COMPARATIVE ANALYSIS OF SCIENTIFIC-TECHNICAL PRODUCT COMMERCIALIZATION PRACTICES IN FOREIGN AND UZBEKISTAN HIGHER EDUCATION INSTITUTIONS

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In today's knowledge-based economy, the ability of universities to transform scientific discoveries into marketable products and businesses has become a defining factor of national competitiveness and economic growth. Higher education institutions are no longer seen merely as centers of learning — they are increasingly expected to serve as engines of innovation, producing not only knowledge but also tangible economic value through patents, licenses, and spinoff companies.

However, the effectiveness of university commercialization varies dramatically across countries. While the United States, United Kingdom, Germany, Israel, China, and South Korea have spent decades — and in some cases over half a century — building mature, well-funded commercialization ecosystems, Uzbekistan remains at the very beginning of this process. Understanding how these leading countries built their systems, what makes them work, and what lessons can be reasonably adapted to a different context is both a scholarly and a practical necessity. This thesis conducts a systematic comparative analysis across these seven countries, examining their legal frameworks, institutional structures, financial mechanisms, researcher incentives, and measurable outcomes — with the goal of identifying actionable recommendations for Uzbekistan.

One of the clearest findings from international experience is that commercialization ecosystems do not emerge spontaneously — they are built on legal foundations. The United States offers the most instructive example. Before 1980, federally funded research inventions were owned by the government, and universities had little motivation to pursue commercialization. The Bayh-Dole Act of 1980 changed this fundamentally by granting universities ownership rights over inventions arising from federally funded research, while obligating them to share royalties with inventors. The results over the following decades were transformative: a flourishing of technology transfer offices, licensing revenues, and university spinoffs that collectively contributed trillions of dollars to the American economy.

The United Kingdom similarly grants universities ownership over employee-produced IP, supported by standardized collaboration agreements known as the Lambert Toolkit. Germany reformed its so-called "Professor's Privilege" in 2002, shifting IP ownership from individual professors to institutions and creating clearer pathways for commercialization.

Israel, China, and South Korea all have national legislation that unambiguously places IP ownership with the university while mandating that a significant portion of revenues flows back to the inventors themselves. Uzbekistan, by contrast, currently lacks a clear and consistently enforced legislative framework for university IP ownership. Most universities operate without formal IP policies, and revenue-sharing arrangements — where they exist at all — are neither standardized nor generous enough to motivate researchers. The Law on Innovation Activity (2020) and the revised Law on Intellectual Property (2022) represent steps in the right direction, but they have not yet translated into functioning institutional practice. This legal ambiguity is not a secondary issue — it is the root cause of many downstream failures in the commercialization process.

Even where good laws exist, commercialization does not happen automatically. It requires dedicated professional institutions — specifically, Technology Transfer Offices (TTOs) — staffed by people who understand both science and business, and who can shepherd inventions from laboratory to market.

In the United States, leading universities operate TTOs employing dozens of professionals who manage invention disclosures, patent applications, licensing negotiations, and startup support. Stanford's Office of Technology Licensing and MIT's Technology Licensing Office are globally recognized for their sophistication and productivity. The UK's model takes this further: Oxford University Innovation and Cambridge Enterprise are legally independent companies that manage commercialization on behalf of their universities, with portfolios spanning hundreds of spinoff companies and generating tens of millions in annual revenue.

Germany's approach is distinctive in that it uses an intermediary institution — the Fraunhofer-Gesellschaft — to bridge the gap between university basic research and industrial application. With dozens of research institutes and thousands of employees, Fraunhofer conducts applied research on contract for industry, effectively solving the "Valley of Death" problem that prevents many early-stage discoveries from ever reaching commercial viability. This model is particularly relevant for countries like Uzbekistan where the private sector may not yet have the capacity or appetite to engage directly with universities.

Israel operates specialized technology transfer companies at each major university — Yissum at Hebrew University, Ramot at Tel Aviv University, T3 at Technion — that function as professional intermediaries with deep expertise in specific technology domains. South Korea complements its university TTOs with a national network of technoparks serving as regional innovation hubs that connect universities, government research institutes, and industry.

Uzbekistan currently has almost none of this infrastructure in place. While over thirty technoparks formally exist, most focus on IT services rather than deep-technology

commercialization. The vast majority of universities manage innovation activity through existing science departments or vice-rectors for research — generalists who lack the specialized skills that effective technology transfer requires. Research consistently shows that the quality and experience of TTO staff is one of the strongest predictors of commercialization output, which means this human capital gap is as important as the legal one.

