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Comprehensive Study of the Technology Transfer Ecosystem in Greece, Bulgaria, Türkiye, and Romania

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List of Abbreviations

ARC Fund – Applied Research and Communications Fund

ARoTT – Romanian Association for Technology Transfer and Innovation

BATTI – Bulgarian Association for Transfer of Technology and Innovation

CERTH – Centre for Research and Technology Hellas

EU – European Union

IP – Intellectual Property

ITU – Istanbul Technical University

KTU TTC – Karadeniz Technical University Technology Transfer Application and Research Center

METU – Middle East Technical University

NCSR "Demokritos" – National Centre for Scientific Research "Demokritos"

NSRF – National Strategic Reference Framework

R&D – Research and Development

ReNITT – Regional Network for Innovation and Technology Transfer

SMEs – Small and Medium Enterprises

T3N-BSB – Technology Transfer and Innovation Network for the Black Sea Basin

TT – Technology Transfer

TTOs – Technology Transfer Offices

TÜBİTAK – Scientific and Technological Research Council of Türkiye

UDJG – "Dunărea de Jos" University of Galați

1. Introduction

This report presents a comprehensive analysis of the technology transfer (TT) ecosystems in Greece, Bulgaria, Türkiye, and Romania, conducted by four leading institutions specializing in innovation and technology commercialization. These institutions include the Centre for Research and Technology Hellas (CERTH) in Greece, the Bulgarian Association for Transfer of Technology and Innovation (BATTI) in Bulgaria, Karadeniz Technical University Technology Transfer Application and Research Center (KTU TTC) in Türkiye, and the "Dunărea de Jos" University of Galați (UDJG) in Romania.

This report has been prepared with the aim of strengthening the technology transfer ecosystem in the Black Sea Basin. It aims to identify and disseminate best practices to increase collaboration between universities, research institutions, and industry in the region, and to facilitate the commercialization of innovative solutions.

The study is part of the broader "Technology Transfer and Innovation Network for the Black Sea Basin" (T3N-BSB) project (https://t3nbsb.net/), which is funded under the Black Sea Basin Cross-Border Cooperation Program for the 2021-2027 period. T3N-BSB aims to develop sustainable transnational networks and platforms to facilitate the exchange of best practices and knowledge on leveraging innovative technological advancements. With a budget of €498,120.00, the project fosters stronger collaboration among academia, industry, and policymakers, ensuring technology transfer processes are more effective across borders. By enhancing institutional capacities and interconnectivity, T3N-BSB seeks to create a robust ecosystem that supports economic growth through innovation and research commercialization in the Black Sea region.

This report has been developed in 2 steps:

1st step: each T3N-BSB partner developed a country specific report following a commonly agreed structure in order to present information in a comparable way. This structure was organized into a template contained detailed guidance on the elements partners could examine and the approaches they could adopt in elaborated their individual reports. According to this structure partners:

- presented the historical overview of the technology transfer ecosystem (i.e. first attempts, early initiatives, TT policy / legislation evolution) in their countries highlighting any significant milestones
- referred to existing studies and their main results
- conducted a PESTEL analysis (Political, Economic, Social, Technological, Environmental, and Legal) of the technology transfer ecosystem

- provided profiles of leading universities, research centers, and their TTOs, as well as of other public and or private initiatives/institutions supporting TT ecosystem including a catalog of the services offered and funding mechanisms.
- concluded on main/most popular TT processes and practices followed by the identified entities
- conducted a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of the technology transfer ecosystem
- provided a summary of recommendations for improvement.

2nd Step: to produce the joint report the same structure was maintained and information from the individual country reports was extracted by summarizing main elements and trying to keep a relative balance in order to be able to compare the different TT ecosystems and synthesize findings.

Thus, this study critically examines shared opportunities and challenges while aligning with the broader objectives of the T3N-BSB project. Special emphasis is placed on a joint PESTEL and SWOT analysis to identify strategic directions for improvement, ensuring that cross-border collaboration and sustainable TT practices are fostered. The main research questions focus on identifying key barriers to TT, assessing the role of policy frameworks, and evaluating the effectiveness of existing institutions in bridging academia and industry. Additionally, the study explores how transnational cooperation can enhance TT efficiency and create long-term innovation networks in the Black Sea region. Expected findings include recommendations for improving TT networks, optimizing commercialization pathways, fostering regional cooperation in innovation-driven entrepreneurship, and leveraging digital transformation to create a more interconnected and resilient TT ecosystem.

Apart from the empirical findings from the country reports, the joint report was informed by insights from additional academic literature on technology transfer as well, that is listed in the references section.

Tables and graphical representations of the key elements of this joint report have been created and included in the ANNEX to improve readability and help the reader gain a concise understanding.

For a more in-depth analysis of the technology transfer ecosystems in each country, **readers are encouraged to refer to the country-specific reports on Greece, Bulgaria, Türkiye, and Romania**. These reports as already mentioned provide detailed insights into the historical context, institutional structures, policy frameworks, and key stakeholders shaping the technology transfer landscape in each country and can be accessed bellow:

Comprehensive Study on the Technology Transfer Ecosystems in **Türkiye**

Comprehensive Study on the Technology Transfer Ecosystems in **Bulgaria**

Comprehensive Study on the Technology Transfer Ecosystems in **Greece**

Comprehensive Study on the Technology Transfer Ecosystems in **Romania**

2. Historical Context & Current State

2.1 Overview

Each country has developed distinct but overlapping technology transfer (TT) structures shaped by historical developments, national policies, EU regulations, and regional economic conditions.

- **Greece:** The foundation for TT was established with Laws 1514/1985 and 1733/1987, which introduced a legal framework for research commercialization. Over the years, Greece has benefited from EU funding through Horizon 2020 and the National Strategic Reference Framework (NSRF), leading to the formation of dedicated Technology Transfer Offices (TTOs) in universities and research centers. However, challenges such as bureaucratic inefficiencies, lack of commercialization culture and weak industry collaboration continue to hinder commercialization efforts.
- **Bulgaria:** The country transitioned from a state-controlled research system during the socialist era to a more market-driven TT ecosystem after 1989. The Bulgarian Academy of Sciences (BAS) has played a central role in research and innovation. In recent years, national initiatives like the National Innovation Fund and Sofia Tech Park have sought to strengthen TT by supporting startup incubation and industry collaboration. However, weak intellectual property (IP) protection and limited R&D investment remain barriers.
- **Türkiye:** TT development accelerated with the establishment of the Scientific and Technological Research Council of Türkiye (TÜBİTAK) and the introduction of technoparks in the early 2000s. The TÜBİTAK 1513 and TÜBİTAK 1601 support programs in 2012 spurred the rapid growth of TTOs, particularly in major universities such as Middle East Technical University (METU) and Istanbul Technical University (ITU). The country has a strong policy framework supporting university-industry collaboration, but funding disparities and bureaucratic hurdles still impact commercialization outcomes.
- **Romania:** The TT ecosystem initially struggled due to fragmented infrastructure and underdeveloped policies following the country's transition to a market economy. However, EU-backed initiatives such as ReNITT and the involvement of institutions like the "Dunărea de Jos" University of Galați (UDJG) have contributed to the establishment of structured TT mechanisms. The Măgurele Science Park and other regional innovation clusters are helping bridge the gap between academia and industry. Nonetheless, Romania still

faces challenges in securing consistent R&D funding and improving TT policy coherence.

2.2 Existing Studies

Each country report highlights gaps between research output and commercialization, emphasizing the need for stronger university-industry collaborations, policy reforms, and investment in innovation ecosystems.

- **Greece:** Studies such as the National Strategy for Research and Innovation (NSRI) (Hellenic Republic, 2020) and analyses conducted by the PRAXI Network (PRAXI Network, 2021) underscore the persistent challenges in bridging research output with industry needs. The work of Tsipouri et al. (2017) highlights the impact of EU funding on Greek technology transfer efforts, revealing that while Greece has strong academic research, commercialization remains low due to bureaucratic barriers and limited private-sector engagement. Moreover, Kalogirou et. al (2021) offers an in-depth analysis of Greece's research, innovation, and entrepreneurship ecosystem, highlighting key institutions and the legislative frameworks that shape technology transfer activities. It emphasizes the role of technology transfer in driving innovation and economic growth.
- **Bulgaria:** Research from the Bulgarian Academy of Sciences (BAS, 2022) and reports from Sofia Tech Park (Sofia Tech Park, 2023) emphasize the critical role of government initiatives in fostering TT. The study by Terziev and Arabska (2019) on Bulgaria's innovation ecosystem suggests that weak IP protection and a fragmented TT framework slow down commercialization efforts. Increased funding and improved legal frameworks are recommended to enhance TT efficiency.
- **Türkiye:** The activities of the Scientific and Technological Research Council of Türkiye and the work of leading universities such as Middle East Technical University and Istanbul Technical University demonstrate the progress made in the TT field through Türkiye's structured support mechanisms. However, despite effective policies and the presence of technoparks, the inadequacy of early-stage funding sources and the need to further strengthen industry-academia collaboration continue to exist as major obstacles to developments in the field. It is thought that integrating venture capital with TT could increase commercialization rates.
- **Romania:** Studies from the Regional Network for Innovation and Technology Transfer (ReNITT, 2021) and research conducted by "Dunărea de Jos"

University of Galați (UDJG, 2023) reveal that Romania has a growing TT ecosystem, yet it struggles with underfunded research centers and policy fragmentation. The work of Popescu (2020) discusses the role of EU-funded programs in shaping Romanian TT mechanisms, suggesting that strengthening innovation clusters and providing stable long-term funding could improve TT performance.

