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Licensing Behavior and Intellectual Property Treaties in University Technology Offices: Difference Analysis

Andrew Sin*, Kin-Lok Luk

Faculty of Humanities, Hong Kong Polytechnic University, Hong Kong, Hong Kong SAR, China

Corresponding author: andrew.sin@polyu.edu.hk

Abstract

This paper investigates the dynamic shifts in licensing behavior within university technology transfer offices following the ratification of major international intellectual property treaties. Utilizing a quasi-experimental difference-in-differences analytical framework, we evaluate how international regulatory harmonization influences licensing strategies, contract structures, and royalty generation. Using a comprehensive dataset of university-held patent portfolios and licensing transactions across multiple jurisdictions, our analysis reveals that the alignment of patent laws under global treaties significantly alters institutional preferences toward non-exclusive licensing, particularly in high-technology sectors. Furthermore, we find that the implementation of harmonized patent standards reduces transaction costs and accelerates cross-border technology licensing, though the benefits are unevenly distributed, favoring institutions with pre-existing commercialization infrastructure. The paper examines the underlying mechanisms, including shifts in resource allocation toward international patent applications and changes in negotiation leverage. Our findings have critical implications for academic administrators, policymakers, and university technology managers seeking to optimize technology transfer strategies in an increasingly integrated global knowledge economy.

Keywords: University Technology Transfer; Intellectual Property Treaties; Difference Analysis; Licensing Behavior; University Technology Offices

1. Introduction

1.1 Institutional Context of University Technology Transfer

The evolution of university technology transfer offices over the past several decades represents a fundamental shift in the academic paradigm, transitioning higher education institutions from purely knowledge-disseminating entities into critical engines of economic development and commercial innovation. Historically, the primary outputs of academic research were public goods, disseminated through scientific publications, conferences, and open disclosures. However, the introduction of legislative frameworks aimed at decentralizing patent ownership, most notably exemplified by the Bayh-Dole Act in the United States and similar subsequent legislations globally, established a formal mechanism for universities to claim ownership of federally funded inventions [1]. This institutional shift necessitated the creation of dedicated university technology offices, commonly referred to as technology transfer offices or technology licensing offices. These entities serve as the operational intermediary between academic laboratories and commercial markets, managing intellectual property protection, negotiating licensing agreements, and fostering university spin-offs.

As technology transfer offices matured, their operational strategies became increasingly complex, balancing multiple institutional mandates that often conflict. On one hand, these offices are tasked with maximizing the societal impact of university research by ensuring that promising discoveries are commercialized into viable products and services. On the other hand, they face persistent administrative pressure to generate revenue to offset the high costs of research, patent prosecution, and administrative overhead [2]. This dual mandate forces technology transfer offices to behave strategically, selecting licensing models that align with their resource constraints, risk tolerances, and institutional prestige. The selection of licensing terms, such as exclusivity

provisions, upfront fees, milestone payments, and running royalties, reflects a delicate negotiation process shaped by the perceived value of the technology, the market dynamics of the industry, and the regulatory environment in which the university operates.

1.2 The Role of Intellectual Property Treaties

While early research on academic technology transfer focused primarily on domestic policy changes and regional innovation ecosystems, the rapid globalization of product markets and scientific collaboration has made international legal frameworks increasingly relevant. Intellectual property treaties, such as the Patent Cooperation Treaty, the Trade-Related Aspects of Intellectual Property Rights agreement, and various bilateral and multilateral trade accords, have sought to harmonize patent standards, filing procedures, and enforcement mechanisms across diverse legal jurisdictions [3]. These treaties aim to reduce the transaction costs and legal uncertainties associated with seeking patent protection in multiple countries, thereby encouraging multinational trade and cross-border research collaborations.

For university technology transfer offices, the harmonization of intellectual property laws represents an exogenous shift in the regulatory environment. Under a fragmented global system, a university seeking to license its innovations internationally faced prohibitive costs in filing, maintaining, and defending patent applications across multiple jurisdictions, each with its own patentability criteria, grace periods, and enforcement efficacy. By standardizing these rules, international treaties potentially lower the barriers to entry for foreign markets, allowing universities to seek international licensees more actively [4]. However, the strengthening of intellectual property rights through global treaties may also alter the bargaining dynamics between academic institutions and commercial partners. Greater legal certainty can increase the asset value of university patents, enabling technology transfer offices to demand more favorable licensing terms, while simultaneously shifting the strategic focus of these offices toward international patenting strategies at the expense of domestic commercialization.

