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Posted Date: 23 December 2025

doi: 10.20944/preprints202512.2105.v1

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 doi:10.20944/preprints202512.2105.v1

Article

The Evolution of the Role of Universities in the Commercialization of Academic Research Outputs

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Abstract

Facilitating the use of academic research outputs, namely new scientific discoveries and technologies made or created by university researchers, to benefit society has become a core function of universities around the world. Today, scholars and practitioners refer to this activity as "technology transfer" or "technology commercialization". The role of universities in the commercialization of academic research outputs resides at the nexus of discourse about the widening gap between academic knowledge production and its societal impact. Although there are vast literatures about the university as a social institution and university activities that facilitate commercialization of academic research outputs, there is sparse discourse that directly examines the evolution of universities' roles in the commercialization of academic research outputs in the context of the expansion of the mission of institutions of higher education. This paper aims to fill this gap. While the paper examines the topic primarily from a Western perspective, specifically from the viewpoint of the United States of America (USA), it provides points of comparison by briefly summarizing the history, evolution, and current status of university technology transfer in select countries around the world. It concludes by considering what the future may hold for the role of U.S. universities in the commercialization of academic research outputs.

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Introduction

Facilitating the use of research outputs, namely new scientific discoveries and technologies made or created by university researchers, to benefit society has become a core function of universities around the world. Over the years, this activity developed into a distinct professional field, called university technology transfer (UTT), with professional organizations, such as AUTM (formerly the Association for University Technology Managers) and the Technology Transfer Society, as well as a plethora of related academic journals. However, this was not always the case. The activities of universities evolved slowly over the course of centuries eventually coming to include the commercialization of academic research outputs as an important component of the mission of universities.

The role of universities in the commercialization of academic research outputs is of central concern regarding the widening gap between academic knowledge production and its societal impact. Understanding the forces that shaped the current role of universities regarding the commercialization of academic research outputs is crucial to enabling scholars, academic administrators, and policymakers formulate policies and programs that close this gap. As such, this paper investigates the expansion of university activities to include engagement in the commercialization of academic research outputs by examining this development in the context of the evolution of the mission of institutions of higher education. It specifically answers the following questions:

 doi:10.20944/preprints202512.2105.v1

1. What is the relationship between university activities that aim to facilitate the commercialization of academic research outputs and the mission of universities?
2. Why did universities involve themselves in the commercialization of academic research outputs?
3. How has the role of universities in the commercialization of academic research outputs changed over time?
4. How might current trends and circumstances influence the role of universities in the commercialization of academic research outputs in the future?

Although this paper strives to be culturally neutral, it is impossible to distill and convey such vast information spanning millennia without the aid of a specific perspective. The examination that follows is conducted from a Western perspective, specifically from that of the United States of America (USA). This undoubtedly influences not only the narrative but also the insights and interpretations that are extracted from it. The paper attempts to mitigate this limitation by briefly summarizing the evolution of university technology transfer in select countries around the world. But it is impossible to fully capture the rich histories and experiences of so many countries within the constraints of a single paper. However, the examination that follows still makes a valuable contribution to the literature because it provides insights and context that are relevant to addressing the widening gap between academic knowledge production and the societal impact of such knowledge. This helps to ground the discourse among scholars, university administrators, and policymakers as they work to formulate policies and programs to close this gap while building resilient and socially consequential institutions of higher education.

The paper begins by briefly recounting the rise of the university as a social institution in Western civilization and its initial mission. It then discusses how conducting scientific empirical research came to be a core function of modern universities. The paper subsequently delves into how universities in the USA came to engage in facilitating the commercialization of the research outputs of their faculty. It then briefly summarizes the history, evolution, and current status of university technology transfer in Brazil, Canada, China, India, Russia, South Africa, and the United Kingdom. These countries were selected to provide broad geographic points of comparison and because they are either significant players on the geopolitical stage or have been influenced by the USA model of university technology transfer. The paper concludes by briefly considering what the future may hold for the role of U.S. universities in the commercialization of academic research outputs.

The Early Mission of the University as a Social Institution

Organized higher education as a social institution in Western civilization can be traced to the academies of ancient Greece (Walden, 2024). Earlier civilizations and cultures and those in other global regions certainly had their versions of what could be considered institutions of higher education (see Eskelson, 2020). These diverse institutions of learning in ancient civilizations constituted an information network that spanned Asia, North Africa, and Europe (Lowe & Yasuhara, 2016). They almost certainly interacted and built on one another's efforts and were likely a necessary precondition for the rise of the first antecedents of modern universities in Europe (Lowe & Yasuhara). However, less is generally known about those institutions and the link to institutions of higher education in Western civilization is not entirely apparent (Brown & Luzmore, 2021).

Plato's Academy in ancient Greece (circa 387 B.C.) is perhaps the earliest long enduring antecedent of modern Western universities about which a significant amount of information is known (see Fideler, 1996, 2021, June 7; Seitkasimova, 2019). The activities of the Academy included lectures and the philosophers who taught there also produced new knowledge (primarily through philosophical inquiry and dialectic reasoning), curated knowledge in the form of book collections, and wrote and published books themselves (Kalligas et al., 2021; Stewart, n.d.). However, scientific research as we currently conceptualize it did not occur and there were none of the bureaucratic elements of modern universities such as courses, curricula, examinations, or the conferring of certified qualifications (Stewart). It was principally an exercise in the production and dissemination

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philosophical knowledge primarily for the purpose of nurturing "good" people as a necessary condition for realizing the "ideal" society (Brown & Luzmore, 2021). So too were other such institutions in ancient Greece.