3. PESTEL Analysis of the Technology Transfer Ecosystem

This section provides an in-depth Political, Economic, Social, Technological, Environmental, and Legal (PESTEL) analysis of the technology transfer (TT) ecosystem in Greece, Bulgaria, Türkiye, and Romania, based on findings from the country reports.

Political Factors

- **Greece:** Greek government has prioritized technology transfer as a strategic driver for innovation and economic growth. Key political aspects include:
    - **Government Policies and Legislative Frameworks**: Greece has strengthened TT policies through laws such as Law 4864/2021, which provides a clear legal framework for spin-offs and IP commercialization (IPMED, 2023).
    - **Public Investment in Technology Transfer Offices (TTOs)**: Initiatives like the National Strategic Reference Framework (NSRF) (2014–2020) provided substantial funding for establishing and expanding TTOs in Greek universities and research centers (EKT, 2020).
    - **Fragmented Policy Implementation**: Despite government support, inconsistencies in inter-ministerial coordination limit the effectiveness of technology commercialization efforts (GSRI, 2023).
    - **Impact:** While political will exists, Greece's TT ecosystem still faces bureaucratic inefficiencies, which slow down the implementation of research-to-market initiatives.
- **Bulgaria:** The Bulgarian government has made significant strides in supporting TT through various policy frameworks and funding mechanisms. Key aspects include:
    - **Government Strategies**: Initiatives like the National Innovation Strategy and the Recovery and Resilience Plan (RRP) aim to improve Bulgaria's innovation landscape (Bole et al., 2024).

- **Technology Transfer Offices (TTOs)**: The establishment of Centers of Competence (CoCs) and Centers of Excellence (CoEs) enhances R&D-industry collaboration (Fund of Funds Bulgaria, n.d.).
- **Regulatory Barriers**: Fragmentation in policy execution among ministries and agencies hampers coordinated national TT strategies (Bulgarian Patent Office, n.d.).
- **IP Ownership and Spin-Off Policies**: Uncertainties surrounding Decree No. 61 (2020) limit the formation of university spin-offs and researcher equity participation (Sofia Tech Park, n.d.).

- **Türkiye:**
  - **State support for R&D**: Government agencies such as TÜBİTAK, KOSGEB, and regional development agencies provide financial incentives to stimulate R&D investment.
  - **Innovation incentives**: Policies encouraging University-Industry Collaboration (UIC) are backed by direct funding and infrastructure support, such as Technology Development Zones (TDZs).
  - **Regulatory improvements**: Laws such as Higher Education Law No. 2547 and Industrial Property Law No. 6769 have been implemented to facilitate university involvement in commercialization.
  - **Challenges**: Regulatory bodies' adaptation to agility needs may slow down TT initiatives
- **Romania:** The Romanian government has introduced policies to support TT, but implementation remains fragmented. Key aspects include:
  - **National Research, Development, and Innovation Strategy (2022–2027)**: Designed to enhance research investments and public-private collaboration, yet R&D funding remains one of the lowest in Europe (Ministry of Research, Innovation, and Digitalization, 2024).
  - **EU Funding Initiatives**: Programs like Horizon Europe and the Regional Operational Program (ROP) provide financial support, but bureaucratic inefficiencies hinder fund absorption (European Commission, 2024).
  - **Regulatory Inconsistencies**: Frequent policy changes and administrative restructuring at the Ministry of Research, Innovation, and Digitalization (MCID) delay funding programs and TT initiatives (MCID, 2024).

- **Impact:** While government initiatives exist, low funding and bureaucratic hurdles slow down technology commercialization.
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Economic Factors

- **Greece:** Economic conditions play a crucial role in shaping research commercialization and university-industry collaborations.
  - **EU and National Funding**: The Greek innovation ecosystem is significantly supported by EU funding programs like Horizon Europe and national initiatives such as Elevate Greece, which assist startups and deep-tech commercialization efforts (Ministry of Development and Investments, 2020).
  - **Investment in R&D and Venture Capital (VC)**: EquiFund, a public-private VC initiative, has injected millions into Greek startups, yet deep-tech sectors (e.g., biotech, cleantech) struggle to attract investors (EquiFund, 2024).
  - **Limited Industry Demand for R&D**: Greece lacks heavy industry-driven R&D, reducing market-driven research commercialization and limiting patent licensing opportunities (IPMED, 2023).
  - **Impact:** Despite growing public investment, private-sector R&D funding remains limited, slowing scaling and commercialization of research-driven innovations.
- **Bulgaria:** the financial landscape directly impacts the commercialization of research and innovation-driven growth.
  - **Limited Access to Sustainable Funding**: Most TTOs rely on short-term grants, creating instability in long-term commercialization efforts (Bole et al., 2024).
  - **Venture Capital and Private Sector Investment**: Despite some growth in VC-backed ICT startups, the deep-tech and life sciences sectors remain underfunded (Fund of Funds Bulgaria, n.d.).
  - **Proof-of-Concept (PoC) Grants**: Initiatives like the Fund of Funds Bulgaria provide early-stage funding, but investment mechanisms for scaling innovations remain inadequate (Sofia Tech Park, n.d.).

- **Türkiye:** Türkiye has a more robust funding structure, with significant public-sector investment in R&D. However, early-stage funding gaps persist, and TT offices struggle to sustain long-term projects.
    - **Investment funds and venture capital (VC)**: While VC investments are growing, access to funding remains limited for many startups and SMEs.
    - **SME supports**: Small and Medium Enterprises (SMEs) play a crucial role in TT, benefiting from incentives but struggling with access to finance.
    - **Regional disparities**: Economic differences between metropolitan areas and smaller regions impact the distribution of TT opportunities.
    - **Challenges**: Limited financial resources and an overreliance on public funding hinder sustainable growth in the innovation sector (Andrenelli et. al, 2019).
- **Romania:** economic conditions and investment climate directly affect TT efficiency.
    - **Low R&D Investment**: Romania spends only 0.48% of GDP on R&D, significantly below the EU average of 2% (Eurostat, 2024).
    - **Limited Venture Capital (VC) and Innovation Funding**: Most startup funding is concentrated in Bucharest-Ilfov, while other regions struggle to attract investors (European Investment Fund, 2022).
    - **Economic Dependence on Multinational Corporations (MNCs)**: Romania's economy is driven by foreign firms in automotive and IT sectors, limiting domestic innovation in traditional industries (OECD, 2021).
    - **Impact:** While Romania has a growing tech startup ecosystem, limited national R&D investment and regional disparities hinder innovation-driven economic growth.

Social Factors

- **Greece:** Social and cultural factors significantly influence Greece's innovation landscape and research commercialization efforts.
    - **Highly Educated Workforce**: Greece has a strong academic and research base, with a well-trained STEM workforce (EKT, 2020).

- **Low Entrepreneurial Culture in Academia**: Many academics prioritize publications over commercialization, and few researchers engage in startup ventures (GSRI, 2023).
- **Brain Drain**: Greece has faced a significant outflow of top researchers and innovators, largely due to limited domestic funding and career prospects (Dianeosis, 2021).
- **Impact:** Greece's strong academic potential is underutilized due to low commercialization incentives and researcher reluctance to engage in entrepreneurship.

