From Labs to Legislation: The Role of Intermediary Organizations in the Research Ecosystem

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Abstract:
Federal research policy in the United States often emphasizes the relationship between government and higher education institutions in a two-actor model: the federal government sets priorities, and universities execute them. Yet this omits a key third actor: intermediary organizations. Intermediary organizations play a central role in shaping how research moves from the lab bench to the broader public. These organizations facilitate coordination, policy alignment, and technical expertise between government and academia, influencing everything from patent policy to translational funding mechanisms. Still, federal research legislation rarely accounts for their role in implementation. This oversight leads to fragmented research translation practices and missed opportunities for more coherent, scalable innovation policy. This article offers an alternative model of the research enterprise. It uses a semiotic lens to explore how communication breakdowns between actors produce policy drift. By highlighting the foundational role of intermediary organizations, the author argues that research outcomes cannot be optimized without acknowledging and formalizing the contributions of these actors.

I. Introduction

Academic research is a cornerstone of American innovation and moves federally funded research from university labs into public use. Since the Bayh-Dole Act of 1980 (Rep. Kastenmeier 1980), policymakers have relied on legislation to structure this pathway, typically emphasizing the flow of knowledge and inventions between federal agencies and higher education institutions. This framing, however, omits a critical dimension of the research ecosystem: the intermediary organizations that define, coordinate, and normalize the processes of research translation.

The research enterprise, though its definition is subject to substantial discussion, effectively refers to the way in which we speak to the realization of the value of the economic enterprise of research. For the purposes of this paper, when I say research enterprise, I mean the federal government, academia, and industry.

Intermediary organizations also play a role in the research enterprise. They can take many forms and serve as connective tissue in the research enterprise. They shape the interpretation of federal policy, establish shared norms and practices, and mediate institutional responses across a decentralized system. In effect, they are active participants in the research policy process, acting as operational co-authors. The work of intermediaries and its effect on the research enterprise has not been seriously investigated in the United States.

An alternative model, the Triple Helix (Etzkowitz and Zhou 2017), frames the research ecosystem from a market lens, describing the interactions between government, academe, and industry. This model fails to account for concepts such as public interest, so others developed further versions such as the Quadruple and Quintuple Helix (Cai and Lattu 2022), along with modes for each. These models still only account for research as primarily intended for market, and that research output must benefit markets.

The aim of this paper is to suggest that the institutional management of the research enterprise may be made more effective: by focusing on the role of intermediary organizations. Through a systems lens, these entities are not external stakeholders but embedded actors whose absence from legislative and regulatory

frameworks undermines both (Chaminade and Edquist 2006). The research enterprise should be understood as a triadic model, not a dyad: government, universities, and intermediary organizations. Each node plays a distinct role, but effective research translation depends on healthy information flow, aligned incentives, and shared definitions among all three. Failures in implementation, especially in translating research into local economic development, can often be traced to communication breakdowns between nodes of this triadic relationship. I offer policy recommendations that treat intermediary organizations as core components of the research ecosystem, inviting a shift from viewing them as background actors to recognizing them as infrastructure.

This article is organized as follows. I begin with a definitions section, which contains concepts essential to all that follows. Next I talk about the background, understanding the state of the research enterprise, including the problem. Then I lay out the model. I follow with a case study where I apply the model. I then explain my findings, and end with recommendations.

II. Definitions

Researchers in both policy and academic arenas use many differing definitions of research translation and research output, which is important to note here. Both terms are highly dependent on the author's discipline. In this paper, I will observe research translation exclusively within the United States.

Direct institutional data on this metric are unavailable, so I used Fractional Scientific Strength (FSS) as a proxy, which prior studies have shown is a reasonable indicator of research labor productivity. In order to apply the FSS model on a university, I look to formally defined Scientific Disciplinary Sectors (SDSs) and apply the university-wide formula (Abramo and D'Angelo 2014). Unlike h-index, FSS accounts for the quality of each publication (via citations normalized to field/year), the share of contribution by each author (via weighted fractional authorship), and the cost of the researcher (via salary or academic rank).