Ancient Rome obtained much of its civilization from ancient Greece, copying many of its systems (Eyre, 1963). With regard to educational practices, ancient Rome selectively absorbed aspects of the Greek model and folded them into its own Roman identity eventually creating an educational system that was much more organized than that of ancient Greece (Brown & Luzmore, 2021; Eyre). With the collapse of the Roman Empire and beginning of the Middle Ages, religious monasteries became the last bastion of formal education (Brown & Luzmore). Eventually, the concept of education for the masses was seen as valuable and began to take root, leading the rulers to decree that monasteries and cathedral priests should provide instruction to the masses similar to that provided to the clergy (Brown & Luzmore). Scientific research, as we have come to think of it, was not yet a concern.

The modern concept of the university would not begin to evolve until the late 11th and early 12th centuries in medieval Europe (see Moore, 2019). This development was primarily driven by societal needs for trained professionals in theology, medicine, and law (Blockmans, 2020; Moore; Sohn, 2021). Many monastery and cathedral schools evolved into universities which filled this need (Brown & Luzmore, 2021). As such, the initial mission of early universities as social institutions focused on knowledge curation, education, and training but generally did not entail knowledge creation through systematic inquiry in the realms of the physical, biological, and social sciences as conceptualized today (see Feingold, 2020). As such, there were no academic research outputs to leverage for societal benefit or from which one could extract economic benefit.

The Emergence of Research as a Core University Function

The medical field was one of the first areas where empirical research began to emerge, but between the 12th and 19th centuries most research was conducted by practicing medical doctors not affiliated with academia, only about half of which were trained at universities (Blockmans, 2020). During this time, the ecclesiastical, social, and political goals of the ruling class confined the mission of universities to the transmission of approved knowledge to the next generation, and the dissemination of approved new scientific knowledge that was chiefly produced outside of academia (Blockmans; De Ridder-Symoens, 2020). In Europe, by the 14th century only the leading three or so universities allowed empirical medical research, including public dissections of cadavers (Blockmans).

The notion that universities should produce new scientific knowledge was first proposed during the early 1800s in Germany. Wilhelm von Humboldt, a prominent German philosopher and educational reformer, initiated a series of reforms as Prussian minister of education that were intended to help revitalize the country after Napoleon's defeat of Prussia (Bongaerts, 2022). Among these reforms was the notion that teaching and research were mutually reinforcing activities and thus should be integrated undertakings within a university (Bongaerts; Östling, 2020). These reforms became the founding principles of what would be called the German or Humboldtian university model, which would come to influence the mission and structure of universities around the world and emerge as the dominant model for institutions of higher education (Bongaerts; Östling).

The principles that Humboldt proposed did not take root and spread immediately after he offered them. The research mission of the university did not truly begin to take hold in Germany until the end of the 19th century and beginning of the 20th century (Östling, 2020). In the United States, Johns Hopkins University, which was founded in 1876, was the first university to explicitly connect the education mission with a scientific research mission (Östling). It would play an important role in helping to proselytize the notion that the education and research are connected in a university context. Researchers who earned their doctorate degrees at Johns Hopkins University and went on to posts at other U.S. universities would help spread the idea that education and research are mutually and beneficially linked missions of the university (Östling). During this period,

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philanthropic foundations funded most academic research conducted in the United States (Gross & Sampat, 2025). Throughout the 1800s and early 1900s, universities were only minimally involved, if at all, in the commercialization of academic research outputs, or what is broadly referred to as "technology transfer" or "technology commercialization" in modern parlance.

Historically, university faculty have typically shared discoveries openly, and until the late 20th century they relied on teaching and scientific publishing as the primary mechanisms to disseminate new knowledge (Carlsson & Fridh, 2002). Universities in the U.S. generally did not have policies reflecting the principle of professor's privilege regarding intellectual property, which was the common practice among European universities (see Etzkowitz, 2016; Färnstrand Damsgaard & Thursby, 2012; Greenbaum & Scott, 2010). Making use of new knowledge and scientific discoveries was largely left to entrepreneurs and the private sector.

When technology transfer from universities did occur, a faculty member would typically pursue the activity as an individual personal endeavor, which might involve consulting for companies, starting a new business venture, or publishing works for general consumption (Andreopoulos, 2001; Etzkowitz & Zhou, 2021; Mowery, 1999; Mowery et al., 2004; Thursby et al., 2009). Not only was it a rarity for university staff and faculty members to engage in efforts to make commercial use of the new knowledge and technology produced in academia, university practices and academic norms often discouraged such activities (D'Este & Perkmann, 2011). The prevailing normative view was that knowledge produced at universities should be a public good and thus should be placed in the public domain without restrictions regarding its use (Goldstein & Drucker, 2006; Mowery et al.). As such, universities did not routinely seek patents for research discoveries and technologies created by their faculty or actively facilitate efforts to convert them into commercial products.