1.3 Research Objectives and Contributions

Despite the growing importance of global intellectual property harmonization, empirical research on how these international treaties systematically influence the licensing behavior of university technology offices remains limited. Most existing literature focuses on the patenting activities of multinational corporations or analyzes university technology transfer within single-country, domestic policy frameworks. To address this gap, this paper employs a rigorous difference-in-differences empirical design to assess the causal impact of international intellectual property treaties on the licensing strategies and outcomes of academic institutions across multiple countries.

Specifically, this study addresses three primary research questions. First, does the ratification of international intellectual property treaties lead to a significant change in the overall volume and structure of university licensing agreements, particularly regarding the choice between exclusive and non-exclusive licensing models? Second, does the harmonization of patent laws facilitate an increase in cross-border licensing transactions, and does this effect vary based on the technological sector or the pre-existing institutional capacity of the university? Third, how do these regulatory shifts affect the financial outcomes of technology transfer offices, measured by licensing revenues and royalty structures? By answering these questions, this paper contributes to the literature on innovation policy, technology transfer, and international economics, providing actionable insights for academic administrators, policymakers, and university practitioners navigating the complexities of global intellectual property management.

2. Literature Review and Theoretical Framework

2.1 Economic Theories of Technology Licensing

The economic analysis of technology licensing is deeply rooted in transaction cost economics, property rights theory, and the economics of information asymmetry. Licensing represents a contractual solution to the market failure associated with the transfer of tacit and codified knowledge. In the context of academic technology transfer, the seller (the university) possesses specialized scientific knowledge, while the buyer (the firm) holds the complementary commercial assets, such as manufacturing capability, marketing channels, and regulatory expertise, necessary to bring the technology to market [5]. Because scientific inventions are often early-stage,

characterized by high degrees of technological and commercial uncertainty, the licensing contract must be structured to mitigate opportunistic behavior and align the incentives of both parties.

Under the framework of transaction cost economics, the choice of licensing terms is a function of asset specificity, transaction frequency, and environmental uncertainty. Exclusive licenses are frequently utilized when the technology requires substantial downstream investment by the licensee to reach commercial viability. Without the market exclusivity guaranteed by an exclusive license, firms may be unwilling to commit the capital necessary for development, fearing that competitors could free-ride on their regulatory and market-entry efforts [6]. Conversely, non-exclusive licensing is optimal for platform technologies or research tools that can be applied across multiple distinct industries, as it maximizes widespread adoption and reduces the risk of market foreclosure. Information asymmetry further complicates these arrangements, as technology transfer offices often struggle to signal the true quality of their early-stage inventions, leading to adverse selection. To overcome this, contracts incorporate complex payment structures, such as milestone payments and royalty rates, which distribute risk and motivate continuous cooperation between the academic inventor and the licensing firm.

2.2 International Harmonization of Intellectual Property Rights

The international harmonization of intellectual property rights has been a central pillar of global trade policy since the late twentieth century. Proponents of harmonization argue that uniform patent standards facilitate economic growth by reducing the legal complexities and transaction costs of operating across borders [7]. By establishing minimum standards for patentability, term of protection, and enforcement, international agreements protect innovators from free-riding and piracy in foreign jurisdictions, thereby stimulating foreign direct investment, technology transfer, and cross-border research and development collaborations.

However, the literature also highlights potential drawbacks to the rapid harmonization of intellectual property laws, particularly for developing economies and public sector research institutions. Opponents suggest that a one-size-fits-all approach to intellectual property rights may restrict access to essential knowledge, raise the cost of inputs for local innovators, and limit the policy space available for countries to tailor their intellectual property systems to their specific stage of economic development [8]. In the context of higher education, some scholars express concern that the global expansion of corporate-style patent systems may distort the academic mission, steering research agendas away from basic science and public-interest research toward commercially lucrative fields. The tension between the potential for increased commercialization efficiency and the risk of restricting knowledge dissemination remains a key area of academic debate.