We can use a formula to approximate institutional FSS:

$$\mathrm{FSS}_{approx.} = \frac{\text{Normalized Citations}}{\text{Total Salary Cost}}$$

And then we can compute a simple efficiency ratio to see how effectively an institution outputs research compared to its research expenditure:

$$\text{Efficiency Ratio} = \frac{\text{Institutional FSS}}{\text{Research Expenditure}}$$

With research output and the efficiency ratio defined, we can proceed with understanding the current research environment in the United States.

III. Background

Since the mid-20th century, the United States has treated the federally funded research enterprise as a national innovation engine. Research translation, or specifically technology transfer, has generated substantial benefits: from 1996 to 2020, United States universities disclosed more than 554,000 inventions, secured 141,000 patents, and launched 18,000 startup companies (AUTM 2017). Further, technology transfer contributed up to $1 trillion in GDP and $1.9 trillion in gross industrial output (AUTM 2017). Additionally, technology transfer has enabled development of more than 200 new drugs and vaccines in the life sciences sector (AUTM 2017). In stark contrast, prior to Bayh-Dole, the federal government had approximately 30,000 patents, of which only 5 percent led to new or improved products, as the government lacked the resources to develop and market inventions (Office 1998).

The Bayh-Dole Act of 1980 kicked off this engine when it changed United States patent policy regarding government-funded research by "allowing universities, not-for-profit corporations, and small businesses to patent and commercialize their federally funded inventions and by allowing federal agencies to grant exclusive licenses for their technology to provide more incentive to businesses" (Office 1998). Future key legislative milestones, namely the Stevenson-Wydler Technology Innovation Act (Sen. Stevenson 1980), and more recently the CHIPS and Science Act of 2022 (Rep. Ryan 2022), have constructed a legal framework for American innovation, assigning universities the role of translating research into usable technologies and economic development, assuming the government will function as the primary financial enabler.

Universities responded to this framework by establishing Technology Transfer Offices (TTOs),

which function as the interface between academe and industry (Eidlisz, von Simson, and Gold-von Simson 2024). Most importantly, TTOs have two critical functions: intellectual property management and partnership facilitation, especially regarding licensing and financial strategy development.

Intellectual property management remains the core function of a university TTO. A TTO will evaluate the commercial potential of university inventions, and help the researcher determine the best course of action. The office will also file and manage patent applications, including often defending the patent on behalf of the researcher. Finally, TTOs provide services to market technologies to potential licensees.

Besides marketing, a TTO will further facilitate partnerships between the researcher and industry. TTOs will negotiate licensing agreements with industry, relieving the task from the researcher. Additionally, TTOs establish collaborative research relationships, manifesting as industry investment or Cooperative Research & Development Agreements (CRADAs) (Interior 2025). Once ready, the office will support the formation of a startup from university research.

Universities follow a well-defined and systematic approach to technology transfer. The first step in this process is invention disclosure. Researchers report potentially commercializable discoveries to the TTO. Next, the TTO will move to evaluation and protection. TTOs assess commercial potential and, if viable, file for intellectual property protection on behalf of the researcher. The third step in the approach is marketing and partnership development. TTOs market the now-protected technologies to potential industry partners. To proceed, the next step is license negotiation. The office will negotiate terms covering exclusivity, royalties, and development milestones. Finally, the TTO provides commercialization support: ongoing monitoring and support for technology development, which can include startup formation.

Institutions must balance multiple objectives in technology transfer. Universities, especially public and land-grant institutions, must benefit the public through commercialization. Furthermore, technology transfer must contribute to regional economic development and job creation. In addition, universities must consider revenue generation, which, while important, is not within scope of this paper. Most university TTOs do not generate enough income to cover operating expenses.

This structure entrenched the two-actor assumption: that technology transfer is a matter of transactional alignment between federal funders and university researchers. In this model, government sets the policy, universities execute, and innovation follows (Powers and Campbell 2011).

At a cursory glance, this model works. Each party contributes essential but different resources to technology transfer and the research enterprise as a whole. The federal government contributes financial resources for basic and applied research. To enable regulation, the government develops the legal framework and offers policy guidance. It further allows for access to federal laboratories and creates a market for technologies through government procurement. Academia contributes its research expertise and innovation capacity. TTOs establish channels for intellectual property development and management, while also building industry relationships and marketing technologies. To fully move from the lab to the store, universities provide entrepreneurial support and startup incubation.