University Involvement in Research Output Commercialization Arises in the USA

If one dates the establishment of research as part of the university mission with the establishment of the Humboldt University of Berlin in 1870, it took another 110 years before universities earnestly began to engage in the commercialization of academic research outputs. But unlike education, teaching, and research which came to be components of the university mission because of exogeneous sociopolitical forces, endogenous actors initiated the evolution of university engagement in what would come to be called technology transfer and commercialization.

Nascent University Research Commercialization Activities in the USA

Given the societal values and academic norms throughout 19th century and early 20th century, it is unsurprising that universities did not have formal offices or programs to facilitate the commercialization of academic research outputs during this period. This would begin to change in the early 1900s in the USA as wartime demands required the enlistment of academic resources. This led to the reshaping of university curricula, refocusing of research priorities, and evolution of the university mission.

During the first and second world wars, there was significant scientific research and technical work conducted at universities that was connected to the war effort on both sides of the conflict (Maas & Hooijmaijers, 2009). In the USA, this work initially focused on military operations and logistics but eventually expanded into other areas (Shrader, 2006). Combatant nations not only leaned on universities to create new knowledge and technologies to meet wartime needs but also depended on university faculty to help facilitate their application and use. Research during this period, much of it conducted by scientists in academia, produced important breakthroughs such as radar, chemical and nuclear weapons, medicines, and cryptanalysis (Gross & Sampat, 2025; Maas & Hooijmaijers; Mindell, 2009).

Much of the early evolution of the role of universities towards actively facilitating the commercialization of academic research outputs to benefit society took place in the USA. Towards

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the end of the Second World War, elected officials and policymakers in the USA were contemplating how to maintain and leverage the scientific research machine that the nation had created (see Bush, 1945/2020). This intellectual infrastructure produced many scientific advancements that were credited with not only helping to win the war but also with improving the quality of life and standard of living for citizens. An important result of this policy decision was the solidification of scientific research as a core function of U.S. universities.

Policymakers of both conservative and liberal persuasion envisioned a post-war framework with the federal government serving as the single major funder of research (Bush, 1945/2020; Schrecker, 2021). However, this vision raised the question of who should own patents for inventions created with the support of federal funding. During the Second World War, the Committee on Medical Research (CMR) for the Office of Scientific Research and Development (OSRD) supported research on numerous wartime challenges such as infectious diseases, wound treatment, blood preservation. Generally, the OSRD tended to execute research contracts primarily with private sector contractors for war-fighting technologies (Sampat, 2021). However, CMR typically entered into research contracts with universities under terms that stipulated presumptive government ownership of patents on inventions resulting from the funded research largely because there were strong academic norms against patenting research outputs at the time (Sampat). Vannevar Bush, the former head of OSRD whom President Franklin Delano Roosevelt tasked with formulating the nation's post-war science policy, was a strong advocate for allowing contractors that performed the research to own the patent rights to the technologies because he believed it would incentive them to develop the technologies for commercial use (Schrecker). However, such policy was not immediately implemented following the end of World War II, and the federal government continued to hold most intellectual property rights for patentable technologies created with the support of federal funding (see Sampat, 2021; Schacht, 2025; Schrecker, 2021; Stevens, 2004).

Although university research activity increased because of federal funding, most academic research outputs in the form of new inventions either entered the public domain or were made available to the private sector through non-exclusive licenses according to U.S. policy at the time regarding patent rights for inventions created with federal funding support. As a rule, universities tended not to patent the inventions and technologies that their faculty created even if they were created without federal funding much less involve themselves in the transfer and commercialization of those technologies. Members of the academic community by and large were concerned that such activities would undermine the education and research missions of their universities (Mowery et al., 2004; Washburn, 2008). Consequently, up through the 1970s there were a relatively small number of patents held by U.S. universities and even fewer had been commercialized (Mowery et al.).

By the end of the 1960s, only about six universities in the USA had formal licensing programs. However, most of these universities outsourced this activity to external patent management organizations or research foundations affiliated with the universities (Etzkowitz & Zhou, 2021). Only a few universities had established dedicated internal units to perform research commercialization activities, which mostly focused on licensing technologies created at the universities. Stanford University and the University of Wisconsin were among the few U.S. universities that took a more proactive approach to commercializing academic research outputs, primarily those in the form of patented university inventions (Etzkowitz, 2016; Etzkowitz & Zhou). Their activities set early precedents for establishing technology transfer as a function of the university. But they were the exception to the rule at the time.

Research Commercialization Takes Hold in U.S. Academia

Facts suggest that the commercialization of academic research outputs, which scholars and practitioners have come to refer to as technology transfer or technology commercialization, first became established as a core university function in the USA. The university's role in the commercialization of academic research outputs really took hold with the passage of the Patent and Trademark Law Amendments Act of 1980, what is commonly referred to as the Bayh-Dole Act of

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1980. The mythologized narrative of its passage would have one believe that the economic and geopolitical challenges of the time motivated forward-thinking policymakers to craft legislation to address the issues and created an environment in which the bill that would become the Bayh-Dole Act sailed smoothly through the U.S. Congress with near unanimous support. In fact, the spark that led to the passage of the Bayh-Dole Act was much more innocuous than what is typically conveyed and the actual path to passage was not nearly as bipartisan as historical accounts might suggest.