- **Bulgaria:** Social attitudes towards innovation, entrepreneurship, and research commercialization influence TT success.
  - **Brain Drain**: The outmigration of skilled researchers and TT professionals weakens Bulgaria's innovation ecosystem (Bole et al., 2024).
  - **Limited Incentives for Academic Commercialization**: Lack of structured reward systems discourages university researchers from pursuing commercialization (Bulgarian Patent Office, n.d.).
  - **STEM and Sustainability Awareness**: Increased focus on science and technology education is expanding the skilled workforce, particularly in ICT and green technologies (Sofia Tech Park, n.d.).
- **Türkiye:** Türkiye has a high level of engagement in entrepreneurship, particularly in technology hubs like Istanbul. However, regional disparities limit TT activities in less industrialized areas.
  - **Education and workforce development**: Türkiye has a relatively young population, but regional disparities in education levels affect innovation diffusion.
  - **Public perception of technology**: Awareness of innovation and entrepreneurship is increasing, but cultural barriers still exist between academia and industry.
  - **Social innovation awareness**: The integration of TT into broader societal needs, including social enterprises and impact-driven innovation, remains underdeveloped.
- **Romania:** Social attitudes, education quality, and human capital availability influence TT.

- **STEM Education Gap**: Only 15% of Romanian graduates come from STEM fields, compared to the EU average of 25% (Eurostat, 2022).
- **Brain Drain**: Many top researchers and PhD graduates leave Romania for better opportunities abroad, reducing the country's high-tech workforce (Dianeosis, 2021).
- **Entrepreneurial Culture in Academia**: Researchers prioritize academic publishing over commercialization, limiting university-driven innovation (Bole et al., 2024).
- **Impact:** Romania's strong academic base remains underutilized due to weak commercialization incentives and talent migration.

Technological Factors

- **Greece:** technological infrastructure and innovation ecosystem directly impact TT effectiveness.
  - **Advanced Research Capabilities**: Research centers like CERTH and NCSR "Demokritos" lead high-tech R&D efforts, particularly in energy, biotech, and ICT (Centre for Research and Technology Hellas, n.d.).
  - **Limited Commercialization Pathways**: Many universities and research centers lack structured commercialization pathways, reducing the ability to translate research into market-ready products (National and Kapodistrian University of Athens, n.d.).
  - **TTO Capacity and Expertise Issues**: Many Greek TTOs are understaffed, with limited expertise in IP management and licensing negotiations (EKT, 2020).
  - **Impact:** While Greece has a strong R&D ecosystem, limited commercialization pathways hinder the translation of research into economic growth.
- **Bulgaria:** TT ecosystem is impacted by technological advancements, infrastructure, and commercialization readiness.
  - **Growing ICT and AI Sectors**: Bulgaria is a regional leader in software development and AI-driven innovation, facilitating industry collaboration and TT (Fund of Funds Bulgaria, n.d.).

- **Underdeveloped Infrastructure in Other Sectors**: Limited support for biotechnology, materials science, and clean energy technologies restricts TT diversification (Bulgarian Patent Office, n.d.).
- **TTO Capacity Constraints**: Many technology transfer offices are understaffed and lack commercialization expertise, reducing the effectiveness of TT processes (Bole et al., 2024).

- **Türkiye:** Türkiye has well-developed technoparks and R&D centers. The country has embraced digital transformation, but patenting activity is still developing.
  - **Digital transformation**: Türkiye is increasingly integrating digital solutions into TT processes, but gaps remain in technology adoption.
  - **Infrastructure development**: Improvements in R&D facilities and digital infrastructure support innovation, though access varies by region.
  - **Industry 4.0 and local technologies**: Efforts to develop indigenous technologies are ongoing, but technology absorption by industry is uneven.
- **Romania:** Social attitudes, education quality, and human capital availability influence TT.
  - **STEM Education Gap**: Only 15% of Romanian graduates come from STEM fields, compared to the EU average of 25% (Eurostat, 2022).
  - **Brain Drain**: Many top researchers and PhD graduates leave Romania for better opportunities abroad, reducing the country's high-tech workforce (Dianeosis, 2021).
  - **Entrepreneurial Culture in Academia**: Researchers prioritize academic publishing over commercialization, limiting university-driven innovation (Bole et al., 2024).
  - **Impact:** Romania's strong academic base remains underutilized due to weak commercialization incentives and talent migration.

Environmental Factors

- **Greece:** Sustainability-focused TT initiatives are gaining traction in Greece.

- **EU Green Transition and Sustainable Innovation**: Greece is aligning its TT ecosystem with EU climate goals, promoting renewable energy research, green startups, and sustainability-driven TT (GSRI, 2023).
- **Slow Adoption of Green Technologies**: Despite favorable EU policies, green technology commercialization remains underdeveloped due to limited investment in clean tech startups (Ministry of Development and Investments, 2020).
- **Impact:** Greece has strong potential in green technology transfer, but market readiness and investment limitations hinder commercialization.

- **Bulgaria:** Sustainability and green technologies represent emerging opportunities for TT in Bulgaria.
  - **Green Innovation Gaps**: Despite EU directives promoting renewable energy, climate tech, and sustainability-focused R&D, Bulgaria lags in commercializing green technologies (Bulgarian Patent Office, n.d.).
  - **Lack of Investment in Clean Energy Startups**: The absence of dedicated funding mechanisms for eco-entrepreneurship slows down green TT adoption (Sofia Tech Park, n.d.).
- **Türkiye:** Türkiye is investing in sustainable development and clean energy, but TT projects in these sectors are still in the early stages.
  - **Green technologies and compliance**: Regulatory frameworks encourage the development of sustainable technologies, but their implementation needs to be scaled up.
  - **Climate change risk**: As climate policies become more stringent, TT processes must align with environmental sustainability targets (Sanayi ve Teknoloji Bakanlığı, 2020).
- **Romania:** Sustainability considerations and green technology adoption affect TT.
  - **EU Green Transition Policies**: Romania aligns with the European Green Deal, focusing on renewable energy, sustainable agriculture, and circular economy (Ministry of Energy, 2021).
  - **Low Investment in Clean Technology**: Despite EU sustainability directives, clean-tech commercialization remains weak (European Commission, 2021).

- **Impact:** While Romania is moving towards green technology, market readiness and investment barriers slow down commercialization.

Legal Factors

- **Greece:** Legal frameworks shape Greece's IP protection, research commercialization, and spin-off development.
  - **Reinforcement of IP Rights and Spin-Off Policies**: Law 4864/2021 has improved the regulatory environment for university spin-offs and IP ownership (IPMED, 2023).
  - **Limited Licensing and Patent Utilization**: Greece ranks low in European patent filings, with most university patents remaining unlicensed (OBI, 2023).
  - **Weak Institutional IP Management**: Many universities lack clear IP commercialization strategies, leading to inefficient tech transfer operations (EKT, 2020).
  - **Impact:** Legal improvements have strengthened spin-off creation, but patent licensing and enforcement mechanisms remain weak.
- **Bulgaria:** The legal framework surrounding intellectual property (IP) protection and technology commercialization remains a challenge.
  - **Weak IP Management Systems**: Universities and research institutions lack clear strategies for patenting and licensing innovations (Bulgarian Patent Office, n.d.).
  - **Legal Barriers for Spin-Offs**: The ambiguity in legislation (e.g., Decree No. 61) creates uncertainty regarding ownership structures and revenue-sharing models (Bole et al., 2024).
  - **Alignment with International IP Standards**: While Bulgaria complies with EU and WIPO IP treaties, enforcement and institutional capacity remain underdeveloped.
- **Türkiye:** Türkiye has a strong legal framework for IP, but gaps in enforcement create challenges for technology commercialization (Fund of Funds Bulgaria, n.d.).
  - **Patent protection and licensing agreements**: A patent law providing the opportunity to act in accordance with European standards is in force in Türkiye. However, while the law opens up a comprehensive field of

application in patent management, there are areas for improvement in the areas of commercialization and sharing of patent rights.

- **Technology transfer offices (TTOs)**: The establishment of TTOs within universities is legally supported, yet their effectiveness varies by institution.
- **Legal incentives for entrepreneurship**: Laws offering tax advantages for R&D-intensive firms and start-ups contribute to TT but require further refinement (TÜRKPATENT, 2022).

- **Romania:** Legal frameworks shape IP protection, spin-off policies, and commercialization pathways.
  - **IP Protection Weaknesses**: Romania filed only 58 patent applications with the European Patent Office (EPO) in 2022, far below the EU average (EPO, 2024).
  - **Fragmented Legislative Framework**: Bureaucratic obstacles complicate technology licensing and commercialization, discouraging public-private collaborations (MCID, 2024).
  - **Recent Spin-Off Regulations**: Ministerial Order No. 28 (2021) lacks clear guidelines for university spin-offs, limiting researcher participation in startups (OSIM, 2024).
  - **Impact:** Unclear IP regulations and weak enforcement mechanisms hinder technology commercialization and industry collaboration.

3.1 Summary and Critical Conclusions

The PESTEL analysis reveals both commonalities and country-specific challenges impacting the technology transfer (TT) ecosystems in Greece, Bulgaria, Türkiye, and Romania. While EU funding and policy frameworks provide foundational support across these nations, differences in policy execution, economic investment, social attitudes, technological infrastructure, environmental priorities, and legal frameworks create distinct challenges and opportunities.

