency, or social value of research without satisfying the formal threshold for misconduct. This distinction recognises that the scientific record can be weakened by practices that are irresponsible or methodologically damaging even when they do not involve invented data, falsified observations, or plagiarism. Research integrity exists on a broader continuum than the legal or institutional definition of research misconduct. This conceptual distinction is useful for analysing financial influence because many sponsor-related concerns involve choices, incentives, omissions, and governance structures rather than demonstrable fraud.

Between exemplary scientific conduct and formal misconduct lies a wide territory of questionable or detrimental research practices. These may include inappropriate statistical flexibility, selective outcome reporting, unjustified exclusion of observations, inadequate record keeping, honorary or inappropriate

authorship, incomplete conflict-of-interest disclosure, failure to report negative findings, inadequate supervision, or other behaviours that reduce the reliability or transparency of research. NASEM (2017) explicitly notes that detrimental research practices may arise from individuals, research institutions, or journals, thereby extending responsibility beyond the behaviour of single investigators. This is especially important for the FIRE Framework because financial influence may operate through institutional policies, contractual arrangements, publishing systems, or incentive structures even where no individual researcher has engaged in formal misconduct. Integrity analysis must be capable of recognising systemic vulnerability without converting every vulnerability into an accusation of fraud.

The practical implication is that research governance requires more than misconduct investigations. Institutions need mechanisms for conflict-of-interest management, data stewardship, protocol transparency, authorship accountability, publication oversight, statistical review, and responsible research assessment. Misconduct procedures generally intervene after serious allegations arise, whereas conflict-of-interest governance should often operate prospectively to reduce circumstances in which competing interests can influence scientific judgement. These two systems should be complementary rather than interchangeable. Research misconduct asks whether accepted boundaries of scientific conduct were seriously breached; conflict governance asks whether the surrounding conditions provided sufficient protection for independent scientific judgement. The FIRE Framework adopts this distinction as a foundational principle because its purpose is to identify and manage risk pathways, not to presume wrongdoing whenever financial interests exist.

From Research Findings to Clinical Guidelines and Policy

Financial influence may become considerably more consequential when individual studies move beyond the scientific literature and enter systematic reviews, clinical practice guidelines, regulatory assessments, diagnostic systems, and public policy. At this stage, evidence is translated into recommendations that can influence the treatment of large populations, reimbursement decisions, pharmaceutical use, diagnostic classifications, and allocation of public resources. Clinical guidelines are very important because they compress complex bodies of evidence into recommendations intended to guide professional decision-making. Conflicts affecting guideline development may have effects substantially larger than those associated with a single research article. The ethical issue is not merely whether an individual study contains financial conflicts but whether the institutional process that converts evidence into practice sufficiently protects independent judgement.

Norris et al. (2011), in a systematic review of conflict of interest in clinical practice guideline development, found that all 12 studies included in their review reported financial relationships between guideline authors and the pharmaceutical industry. Their review also demonstrated substantial variation in the prevalence and disclosure of such relationships across guideline settings. Importantly, however, Norris et al. emphasised that the available evidence was insufficient to establish the actual causal effect of these conflicts on guideline recommendations. This qualification is methodologically crucial. The presence of a financial relationship warrants scrutiny and governance, but it does not establish that a recommendation is incorrect, biased, or commercially motivated.

More recent evidence indicates that financial relationships remain relevant in highly influential areas of medicine and psychiatry. A 2024 cross-sectional study of physicians involved in the development of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision* (DSM-5-TR) found that 55 of 92 eligible US physician panel and task-force members—60%—had received industry payments during the study period, with reported payments collectively exceeding US$14 million (Davis et al., 2024). This example is especially consequential because diagnostic classifications can influence research agendas, clinical practice, insurance systems, pharmaceutical markets, and public understandings of mental health. Nevertheless, the same analytical caution applies: documented payments demonstrate financial relationships, not that individual diagnostic decisions were scientifically invalid or deliberately distorted. The question is whether governance arrangements were sufficiently robust to protect diagnostic decision-making from actual or perceived competing interests.

Financial influence at the translation stage is epistemic as well as ethical. Readers, clinicians, policymakers, and patients need confidence that guideline recommendations arose primarily from transparent evaluation of evidence rather than from secondary interests. This is especially important where evidence is uncertain, where expert judgement plays a substantial role, or where several defensible recommendations are possible. In such contexts, the composition and governance of expert panels become part of the evidentiary process itself. Financial relationships should be regarded not simply as biographical information about individual experts but as characteristics of the institutional structure through which scientific evidence is converted into recommendations.

Guideline organisations can respond by establishing clear limits on conflicted participation, requiring comprehensive disclosure, ensuring balanced panel composition, appointing conflict-free chairs where feasible, documenting recusals, separating evidence review from recommendation voting, and making conflict-management procedures publicly accessible. These safeguards do not require excluding every individual who has ever worked with industry, which in highly specialised fields could remove substantial expertise. Instead, governance should be calibrated according to the magnitude, relevance, timing, and controllability of the financial relationship. Within the FIRE Framework, translation into policy and practice constitutes the final amplification stage, where relatively subtle upstream influences can potentially acquire population-level consequences.

Beyond Medicine

Biomedical research provides the largest and strongest empirical literature on financial conflicts of interest. The discussion beyond medicine is deliberately comparative and hypothesis-generating rather than evidentiary equivalence: the presence of analogous financial dependencies in psychology, nutrition, environmental research, technology and artificial intelligence does not establish that sponsorship effects occur with the same prevalence, magnitude or mechanism in those fields. The FIRE domains are proposed as questions that can be asked across disciplines, while the empirical answer must be established separately within each field.

Psychology provides an important example. Pachter et al. (2007) specifically examined corporate funding and conflicts of interest within psychology, demonstrating that concerns about secondary financial interests extend beyond pharmaceutical medicine. Cristea and Ioannidis (2018) later argued that discussion and disclosure of financial conflicts associated with psychosocial interventions remained comparatively underdeveloped, even though analogous conflict-of-interest concerns had been extensively debated in biomedical treatment research. This is particularly noteworthy because psychosocial interventions may generate professional, intellectual, commercial, or proprietary interests even when no drug or medical device is involved. Researchers may develop intervention programmes, training systems, manuals, digital products, assessment tools, or therapeutic methods whose success has reputational or economic implications.