Federal patent policies at the time were a hodgepodge of different practices across the agencies. However, the National Institutes of Health (NIH) had what was considered a successful policy of granting patent ownership to the universities where the inventions were created but the administration of President James Earl Carter, Jr. intended to end such practices (Allen, 2009, 2023). While the Department of Defense (DoD), as well as other departments and agencies, routinely granted patent ownership to major contractors, it did not afford the same treatment to universities and small businesses which had to make a formal request to own inventions that their staff members and employees created with the benefit of federal funding (Allen, 2023). The request process could take 18 months or longer, and department and agency administrators frequently denied such requests (Allen, 2009; Sarpatwari et al., 2022). The results of this system were that roughly 28,000 invention patents had been secured by the federal government but less than 5% were licensed according to the Comptroller General's analysis (Sarpatwari et al.; Schacht, 2012, 2025).

In the late 1970s, representatives from Purdue University contacted staffers in the office of U.S. Senator Birch Bayh because the federal government had claimed patent rights to several promising inventions created at the university with the support of federal funding. The Purdue University representatives along with representatives from Wisconsin Alumni Research Foundation (WARF) asked Senator Bayh to intercede, arguing that by claiming patent rights to such inventions, the federal government was taking early stage inventions away from the inventors and dooming the technologies to remain undeveloped and unexploited because the government would only license them non-exclusively (Allen, 2023). This argument was logically flawed because it employed strawman, slippery slope, and post hoc fallacies. But it was effective, nonetheless. The issue was already on the radar of U.S. Senator Robert "Bob" Dole because of the pending Carter Administration change to the NIH patent policy and Senators Bayh and Dole agreed to collaborate on the issue (Allen, 2009, 2023; Stevens, 2004).

The concerns about the nation's economic problems and perceived faltering global competitiveness provided a policy window for advocates of university ownership of patent rights to push for a policy solution that would deliver their desired outcome. During this period, the USA was in fact struggling economically and facing increasing competition in the emerging industries of biotechnology, semiconductors, and telecommunications which elected officials and policymakers viewed as critically important to the nation's prominence, security, and future economic well-being (Sarpatwari et al., 2022). There was a general belief that ending the economic malaise that shrouded the country would require leveraging the nation's remaining competitive advantage in these industries and its research excellence. Some national leaders and policymakers believed that leveraging the portfolio of current and future technologies created with the support of federal funding would substantially contribute to accomplishing this goal, but the federal government's patent policy was seen by many as a serious impediment (Sarpatwari et al.; Stevens, 2004).

Despite the unifying nature of a common threat, namely a struggling economy and global competition, lawmakers passed the Bayh-Dole Act of 1980 only after intense ideological discourse and much political wrangling (Allen, 2023; Cutler, 2022; Stevens, 2004; White & Kerbel, 2022). But with the passage of the Bayh-Dole Act, the USA adopted a technology transfer model that was in the tradition of Jeffersonian *laissez-faire,* and the government would henceforth grant patent rights to universities as the default mode.

The Modern Era of University Technology Transfer in the USA

 doi:10.20944/preprints202512.2105.v1

Since the 1980s, the United States of America has been the *de facto* epicenter of academic research outputs commercialization. University technology transfer grew rapidly as a profession after the U.S. Congress passed the Bayh-Dole Act of 1980, which effectively marked the beginning of the modern era of the role of U.S. universities in the commercialization of academic research outputs. AUTM (formerly the Association of University Technology Managers) began in 1974 as the Society of University Patent Administrators (SUPA) which had the mission of understanding and addressing issues that prevented inventions created with funding from the U.S. government from being effectively commercialized (Sandelin, 2003). By 2025, what began as a small organization comprised of 75 members representing 40 universities and a few research institutions had grown to a global association with more than 3,000 members from across 65 countries who represent nearly 540 universities and research centers and another 264 hospitals, businesses, and government organizations (AUTM, 2025; Sandelin).

The passage of the Bayh-Dole Act of 1980 provided an impetus and incentive for U.S. universities to expand their missions to include economic development. Along with the federal government adopting the policy of granting patent rights to universities as the default mode came the expectation for universities to actively contribute to development and growth of local and regional economies (Armstrong, 2021; Pugh et al., 2022; Thomas et al., 2023). Commercializing technologies naturally aligned with this new expectation.

During the years immediately following the enactment of the Bayh-Dole Act, universities in the USA established technology transfer offices (TTOs) principally focused on securing patent rights for patentable subject matter created by university faculty and licensing those patents, primarily to private sector organizations. Initially, TTOs were small units whose staff acted as intermediaries between faculty inventors and potential private sector partners (Brantnell & Baraldi, 2022). TTO staff focused on technical, legal, and commercial issues necessary to effectuate private sector firms' access to patented university-owned inventions. The activities of TTO staff included identifying patentable subject matter, filing and prosecuting patent applications, soliciting potential licensees, negotiating license terms, enforcing license agreements, and managing licensing income.

As the field of university technology transfer grew and practitioners sought ways to increase the adoption and use of university-owned technologies, the functions of university TTOs broadened to include a range of additional activities aimed at facilitating research output commercialization (see Etzkowitz, 2013; Fasi, 2022; Sadek et al., 2015). Fostering academic entrepreneurship and encouraging the formation of companies to pursue the commercialization of university-owned technology assets (i.e., so called university startup companies, spin-out companies, or spin-off companies) became increasingly important functions of university TTOs. By 2019, the percentage of technologies licensed to startup companies was within 5 percentage points of technologies licensed to large companies (see Allard et al., 2021; Massing et al., 2020).