A recurring challenge across all systems is the "Valley of Death" — the funding gap between a proven scientific concept and a commercially viable product. Early-stage research is too risky for most private investors, yet too applied for basic research grants. How countries bridge this gap reveals much about their broader approach to innovation.

The United States relies heavily on a vast private venture capital ecosystem, supplemented by university-affiliated proof-of-concept funds that provide the earliest-stage financing to help inventions become investable. Israel has built a similarly dense VC ecosystem, bolstered by government co-investment programs and the innovation spillovers from its defense sector. Notably, Israel's R&D expenditure as a share of GDP is the highest in the world, reflecting a national commitment to treating research as a strategic investment rather than a budget line.

Germany's Fraunhofer model effectively eliminates the Valley of Death for applied research by having industry directly fund applied research at the institutes — meaning the commercial application is baked into the research process from the start, rather than being retrofitted after the fact. China has addressed the same problem through sheer scale of state investment, mandating that universities establish commercialization infrastructure and directing enormous public resources toward technology transfer.

South Korea's approach blends government direction with industrial partnership, using technoparks and close relationships with large industrial conglomerates (chaebols) to ensure that university research feeds into industrial development pipelines.

Uzbekistan currently has very limited venture capital availability and no systematic proof-of-concept funding mechanism. Government R&D expenditure as a share of GDP is far below every comparator country. Without dedicated early-stage funding, even the best research produced by Uzbek universities will struggle to attract the investment needed to reach the market — making a national proof-of-concept fund one of the most urgently needed interventions.

Laws and institutions create the conditions for commercialization, but it is individual researchers who actually do it. Their motivation — or lack thereof — depends heavily on whether the system makes commercialization worth their time and effort.

Across all successful systems, one pattern is remarkably consistent: countries and institutions that offer higher revenue shares to inventors see greater commercialization activity. The United States typically allocates one-third to one-half of licensing income to

inventors. Israel's Hebrew University gives forty percent to the inventor. Post-reform China mandates a minimum of fifty percent, with many universities offering seventy percent. South Korea offers fifty to sixty percent. These are not trivial sums — they can represent life-changing financial rewards for researchers whose technologies reach commercial scale, and they send a powerful signal that the institution takes commercialization seriously.

Beyond financial incentives, promotion and tenure criteria also matter. In most successful systems, commercialization activities — patents, licenses, spinoffs, industry collaborations — are increasingly recognized alongside publications in academic career advancement. Where promotion depends exclusively on publication metrics, researchers rationally allocate their time to publishing rather than commercializing, regardless of the financial incentives on offer.

In Uzbekistan, inventor revenue shares are neither standardized nor generous, academic promotion criteria do not meaningfully reward commercialization, and the institutional culture has historically placed little value on industry engagement. Changing this requires both formal policy reform and a longer-term cultural shift — the latter being harder to mandate but no less important.

The comparative analysis makes clear that no single international model is directly transferable to Uzbekistan's context. The U.S. model depends on a VC ecosystem that takes decades to develop. The Fraunhofer model requires a strong industrial base of medium-sized enterprises. Israel's model benefits from unique defense sector dynamics. China's approach requires state investment capacity that Uzbekistan does not currently possess at the same scale.

However, selectively combining elements from multiple models offers a realistic path forward. In the short term — within one to two years — the most urgent priorities are passing clear legislation that assigns IP ownership to universities and sets a minimum inventor share of at least forty percent, establishing pilot TTOs at five to ten leading universities with support from international partners, creating a modest national proof-of-concept fund, and launching professional training programs for technology transfer specialists. In the medium term, the focus should shift to scaling TTOs across all research-active universities, establishing Fraunhofer-style applied research centers in priority sectors such as agriculture, energy, and ICT, and developing the early-stage funding ecosystem. Over the longer term, the goal should be a self-sustaining commercialization system integrated into international technology transfer networks.

Uzbekistan's university commercialization system faces significant challenges, but it also stands at a genuine inflection point. Recent legislative reforms and the establishment of the Ministry of Higher Education, Science and Innovation signal political commitment to change. The international experience analyzed in this thesis shows clearly what works

— and equally importantly, how long it takes. Every successful system required fifteen to twenty-five years of sustained investment, policy consistency, and institutional capacity building before reaching maturity.

The critical lesson is not to replicate any single model, but to build the foundational conditions — clear IP law, professional TTOs, meaningful inventor incentives, and early-stage funding — that allow a commercialization ecosystem to develop organically over time. Uzbekistan has the scientific talent and the political will. What it needs now is the institutional architecture to turn that potential into economic reality.

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