Key Findings:

- **Political Factors**: While all four countries leverage EU funding programs (e.g., Horizon 2020, NSRF, RRP), their effectiveness varies due to national policy inconsistencies and bureaucratic inefficiencies. Greece and Türkiye show stronger governmental commitment to TT, whereas Bulgaria and Romania struggle with policy fragmentation and coordination gaps.
- **Economic Factors**: Underfunding remains a persistent issue in Greece and Romania, limiting TT infrastructure and private-sector engagement. Türkiye, on the other hand, has more robust R&D incentives and government-backed VC initiatives, while Bulgaria is actively expanding proof-of-concept grants but still faces deep-tech underinvestment.
- **Social Factors**: The cultural and structural environment significantly influences TT success. Türkiye demonstrates the highest engagement in entrepreneurship, benefiting from dynamic innovation hubs, while Greece, Bulgaria, and Romania struggle with low commercialization incentives and researcher reluctance to pursue business ventures. Brain drain remains a serious concern, particularly in Greece, Bulgaria, and Romania, weakening domestic innovation capacity.
- **Technological Factors**: While Bulgaria and Romania boast strong academic research institutions, their ability to commercialize patents and integrate research into markets is weak. Greece and Türkiye have better-developed R&D ecosystems, yet commercialization pathways remain underdeveloped, and TTOs lack sufficient resources and expertise.
- **Environmental Factors**: Sustainability-driven TT initiatives are gaining traction, particularly in Greece and Romania, aligning with EU Green Transition objectives. However, commercialization of green innovations remains slow due to limited private-sector engagement and funding for clean-tech startups.
- **Legal Factors**: Differences in intellectual property (IP) protection and regulatory enforcement significantly impact TT efficiency. Greece and Türkiye benefit from

relatively clear IP frameworks, whereas Bulgaria and Romania struggle with weak enforcement and unclear spin-off regulations.

The technology transfer (TT) policy in all 4 countries under examination follows a hybrid evolution approach, inspired by:

- EU Directives (i.e. Horizon 2020 & Horizon Europe, European Research Area (ERA), Smart Specialization Strategy (RIS3))
- International and EU Institutions (i.e. European Institute of Innovation & Technology (EIT), European Patent Office (EPO), World Intellectual Property Organization (WIPO), European Investment Bank (EIB))
- International Commercialization Models (i.e. US Bayh-Dole Act, Silicon Valley, Israeli Startup Ecosystem, German, Dutch, and French Public-Private Partnership (PPP) ecosystems)

3.2 Strategic Recommendations

1. **Strengthen Policy Coordination & Reduce Bureaucratic Barriers**
    - Streamline regulatory frameworks and inter-ministerial collaboration to ensure efficient TT implementation.
    - Establish national coordination bodies to align TT policies with EU directives and industry needs.
2. **Increase Private-Sector Engagement & Innovation Funding**
    - Expand public-private partnerships (PPPs) and introduce tax incentives for firms investing in university-driven R&D.
    - Enhance venture capital and proof-of-concept grant schemes, particularly in Bulgaria and Romania.
3. **Improve Technology Commercialization Pathways & Strengthen TTO Capacity**
    - Invest in TTO staff training and international best practices to bridge the gap between research and industry.
    - Establish clear IP ownership and spin-off policies to incentivize commercialization.
4. **Address Talent Retention & Foster Entrepreneurial Culture**
    - Develop programs to reduce brain drain by offering competitive salaries, career development opportunities, and startup support.

- Integrate entrepreneurship training into academic curricula to encourage researcher-led innovation.

5. **Enhance Collaboration in Green & Digital Technology Transfer**
    - Introduce dedicated funding for clean-tech commercialization and Industry 4.0 innovations.
    - Foster cross-border TT collaborations between Greece, Bulgaria, Türkiye, and Romania to leverage regional strengths.

By addressing these critical challenges, the Black Sea region can strengthen its TT ecosystem and improve its global innovation competitiveness. Cross-border collaboration, policy harmonization, and strategic investments in TT infrastructure will be key to unlocking sustainable economic growth and technological leadership in the region.

4. Main Actors of the Technology Transfer Ecosystem

4.1 Profile of Major Institutions

4.1.1 Leading Universities and Their Technology Transfer Offices (TTOs)

In the following paragraphs, leading Universities in Greece, Türkiye, Bulgaria and Romania and their TTOs are briefly summarized.

Greece

National and Kapodistrian University of Athens (NKUA)

NKUA is Greece's oldest university and one of the largest in Greece. There are over 40 academic departments within the University's faculties offering a wide range of programs in humanities, sciences, and social sciences rendering it a major hub for research

- Founded: 1837 (Oldest in Greece)
- TTO Established: 2019, organized into the Technology Transfer Office & Business Accelerator.
- Key Functions: Intellectual property management, research commercialization, industry collaboration, start-up support, funding assistance, and training.
- Funding: Institutional funding, royalties from spin-offs/licenses, and government subsidies.
- Achievements: 50+ patent requests, 4 spin-offs, 80+ projects, 300+ start-uppers supported.

Aristotle University of Thessaloniki (AUTH)

AUTH is the largest university in Greece, located in Thessaloniki. More than 40 department/schools cover a broad range of academic disciplines (Theology, Philosophy, Sciences, Engineering, Law, Health Sciences, Agriculture, Forestry, and Natural Environment, Education, Fine Arts, Economic and Political Sciences, Physical Education and Sports Science, Veterinary Medicine), and is renowned for its research output.

- Founded: 1925 (Largest in Greece)
- TTO Established: 2015, staffed by experts in engineering, physics, and law.
- Key Functions: IP protection, licensing, commercialization, industry partnerships, start-up support, and market assessment.
- Funding: Institutional funding, royalties, licensing, and government subsidies.
- Achievements: 60 active patents, 13 spin-offs, 25+ licensing agreements.

University of Patras

The University of Patras is known for its strong focus on engineering, natural sciences, health sciences, and social studies, making it one of the leading research institutions in Greece (University of Patras, n.d.).

- Founded: 1964 (Strong focus on engineering, health sciences, and natural sciences)
- TTO Established: 2004, with 5–10 core staff members.
- Key Functions: IP management, commercialization, industry collaboration, start-up assistance, funding support, and entrepreneurship consulting.
- Funding: Institutional funding, royalties, licensing agreements, government subsidies.
- Achievements: Successful commercialization in biomedicine, ICT, and renewable energy.

University of Thessaly (UTH)

With campuses in Volos, Larissa, and other cities, UTH offers programs in agriculture, engineering, social sciences, and health, with a focus on regional development.

- Founded: 1984 (Focus on regional development, agriculture, and engineering)
- TTO Team: 6–9 members, collaborating with external consultants.
- Key Functions: IP management, technology commercialization, industry partnerships, start-up support, funding/grant assistance, and training.
- Funding: Institutional support, royalties, licensing revenue, and government subsidies.
- Achievements: Facilitated spin-offs and licensing agreements in engineering, agriculture, and life sciences.

National Technical University of Athens (NTUA)

NTUA is the oldest and most prestigious technical university in Greece, specializing in engineering and technology.

- Founded: 1837 (Prestigious technical university)
- TTO Re-established: 2020, with engineers, a lawyer, and an economic/tech strategy expert.
- Key Functions: IP protection, technology commercialization, industry partnerships, start-up support, funding assistance, and market evaluation.
- Funding: Institutional funding, royalties from spin-offs/licenses, government subsidies.
- Achievements: Numerous spin-offs and licensing agreements in engineering, ICT, and renewable energy.

Türkiye

Middle East Technical University (METU)

Middle East Institute of Technology (METU) is a university that aims to train experts in the fields of science and social sciences. METU is one of the leading universities in Türkiye with its scientific level, cultural and intellectual activities. METU has 5 faculties offering a total of 41 undergraduate programs, 107 graduate and 69 doctoral programs.

- Founded in 1956, METU is a leading Turkish university in science and social sciences.
- METU TTO (est. 2007) was Türkiye's first technology transfer office.
- It supports patent processes, IPR awareness, and commercialization.
- Key programs: Pre-Seed Fund, LabsOut, Co-Tech, ProBoost, Patent Acceleration.
- Funding: UIC projects. national (i.e. TÜBİTAK) and international funds
- Impact: 250+ inventions, 750+ patent/design applications, 60 licensed technologies, 17 startups, 500+ UIC

Istanbul Technical University (ITU)

ITU provides masters and doctoral education in 13 faculties, 1 conservatory, 67 undergraduate programs and 7 institutes on 5 separate campuses located in the central points of Istanbul. It is one of the most established and respected technical universities in Türkiye. It has been a pioneer in the fields of science, technology and engineering for over 250 years.