Beginning in the early 2000s, the landscape of the U.S. and global economy began to change dramatically. The nature of technologies themselves also evolved to include additional forms of intangible assets such as data algorithms, software, care delivery models, and informatics (Corrado et al., 2022). This changing environment helped push leaders of TTOs in the U.S. to expand their conceptualizations of what kinds of technologies are licensable (see e.g., Borrás et al., 2024; Brantnell & Baraldi, 2022; Townes, 2025). In response to this changing landscape, universities leaders and TTO directors continued to expand the scope of their TTO operations, many of which now included activities such as entrepreneur in residence (EIR) programs as well as gap funds, proof-of-concept centers, and other seed funding programs (see e.g., Garetto et al., 2018; Hall et al., 2022; Johnson, 2022; Wang & Shen, 2022).

As universities' roles in the commercialization of academic research outputs continued to expand, the nature of TTOs at U.S. universities also changed. What were initially established as small units narrowly focused on filing patents and executing licenses often evolved in multidisciplinary offices comprised of specialized functions. Traditionally, positions in university TTOs were limited to individuals with STEM-related research doctorates and juris doctorates with experience in

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intellectual property law (Garetto et al., 2018; Soares & Torkomian, 2021). Today, TTO staff at many universities also include patent scientists, contract lawyers, marketing professionals, business strategists, former venture capitalists, and experienced entrepreneurs (Garetto et al.).

The Global Evolution of University Technology Transfer

Although the USA receives a lot of attention when it comes to university technology transfer, it is important to remain cognizant that university technology transfer is a global phenomenon. However, the USA experience and the Bayh-Dole Act have certainly influenced the roles that universities in other countries have adopted regarding the commercialization of academic research outputs. This section briefly summarizes the history and evolution of university technology transfer in select countries outside of the USA.

Brazil

Based on reporting in the popular press, Brazil is probably the most advanced South American country when it comes to university technology transfer. Brazilian policymakers began to focus more on the country's global economic competitiveness in the 1980s as the nation transitioned towards democratic rule and slowly opened its markets to global trade (Gupta et al., 2013). However, cultural and historical factors appear to have impeded the extent to which Brazilian universities have engaged in the commercialization of research outputs. Industry and academia evolved without much interaction between them, there is a cultural bias that favors pure research over applied research, and there is a historical mistrust of the military which limits its ability to provide impetus to technology transfer efforts (Dalmarco et al., 2018; Gupta et al.). While public funding for research as a percentage of gross domestic product (GDP) is only slightly behind that of Russia and China and the number of publications from Brazilian academic researchers has steadily increased, patenting rates in Brazil are substantially less than other countries with emerging economies (Gupta et al.).

Policymakers in Brazil have taken proactive measures to encourage and increase the role of universities in the commercialization of research outputs. In 1996, Brazilian policymakers revised the country's intellectual property laws to stabilize the patent system (Guerrero et al., 2021). Although this policy is not exclusively targeted to Brazilian universities, it likely influenced the effectiveness of subsequent policies that were specifically aimed at increasing the technology transfer activities of universities. In 2004, lawmakers passed the Brazilian Innovation Act (officially the Technological Innovation Act), which was primarily based on the USA's Bayh-Dole Act of 1980, and they implemented the Industrial, Technological and Trade Policy, which included establishing and strengthening university-industry connections as a core strategic component (Guerrero et al.). The Brazilian Innovation Act mandates that each public university establish and operate a TTO to facilitate the commercialization of research outputs and specifically calls for them to pursue collaborative projects between the university and private sector firms (Guerrero et al.; "Technological Innovation Act, Law No. 10.973 of December 2, 2004," 2004).

Canada

Even though Canada is generally considered to have a high level of technology creation and innovation outputs, technology transfer outcomes in the country are far less than expected (Galushko & Sagynbekov, 2014; Smyth et al., 2016). For most of its existence, there was little concern for the economic impact of the Canadian academia (McNaughton, 2008). But as the federal government increased its level of funding support for university research, public expectations concerning the economic impact of Canadian universities shifted. Within 10 years after the enactment of the Bayh-Dole Act in the USA, some Canadian universities followed the lead of U.S. universities and began establishing TTOs to facilitate the commercialization of research outputs (Smyth et al.). Significant increases in the commercialization of technologies in exchange for increased levels of federal funding for research were among the commitments that Canadian universities made in a 2002 memorandum

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of agreement between the Association of Universities and Colleges of Canada (AUCC) and the Canadian federal government (McNaughton).

Recognition of the nation's lagging position in technology commercialization led Canadian lawmakers to implement policies and programs to address the issue. The first among these efforts was the Intellectual Property Mobilization Program, which operated from 1995 until 2009 with the aim of increasing the ability of Canadian universities to manage and commercialize their intellectual property assets (Galushko & Sagynbekov, 2014). In 1998, the Prime Minister's Advisory Council on Science and Technology convened an expert panel to recommend strategies to increase the economic and social returns from federal funding of university research (Smyth et al., 2016). From 1995 to 2010, the Canadian government enacted several policies aimed at increasing the commercialization of the research outputs of Canadian universities (Galushko & Sagynbekov). Currently, most Canadian universities have established technology transfer offices (TTOs) or industry liaison offices (ILOs) that are primarily staffed by commercialization managers and intellectual property lawyers (Galushko & Sagynbekov).