Nutrition research provides another instructive context because food and beverage companies possess direct commercial interests in scientific findings concerning dietary patterns, ingredients, health claims, obesity, cardiovascular outcomes, and product safety. Similar considerations arise in environmental and chemical research, where scientific conclusions may influence regulatory limits, industrial liabilities, manufacturing practices, or decisions about the continued use of commercially valuable substances. Here again, the presence of industry funding does not invalidate research automatically. Rather, the structure of financial relationships becomes relevant because decisions about research questions, exposure definitions, comparator groups, data interpretation, publication, and regulatory communication can carry substantial economic consequences.

Technology and artificial intelligence illustrate a potentially different conflict environment in which corporations may finance laboratories, employ scientists, own proprietary datasets and control specialised computational infrastructure. These features make resource dependence and decision-making control conceptually relevant, but the empirical literature is not yet comparable in maturity to the biomedical sponsorship literature reviewed above. Accordingly, FIRE treats AI-related pathways as emerging or conceptual propositions unless direct empirical evidence is available, and no biomedical effect estimate is transferred to AI by analogy.

These developments expose an important conceptual gap. A framework built primarily around pharmaceutical payments to physicians cannot adequately represent financial influence across contemporary scientific systems. The relevant unit of analysis must expand from the individual investigator to the research ecosystem, including funders, institutions, commercial partners, data infrastructures, journals, regulators, professional societies, and translation bodies. This extension does not dilute personal responsibility; rather, it recognises that individual behaviour is shaped by organisational structures and distributions of power. The FIRE Framework is designed specifically to fill this gap by examining financial influence across multiple domains and by measuring risk according to more than the mere presence or absence of money.

The Financial Influence on Research Ecosystem (FIRE) Framework

This paper proposes the Financial Influence on Research Ecosystem (FIRE) Framework as a conceptual and hypothesis-generating model for analysing how financial resources, financial interests and financially linked forms of control may affect scientific knowledge production. FIRE is not presented as a validated scale, index, risk score or measurement instrument. Its seven domains are conceptually differentiated by stage of knowledge production, but their empirical distinctiveness, reliability and predictive validity have not yet been established. The framework organises existing evidence and identifies testable pathways rather than assigning numerical risk. Any future FIRE instrument will require item development, expert content validation, inter-rater reliability testing, dimensionality assessment, construct and discriminant validity, and prospective predictive validation.

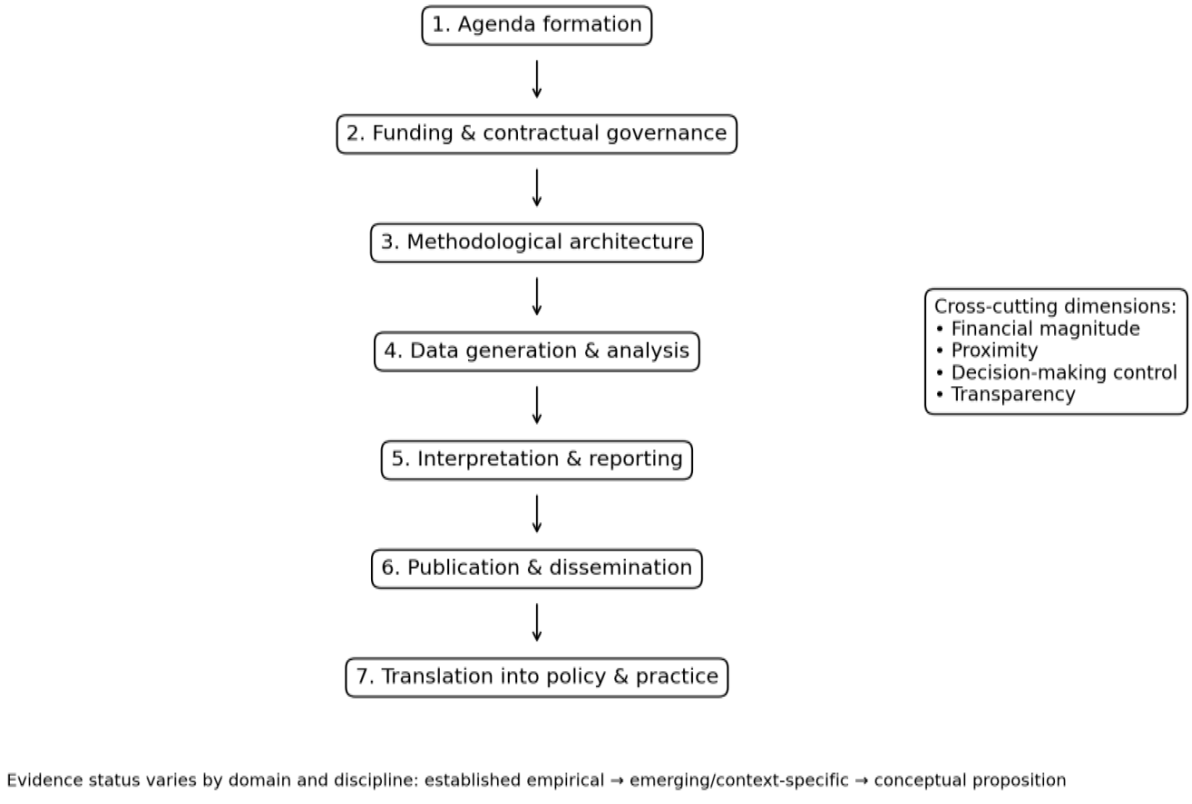

Figure 1. Financial Influence on Research Ecosystem (FIRE) Framework. The seven domains represent conceptual stages through which financial influence may accumulate; the four cross-cutting dimensions describe characteristics that may modify vulnerability. The framework is hypothesis-generating and has not yet been psychometrically or predictively validated.

Table 1. Evidentiary status and interpretive boundaries of the seven FIRE domains.