The relationship between the federal government and universities is not perfect, however, and faces major challenges. Most immediately, funding pressures affect both actors. Federal cuts to science and research funding impact university research, subsequently impacting technology transfer capabilities. Most university TTOs operate without generating sufficient revenue to cover costs, so they cannot exist without external support. Additionally, policy debates, specifically ongoing discussions about march-in rights and pricing of federally funded innovations, stress the relationship further. Critically, resource constraints limit technology transfer. These constraints go beyond financial concerns, but include lack of staff, institutional knowledge, and legal counsel.

Over the past four decades, professional societies, associations, and consortia have emerged not just as advocacy groups but as operational partners (Newell and Swan 1995). These entities have defined shared language around “research translation” and “public impact” (Universities 2019), developed standardized tools (e.g., model IP licensing agreements) (AUTM 2025), interpreted legislation and guided institutional compliance (Universities 2024), and created training programs and metrics for evaluating translational success (AUTM 2022).

A comprehensive list of these intermediary organizations would result in a paper much longer than I intend to write. To demonstrates the concept of the intermediary without burdening the reader, I select one, but some example organizations include the Association of Public & Land-Grant Universities (APLU), the Association of American Universities (AAU), and the Institute of Electrical and Electronics Engineers (IEEE).

> “Currently, there is no definitive source for metrics regarding research translation impact.”

Currently, there is no definitive source for metrics regarding research translation impact. Instead, intermediaries control the market by conducting private surveys. Indeed, the metrics provided regarding the public impact of technology transfer are exclusively maintained by AUTM.

Intermediaries are not simply peripheral actors; they are semiotic and infrastructural engines that actively translate the symbolic and regulatory content of legislation into institutional behaviors. Intermediaries also function as representatives of the otherwise territorial academe, providing a single academic perspective. Their work creates coherence across a fragmented academic landscape.

The work of intermediaries spans across every element of the research enterprise, from specific interest groups to academic associations to professional societies. I focus specifically on AUTM, which was previously called the Association of University Technology Managers’. Although individual universities may publicize information, the federal government elected not to develop a standardized way of gathering this data, leaving the gap for AUTM. AUTM acts in a unique capacity in our intermediary node and I explore it further as a case study later in the paper.

IV. Model

To understand the findings of the research, I begin by explaining the research enterprise through a three actor model, hereon referred to as the research triad, presented visually in Figure 1.

I refer to each actor as a node. This distinction is important, for each node contains enough detail to constitute multiple other papers- this is not within the scope of this paper. Instead, I offer a view where each node is an abstraction of the inner workings of each actor (for example, the federal government node encompasses Congress, the Office of Science and Technology Policy, federal agencies such as the National Science Foundation, etc.). The node as an abstraction does not lessen the quality of the research triad model, instead it allows for communicating only the information needed to understand the author’s recommendations whilst acknowledging the complexities of each actor’s inner system.

We begin with creating a model of the research enterprise and defining our system. The research triad model features three nodes interacting with one-another: the federal government, academe, and intermediaries. The federal government and academe are core nodes, which feature solid borders, while the intermediaries’ node, acting as the translation engine, has a dashed border. Each node communicates with another node and an arrow demonstrates this. The core nodes communicate indirectly with each other, visualized through arched arrows, but communicate directly with the translation engine, designated with a bi-directional arrow. Each arrow represents a communication vector, that is, a space where if communication breakdown occurs, policy drift will follow. This paper defines communication breakdown as the state that arises when a recipient misinterprets the signs used to convey meaning, rendering the message ineffective. In the context of the model, communication breakdown can range from incorrect implementation of a memo to the inability to commercialize technology due to the misunderstanding of a regulation. Core nodes communicating with one-another directly are more likely to result in communication breakdown, and

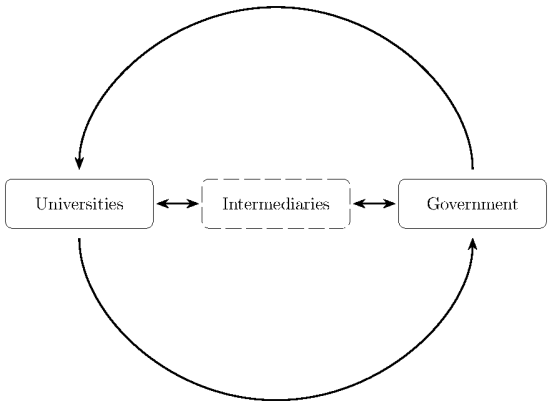

Figure 1: The Research Triad

when communicating through a translation engine, both nodes have a higher chance of successfully communicating.