China

Political goals were mainly responsible the establishing the role of Chinese universities in academic research output commercialization. Policymakers began implementing economic reforms in the late 1970s with the aim of modernizing China's economy and enabling it to better compete in a global knowledge-based economy (Krishna et al., 2025; Zhang & Shi, 2020). These reforms included policies to implement "de-Sovietization" of Chinese higher education, which had followed the Soviet model since the establishment of the People's Republic of China in 1949 (Shen et al., 2022). These actions helped reconnect Chinese academia with that of the rest of the world. However, Chinese universities remained predominantly focused on teaching until the 1980s (see Shen et al.; Zhang & Shi). In the absence of a research mission, there was no clear rationale for Chinese universities to involve themselves in research commercialization.

In 1986, policymakers established two research councils which helped establish scientific research as a core function of Chinese universities (see Krishna et al.; Shen et al.). These transformations positioned Chinese universities to take on a significant role in research and innovation hubs, which was an important component of China's economic modernization strategy. Currently, universities are seen as a crucial element of China's national innovation system. Universities not only facilitate the formation of new business ventures to commercialize technologies created by their faculty but are often the largest shareholders in what are called university-owned enterprises (UOEs), which appears to be unique to higher education in China (Krishna et al.; Zhang & Shi).

India

University technology transfer in India seems to be well behind that of other developed countries. From the enactment of the country's first science policy in 1958 until the late 1980s, it appears that most of the cases of research commercialization success involved technologies created by research organizations under the control of the federal government (see Ravi & Janodia, 2022). The research mission of Indian universities did not gain momentum until the late 1960s (see Chandra & Krishna, 2010; Kuriakose & Kylasam Iyer, 2016). Political leaders have encouraged the commercialization of new technological developments as a means to improve India's economic circumstances and increase its global competitiveness (K., 2020). However, it was not until 2008 that public policy was enacted to specifically enable universities to better engage in the transfer of technologies created by their faculty to private sector firms (Ravi & Janodia). Consequently, the universities of India are still very early in the evolution of their roles in commercializing academic research outputs.

 doi:10.20944/preprints202512.2105.v1

Russia

From the about 1928 until 1991, Russia was a command economy in which the economic activity for a number of products was centrally planned by the federal government (Zhuravskaya et al., 2024). It was globally competitive in scientific and technological achievements but research was a secondary activity of universities and they played minimal roles in the commercialization of research outputs (Williams, 2011; Williams & Kluev, 2014). With the transition to a market economy beginning in 1991, the country faced economic and social pressures that helped give rise to university technology transfer. But at the turn of the century, university involvement in the commercialization of research outputs was only perfunctory (Shaposhnikov, 2001).

University technology transfer in Russia currently lags the U.S. and other nations with advanced economies considerably. Private sector technological innovation activity is a key driver of university technology transfer. This remains low in Russia compared to other industrialized nations (Shmeleva et al., 2021). But this is only one of several factors that inhibits university technology transfer in the country. From 2000 to 2020, the Russian Federation enacted several policies to establish technology transfer networks and create conditions that would encourage and increase technology transfer activity (Shmeleva et al.).

The Russian technology transfer infrastructure consists of a network of technology transfer centers (105 centers as of 2019), most of which are established at universities and function to promote interaction between private sector firms and universities (Shmeleva et al., 2021). Schmeleva et al. notes that these efforts emphasize the following four primary mechanisms for effectuating technology transfer:

1. Intellectual property licensing
2. Human capital movement
3. Research and development (R&D) collaborations and cooperative activities
4. New business venture formation

Despite the country's history of scientific and technological prowess, Russian universities are still in the early stages of their evolution towards becoming significant participants in the commercialization of academic research outputs.

New business ventures account for a substantial amount of university technology transfer activity in the United States. However, it has only been since 2008 that many Russian universities have begun providing services and implementing infrastructure to support and encourage entrepreneurial endeavors (Williams & Kluev, 2014). It was not until 2009 that the Russian government implemented policy to allow universities to participate in new business venture formation to commercialize university research outputs (Williams & Kluev). In recent years, particular emphasis seems to have been placed on new business venture formation to effectuate technology transfer, which has significantly influenced the efforts of Russian universities to commercialize research outputs.

South Africa

In general, university technology transfer is at an early stage in its industry life cycle in most African nations. The legal infrastructure necessary to support effective university technology transfer has only begun to be implemented in the last 15 years in many African countries. South Africa is considered to be among the most advanced African nations regarding the participation of universities in the commercialization of academic research outputs (Fadeyi et al., 2019). In the late 1990s, a handful of South African universities established technology transfer offices (Wolson, 2007). However, university technology transfer activity only began to increase around 2008 with the enactment of the Technology Innovation Agency Act and the Intellectual Property Rights from Publicly Financed Research and Development Act. Prior to these legislative actions, only a handful of South African universities had intellectual property policies and those often were not uniform across departments within a university (Wolson).