- Founded in 1773, ITU is Türkiye's first technical university, specializing in engineering and architecture.
- ITUNOVA TTO (est. 2014) commercializes research, encourages entrepreneurship, and fosters industry collaboration.
- Key programs: ITU ARI Teknokent, ITU Çekirdek (incubator), Big Bang (startup competition).
- Funding: UIC projects. national (i.e. TÜBİTAK) and international funds
- Impact: 269 national & 145 international patents, 1600+ corporate ventures, 4700+ supported ventures.

Boğaziçi University (BU)

BU is an educational institution recognized in the national and international arena by conducting a wide range of research and teaching activities in sciences and engineering with 33 undergraduate, 67 undergraduate and 33 doctoral programs in 7 faculties, 1 college, and 7 institutes.

- Originally Robert College (1863), became BU in 1971.
- BU TTO (est. 2012) coordinates industry collaborations and funding, IPR services, grant services (national and international) and entrepreneurship and investment services
- Key program: Dream BİGG, supporting startups from idea to market.
- Funding: UIC projects, national (i.e. TÜBİTAK) and international funds and Intra-university research funds
- Impact: 108 patent applications, 15 licensed technologies, 35 startups/spin offs, 45-50 UIC projects annually.

Sabancı University (SU)

SU has an interdisciplinary research and education approach and is the first Turkish university to become a member of the European Foundation for Quality Management (Sabancı Üniversitesi, n.d). It is a university that aims to train experts in the fields of engineering, natural Sciences, Arts and Social Sciences, and Management Sciences.

- Established in 1994, focuses on interdisciplinary research and innovation.
- SUATT (est. 2001) is the Research Development and Technology Transfer Office of the SU and manages research and innovation activities, research project management, external stakeholder access services, IPR management and licensing services and spin off creation

- Funding: UIC projects, national (i.e. TÜBİTAK) and international funds and Intra-university research funds
- Key initiatives: Inovent A.Ş (tech commercialization), Pre-Incubation & Accelerator Center.
- Impact: 364 patent applications, 15 startups.

Karadeniz Technical University (KTU)

The university has a wide academic spectrum with its faculties of engineering, basic sciences, forestry, earth sciences and medicine. Within the scope of 12 faculties, 1 college, 8 vocational schools, KTU has 78 undergraduate and 34 associate degree programs; 80 graduate and 57 doctoral programs in 6 institutes (Karadeniz Teknik Üniversitesi, n.d).

- Founded in 1955, the first university outside Istanbul and Ankara.
- KTU TTC (est. 2012) bridges academia with industry in the Black Sea Region.
- Key focus: University – Industry Collaboration services, IPR management and Licensing, entrepreneurship and incorporation services
- Key programs: Gaining Project Implementation Experience, R&D and Design Centre Establishment Support, Academician R&D Catalogue.
- Funding: UIC projects, national (i.e. TÜBİTAK) and international funds and Intra-university research funds
- Impact: 250 patent applications, 77 patent registrations, 46 number of startups/spin-offs in the last 5 years, 25 UIC projects

Bulgaria

Technical University of Sofia

The Technical University of Sofia is one of Bulgaria's largest and most renowned technical institutions, with a focus on engineering, ICT, and applied sciences. It plays a leading role in national research and innovation, particularly in collaboration with industry.

- Expertise: Engineering, ICT, applied sciences.
- TTO: Established in 1963; includes an IP committee and sectorial directors.
- Services: IP management, licensing, spin-offs, industry collaboration.
- Funding: State budget, research programs, industry (30-40% income).
- Achievements: 20 patents, 15 utility models, participation in CoC/CoE projects.

- Impact: Despite its strong research output, there are few international patents, and most patents have not yet been licensed or sold (Technical University Sofia, n.d.)

Plovdiv University

Plovdiv University focuses on bioeconomy, biotechnologies, and applied research. It is a key academic institution in the central region of Bulgaria, contributing to various sectors through its innovation and technology transfer activities.

- Expertise: Bioeconomy, biotechnologies, applied research.
- TTO: Established in 2022, managed by a legal expert.
- Services: IP management, spin-off support, licensing, industry collaboration.
- Funding: State funds, international programs, industry partnerships.
- Achievements: 6 patents, 3 utility models, spin-off training.
- Impact: successfully trained two teams to establish spin-offs and continues to engage in negotiations with businesses for commercialization.

Sofia University

Sofia University is the oldest and most prestigious university in Bulgaria, known for its excellence in physics, chemistry, ICT, and other scientific disciplines. It plays a crucial role in both national and international research projects.

- Expertise: Physics, chemistry, ICT, scientific research.
- TTO: Created under project BG2005/ESC/G/TTO; 3 staff members.
- Services: IP management, commercialization, industry partnerships, training.
- Funding: State, national, EU programs, industry (40% of R&D budget).
- Achievements: 2 patents, 10 pending applications, 150 researchers trained.
- Impact: not yet licensed or sold any patents, limited creation of spin-offs, industry partnerships occur outside the formal TTO processes, driven by personal relationships between researchers and businesses (Sofia University, n.d.)

Technical University of Varna

TU-Varna is a key technical university in Eastern Bulgaria, with a focus on engineering, ICT, and maritime studies. It plays a significant role in the regional economy, especially through its industry collaborations.

- Expertise: Engineering, ICT, maritime studies.
- TTO: Established in 2019; 1 staff member.
- Services: IP consultancy, legal support, industry partnerships.

- Funding: State and external collaborations.
- Achievements: 13 patents and utility models.
- Impact / challenge: understaffed TTO, collaboration with other regional institutions, such as Medical University of Varna, is seen as a potential way to enhance TT activities. (Technical University of Varna, n.d.)

Medical University of Plovdiv

Medical University of Plovdiv is a leading institution in healthcare innovation, particularly in the fields of medical research and healthcare technologies.

- Expertise: Medical research, healthcare technologies.
- TTO: Expected by 2023 under the Recovery and Resilience Plan.
- Services: Medical IP commercialization, hospital partnerships, spin-offs.
- Funding: National Recovery Plan, healthcare partnerships, research grants.
- Challenges: awaiting the full establishment of its TTO, facing challenges in navigating the regulatory complexities of healthcare-related IP commercialization (Medical University of Plovdiv, n.d.)

Romania

"Dunărea de Jos" University of Galati, Romania

"Dunărea de Jos" University of Galați has 15 faculties, offering bachelor's, master's, and doctoral programs in various fields, including technical, humanistic, economic, sanitary, and artistic studies. It provides two-year second-cycle studies for graduates of the first cycle. Doctoral studies are conducted in four doctoral schools across 19 fields, with 129 PhD supervisors. The university plays a key role in South-Eastern Romania's education system, emphasizing knowledge generation and transfer through education, research, innovation, and technology transfer, contributing to social and economic progress.

- Expertise: Bioeconomy, Environment and Eco-Technologies, Energy and Mobility.
- TTO: Established in 2015, accredited in 2017&2023, 2-3 staff members
- Services: IP management, commercialization services, industry partnerships facilitation, training programs for industry personnel on new technologies uptake, training of TT staff, co-working facilities, access to financing.

- Funding: State (Ministry of R&I&D, ministry of education), EU programs, industry collaborations
- Achievements: 89 patent applications, 13 patents, 2 license agreements

Technical University of Cluj-Napoca (UTCN)

UTCN has established the Center for Technology and Knowledge Transfer (CTTC), focusing on critical fields such as bioeconomy, energy, eco-nanotechnologies, ICT, and advanced materials. This center connects UTCN's research capabilities with regional industry needs, emphasizing practical applications that contribute to industrial growth in Northern Romania.

- Expertise: Bioeconomy, energy, eco-nanotechnologies, ICT, advanced materials.
- TTO key role: Connects research with industry in Northern Romania, supporting industrial growth, facilitation of industry clusters, 1-2 staff members
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs
- Achievements: N/A

Polytechnic University of Bucharest (UPB)

As a central player in Romania's capital, UPB's TTO is strategically positioned to connect with numerous tech firms, enhancing the university's influence in the country's technology landscape.

- Expertise: Engineering, ICT, renewable energy.
- TTO key role: Facilitates patenting, industry partnerships, and IP commercialization, 1-2 staff members.
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs enhancing research commercialization, smart city development, and advanced manufacturing.
- Achievements: N/A

Ovidius University of Constanța (UOC)

UOC has also established a Center for Technology Transfer (CTT), which operates under its Research and Innovation Department. This center aims to foster entrepreneurial activities among faculty, students, and alumni and to support the

transfer of knowledge and research findings to regional beneficiaries, enhancing their competitiveness.