Applying this model to the research enterprise, we see that the core nodes communicate through two messages: financial investment and research output. In the context of this application the core nodes communicate one-way: the federal government invests in the university, setting priorities, and the university responds to the input with research output. Notably, this is the only way that these core nodes communicate: they cannot change the message sent, and expect the same response every time. This is in contrast to the Triple Helix, which characterizes the research innovation ecosystem as three equal nodes (government, academia, industry) that communicate with each other. The research triad instead contends that, if any further communication shall exist without communication breakdown, an intermediary node must exist between the core nodes, functioning as a translation engine.

The intermediaries node performs three critical functions: symbolic translation (defining what "research translation" means), policy filtration (translating law into university practice), and norm entrepreneurship (e.g., AUTM's role in Bayh-Dole implementation). The research triad does not argue that the core nodes of government and academia only communicate one way, instead it characterizes the most effective way. Through this lens, core nodes only communicate to each other through the common language, and the remaining messages pass through the intermediaries. To illustrate a practical application of the research triad, I present a case study using AUTM and the Bayh-Dole Act.

V. Case Study

The Bayh-Dole Act of 1980 is widely regarded as a turning point in American innovation policy. By granting universities the right to retain ownership of inventions produced through federally funded research, Congress hoped to spur commercialization, regional development, and a more entrepreneurial research culture. Yet while the law provided a legal framework, it offered little guidance on how technology transfer should be implemented at scale. There was no blueprint for how institutions should handle disclosures, licensing, valuation, or reporting.

> "Without AUTM, it is unlikely that Bayh-Dole would have succeeded as well as it did."

This is where intermediaries, particularly AUTM, stepped in. Founded in the late 1970s as the Society of University Patent Administrators (SUPA), AUTM emerged as the de facto engine of operational translation for Bayh-Dole (AUTM 2025). It provided the tools, practices, and professional infrastructure necessary to bring the statute's intent to life.

AUTM developed model licensing agreements, offering universities shared templates for negotiating technology transfer deals. It built out training programs and certification pathways, helping professionalize the role of tech transfer officers. AUTM also established standardized performance metrics, such as the number of disclosures, licenses issued, startups launched, and revenue generated. These benchmarks enabled both institutional accountability and system-wide analysis.
Importantly, AUTM also served as an informal feedback loop between institutions and federal policymakers. Through surveys, policy statements, and advocacy, it helped federal agencies understand how legislation was playing out in practice, surfacing barriers and proposing clarifications. Though AUTM held no statutory authority, its influence effectively shaped how Bayh-Dole was interpreted, implemented, and measured.

To apply the research triad model, we can assign a node to each actor: any university, AUTM (representing the intermediaries), and Congress (representing the government). In this model, AUTM acts as the translation engine, converting the text of Public Law 96-517 into practical toolkits that the university can understand. The engine relieves the university of the burden required in understanding messages not written in its language.

This case illustrates the larger theme of this paper: intermediary organizations are not simply advocates. They are translators, standard-setters, and infrastructure builders, and, in systems terms, they stabilize the meaning of policy and provide the connective tissue between high-level mandates and institutional behavior. Yet despite their foundational role, they remain largely unacknowledged in legislative design.

Without AUTM, it is unlikely that Bayh-Dole would

have succeeded as well as it did. But the success came not from federal coordination, but from an intermediary actor that took on systemic responsibility without systemic support. This structural reliance on informal infrastructure creates policy fragility: we depend on these organizations, but we do not design for them.

VI. Findings

By applying the research triad model, it becomes more apparent that the current approach to research translation is out of sync with the system built to support it. The research enterprise operates as if policy directives flow cleanly from Congress to federal agencies to universities, although in reality this pipeline would fail without intermediaries as the connective tissue. And yet, despite their central roles in implementation, these organizations are chronically underfunded, structurally informal, and effectively invisible to federal stakeholders.