FIRE domain	Typical mechanism	Current evidentiary status	Interpretive boundary
Agenda formation	Funding priorities shape which questions receive resources	Emerging/context-specific	Strong conceptual rationale; causal quantification varies by field

Funding & contractual governance	Sponsor rights, publication restrictions, contractual control	Established in parts of biomedical literature	Do not infer misconduct from sponsorship alone
Methodological architecture	Comparator, outcome, follow-up and analytic design choices	Established/emerging in biomedical research	Evidence is not automatically transferable to other disciplines
Data generation & analysis	Data ownership, access and statistical control	Established/emerging in biomedical research	Mechanism and prevalence require discipline-specific testing
Interpretation & reporting	Framing, selective emphasis, outcome reporting	Established for reporting-bias phenomena; financial pathway varies	Association does not establish intentional manipulation
Publication & dissemination	Publication bias, ghost management, journal incentives	Established/emerging, strongest in biomedicine	Commercial and non-commercial publication incentives may coexist
Translation into policy & practice	Guidelines, regulation, reimbursement and policy uptake	Established in selected health-policy/guideline contexts	Broader disciplinary generalisation remains provisional

Domain 1: Research Agenda Formation. Financial resources influence which questions receive sustained attention, which diseases or technologies attract investment, which populations become research priorities, and which problems remain comparatively neglected. This domain captures the most upstream form of financial influence because it concerns the construction of the research portfolio before individual study methods are assessed. The principal concern is not that commercially attractive research is inherently undesirable, but that unequal funding can make some questions highly visible while rendering others scientifically underdeveloped. Agenda formation affects the evidence universe on which later reviews, guidelines, and policy decisions depend.

Domain 2: Funding and Contractual Governance. The source of funding alone provides limited information unless the rights attached to that funding are also examined. Relevant questions include whether sponsors participate in protocol development, control data access, appoint analysts, possess intellectual-property interests, influence manuscript preparation, or retain rights to delay or prevent publication. Two studies may both be labelled “industry funded” while differing substantially in the degree of sponsor authority. This domain shifts analytical attention from financial source to contractual power.

Domain 3: Methodological Architecture. Financial interests may intersect with comparator selection, outcome choice, treatment dosage, sampling, eligibility criteria, follow-up duration, stopping rules, subgroup definitions, and analytical flexibility. These decisions determine the conditions under which evidence is generated and can influence findings before any data manipulation occurs. The framework treats methodological design as a potential pathway of financial influence rather than whether the bias must arise retrospectively. Prospective registration, independent protocol review, and transparent analysis plans become especially relevant safeguards within this domain.

Domain 4: Data Generation and Analysis. Scientific integrity depends on accurate data collection, appropriate data management, complete investigator access, valid statistical methods, and protection against unjustified exclusion, transformation, or selective analysis. Control over datasets can become a significant source of power where sponsors or financially interested institutions possess exclusive access to information. Independent or externally verifiable analyses may be very important in studies with major commercial or regulatory consequences. This domain evaluates not only whether analyses are technically correct but whether the distribution of data access permits meaningful scientific scrutiny.

Domain 5: Interpretation and Reporting. Numerical results do not interpret themselves. Researchers decide which findings receive prominence, how uncertainty is described, whether harms or benefits dominate the discussion, and whether conclusions emphasise primary or secondary endpoints. Two reports containing

identical numerical findings can communicate substantially different impressions depending on framing. Financial influence may appear through language, emphasis, selective contextualisation, or interpretation even where reported statistics remain technically accurate. This domain highlights the distinction between data integrity and interpretative neutrality.

Domain 6: Publication and Dissemination. Scientific visibility is shaped by publication decisions, manuscript preparation, authorship structures, journal economics, commercial reprints, article-processing charges, conference presentation, professional communication, media coverage, and other dissemination systems. Evidence that remains unpublished or receives limited visibility contributes differently to the scientific record from evidence that is repeatedly disseminated or strategically amplified. The domain consequently encompasses both individual publication decisions and the economic structure of scholarly communication.

Domain 7: Translation into Policy and Practice. Systematic reviews, clinical guidelines, diagnostic systems, regulatory decisions, reimbursement policies, and public policies transform research findings into institutional action. At this stage, financial conflicts can potentially influence recommendations whose consequences extend far beyond the original studies. Guideline authors' financial relationships have been repeatedly documented, although such relationships should not be interpreted automatically as proof of biased recommendations (Norris et al., 2011). The FIRE Framework treats translation as an amplification domain in which upstream patterns of evidence production and downstream decision-making intersect.

Across these seven domains, the FIRE Framework proposes four cross-cutting dimensions for assessing the intensity of potential financial influence: financial magnitude, proximity, decision-making control, and transparency. Financial magnitude refers to the size or economic significance of the interest, recognising that a modest reimbursement and substantial equity ownership may create different incentive structures. Proximity refers to how directly the financial interest is connected to the product, intervention, organisation, or conclusion under investigation. Decision-making control concerns the degree of authority possessed over study design, data, analysis, interpretation, publication, or policy translation. Transparency concerns whether relevant relationships, contractual arrangements, analytical roles, and financial interests are completely and publicly disclosed.

These four dimensions are intended to operate jointly rather than independently. A relatively large financial relationship may present limited epistemic risk if it is remote from the research question, fully transparent, and accompanied by strong structural separation from scientific decision-making. Conversely, a smaller financial interest may warrant substantial concern if it is directly linked to the research outcome and combined with extensive control over data or publication. Thus, the FIRE Framework rejects the assumption that the magnitude of money alone determines risk. What matters is the configuration created by money, proximity, authority, and transparency.

The framework can be represented conceptually as:

Conceptual influence profile = f(financial magnitude, proximity, decision-making control, transparency)

This notation is only a conceptual reminder that several characteristics may jointly shape vulnerability to financial influence; it is not a mathematical model and implies neither multiplication nor empirically estimated weights. Until formal measurement studies are completed, the four cross-cutting dimensions should be reported descriptively rather than combined into a numerical FIRE score.

The FIRE Framework makes two broader contributions. First, it shifts conflict-of-interest analysis from individual morality to research-system architecture. Second, it separates the legitimate financing of science from the problematic concentration of financial interest and scientific control. This distinction is essential because research requires money, but money does not need to determine scientific truth. The objective of responsible governance should not be to create an impossible science without financial interests; it should be to construct a scientific ecosystem in which the resources necessary for discovery are accompanied by sufficient independence, transparency, accountability, and institutional safeguards to protect the credibility of knowledge.