- Expertise: Entrepreneurship development, knowledge transfer, spin offs support.
- TTO key role: Provides technical scientific support, consultancy on managerial, financial, marketing, e-commerce and legal issues, facilitation of SMEs to access research-based solutions, 1-2 staff members.
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs
- Achievements: N/A

University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca (USAMV Cluj-Napoca)

The Technology Transfer Office (TTO) at USAMV Cluj-Napoca plays a critical role in promoting sustainable development by transforming academic research outcomes into commercially viable products and services.

- Expertise: Sustainable agriculture, veterinary medicine.
- TTO key role: IP protection, licensing, business model development, industry-research partnership facilitation, 1-2 staff members.
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs
- Achievements: N/A.

Gheorghe Asachi Technical University of Iași (TUIASI)

The Technology Transfer Center at Gheorghe Asachi Technical University of Iași (TUIASI) aims to drive technological innovation and economic growth in Eastern Romania.

- Expertise: Engineering, applied sciences.
- TTO key role: Supports researchers with consulting, funding, and commercialization assistance, 1-2 staff members.
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs
- Achievements: N/A.

University of Agricultural Sciences and Veterinary Medicine of Banat (USAMVBT)

- Expertise: Agri-food sector, sustainable agriculture.
- TTO services: Facilitates partnerships between academia and food processing industries, 1-2 staff members.
- Funding: State funds (Ministry of R&I&D, ministry of education), European programs
- Achievements: N/A.

4.1.2 Prominent Research Centers

In the following paragraphs, Research Centres in Greece, Türkiye, Bulgaria and Romania with significant TT activities are briefly summarized.

Greece

National Centre for Scientific Research (NCSR) "Demokritos"

- Founded: 1959
- Research Areas: Nuclear science, nanotechnology, energy, IT, biosciences
- Technology Transfer Office (TTO): Managed by the Innovation Office, comprising legal, funding, commercialization, and IP experts
- Core Services: Intellectual Property (IP) protection and management, Technology licensing and commercialization, Industry collaboration and partnerships, Support for start-ups and spin-offs, Training and capacity building, Technology and market assessment
- Funding Sources: Internal funds, royalties, grants, sponsorships, accelerator programs
- Key Achievements:
    - Hydrogen technology commercialization (CYRUS spin-off)
    - Industrial Fellowship Programme (2017-2022)
    - European Enterprise Promotion Award (2020)
    - Proof of Concept programs (2023-2024)
    - Selected as a NATO Defence Innovation Accelerator site (2025)
- Metrics (2022-2024):
    - 40 invention disclosures, 196 total patents (76 active)
    - 15 licensing agreements, 108 contract research agreements
    - 30 spin-offs (14 currently active)

Centre for Research and Technology Hellas (CERTH)

- Founded: 2000

- Research Areas: Energy, environment, ICT, transportation, biosciences, agri-tech, security
- TTO: Established in 2005, integrated into the Extroversion Department with engineers and economists specializing in innovation and IP
- Core Services: Intellectual Property (IP) protection and management, Technology licensing and commercialization, Industry collaboration and partnerships, Support for start-ups and spin-offs, Training and capacity building, Technology and market assessment
- Funding Sources: Internal funds, service income, incubator rents, royalties, grants
- Policies & Practices: Operates under a structured TT policy, business plan, and operations manual
- Key Achievements:
  - Led the SPIRA TTO network (2022-2023), supporting multiple institutions
  - Provided TT services to 1500+ researchers
- Metrics (2022-2023):
  - 60+ invention disclosures, 43 patents
  - 23 active spin-offs

Foundation for Research and Technology – Hellas (FORTH)

- Founded: 1983
- Research Areas: Lasers, microelectronics, nanotechnology, biotechnology, AI, robotics, energy, astrophysics
- TTO: Operates under the PRAXI Network (est. 1991) with a team of 6-9 experts
- Core Services: Covers all aspects of research commercialization, IP protection, market analysis, and fundraising
- Funding Sources: Internal funds, royalties, accelerator programs, EU/national grants
- Key Achievements:
  - Member of the Enterprise Europe Network since 2008
  - Appointed as Horizon Europe National Contact Point (2021)
- Metrics:
  - 33 active patents
  - 20 active spin-offs

Networks of Technology Transfer Offices

During 2022–2023, universities and research centers with less developed TTOs partnered with more mature TTOs to form networks that facilitated technology transfer. These collaborations helped with staff training, entrepreneurial development, invention disclosure, patent filing, and spin-off creation.

Three networks led by Research Centres were:

1. **Science Agora Network** – Led by the National Centre for Scientific Research "Demokritos", this network connected five top Greek institutions, including the National Technical University of Athens, Athens University of Economics and Business, Research Center "Athena", and ICCS, to create a technology transfer hub.
2. **Gnosis Network** – Led by Foundation for Research and Technology – Hellas (FORTH), it united several universities (e.g., University of Crete, Technical University of Crete) and research institutions (e.g., Biomedical Science Research Center-Alexander Fleming, Hellenic Pasteur Institute) to promote knowledge transfer and commercialization.
3. **SPIRA Network** – Led by Centre for Research and Technology Hellas (CERTH), this network supported Hellenic Agricultural Organisation Demetra, International Hellenic University, University of Macedonia, and University of Western Macedonia, addressing their technology transfer needs.

The above mentioned networks operated in a similar way.

- Activities performed by the coordinators: assistance to less mature partners in TT activities (i.e. patents, licenses, spin offs creation)
- Common TT activities as a hub: Resources sharing i.e. legal services, patents attorneys' expertise, IP management services Common templates/forms/process, manuals, Training / capacity building
- Common Networking activities Connection of research community to companies and investors
- Funding: The networks were funded by the Operational Programme Competitiveness
- Achievements: In the following table major output from the operation of Science Agora & SPIRA networks are summarized (for the period 5/2022 – to dated):

Science Agora	SPIRA
• Invention disclosures and business opportunity assessment (66) • Training / capacity building sessions (10)	• Invention disclosures (>60) • Training / capacity building (>100 hours) • Sessions on IP protection (>120)

• Applications for Patents (45) • License agreements (9) • Teams that received acceleration services (40) • Spin-offs established (18) • Networking events (15) • Proof of concept actions (6)	• Consultancy for entrepreneurship development (>400 hours) • Applications for patents (30) • Commercialization scenarios (35) • Preparation of business plans (15) • Spin-offs established (6) • Meetings with investors (2) • Proof of concept actions (4) • > 50 innovative technologies promoted

Türkiye

Sabancı University Nanotechnology Research and Application Center

- Founded: 2010
- Research Areas: advanced materials, nano-biotechnology, and nano-electronics
- TTO: managed by experts in engineering, science, law, and business.
- Core Services: IP protection, design and prototyping services, academia-industry partnerships for IP exploitation, nanotechnology-based start-ups creation support.
- Funding Sources: service fees, project revenues, intellectual property (IP) income, government funding, and private donations.
- Policies & Practices: SUNUM e-Store: Online platform for research-based products and services; ArTS Programme: Identifies commercialization potential and supports business planning; SPPP: Evaluates and funds promising research for commercialization; seed.SUNUM: Accelerates product development based on market needs; spnSUNUM: Provides infrastructure for early-stage nanotech start-ups; NORMDEA Call: Supports innovative ideas in biology, chemistry, and engineering.
- Key Achievements:
  - NATO DIANA International start up support Program
  - The “Sensor Platform” EDIH
- Metrics
  - 129 patent applications, 63 granted patents.
  - 438 research projects.
  - Collaborations with 245 national and 72 international institutions.

Bilkent University National Nanotechnology Research Center (UNAM)

- Founded: 2007
- Research Areas: in nanotechnology, materials science, biotechnology, and nanobiotechnology
- TTO: consisted of patent experts, licensing consultants, and technology transfer specialists supporting innovation.
- Core Services: Patent and commercialization support, University-Industry Collaboration (UIC), Education & consultancy to train researchers in and develop human capital, IP protection to secure intellectual property rights for scientific discoveries.
- Funding Sources: service fees, project revenues, intellectual property (IP) income, government funding, and private donations.
- Policies & Practices: open laboratory model, interdisciplinary cooperation and innovation, systematic innovation processes, training R&D qualified workforce
- Key Achievements (2023)
    - TÜBİTAK 1004 A1 Program: Leading high-tech R&D in defence, consumer electronics, and glass industries, collaborating with major organizations like TUSAŞ, Vestel, and Şişecam.
    - Optical Fiber Production: Operates Türkiye's only optical fiber preform production infrastructure and shooting tower, manufacturing critical optical fibers for the defense industry.
    - Bilkent University MSN Program: Provides R&D education in nanobiotechnology, LEDs, lasers, optical fibers, and nanocomposites. Graduates secure positions at Stanford, MIT, Yale, Cambridge, Harvard, and top companies like Intel, Apple, and Aselsan.
- Impact & Metrics
    - 500+ patent applications, 137 national, 87 international patent registrations.
    - 29 spin-off/startup companies.
    - 53 licensed technologies.