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United Kingdom

Given the United Kingdom's past as the cradle of the Industrial Revolution, one might expect that UK universities have engaged in the commercialization of academic research outputs for an extended portion of their histories. This does not appear to be the case. Historically, university and industry scientists have been suspicious, and even acrimonious, towards one another (Grady & Pratt, 2000). Education and teaching seem to have dominated the missions of UK universities. Although research, publications, and other knowledge creation activities are the factors that determine career advancement for university faculty, teaching increasingly drives income generation for universities as evidenced by the fact that about 95% of all university income in 2022 was generated from student tuition (Williamson, 2024). The lower reliance of UK universities on government research funding has likely played a role in the lack of significant public expectations for universities to engage in the commercialization of academic research outputs.

In the early 1990s, advocacy groups in the UK noted the paradox of the nation's ability to excel in producing scientific advancements and technological development and its inability to reap economic benefits from those achievements (Grady & Pratt, 2000). Going back to the 1970s, there were debates about the UK's inability to commercialize research outputs and calls for the federal government to intervene to rectify the situation (Grady & Pratt; Rossi & Athreye, 2021). It wasn't until the mid-1980s that the UK government began taking tentative measures to encourage university-industry interaction (Grady & Pratt). However, by the 1990s both industry and university leaders acknowledged the importance of technology transfer for the economic well-being of the nation and efforts to formulate and implement a national technology transfer policy began in earnest (Grady & Pratt).

Policymakers began to specifically identify the participation of universities and partnerships between private sector firms and universities as critical conditions for economic development (Rossi & Athreye). This appears to have been an effort to directly address the historical suspicion and acrimony that researchers and scientists from the two sectors had for one another. Since the 2000s, government policy encouraging and supporting university technology transfer has evolved from focusing on a linear compartmentalized approach where universities either licensed their patents to private sector firms or directly commercialized their patents through new business ventures to favoring more nuanced policies that embrace the potential for universities to commercialize additional forms of academic research outputs and other kinds of engagements with the private sector (Rossi & Athreye). This evolution seems to have been driven by a broader focus on knowledge transfer rather than just the transfer of technology. Currently, a large percentage of UK universities engage in some form of activity aimed at commercializing academic research outputs, but in fiscal year 2015 only about 16% of universities accounted for roughly 80% of all patent applications filed by UK universities and just 11% of universities accounted for 80% of all intellectual property income that universities received (Rossi & Athreye).

What the Future May Hold

It seems reasonable to anticipate that the role of the university, as an institution, in the commercialization of academic research outputs will continue to expand. Exogenous pressures from the sociopolitical environment in addition to endogenous factors from within universities have the potential to influence this evolution to various degrees and in many ways. Consequently, the exact nature of the change in the institution's role in research output commercialization will likely vary substantially across countries even amid globalization and the rapid dissemination of technology transfer best practices. Focusing on the USA, the following issues are likely to exert significant influence on how U.S. universities' roles in the commercialization of academic research outputs will change over time:

1. Increasing financial pressures
2. Concerns about the overemphasis of applied research to the detriment of basic research

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3. Inclusion of commercialization activity in faculty tenure and promotion decisions
4. Changes in the nature of new technologies that are created at universities
5. Bureaucratic inertia that tends to impede efforts to modify organizational policy in response to changes in the sociopolitical and economic environment
6. Continuing difficulties recruiting and hiring qualified technology transfer professionals

Increasing financial pressures will probably strengthen U.S. universities' commitment and involvement in academic research outputs commercialization if leaders of U.S. universities perceive the technology transfer function as a viable means to help balance the budgets of their universities. U.S. universities are faced with increasing financial stresses that make balancing their budgets challenging. Increasing operating costs and declining enrollments are causing many of these difficulties (see Ambrose & Nietzel, 2023; Corrigan, 2023, June 14). Public concerns about the increasing unaffordability of a university education are likely to limit the extent to which U.S. universities can increase their tuition rates to offset increasing costs (see Corrigan; Gallup & Lumina Foundation, 2024). Stagnant federal funding for research, decreases in the facilities and administrative (F&A) rates that the federal government allows, and reductions in state appropriations for higher education will only exacerbate the situation (see Falkenheim & Alexander, 2023; National Center for Science and Engineering Statistics, 2024; National Education Association, 2025; Taylor et al., 2023). The net effect of these pressures is likely to make research output commercialization an appealing potential solution to the problem (see e.g., Eisenberg & Cook-Deegan, 2018). This will likely be the case even though most university TTOs do not breakeven financially, must less generate a significant economic profit (Abrams et al., 2009; Graff et al., 2002; Greenbaum & Scott, 2010).

Concerns about the overemphasis of applied research to the detriment basis research will likely act as a counterbalance to the tendency of financial pressures to push U.S. universities towards increased involvement in research outputs commercialization. This concern was expressed from the very first debates about the Bayh-Dole Act and continues to generate discourse (see e.g., Eisenberg & Cook-Deegan, 2018; Fins, 2010). There is no mathematical solution to what percentage of federal academic research funding should be directed to each category of research, which is a normative issue. Moreover, there is no clear demarcation between basic research and applied research. U.S. policymakers and society at large have reified these constructs. But so long as social and institutional normative standards continue to value basic research above applied research and the linear model of innovation (in which basic research flows directly to applied research) remains the dominant paradigm, then this concern will continue to act as a counterweight to some extent, constraining universities' involvement in the commercialization of academic research outputs.