DISCUSSION

The evidence reviewed in this paper supports neither the proposition that commercially funded research is inherently unreliable nor the opposite proposition that disclosure by itself provides adequate protection for scientific independence. A more defensible interpretation occupies the analytical space between these positions. Industry-supported science has made indispensable contributions to medicines, vaccines, medical devices, biotechnology, diagnostic systems, digital technologies, and other innovations that have improved human welfare. At the same time, empirical research provides credible and recurring evidence that financial sponsorship can be associated with findings and conclusions favourable to sponsors. Bekelman et al. (2003), in their systematic review of biomedical research, documented associations between industry sponsorship and pro-industry conclusions, while Lundh et al. (2017) subsequently demonstrated that industry-sponsored drug and medical-device studies were more likely than studies with other forms of sponsorship to report favourable efficacy results and favourable overall conclusions. Such findings justify systematic governance and continue empirical investigation, but they do not justify treating every commercially supported study as corrupted. The appropriate scientific response is neither institutional innocence nor indiscriminate suspicion, but evidence-based governance proportionate to the nature and structure of financial influence.

The central theoretical argument emerging from this review is that power, rather than money considered in isolation, constitutes the most consequential variable in understanding financial influence on research. Financial support becomes increasingly significant when the financially interested party simultaneously possesses authority over multiple stages of knowledge production. A sponsor that provides resources without controlling protocol design, access to raw data, statistical analysis, interpretation, manuscript preparation, or publication occupies a fundamentally different position from a sponsor that finances the research while also controlling several of these functions. This observation explains why binary classifications such as *industry-funded: yes/no* can obscure important differences among funding relationships. The FIRE Framework redirects attention from the mere presence of money to the distribution of authority across the research ecosystem. Financial magnitude remains important, but its ethical and epistemic significance depends substantially on its proximity to the research question, the decision-making authority attached to it, and the transparency and independence mechanisms surrounding the relationship.

The evidentiary strength of these claims is not uniform. Sponsorship-associated favourable conclusions and several publication/reporting mechanisms have comparatively strong empirical support in biomedical research; evidence for analogous mechanisms in other disciplines ranges from emerging to largely theoretical. FIRE offers a common vocabulary for cross-disciplinary investigation, not proof that the same causal structure operates everywhere. Its value at this stage lies in generating explicit, testable propositions and a research programme for determining which domains are distinct, measurable and predictive in disciplinary contexts.

The framework's distinctive contribution is structural rather than psychometric: it asks where financial interests intersect with authority across the research life cycle and separates legitimate financing from mechanisms that may threaten independence. Disclosure remains necessary but is treated as one governance mechanism among several, including contractual independence, data access, preregistration, independent analysis and publication rights. The analysis also preserves the distinction among conflicts of interest, questionable practices, bias and formal misconduct so that financial relationships are not treated as evidence of wrongdoing without supporting evidence.

RECOMMENDATIONS

First, research institutions should move beyond disclosure-only approaches towards risk-stratified conflict-of-interest management. Financial relationships should be assessed according to their magnitude, type, duration, proximity to the research question, and the level of decision-making control held by financially interested parties. Institutional review should distinguish, for example, between an unrestricted research contribution administered independently and direct personal equity ownership linked to a product being evaluated by the investigator. Management strategies could then be graduated according to risk, ranging from disclosure and routine oversight to independent analysis, recusal from decisions, divestment, or prohibition of arrangements that cannot be adequately managed. Such an approach recognises the potential benefits of relationships with

industry while addressing risks of bias and diminished public trust, a balance also recognised in established conflict-of-interest policy discussions. The objective is not to eliminate financial relationships indiscriminately but to prevent financial interests from acquiring disproportionate influence over scientific judgement.

Second, contracts governing commercially financed research should establish meaningful scientific independence before research begins. Investigators should have appropriate access to complete study datasets and sufficiently detailed information to evaluate both benefits and harms. Research contracts should protect reasonable rights to analyse data independently and publish scientifically important results irrespective of whether the findings support the sponsor's commercial objectives. Legitimate temporary restrictions intended to protect intellectual property, patent applications, or confidential commercial information may sometimes be justified, but these should be clearly distinguished from provisions that could indefinitely suppress unfavourable evidence. Agreements should also specify the roles of sponsors in protocol design, statistical analysis, manuscript preparation, and publication decisions. By embedding these requirements prospectively in contracts, research institutions can replace reliance on retrospective assurances with enforceable structural protections.

Third, prospective registration, protocol transparency, and pre-specification should become routine for hypothesis-testing research wherever methodologically feasible. Primary outcomes, major secondary outcomes, core analytical strategies, eligibility criteria, and relevant stopping rules should be defined before investigators examine outcome data. Where deviations become scientifically necessary, researchers should be required to report and explain them transparently rather than concealing them. Registration is not an absolute protection against selective reporting, but it establishes an evidentiary record against which subsequent publications can be compared. Protocol accessibility should similarly be encouraged because registry entries alone may not provide sufficient methodological detail to reconstruct all critical design decisions. These safeguards would make methodological changes more visible to peer reviewers, editors, evidence synthesists, and the wider research community.

Fourth, independent statistical verification should be considered for high-stakes studies in which sponsors or investigators possess major financial interests in the findings. Independence does not necessarily require excluding statisticians employed or contracted by the sponsor, since these analysts may possess specialised knowledge essential to the study. Instead, the objective should be reproducibility of key analyses by appropriately qualified individuals or teams whose incentives are not materially aligned with a predetermined commercial outcome. High-consequence clinical trials, regulatory submissions, safety analyses, or studies expected to affect major markets may warrant stronger verification requirements than exploratory studies with limited policy or commercial implications. Statistical analysis plans should be sufficiently transparent to allow important assumptions to be evaluated. Where feasible, sensitivity analyses should assess whether principal findings remain robust under alternative defensible analytical choices.

Fifth, journals and publishers should expand conflict-of-interest governance beyond authors and reviewers to include relevant institutional interests. Journals should disclose policies governing commercial reprints, advertising, sponsored supplements, institutional partnerships, article-processing revenue, and other financial relationships capable of creating perceived or actual institutional conflicts. Such disclosure should not imply that revenue arrangements have corrupted editorial decisions. Instead, it would apply to journals the same principle of transparency that journals routinely require of authors. Editorial decision-making procedures should also provide safeguards where major institutional financial interests coincide with commercially valuable manuscripts. Research integrity is more credible when disclosure standards operate symmetrically across the scientific ecosystem.