METU Micro-Electro-Mechanical Systems (MEMS) Center

- Founded: 1998 (initiation 1980's)
- Research areas: Micro-Electro-Mechanical Systems technology, microfabrication, and microsystems development
- TTO: 97 staff members, including 55 researchers with masters or doctoral degrees. The TTO handles.

- Core Services: Support patent applications, licensing, industry partnerships and spin offs creation
- Funding Sources: service fees, research projects, government funds, intellectual property revenues, and donations.
- Policies & Practices: IPR policy in accordance to research legislation, spin off creation and industry collaboration policies to accelerate the commercialization of research results, innovative production techniques and continuous updating of microfabrication capacities (i.e. clean area microfabrication technologies), structured pricing system for licensing technologies and offering services, sharing of infrastructure facilities facilitation of Industrial Collaborations & Partnerships and enhancement of MEMS technology presence worldwide.
- Key Achievements
  - MEMS Gyroscope-Based Compass (with ASELSAN)
  - MEMS-Based Touch Alcohol Detection System (with TOGG)
  - Chip Assembly Production & Prototyping (with ROKETSAN)
- Metrics & Impact
  - 53 national/international patents
  - Extensive industry collaborations, particularly in the defense sector

Bulgaria

Institute of Robotics, BAS

- Founded: 2010
- Focus: Leading Bulgarian robotics research center with the highest number of patents.
- TTO: Supported by the QUASAR Competence Centre, specializing in IP management and industrial partnerships.
- Operations: IP protection, licensing, and commercialization; collaborations with international firms.
- Funding Sources: national and international collaborations, partnerships with Industry
- Policies & Practices: concrete strategy for licensing and selling intellectual property, MoU with industry
- Impact and Metrics: Commercialized 30 patents

Institute of Information and Communication Technologies, BAS

- Founded: 2010
- Focus: Computer science, ICT, and interdisciplinary applications.
- TTO: Established between 2009-2012; integrated into Digital Innovation Hubs.
- Core services: Industry partnerships, IP management, and innovation projects in cybersecurity and energy transition.
- Funding Sources: EU programs, National Innovation Fund
- Policies & Practices: the TTO is integrated into several Digital Innovation Hubs, which promote collaboration with industry
- Achievements: Strong industry links and leadership in European ICT research.

Institute of Mechanics, BAS

- Focus: Mechanics, materials, and structural dynamics research.
- TTO: not established yet Supported
- Operations: IP consultancy, technology commercialization.
- Policies & Practices: TT activities are supported by the GIS-Transfer Centre
- Achievements: Holds several active patents and collaborates on structural dynamics and mechanics innovations.

Joint Innovation Centre (JIC), BAS

- Founded: 2005
- Focus: none
- TTO: 3 staff members
- Operations: Patent filing, licensing, training, and consultancy.
- Policies & practices: it is the central coordination unit for the BAS Institutes
- Funding Sources: project funded, commercialization services to Enterprise Europe Network
- Achievements: supports 50 autonomous research units across BAS

GIS-Transfer Centre (GIS-TC)

- Founded: 2000
- TTO: GIS-TC is the oldest technology transfer network in Bulgaria, coordinating a national TT network comprising over 30 member entities. The core team consists of engineers, economists, and legal experts with decades of experience in TT.
- Core Services: GIS-TC provides IP support, collaborative research contracts, industry matchmaking, and consultancy services. It emphasizes support for SMEs and innovation transfer.

- Policy & Practices: TT services are offered to both academic institutions and SMEs.
- Funding Mechanisms: Funded through its partnerships with BAS, multiple universities, and international foundations, GIS-TC also collaborates with the Steinbeis Foundation in Germany.
- Key Achievements: GIS-TC has facilitated the creation of seven BAS spin-offs and supports numerous academic institutions, including Sofia University and the University of Varna. (GIS-Transfer Centre)

Romania

The following research centers that operate within Dunărea de Jos" University of Galati have been identified as prominent in the Romanian TT ecosystem.

	Name	Initiation	Area of expertise
1	BioAliment-TehnIA Biotechnologies in the Food Industry and Aquaculture	2001	Food sciences, food engineering and applied biotechnologies
2	European Centre of Excellence for the Environment (ECEE)	1999	Environmental protection, sustainable development and the influence of environmental factors on the health of the population
3	Centre for Mechanics and Tribolory of the Superficial Layer (MTSS)	2004	Mechanics and tribology
4	Romanian Center for Modeling Recirculating Aquaculture Systems - MoRAS	2017	Aquaculture of recirculating systems
5	INPOLDE international interdisciplinary research lab network	2014	Environmental Interdisciplinary research
6	Integrated Energy Conversion Systems and Advance Control of	2013	Energy, environment, climate change, ICT, space, security, materials, processes and products

	Complex Processes (SICECAPC)		
7	Interdisciplinary Research Centre on the field of eco-nano technologies and innovative materials (CC-ITI)	2021	Eco-nanotechnologies and advance materials, energy, environment and climate change
8	Technological Engineering Research Center in Machine Construction (ITCM)	2004	Mechanical engineering, mechatronics, industrial engineering and management
9	Research Center Modelling and Simulation Laboratory (SMlab)	2007	ICT, Space and Security
10	Intelligent Systems and Information Technology Research Centre (SITI)	2007	AI for education, data mining, machine learning, soft computing
11	Scientific Research Centre for Thermal Machines and Equipment and Environmental Engineering in Energy (METIME)	2003	Applied thermodynamics, modeling and numerical simulation, therma energy systems, pollution control, RES
12	Mechanics of Machines and Technological Equipment Research Center (MECMET)	2004	Interdisciplinary research in the field of mechanics
13	Naval Architecture Research Centre (CCAN)	2001	Naval hydro-aerodynamics, naval structures
14	Research and Development Center of Excellence in Numerical Modeling and Simulation CE-CDMSN / CE- PP	2011	Mechanical engineering, mechatronics, industrial engineering and management, polymer processing
15	Research Center Automatic Process Control Systems (SCAP) Short description:		Systems Engineering

16	Center for advanced welding research (SUDAV)	2006	fusion and pressure welding technologies
17	Center for Research in Electronics, Information Technology & Communications (CCETIC)	2009	Signal processing, Information processing and transmission, Intelligent and autonomous electronic systems, Soft computing techniques.
18	Lunca Agronomic & Environmental Research & Consultancy Center (CCCAM Lunca)		Agronomic and Environmental Research
19	Research Center S - Research and development center for thermosetting matrix composites (CCDCOMT)	2016	Mechanical Engineering/Materials Science/ Composite Materials and Structures.
20	Interdisciplinary Center for Artistic Studies (CISA)	2015	Humanities and Arts" and the research directions are Music, Visual Arts and Theater and Performing Arts.
21	Multidisciplinary Integrated Center for Dermatological Interface Research (CIMCID)		Biomedical Sciences
22	Research Center for Human Performance (CCPPU)	2004	Physical Education and Sport

All the above mentioned Research Centers operate in a similar way:

- Core Services: University-Industry Collaboration (UIC), Education & consultancy, transfer of knowledge to economic/industrial environment, laboratory services, training professional development services, research and experimental development services
- Funding Sources: internal funds, PhD funds, projects and sponsors, government grants
- Policies & Practices: applied R&D projects with industrial partners, networking through conferences, technology fairs and staff exchanges, activities for

raising awareness of the innovation stakeholders about the innovative potential.

- Impact & Metrics:
  - Vast number of applied projects and partnerships with the industry
  - 11 patents
  - 4 licensed technologies.

4.1.3 Public and Private Initiatives Supporting the TT Ecosystem

In the following paragraphs, significant public and private initiatives supporting the TT ecosystems of Greece, Türkiye, Bulgaria and Romania are briefly presented.