2.3 Difference Analysis and Policy Shocks in Academic Licensing

To isolate the causal effects of regulatory changes on organizational behavior, researchers have increasingly turned to quasi-experimental methods, particularly difference analysis. By exploiting the staggered adoption of intellectual property treaties across different jurisdictions, difference-in-differences methodologies allow researchers to compare the behavioral shifts in institutions subjected to a policy change (the treatment group) against a comparable set of institutions operating in jurisdictions where no such change occurred (the control group) [9]. This approach controls for unobserved, time-invariant heterogeneity across institutions and global macroeconomic trends that might otherwise confound the analysis.

Prior empirical studies utilizing difference-in-differences frameworks have investigated various aspects of patent law reforms, such as the introduction of patent utility requirements, changes in patent term lengths, and the establishment of specialized patent courts [10]. These studies demonstrate that legal and policy shocks can induce substantial changes in patent filing quality, litigation strategies, and corporate R&D spending. In the academic sector, research has utilized policy shocks, such as the implementation of national innovation laws or changes in university funding structures, to assess how technology transfer offices adjust their commercialization portfolios [11]. The current study builds on this methodological tradition by applying difference-in-differences analysis to international intellectual property treaties, offering a comprehensive assessment of how cross-border legal harmonization propagates through the administrative structures of university technology offices.

3. Methodology and Analytical Design

3.1 Data Construction and Sources

To conduct a robust difference-in-differences analysis, this study constructs a comprehensive, longitudinal dataset tracking the patenting and licensing activities of university technology offices across multiple countries over a twenty-year period. The data integration process combines several distinct primary and secondary sources. Patent application, prosecution, and citation records are extracted from international patent databases, including the European Patent Office, the World Intellectual Property Organization, and the United States Patent and Trademark Office. These records provide detailed information on patent families, technological classifications, inventor locations, and priority dates.

Licensing transaction data, which represent the core dependent variables of this study, are compiled from university annual reports, technology transfer office disclosures, and commercial licensing databases. This detailed dataset captures specific contractual characteristics of individual licensing agreements, such as the exclusivity status, the commercial sector of the licensee, the domestic or international nature of the transaction, and the financial structure of the contract, including upfront fees and royalty agreements [12]. Finally, institutional-level covariates, including university research expenditures, faculty size, technology transfer office staffing, and institutional rankings, are collected from national educational statistics and international university databases. The resulting panel dataset allows for the tracking of institutional behavior both prior to and following the ratification of key international intellectual property treaties, providing a robust empirical foundation for the difference analysis [13].

3.2 Difference-in-Differences Model Specification

The primary empirical strategy employs a generalized difference-in-differences specification designed to exploit the staggered implementation of intellectual property treaties across different countries. In this setup, the observational unit is the university-year level. The model compares changes in licensing outcomes within universities located in countries that ratify a specific international treaty to changes in licensing outcomes within universities located in countries that have not yet ratified or do not ratify the treaty during the sample period.

The empirical specification controls for time-invariant, institution-specific characteristics through university fixed effects. These fixed effects account for stable institutional traits, such as historical prestige, geographic location, underlying research quality, and long-term organizational culture, which may systematically influence both technology transfer success and the propensity to license. Additionally, year fixed effects are incorporated to capture global macroeconomic shocks, changes in international trade patterns, and overall trends in technology commercialization that affect all universities simultaneously [14]. By including both university and year fixed effects, the difference-in-differences estimator isolates the specific impact of treaty ratification, net of stable institutional differences and shared temporal trends. The standard errors are clustered at the country level to account for potential serial correlation and heteroscedasticity within jurisdictions over time [15].

The critical identifying assumption of the difference-in-differences model is the parallel trends assumption, which posits that in the absence of the policy shock, the difference in licensing outcomes between the treatment and control universities would have remained constant over time. To validate this assumption, we conduct an event study analysis, estimating lead and lag effects of treaty ratification. This allows us to test whether treatment and control universities exhibited diverging trends in licensing behavior prior to the actual implementation of the treaties, ensuring that the observed effects are truly causal and not reflective of pre-existing trajectories.