“Intermediaries shape what research translation looks like in practice.”

Intermediaries shape what research translation looks like in practice. They create tools, define expectations, and translate policy into something operable. Still, they are rarely named in legislation. When consulted, it is often through ad hoc relationships or nonbinding mechanisms. As a result, there exists a growing disconnect between what policy mandates on paper and what universities can implement.

This disconnect compounds further through definitional problems. Terms like “economic development” or “innovation” see use across agencies and institutions assuming the same meaning, which often is untrue. Without shared language or cross-actor alignment, even well-intentioned policies drift in implementation. Additionally, the lack of a standard metric system or coordinated evaluation framework across intermediary organizations creates difficulties in identifying drift, making effective corrections impossible.

The result of these findings is the failure of attempts to change the behavior of the research enterprise. Recommendation boards get cancelled, legislative goals fail to scale, and public dollars do not create a return on investment. Business as usual means continuing to rely on intermediaries while failing to account for them.

Beyond case studies and qualitative research, it is helpful to have metrics for benchmarks. Currently, due to limited access to proprietary data (or complete lack of measurement), precise metrics of intermediary organization effects are unavailable. FSS, however, offers a reliable proxy for research efficiency, effectively capturing both volume and quality of research output. Previous studies have validated this indicator as an appropriate measure to assess institutional research productivity relative to investments. Moving forward, adopting systematic collection and transparent reporting of institutional expenditure data alongside FSS measurement will enable precise and actionable assessments of research efficiency. With access to accurate spending data, policymakers could directly pinpoint areas of inefficiency and allocate resources to maximize research impact.

To demonstrate FSS today, I calculate current institutions’ efficiency ratio in **Table *1***. The intent of this is not to compare institutions: it is to show how a formula can be used to determine productivity. With this understanding of institutional efficiency, we can then compare the effect of intermediary organizations in a quantitative way. I apply the efficiency ratio formula to the BIG10 universities, getting a simplistic view of each institutions’ research output performance. Detailed metrics used to compute the FSS and efficiency ratio were retrieved from Zenodo (Eck and Jan 2023), the National Science Foundation (2024), and the National Center for Education Statistics (U.S. Department of Education 2023).

The FSS and efficiency ratio do not fully reflect research output, but they are an effective measure in combination with performance measures of invention disclosures and patent filings (Hall 2022). By then applying this information to the research triad, we can analyze the effect of intermediaries on output. One example usage is when an intermediary introduces a new program or standard: for example, when AUTM introduced revisions to the Model IIA Project (AUTM 2025). Institutions can model the effect of this program and see if the intermediary is benefiting or holding them back by comparing the FSS and efficiency ratio before and after the programs implementation.

Table 1: Research Output Productivity

Institution	FSS	Efficiency Ratio
Indiana University	2.44	2.86
Michigan State University	3.49	4.14
Northwestern University	6.06	5.44
Ohio State University	5.19	3.58
Pennsylvania State University	5.32	4.41
Purdue University	4.41	5.22
Rutgers University	3.39	4.08
University of California, Los Angelos	5.44	3.16
University of Illinois	4.02	4.90
University of Iowa	4.51	6.81
University of Maryland	4.02	2.90
University of Michigan	6.62	3.44
University of Minnesota	5.71	4.32
University of Nebraska	2.76	4.47
University of Oregon	2.44	14.87
University of Southern California	3.47	3.00
University of Washington	7.54	4.34
University of Wisconsin	4.88	2.81

At a time when scientific competition is global, and when national investments in research and development are rising in countries like China, Germany, and South Korea, measuring these inefficiencies is not just an internal problem—it is a strategic liability. If we want to maintain American research leadership and ensure that our public investments yield real-world impact, then we must treat the research enterprise as the complex, triadic system it actually is and measure its performance.