Sixth, universities and research institutions should reconsider incentive systems that disproportionately reward publication volume, journal prestige, grant income, and citation metrics while giving comparatively limited recognition to activities that strengthen the reliability of science. Replication studies, null findings, high-quality datasets, data sharing, preregistration, methodological innovation, correction of errors, responsible mentoring, peer review, and research-integrity service contribute materially to scientific progress but often provide weaker career rewards than highly visible publications and substantial grant acquisition. NASEM (2017) argues that institutional structures and incentives form an important part of the research environment

and should be monitored and improved to support integrity. Promotion and appointment systems should evaluate the quality, transparency, reproducibility, and social value of scholarship rather than relying excessively on easily quantified indicators.

Seventh, empirical research on financial conflicts of interest should expand substantially beyond biomedical science. Medicine provides important theoretical and methodological foundations, but its evidence cannot automatically be assumed to describe artificial intelligence, environmental science, psychology, education, economics, agriculture, engineering, or other disciplines. Corporate influence in these fields may occur through different mechanisms, including proprietary datasets, computing resources, consulting relationships, privately funded institutes, software access, research infrastructure, or employment pipelines. Discipline-specific empirical research should identify the forms of financial dependence most relevant to each research environment. Cross-disciplinary comparison would subsequently help determine which mechanisms represent general features of financial influence and which are context-specific.

Finally, future conflict-of-interest studies should move decisively beyond the binary variable *industry funded: yes/no*. At minimum, researchers should attempt to measure the amount and type of funding, investigator financial interests, sponsor involvement in protocol development, data ownership, statistical control, manuscript participation, publication rights, intellectual-property interests, and relevant institutional relationships. These factors should then be examined against outcomes such as methodological choices, effect estimates, conclusions, reporting completeness, time to publication, citation patterns, and policy recommendations. Such multidimensional measurement may provide considerably stronger explanations for the sponsorship associations documented by Bekelman et al. (2003) and Lundh et al. (2017). The FIRE Framework offers a conceptual structure from which these variables can be operationalised and empirically tested.

IMPLICATIONS FOR FUTURE RESEARCH

The FIRE Framework generates a series of empirically testable propositions that can move research on financial conflicts beyond descriptive disclosure studies. One hypothesis is that the probability of sponsor-favourable outcomes or conclusions increases as financially interested actors accumulate control across multiple stages of research. For example, studies could compare research supported by unrestricted funding with studies in which sponsors additionally participate in protocol development, own or control datasets, select statistical analysts, contribute extensively to manuscript preparation, or possess publication authority. The framework predicts that financial magnitude alone will explain less variation than models incorporating financial proximity and decision-making control. Such hypotheses could be examined through meta-epidemiological studies, prospective cohort designs, contractual analyses, and multilevel models in which individual studies are nested within institutions, funders, journals, or disciplines.

A second research direction is formal validation of the FIRE Framework. Instrument development should begin with domain-specific item generation and expert content-validity assessment, followed by pilot coding to establish inter-rater reliability. Larger samples could then test whether the seven proposed domains are empirically distinguishable using exploratory and confirmatory factor-analytic or other appropriate latent-structure methods, while convergent and discriminant validity should be assessed against established conflict-of-interest indicators. Only after dimensionality and reliability are established should researchers examine predictive validity against outcomes such as sponsor-favourable conclusions, reporting completeness, protocol deviations, publication delay, guideline uptake or policy recommendations. A cumulative FIRE index should not be used as a validated risk score until these steps demonstrate defensible weighting, calibration and external validity across independent samples and disciplines.

Bibliometric and scientometric research provides another promising avenue. Studies could examine whether commercially funded and non-commercially funded research differ in citation rates, journal placement, media visibility, conference presentation, guideline inclusion, social-media amplification, or rates of correction and retraction. Importantly, such differences should not automatically be attributed to financial manipulation because commercially supported studies may differ systematically in sample size, research topic, resources, multinational collaboration, or clinical relevance. Appropriate matching, weighting, regression adjustment, or

quasi-experimental methods would be necessary to reduce confounding. Investigators could additionally examine whether sponsor involvement at different FIRE domains predicts dissemination more effectively than the funding source alone.

Geographical context represents another major research priority. Much of the established empirical literature on financial conflicts of interest has been produced in high-income settings, particularly the United States and Europe, while contemporary research networks are increasingly multinational. Clinical trials, epidemiological projects, technology collaborations, and other research programmes may involve sponsors headquartered in high-income countries while participants, field sites, or investigators are in low- and middle-income countries (LMICs). Under these circumstances, external funding may represent both an indispensable source of scientific capacity and a substantial form of institutional dependence. Differences in regulatory resources, salary structures, research infrastructure, negotiating power, and domestic funding availability may alter how financial relationships operate. Future comparative research should examine whether identical financial arrangements generate different levels of dependency or control across national and institutional contexts.

This geographical issue raises broader questions concerning research equity and agenda sovereignty. Institutions that depend heavily on external financing may possess limited bargaining power over research priorities, intellectual property, authorship, data ownership, capacity building, or publication. A project may comply fully with formal ethical requirements while still reflecting substantial inequalities in who determines the scientific agenda and who benefits from the resulting knowledge. Future work could extend the FIRE Framework to investigate whether magnitude, proximity, control, and transparency interact differently where research institutions have highly unequal economic resources. Interviews with investigators, contract analyses, funding-flow studies, and comparative institutional case studies could illuminate dimensions of financial influence that cannot be captured through publication records alone.

Another critical research need is to distinguish perceived conflict, disclosed conflict, measurable association, and demonstrable causal influence. Disclosure studies establish that financial relationships exist; they do not demonstrate that those relationships changed scientific decisions. Outcome studies can establish statistical associations between sponsorship and findings or conclusions, as demonstrated in biomedical literature, but association alone does not identify the mechanisms producing the observed difference. Stronger causal evidence will require research designs capable of observing intermediate decisions. Longitudinal studies could follow projects from funding negotiations through publication, while contractual analyses could identify sponsor rights before outcomes are known. Mixed-methods research could combine quantitative sponsorship measures with interviews, document analysis, and process tracing to determine how financial relationships influence actual decision-making.