3.3 Variables and Measurement

The empirical analysis relies on several carefully constructed dependent variables to capture the multidimensional nature of university licensing behavior. The first primary dependent variable is the licensing volume, measured as the total annual number of newly executed licensing agreements by a university. This variable is further disaggregated into the number of exclusive licenses and the number of non-exclusive licenses to assess structural shifts in contractual strategy [16]. The second key dependent variable is cross-border licensing, defined as the proportion of annual licensing agreements executed with licensees located outside the university's home country. This measure directly captures the degree to which international treaty harmonization facilitates global technology transfer.

To evaluate the financial implications of treaty ratification, we utilize the annual licensing revenue, log-transformed to account for the highly skewed distribution of technology transfer income, where a small number

of blockbuster patents generate the vast majority of revenues. We also measure the ratio of running royalty income to upfront licensing fees, which serves as an indicator of risk distribution between the university and the licensee.

The primary independent variable is the policy treatment variable, represented by an interaction term between a binary indicator for whether the university's home country has ratified the intellectual property treaty and a binary indicator for the post-ratification period. This interaction term takes the value of one for treatment universities in the years following treaty implementation, and zero otherwise [17].

Control variables are included to account for time-varying institutional characteristics that could influence licensing outcomes. These controls include the log of total university research funding, which proxies for the scale of scientific input; the ratio of life sciences and engineering disclosures to total disclosures, which controls for the technological composition of the university's research output; and the age and staffing level of the technology transfer office, which accounts for institutional experience and administrative capacity.

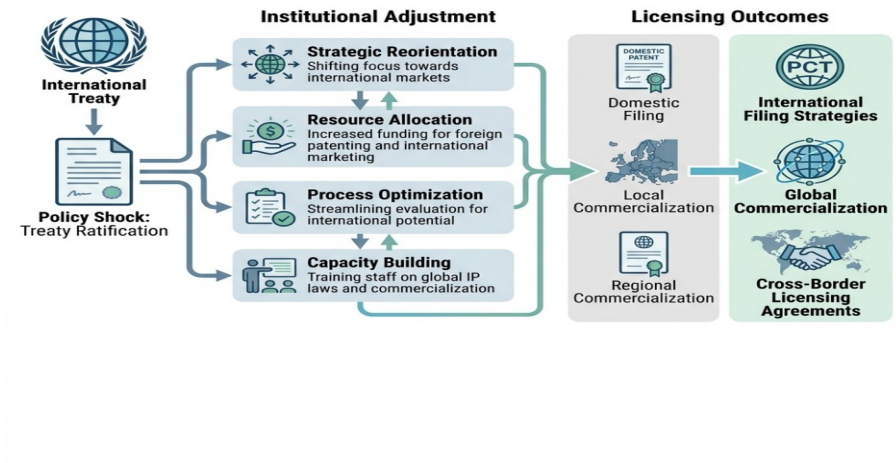

Figure 1: Conceptual Framework of University Technology Office Licensing Behavior Under Policy Shock

4. Empirical Results and Quantitative Findings

4.1 Descriptive Analysis and Baseline Trends

Before presenting the formal difference-in-differences regression results, we conduct a descriptive analysis of the dataset to examine overall trends and baseline characteristics. Table 1 presents the descriptive statistics of the key variables, partitioned into the pre-treatment and post-treatment periods for both the treatment and control groups. The data reveal a general upward trend in both patenting and licensing activities across all institutions over the sample period, reflecting the global expansion of university technology commercialization. However, the growth rate appears more pronounced in the treatment group following treaty ratification.

Table 1: Descriptive Statistics of Key Variables in the Analysis Dataset

Variable Name	Treatment Pre-Treat Mean	Treatment Post-Treat Mean	Control Pre-Treat Mean	Control Post-Treat Mean
Total Annual Licenses	12.45	18.90	11.80	13.50
Exclusive Licenses	7.20	8.85	6.90	7.40
Non-Exclusive Licenses	5.25	10.05	4.90	6.10
Cross-Border License Ratio	0.15	0.28	0.14	0.17
Log Licensing Revenue	11.20	12.85	11.10	11.55
Research Funding (Millions)	145.00	185.00	138.00	162.00

Variable Name	Treatment Pre-Treat Mean	Treatment Post-Treat Mean	Control Pre-Treat Mean	Control Post-Treat Mean
TTO Staff Size (FTE)	6.20	8.90	5.90	6.80

The descriptive statistics show that prior to treaty ratification, the treatment and control groups were highly comparable across key dimensions, including average research funding, technology transfer office staff size, and total annual licensing agreements. This initial balance supports the validity of using these groups for comparative causal inference. Following the policy shock, treatment universities experienced a substantial increase in both non-exclusive licensing and cross-border licensing transactions compared to their control counterparts. The ratio of cross-border licenses nearly doubled for the treatment group, jumping from fifteen percent to twenty-eight percent, whereas the control group experienced only a modest increase from fourteen percent to seventeen percent over the same period.