VII. Recommendations

Federal policy must fundamentally reconceptualize the role of intermediaries, viewing them as central infrastructure rather than peripheral actors. As demonstrated throughout this paper, the U.S. research enterprise functions as a triadic ecosystem involving government, academia, and intermediary organizations, with intermediaries critically shaping policy interpretation and implementation. Yet, current legislative and administrative frameworks often overlook this role, compromising efficiency, coherence, and equity in technology transfer outcomes. To improve the efficiency, consistency, and equity of research translation outcomes, the paper contains possible formulas for measuring research output and developing metrics. I offer the following recommendations as concrete steps to improve the research enterprise through broadening awareness of intermediaries.

A fundamental challenge facing the research ecosystem is the pervasive invisibility of intermediary organizations to policymakers and institutional actors. Government agencies frequently introduce initiatives that fail to reach their intended audiences, especially at institutions without robust Technology Transfer Offices (TTOs). Intermediaries, by their nature, are uniquely positioned to bridge this communication gap. They possess the capacity to translate federal policies into actionable practices within universities, thereby ensuring broader dissemination and adoption. Broadening awareness of these intermediaries among federal agencies could significantly improve program outreach and policy alignment, maximizing the impact of federal investments in research.

> “ **Recommendation**: Institutionalize FSS as a Standard Metric. ”

i. Institutionalize FSS as a Standard Metric

To definitely recommend the use of intermediary organizations, we must define a metric that can appropriately assess research output. Fractional Scientific Strength (FSS) is a superior and validated measure of institutional research productivity. It effectively integrates both research quantity and quality by accounting for citations, authorship contributions, and the cost of research labor, providing a nuanced understanding of research efficiency. The extensive validation of FSS by Abramo and D’Angelo (2014) confirms its utility as a precise productivity metric, superior to traditional publication count metrics that disregard output value or research costs. Adopting FSS as a standardized metric across institutions could facilitate consistent evaluation, enabling more effective resource allocation and performance assessment across the research landscape.

ii. Near-Term Solution: Developing Pilot Programs to Validate and Refine Metrics

Given the potential impact of institutionalizing efficiency metrics, I propose the implementation of targeted pilot programs at select universities to rigorously validate and refine the proposed FSS-based efficiency metrics. These pilot programs should systematically explore how these metrics function in practice, assessing their implications for institutional decision-making, policy refinement, and broader stakeholder confidence. Pilot initiatives offer a controlled environment to address any unforeseen practical adjustments and ensure these measures effectively reflect real-world complexities. Insights from these pilots would not only refine the metrics but also enhance their credibility and eventual nationwide adoption.

> “**Recommendation**: Develop Pilot Programs to Validate and Refine Metrics.”

iii. Long-Term Solution: Introducing Efficiency Benchmarks to Guide Funding Decisions

A strategic long-term recommendation involves integrating research efficiency ratios (FSS relative to research expenditures) into federal and state funding allocation criteria. By doing so, agencies would incentivize institutions demonstrating greater productivity per dollar invested, inherently encouraging optimal resource utilization and intermediary partnerships. This method aligns institutional incentives with national strategic goals for research impact, fostering an environment of continuous improvement and efficient resource management.

Collectively, these recommendations advocate for a transformative shift in how federal policy conceptualizes and integrates intermediary organizations. Recognizing their essential infrastructural role through explicit legislative acknowledgment, robust metrics, pilot validation programs, and long-term benchmarks is crucial. This strategic realignment ensures a more cohesive, efficient, and impactful approach to technology transfer, safeguarding the competitive position of American research in the global innovation landscape.

> “**Recommendation**: Introduce Efficiency Benchmarks to Guide Funding Decisions.”

VIII. Conclusion

For decades, the United States has relied on a research enterprise built on the assumption of a direct and functional partnership between government and academia. Yet as this paper demonstrates, that assumption overlooks a critical layer of the system: the intermediary organizations that translate legislative goals into institutional behavior. These organizations perform essential functions in the research ecosystem. They create shared language, develop tools and metrics, train professionals, and maintain the connective tissue across a decentralized landscape.

Treating research translation as a binary interaction between funder and performer has led to fragmented implementation, inconsistent outcomes, and missed opportunities. Recognizing the research enterprise as a system opens new pathways for legislative clarity, operational equity, and translational success.

To ensure that future research policy is not just well-intentioned but well-executed, policymakers must design for the whole system. This means not just funding research, but also supporting the infrastructure that makes research matter, including intermediary organizations.

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