The discourse about including criteria regarding research outputs commercialization activities in faculty tenure and promotion decisions began in the mid-1990s and the idea seemed to gain momentum in the 2010s (Genshaft et al., 2016; Sanberg et al., 2014). To date, only a limited number of U.S. universities explicitly considered select technology transfer activities when evaluating faculty for promotion and tenure (see e.g., Office of Innovation and Entrepreneurship, 2013; Sanberg et al.). On the face of it, one might expect this trend to substantially increase university involvement in the commercialization of academic research outputs. This is likely to be the case only if technology transfer activities can be substituted for traditional promotion and tenure criteria such as publications and universities begin to recruit and hire faculty that have an intrinsic desire to engage in the commercialization of the technologies they create from their research activities. Otherwise, the impact will probably only be marginal.

The nature of new technologies being created is likely to continue evolving. Such evolution will undoubtedly create new opportunities for economic profit. In response to the leadership of U.S. universities looking to the technology transfer function to help cope with financial pressures, TTO leaders will probably continue reconsidering their conceptualizations of what constitutes technologies that faculty researchers should be disclosing to their universities. Thus, changes in the

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nature of technologies that are created will probably have the effect of expanding university involvement in the commercialization of academic research outputs.

The law often lags societal changes. This is true of U.S. patent law as well. And universities tend to be slow in modifying or enacting new policies in response to changes in the sociopolitical and economic environments. Consequently, the intellectual property policies that U.S. universities established in the years immediately following the implementation of the Bayh-Dole Act of 1980 are often ill-suited to guide responses to the challenges presented by the nature of newer technologies (Marr & Phan, 2020). Thus, bureaucratic inertia will likely serve as a *de facto* restraint on efforts to expand and increase the involvement of U.S. universities in research outputs commercialization.

Finally, leaders of TTOs at U.S. universities have encountered difficulties recruiting and hiring qualified technology transfer professionals in recent years. These are highly specialized roles in a highly specialized, niche industry. They often require a multidisciplinary skillset and a multifaceted perspective for one to be effective in them. Finding individuals with the qualifications to fill these roles is becoming more challenging each year. An examination of job listings on several job websites and social media platforms reveals that in July 2025 there were roughly 1,700 open technology transfer or technology commercialization positions. This number was relatively stable throughout the calendar year. Historically, TTO hiring managers preferred to fill positions with individuals who possess either a research doctorate in a hard science (e.g., physics, biology, chemistry, etc.) or a Juris Doctorate with several years of experience in intellectual property law. There is anecdotal evidence that this preference has been relaxed in some cases in recent years and managers have hired individuals with a Master of Business Administration (MBA) along with a bachelor's or master's degree in a STEM (science, technology, engineering, or mathematics) discipline. However, if the preference for individuals with research doctorates remains, it will likely impede the ability of universities to expand their involvement in the commercialization of academic research outputs.

Conclusion

The university as an institution has not always had a role in the commercialization of academic research outputs – what is commonly referred to as technology transfer or technology commercialization in the modern parlance. The decrees of political rulers have historically exerted the most influence on the activities of the universities. The establishment of the modern university on the foundation of the ecclesiastical institutions of the 11th and 12th century and the eventual incorporation of scientific research as a core function of universities beginning in the late 19th century were instigated primarily for sociopolitical and economic reasons. During these periods, mission determined the activities of the universities. However, university involvement in the commercialization of academic research outputs emerged from endogenous factors. The aspirations of staff members and administrators of select U.S. universities in the late 20th century instigated the eventual expansion of the activities of universities to include facilitating the commercialization of academic research outputs. Economic and sociopolitical factors merely provided a window to effectuate policy change that would enable administrators to establish and expand the role of universities in the commercialization of academic research outputs. University administrators modified the missions of their organizations to include economic development in response to the new societal expectations that came as a result of a change in U.S. policy that granted patent rights to the universities where the research was performed thus enabling the activity that university staff and administrators desired. Essentially, policy enabled activity which influenced the mission of the institution. Once this phenomenon occurred in the USA, it spread to other countries relatively quickly with many nations using the U.S. model as a reference. However, the specific nature of the role of universities within each country regarding the commercialization of academic research outputs was, and continues to be, greatly influenced the by local geopolitical and socioeconomic pressures. Financial stresses, concerns about the overemphasis of applied research, decisions about faculty promotion and tenure criteria, the changing nature of technology, bureaucratic inertia, and challenges hiring technology transfer practitioners are likely to exert significant influence on how the

 doi:10.20944/preprints202512.2105.v1

role that U.S. universities play in the commercialization of academic research outputs will evolve in the future.

Author's Contribution Statement: Malcolm S. Townes 0000-0002-9106-3634: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Validation, Visualization, Writing - Original Draft Preparation, Writing - Review & Editing.

Funding Sources: The author did not receive funding support from any organization to assist with this work or the manuscript.

Ethics Statement: This research did not require Institution Review Board approval because it did not involve human participants or animals as subjects.

Informed Consent: Informed consent for patient information to be published in this article was not obtained because this research did not involve human subjects.

Data availability: Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Competing interests: The author has no relevant financial or non-financial interests to disclose.

Declaration regarding artificial intelligence (AI) and AI-assisted technologies: During the preparation of this work the author did not use AI or AI-assisted tools to write any text and takes full responsibility for the content of this paper.

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 doi:10.20944/preprints202512.2105.v1

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