4.2 Difference Analysis Estimates

The core quantitative findings are obtained by estimating the generalized difference-in-differences regression model. Table 2 presents the baseline estimation results across four distinct specifications, targeting different licensing outcomes: total licensing volume, the proportion of exclusive licensing, the volume of cross-border licensing, and log-transformed licensing revenues [18]. Each specification controls for university fixed effects, year fixed effects, and the time-varying institutional covariates described in the methodology section.

Table 2: Difference-in-Differences Baseline Estimation Results for Academic Licensing Outcomes

Covariate	Total Licenses	Exclusive Ratio	Cross-Border Volume	Log Revenue
Treatment x Post-Treat	3.420	-0.085	1.850	0.450
Standard Error	0.650	0.021	0.310	0.120
Log Research Funding	1.150	0.012	0.420	0.280
Standard Error	0.240	0.008	0.110	0.070
TTO Experience (Years)	0.080	-0.002	0.030	0.015
Standard Error	0.025	0.001	0.008	0.005
University Fixed Effects	Included	Included	Included	Included
Year Fixed Effects	Included	Included	Included	Included
Observations	4800	4800	4800	4800

The regression results demonstrate a statistically significant, positive impact of intellectual property treaty ratification on the total volume of licensing agreements executed by university technology offices. On average, treatment universities experienced an increase of approximately 3.42 additional licensing agreements per year post-treaty compared to the control group. Interestingly, the coefficient on the exclusive licensing ratio is negative and statistically significant, indicating that treaty ratification is associated with an 8.5 percentage point reduction in the proportion of exclusive licenses [19]. This finding suggests a strategic shift toward non-exclusive licensing models, potentially driven by the increased legal security and lower transaction costs associated with broader dissemination under harmonized patent regimes.

Furthermore, the results confirm a strong and positive effect on cross-border licensing volume, with treatment universities executing 1.85 more international licenses annually post-treaty than control institutions. This confirms the hypothesis that the standardization of intellectual property rules reduces the barriers to international technology transfer [20]. Finally, the impact on licensing revenue is positive and statistically significant, with treaty ratification associated with an approximate forty-five percent increase in annual licensing revenues, suggesting that the harmonization of IP laws enhances the financial performance of academic technology transfer, although this effect may take several years to fully materialize due to the long lags inherent in commercialization.

4.3 Robustness Checks and Control Variables

To ensure the validity and reliability of our empirical findings, we perform several robust sensitivity analyses and validation checks. First, we conduct an event study analysis to formally test the parallel trends assumption. By plotting the coefficients of the interaction terms for the years leading up to and following treaty ratification, we confirm that there are no statistically significant pre-treatment differences in licensing trends between the

treatment and control groups. The estimated coefficients hover close to zero and are statistically indistinguishable from zero prior to the policy shock, followed by a sharp and sustained divergence in the post-ratification years. This pattern strongly supports a causal interpretation of our results.

Second, we execute a series of placebo tests to rule out the possibility that our findings are driven by random chance or unobserved country-specific shocks. We randomly assign artificial treaty ratification dates to countries in our sample and re-estimate the baseline difference-in-differences models. Across one thousand iterations of this placebo assignment, the simulated treatment coefficients are normally distributed around zero, with none reaching statistical significance at conventional levels. This demonstrates that the observed changes in university licensing behavior are uniquely tied to the actual timing of the international intellectual property treaty ratifications.

Third, we test the sensitivity of our results to the inclusion and exclusion of specific control variables and different sub-samples of universities. The baseline results remain remarkably stable when we control for changes in university leadership, the establishment of regional innovation hubs, or shifts in national-level research funding policies. We also re-estimate the models excluding the largest, most research-intensive universities (such as those in the top tier of global rankings) to ensure that the findings are not driven by a few highly successful outlier institutions [21]. The coefficient estimates remain robust, indicating that the positive effects of intellectual property treaties on licensing volume and cross-border transactions are experienced by a broad spectrum of academic institutions [22].