Natural experiments and policy evaluations could further strengthen causal understanding. Institutions and journals periodically introduce new disclosure requirements, trial-registration rules, data-sharing mandates, open-science practices, and conflict-management policies. Researchers could examine whether these changes alter selective reporting, publication delays, outcome switching, sponsor involvement, or confidence in the scientific literature. Difference-in-differences designs, interrupted time-series analyses, regression discontinuity approaches, and other quasi-experimental methods may be ly useful where randomised policy interventions are infeasible. This programme of research would shift the literature from repeatedly demonstrating that conflicts exist towards determining which governance mechanisms reduce their potential influence.

STRENGTHS AND LIMITATIONS

The principal strength of this paper is its ecosystem approach to financial influence. Rather than treating financial conflict exclusively as a characteristic of an individual researcher, the analysis integrates the processes through which money and financially related forms of power may operate from the earliest stages of research prioritisation to the final translation of evidence into policy and practice. The FIRE Framework consequently encompasses agenda-setting, contractual governance, methodological architecture, data generation and analysis, interpretation, publication and dissemination, and evidence translation. This expanded unit of analysis reflects the organisational nature of contemporary science and is consistent with the view that

research environments and institutional incentives contribute materially to scientific integrity (NASEM, 2017). The framework offers a conceptual bridge between scholarship on individual conflicts of interest and broader research concerning institutional governance, publication systems, scientific incentives, and knowledge production.

A second strength is the paper's explicit differentiation among legitimate research funding, financial conflicts of interest, bias, detrimental or questionable research practices, and formal research misconduct. This distinction protects the analysis from a common conceptual error whereby financial involvement is implicitly treated as evidence of wrongdoing. ORI defines formal research misconduct around fabrication, falsification, and plagiarism, whereas research integrity encompasses a substantially wider set of practices and institutional responsibilities. By maintaining these boundaries, the paper can examine structural vulnerability without accusing individual researchers or sponsors of misconduct in the absence of appropriate evidence. The approach also permits a more constructive discussion of governance because conflicts can be identified, disclosed, and managed before they produce demonstrable harm.

A third strength is the development of financial magnitude, proximity, decision-making control, and transparency as cross-cutting dimensions that can be applied across the seven FIRE domains. This provides greater conceptual precision than binary sponsorship measures. The framework recognises that financially similar arrangements can differ considerably in epistemic risk depending on the authority attached to them, while apparently modest financial interests can become important when directly linked to the research outcome and accompanied by extensive decision-making power. These dimensions also create a foundation for future measurement development. If operationalised and validated, they may allow researchers to test whether multidimensional financial-influence measures predict research outcomes more effectively than simple disclosure categories.

Nevertheless, the study has several limitations. First, it employs an integrative critical literature review and conceptual synthesis rather than a systematic review or meta-analysis. The study was designed to synthesise heterogeneous empirical, theoretical, methodological, ethical, and institutional literature across disciplines rather than exhaustively identify and quantitatively pool every study examining a specific exposure–outcome relationship. The paper cannot provide precise pooled estimates of the magnitude of financial influence across all FIRE domains. The conclusions concerning specific associations should be interpreted in relation to the underlying evidence from the cited systematic reviews and primary studies rather than as newly estimated quantitative effects.

Second, the evidence base is unevenly distributed across scientific disciplines. Biomedical research has generated a relatively mature literature on industry sponsorship and financial conflicts of interest, including systematic evidence of associations between industry sponsorship and sponsor-favourable outcomes or conclusions. Comparable empirical literatures remain less developed in several other disciplines discussed in the paper. The FIRE Framework's cross-disciplinary application should currently be regarded as a theoretically grounded proposition requiring further empirical validation rather than evidence that sponsorship effects occur with identical magnitude or mechanisms in every field. Future studies should examine the framework separately within medicine, psychology, artificial intelligence, environmental science, education, economics, and other relevant domains.

Third, financial influence is methodologically difficult to isolate from confounding factors. Industry-funded trials may differ from other studies in sample size, research phase, disease area, intervention type, regulatory purpose, statistical resources, methodological quality, multicentre participation, or probability of commercial relevance. An observed association between funding source and study conclusion does not necessarily represent a direct causal effect of sponsor pressure. This limitation reinforces the methodological rationale for the FIRE Framework: identifying who financed a study is insufficient unless researchers also examine what authority accompanied the funding and through which mechanisms influence might plausibly have operated.

Fourth, the FIRE Framework has not undergone formal empirical validation. The seven domains and four cross-cutting dimensions were derived through conceptual synthesis, not through psychometric scale development or predictive modelling. Their boundaries may overlap, and the review does not establish that

they are statistically independent constructs. FIRE should be interpreted as a conceptual taxonomy and hypothesis-generating model only. Future studies must establish content validity, inter-rater reliability, dimensionality, construct and discriminant validity, weighting and predictive validity before any numerical FIRE instrument or risk score can be justified.

Finally, publication-based research on financial influence inevitably confronts a visibility problem. The available scholarly record permits researchers to study published financial disclosures, methods, results, corrections, and known contractual arrangements, but many potentially important processes remain unobservable. Unfunded research questions, private negotiations, unpublished analyses, unsuccessful publication attempts, informal sponsor communications, and undisclosed institutional dependencies may leave little trace in publicly accessible literature. The measurable evidence may systematically underestimate forms of influence occurring before publication or outside formal reporting mechanisms. Mixed-methods and prospective research will be essential for investigating this hidden architecture of financial influence.

CONCLUSION

Money and research are inseparable components of modern scientific production. High-quality scientific inquiry requires resources, and collaborations among governments, universities, charities, foundations, industry, and other organisations have produced enormous scientific and social benefits. Commercially supported research has contributed materially to medical treatments, technologies, diagnostic tools, and numerous other forms of innovation. The ethical challenge is not to construct an unrealistic scientific system from which money has been removed. The more consequential question is under what circumstances financial resources acquire sufficient proximity and decision-making authority to redirect scientific judgement, evidence production, interpretation, dissemination, or translation into policy and practice.

The existing literature provides substantial reason for taking this question seriously. Systematic evidence in biomedical research demonstrates recurring associations between industry sponsorship and sponsor-favourable results or conclusions, although such associations cannot by themselves establish intentional manipulation or misconduct. Financial relationships can involve investigators, institutions, journals, professional organisations, and bodies responsible for translating evidence into recommendations. Yet the presence of these relationships should never be treated automatically as evidence of scientific corruption. Financial conflict identifies conditions under which competing interests may threaten or appear to threaten independent judgement; research misconduct represents a more specific category that, under the ORI framework, includes fabrication, falsification, and plagiarism. Preserving this distinction is essential for both ethical fairness and methodological precision.