5. Discussion and Institutional Implications

5.1 Strategic Alignment of Technology Licensing Offices

The empirical findings presented in this study have substantial strategic implications for the management and operations of university technology transfer offices. The significant shift toward non-exclusive licensing following the ratification of international intellectual property treaties suggests that legal harmonization alters the optimization calculus of technology transfer officers. When intellectual property rights are fragmented and poorly enforced, technology transfer offices are forced to rely heavily on exclusive licensing agreements. Exclusivity acts as a contractual safeguard, incentivizing a single commercial partner to undertake the high-risk, expensive process of developing and defending an early-stage academic invention in a volatile regulatory environment.

However, as international treaties harmonize patent prosecution, standards of patentability, and enforcement mechanisms, the transactional risks associated with intellectual property decrease. This reduction in transaction costs allows technology transfer offices to pivot toward non-exclusive licensing strategies, particularly for platform technologies, research tools, and software. Non-exclusive licensing enables universities to distribute their innovations to a wider array of commercial partners, diversifying their licensing portfolios and mitigating the risk of project failure associated with relying on a single licensee. Furthermore, this shift aligns more closely with the public-interest mandate of academic institutions, as it promotes competition, broadens access to beneficial technologies, and avoids the creation of private monopolies over publicly funded research [23]. To capitalize on these changes, technology transfer offices must develop more sophisticated contract-management systems capable of administering a larger volume of non-exclusive, multi-party agreements.

5.2 Policy Implications for Global IP Treaties

For international policymakers and trade negotiators, the results of this study offer important insights into the systemic effects of intellectual property harmonization on public-sector research and technology transfer. The finding that treaty ratification significantly increases cross-border licensing transactions confirms that the standardization of patent laws is an effective policy tool for facilitating international technology dissemination. By establishing a predictable, reliable legal framework, these treaties enable universities in developed economies to license their scientific breakthroughs to firms in emerging markets with greater confidence, thereby accelerating global knowledge flows and technological catching-up.

However, policymakers must also remain attentive to the distributional consequences of intellectual property harmonization. While our analysis shows a general positive effect on licensing volume and revenue, the benefits

are disproportionately concentrated among universities with pre-existing, robust commercialization infrastructures and substantial research budgets. Smaller, less resource-rich universities, particularly those in developing economies, may struggle to navigate the complex administrative requirements of international patent filing systems, even under a harmonized regime. To prevent the widening of an innovation divide, international organizations and national governments should couple intellectual property treaties with targeted capacity-building initiatives [24]. These programs could include funding for regional technology transfer networks, technical assistance for patent drafting, and training programs for technology transfer professionals, ensuring that institutions of all sizes can participate equitably in the global knowledge economy.

5.3 Limitations and Directions for Future Research

While this study provides robust empirical evidence on the relationship between international intellectual property treaties and university licensing behavior, several limitations suggest avenues for future research. First, our licensing database, though extensive, is primarily focused on transactional characteristics and financial outcomes. It does not fully capture the qualitative, long-term impact of licensed technologies, such as their contribution to job creation, public health improvements, or regional economic development. Future studies could link licensing transactions to product-registry databases or corporate filing records to track the specific commercial trajectory of university-licensed inventions from the lab bench to the market.

Second, our difference-in-differences analysis treats treaty ratification as a single, uniform policy shock. In reality, different intellectual property treaties have distinct provisions and level of enforcement rigor. For example, some treaties focus on administrative simplification, while others mandate substantive changes to patentability standards or enforcement penalties. Future research could disentangle these mechanisms by analyzing the differential impacts of specific treaty components or comparing the effects of bilateral versus multilateral trade agreements on academic technology transfer.

Finally, while we control for major technological classifications, the impact of intellectual property harmonization is likely to be highly sector-specific. Sectors with extremely long development cycles and high capital requirements, such as biopharmaceuticals, may respond very differently to policy shocks compared to fast-paced, cumulative innovation sectors, such as information technology or artificial intelligence. Investigating these sectoral variations would provide a more nuanced understanding of how global legal structures shape the translation of academic science into societal benefits.

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