The principal literature gap identified by this study concerns the fragmented way financial influence has generally been conceptualised and investigated. Important bodies of scholarship examine industry sponsorship, investigator disclosures, publication bias, ghost authorship, journal incentives, conflicts among guideline authors, and institutional research integrity, but these domains are often investigated separately. Such fragmentation makes it difficult to understand how financial influence may accumulate across the entire process through which research questions become scientific knowledge and scientific knowledge becomes social action. A funding relationship that appears relatively benign when examined only at the point of payment may become more consequential if the same interested actor also participates in agenda formation, methodological design, data control, statistical analysis, interpretation, publication, and downstream recommendations.

The Financial Influence on Research Ecosystem (FIRE) Framework addresses this conceptual fragmentation by organising potential financial influence across seven interconnected stages of knowledge production. At present, however, FIRE is a conceptual model rather than a validated measurement instrument. The empirical foundation is strongest in biomedical and pharmaceutical research, while applications to artificial intelligence, environmental science and several other fields should be treated as hypotheses requiring discipline-specific investigation. The framework's contribution is to make pathways, distinctions and testable propositions explicit—not to claim that the seven domains are already psychometrically distinct or that they predict

research outcomes. Formal reliability, construct-validity and predictive-validity studies are required before FIRE can support quantitative scoring or cross-disciplinary comparison.

This conceptual shift has implications for research institutions, funders, journals, regulators, guideline organisations, and individual researchers. Disclosure remains indispensable because hidden financial relationships are incompatible with transparent science. However, disclosure alone cannot resolve structural dependence or remove decision-making authority from interested parties. Stronger protections include independent data access, publication rights, prospective registration, transparent protocols, reproducible statistical analysis, proportional conflict management, balanced guideline governance, institutional disclosure, and incentive systems that reward research reliability rather than publication or funding volume alone. NASEM's emphasis on institutions' responsibility for creating research environments that foster integrity supports this wider distribution of responsibility.

Ultimately, scientific integrity cannot depend exclusively on declarations of individual virtue or financial disclosure after conflicts have already been created. It requires research systems whose architecture protects independent inquiry even when powerful commercial, institutional, professional, or political interests are present. Transparency makes financial relationships visible; governance determines what those relationships are permitted to control. The strongest objective is neither a science without money nor a science in which financial relationships are presumed harmless once disclosed. It is a system in which financing enables discovery while institutional safeguards prevent the purchase of disproportionate authority over the questions science asks, the evidence it produces, and the conclusions society is ultimately invited to trust.

REFERENCES

1. Ahmed, N., & Wahed, M. (2020). The de-democratization of AI: Deep learning and the compute divide in artificial intelligence research. *arXiv*. https://doi.org/10.48550/arXiv.2010.15581
2. Bekelman, J. E., Li, Y., & Gross, C. P. (2003). Scope and impact of financial conflicts of interest in biomedical research: A systematic review. *JAMA, 289*(4), 454–465. https://doi.org/10.1001/jama.289.4.454
3. Çaparlar, C. Ö., & Dönmez, A. (2016). What is Scientific Research and How Can it be Done? *Turkish Journal of Anaesthesiology and Reanimation*, *44*(4), 212. https://doi.org/10.5152/TJAR.2016.34711
4. Centers for Disease Control and Prevention. (2026, May 26). *About scientific integrity*. https://www.cdc.gov/scientific-integrity/php/about/index.html
5. Cosgrove, L., Shaughnessy, A. F., Peters, S. M., Lexchin, J. R., Bursztajn, H. J., Bero, L., & D'Ambrozio, G. (2024). Undisclosed financial conflicts of interest in DSM-5-TR: Cross sectional analysis. *BMJ, 384*, e076902. https://doi.org/10.1136/bmj-2023-076902
6. Cristea, I. A., & Ioannidis, J. P. A. (2018). Improving disclosure of financial conflicts of interest for research on psychosocial interventions. *JAMA Psychiatry, 75*(6), 541–542. https://doi.org/10.1001/jamapsychiatry.2018.0382
7. Davis, L. C., Diianni, A. T., Drumheller, S. R., Elansary, N. N., D'Ambrozio, G. N., Herrawi, F., Piper, B. J., & Cosgrove, L. (2024). Undisclosed financial conflicts of interest in DSM-5-TR: Cross sectional analysis. *BMJ, 384*, e076902. https://doi.org/10.1136/bmj-2023-076902
8. Diaba-Nuhoho, P., & Amponsah-Offeh, M. (2021). Reproducibility and research integrity: The role of scientists and institutions. BMC Research Notes, 14, 451. https://doi.org/10.1186/s13104-021-05875-3
9. Dwan, K., Gamble, C., Williamson, P. R., & Kirkham, J. J. (2013). Systematic review of the empirical evidence of study publication bias and outcome reporting bias—An updated review. *PLOS ONE, 8*(7), e66844. https://doi.org/10.1371/journal.pone.0066844
10. Elmore, S. A., & Weston, E. H. (2020). Predatory journals: What they are and how to avoid them. *Toxicologic Pathology, 48*(4), 607–610. https://doi.org/10.1177/0192623320920209
11. Graham, S. S., Majdik, Z. P., Clark, D., & Kessler, M. M. (2023). Relationships among commercial practices and author conflicts of interest in biomedical publishing. *PLOS ONE, 18*(7), e0287544.
12. Graham, S. S., Majdik, Z. P., Clark, D., Kessler, M. M., Hooker, T. B., Smith, S., & Tan, X. (2022). Evidence for stratified conflicts of interest policies in research contexts: A methodological review. *BMJ Open, 12*(9), e063501. https://doi.org/10.1136/bmjopen-2022-063501

13. Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal, 26*(2), 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x
14. Hundemer, S., Loizzo, J., Peterson, A. L., et al. (2026). Scientific objectivity and the pursuit of the public good. *Science and Engineering Ethics, 32*, Article 33. https://doi.org/10.1007/s11948-026-00601-3
15. Institute of Medicine. (2009). *Conflict of interest in medical research, education, and practice*. The National Academies Press. https://doi.org/10.17226/12598
16. International Committee of Medical Journal Editors. (n.d.). *Clinical trials*. https://www.icmje.org/recommendations/browse/publishing-and-editorial-issues/clinical-trial-registration.html
17. Krimsky, S. (2013). Do financial conflicts of interest bias research? An inquiry into the "funding effect" hypothesis. *Science, Technology, & Human Values, 38*(4), 566–587. https://doi.org/10.1177/0162243912456271
18. Lundh, A., Barbateskovic, M., Hróbjartsson, A., & Gøtzsche, P. C. (2010). Conflicts of interest at medical journals: The influence of industry-supported randomised trials on journal impact factors and revenue—Cohort study. *PLoS Medicine, 7*(10), e1000354. https://doi.org/10.1371/journal.pmed.1000354
19. Lundh, A., Lexchin, J., Mintzes, B., Schroll, J. B., & Bero, L. (2017). Industry sponsorship and research outcome. *Cochrane Database of Systematic Reviews, 2017*(2), MR000033. https://doi.org/10.1002/14651858.MR000033.pub3
20. Mezhoud, S. (n.d.). *The concept of scientific research: Its types and morals*. Abdelhafid Boussouf University Centre of Mila. https://elearning.univmila.dz/a2024/pluginfile.php/111889/mod_resource/content/1/%20Research%20methodology%20and%20teaching%20pedagogy.pdf
21. National Academies of Sciences, Engineering, and Medicine. (2017). *Fostering integrity in research*. The National Academies Press. https://doi.org/10.17226/21896
22. National Research Council & Institute of Medicine. (2002). Integrity in research. In *Integrity in scientific research: Creating an environment that promotes responsible conduct*. National Academies Press. NCBI Bookshelf chapter
23. Nguyen, L. T., & Tuamsuk, K. (2025). Factors influencing researchers' scientific integrity in scholarly publishing: A path analysis approach. *Research Ethics*. https://doi.org/10.1177/17470161241257445
24. Norris, S. L., Holmer, H. K., Ogden, L. A., & Burda, B. U. (2011). Conflict of interest in clinical practice guideline development: A systematic review. *PLoS ONE, 6*(10), e25153. https://doi.org/10.1371/journal.pone.0025153
25. Nosek, B. A., Spies, J. R., & Motyl, M. (2012). Scientific utopia: II. Restructuring incentives and practices to promote truth over publishability. *Perspectives on Psychological Science, 7*(6), 615–631. https://doi.org/10.1177/1745691612459058
26. Office of Research Integrity. (n.d.). *Definition of research misconduct*. U.S. Department of Health and Human Services. https://ori.hhs.gov/definition-research-misconduct
27. Pachter, W. S., Fox, R. E., Zimbardo, P., & Antonuccio, D. O. (2007). Corporate funding and conflicts of interest: A primer for psychologists. *American Psychologist, 62*(9), 1005–1015. https://doi.org/10.1037/0003-066X.62.9.1005
28. Purdue University College of Science. (n.d.). *What is research?* Purdue University. https://www.purdue.edu/science/careers/find_internship_research/getting_started_with_research/what_is_research.html
29. Redman, B. K. (2023). Rebalancing commercial and public interests in prioritizing biomedical, health, and health care research. *Accountability in Research*.
30. Resnik, D. B. (2007). *The price of truth: How money affects the norms of science*. Oxford University Press.
31. Resnik, D. B. (2023). Disclosing and managing non-financial conflicts of interest in scientific publications. *Research Ethics, 19*(2), 121–138. https://doi.org/10.1177/17470161221148387
32. Resnik, D. B., & Elliott, K. C. (2019). Value-entanglement and the integrity of scientific research. *Studies in History and Philosophy of Science Part A, 75*, 1–11.

https://doi.org/10.1016/j.shpsa.2018.12.011

33. Shamoo, A. E., & Resnik, D. B. (2022). *Responsible conduct of research* (4th ed.). Oxford University Press. https://doi.org/10.1093/oso/9780197547090.001.0001
34. Sismondo, S. (2007). Ghost management: How much of the medical literature is shaped behind the scenes by the pharmaceutical industry? *PLOS Medicine, 4*(9), e286. https://doi.org/10.1371/journal.pmed.0040286
35. Sismondo, S. (2010). Publication ethics and the ghost management of medical publication. *Bioethics, 23*(8), 403–413.
36. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research, 104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039
37. Song, F., Parekh, S., Hooper, L., Loke, Y. K., Ryder, J., Sutton, A. J., Hing, C., Kwok, C. S., Pang, C., & Harvey, I. (2010). Dissemination and publication of research findings: An updated review of related biases. *Health Technology Assessment, 14*(8), iii, ix–xi, 1–193. https://doi.org/10.3310/hta14080
38. Taichman, D. B., Sahni, P., Pinborg, A., Peiperl, L., Laine, C., James, A., Hong, S.-T., Haileamlak, A., Gollogly, L., Godlee, F., Frizelle, F. A., Florenzano, F., Drazen, J. M., Bauchner, H., Baethge, C., Backus, J., & Mello, M. M. (2020). Data sharing statements for clinical trials: A requirement of the International Committee of Medical Journal Editors. *Annals of Internal Medicine, 172*(1), 63–65.
39. Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review, 4*(3), 356–367. https://doi.org/10.1177/1534484305278283
40. Viergever, R. F. (2013). The mismatch between the health research and development (R&D) that is needed and the R&D that is undertaken: An overview of the problem, the causes, and solutions. *Global Health Action, 6*(1), 22450. https://doi.org/10.3402/gha.v6i0.22450
41. Wedderkopp, N., & Rutz, E. (2024). Scientific Integrity and Transparency in Academic Writing: The Foundation of Credible Science. *Children*, *11*(10), 1191. https://doi.org/10.3390/children11101191
42. Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing, 52*(5), 546–553. https://doi.org/10.1111/j.1365-2648.2005.03621.x
43. Woolf, S. H. (2008). The meaning of translational research and why it matters. *JAMA, 299*(2), 211–213. https://doi.org/10.1001/jama.2007.26
44. World Medical Association. (2024a). *WMA Declaration of Helsinki: Ethical principles for medical research involving human participants*. World Medical Association.https://www.wma.net/policies-post/wma-declaration-of-helsinki/
45. World Medical Association. (2024b). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human participants. *JAMA, 333*(1), 71–74. https://jamanetwork.com/journals/jama/fullarticle/2825290