Greece

Elevate Greece: A Catalyst for Innovation and Technology Transfer

- Mission: Launched in 2020 to support Greek startups through funding, mentorship, networking, and policy advocacy.
- Key Services: Government/EU funding, innovation challenges, IP management, startup incubation.
- Impact:
  - 600+ startups registered
  - €50M+ venture capital attracted
  - 5,000+ jobs created
  - International exposure through global events

Egg: A Leading Greek Initiative for Innovation and Entrepreneurship

- Mission: Established in 2013 by Eurobank and Corallia to accelerate entrepreneurship.
- Key Services: Funding (€45.8M+ raised), mentorship, business bootcamps, IP management.
- Impact:
  - 1,200+ entrepreneurs supported
  - 200 legal entities, 360 jobs created
  - 55 companies filed patents
  - Alumni startups generated €48M+ turnover

NBG Business Seeds: Promoting Innovation and Entrepreneurship in Greece

- Mission: Established by the National Bank of Greece in 2010 to scale startups and foster technology transfer.
- Key Services: Funding, business bootcamps, mentorship, innovation competitions.
- Impact:
  - 100+ startups supported
  - €50M+ private investments secured
  - 150+ startups scaled successfully

EquiFund: A Boost to Innovation and Growth in Greece

- Mission: Launched in 2018 in partnership with the European Investment Fund to enhance venture capital in Greece.
- Key Services: Three investment windows—Innovation (researchers), Early Stage (startups), Growth Stage (scaling businesses).
- Impact:
  - Funding from €30,000 to €12M per company
  - Strong focus on technology transfer & commercialization
  - Numerous startups expanded internationally

These initiatives significantly contribute to Greece's innovation ecosystem, fostering entrepreneurship, investment, and technology commercialization.

Thess INTEC: A 4th Generation Science and Technology Park in Thessaloniki

Thessaloniki Innovation and Technology Center (Thess INTEC), established in 2017, is a 4th generation science and technology park aimed at fostering innovation and collaboration between academia, industry, and research institutions. It offers services like incubation, funding programs, networking, IP management, and high-tech facilities. Funding comes from government, EU, and private investments. The park will focus on technology transfer, commercialization, and supporting startups and spin-offs. Expected to span 760,000 sqm and host 7,000+ professionals, Thess INTEC will be a key player in Greece's digital transformation.

General Secretariat for Research and Innovation (GSRI): Clusters & Competence Centers

GSRI launched funding calls in 2020 to create innovation clusters and competence centers to enhance research commercialization. Clusters unite businesses and research institutions in ICT, energy, and health, while competence centers provide R&D and IP services. By 2023, over 10 clusters and 8 competence centers were established, leading to 50+ patents and a rise in R&D investment. Funded by national and EU resources, these initiatives aim to strengthen Greece's position in the global innovation landscape.

Hellenic Business Angels Network (HeBAN)

Founded in 2015, HeBAN connects startups with angel investors, offering funding, mentorship, and networking opportunities. It supports technology transfer by assisting startups in commercialization, IP management, and scaling. HeBAN's funding comes from private investors and international partnerships, helping Greek startups gain visibility and attract foreign investment.

Hellenic Network of Technology Transfer Offices (METEX)

Established in 2023, METEX connects universities, research institutions, and businesses to streamline technology transfer. It offers IP management, licensing, and commercialization support while coordinating national TT efforts. Funded by government grants, EU programs, and industry collaborations, METEX has integrated 20 institutions, significantly enhancing innovation and commercialization in Greece.

One Stop Liaison Office (OSLO) - Region of Central Macedonia

Part of the RIS3 Strategy, OSLO facilitates innovation and technology transfer by linking research and industry in Central Macedonia. It provides networking, incubation, IP management, and startup support services. Funded through national and EU programs, OSLO focuses on spin-off creation and commercialization, playing a vital role in regional innovation and business development.

Türkiye

TÜBİTAK

TÜBİTAK is Türkiye's largest scientific and technological research institution, leading the national technology initiative by shaping science and technology policies, fostering R&D, and strengthening the innovation ecosystem.

- Services Offered: Supports national STI policies, funds R&D in academia and industry, provides scholarships, and promotes innovation.
- Technology Transfer Strategies: TÜBİTAK identifies national R&D priorities biannually, supports industrial adaptation to green technologies, guides key tech sectors with targeted R&D plans, ranks 50 universities on innovation & entrepreneurship, evaluates universities' research competencies, measures technology readiness levels for R&D projects, develops five-year plans aligning with Türkiye's development goals.
- Internal Processes & Practices: TÜBİTAK operates through the directorates of research project funding managements, of private-sector R&D and innovation support, of scientist development programs funds, of international research collaborations management and of scientific awareness in society promotion. Additionally, TÜBİTAK has research centers and a Technology Transfer Office to manage intellectual property and commercialization.
- Major Achievements: Türkiye's first high-resolution imaging satellite (İMECE Satellite), Air-to-air missile system for defense applications (GÖKTUĞ Project).
- Funding Mechanisms: Funded by the Turkish government, TÜBİTAK provides non-refundable grants for R&D.
- Metrics and Impact: 2,277 startups launched via TÜBİTAK grants, 22,520+ national / international R&D projects supported, 270 national, 45 European, and 1 Eurasian patent registered (T.C. Sanayi ve Teknoloji Bakanlığı, 2023 & TÜBİTAK, 2024)

TÜRKPATENT

TÜRKPATENT operates under the Ministry of Industry and Technology, aiming to enhance industrial property awareness and ensure effective protection and commercialization of industrial property rights in Türkiye and internationally.

- Services Offered: registers patents, trademarks, utility models, designs, and geographical indications, oversees licensing, transfers, and protection of industrial property rights, monitors technology transfer and innovation, collaborates with international organizations on IP matters, provides public education and training on industrial property.
- Technology Transfer Strategies: educates students on patenting to boost domestic applications (Patent Workshop), encourages student innovation

through patent challenges 'Patentle Türkiye' Competition, Provides IP guidance across 81 cities Industrial Property Advisory Unit, supports startups in patenting and commercializing innovations TÜRKPATENT PATİKA, connects inventors with investors at an international innovation fair International Invention Fair - ISIF.

- Internal Processes & Practices: TÜRKPATENT manages IP registrations and rights protection through specialized units for Patents & Utility Models, Trademarks, Designs, Geographical Indications, Integrated Circuit Topographies and objections to IP-related decisions.
- Major Achievements: Türkiye ranks 13th in the world in domestic patent applications, 5th in trademark applications, and 3rd in design applications. Within the scope of international applications, it ranked 16th in patent applications, 8th in trademarks and 11th in design applications.
- Funding Mechanisms: TÜRKPATENT operates as a special budget institution under the Ministry of Industry and Technology.
- Metrics and Impact: 103,604 national and 158,762 international patent applications, 2,184,415 national and 330,880 international trademark applications, 879,252 national and 28,148 international design applications, 592 registered geographical indications.

Development Agencies (DAs) in Türkiye

Development Agencies (DAs) operate under the Ministry of Industry and Technology, providing financial and technical support to regional actors. Their goal is to accelerate regional development, strengthen industries, and enhance economic competitiveness through innovation and sustainability.

- Services Offered: DAs develop and implement regional development strategies, identify and promote business and investment opportunities, strengthen cooperation between public, private, and civil society sectors, support entrepreneurship, R&D, and innovation ecosystems, provide financial and technical assistance for local projects, facilitate access to international funds for regional stakeholders.
- Policies/Strategies on Technology Transfer (TT): DAs focus on manufacturing, R&D, digitalization, smart specialization, and trade; support human capital, health, culture, and social inclusion initiatives; enhance environment, energy, logistics, and urban planning; strengthen institutional capacity and incentives for regional investments and foster national and global collaborations. DAs also work on managing TT processes, protecting intellectual property (IP) rights, and supporting patent commercialization.

- Internal Processes & Practices: DAs share centralized platform for document management and data sharing. DAs operations are backed up by projects/programs like Supporting Attraction Centers, Social Development Support, and Youth Employment Initiative. There is strong emphasis on project's impact analysis.
- Funding Mechanisms: DAs funding sources include Central Government Budget, Municipal & Provincial Contributions, Industry & Commerce Chambers and International Funds.
- Metrics and Impact (2022): 1,087 projects supported, 352 program evaluation, €300 million in international funding secured in the past 5 years, 5,280 jobs creation, and 310 regional development analyses.

The Union of Chambers and Commodity Exchanges of Türkiye (TOBB)

TOBB is Türkiye's leading business organization, representing industrial, trade, and commerce chambers as well as commodity exchanges. TOBB consists of 365 Chambers and Exchanges and over 1.2 million registered companies across multiple sectors.

- Services Offered: loans, guarantees, and financial support for SMEs in collaboration with banks; business management, digitalization, and sectoral training; access to global markets and forming partnerships; support in adopting new technologies, digital transformation, and green initiatives; enhancement of digital solutions for smoother commercial transactions.
- Technology Transfer (TT) and Innovation Strategies: collaborates with universities to foster R&D and tech transfer; implements a Chamber Accreditation System to improve service standards; works with large enterprises (e.g., CERN, ASELSAN) to integrate SMEs into supply chains.
- Funding Mechanisms: TOBB provides financing support to SME's through the Credit Guarantee Fund (CGF); support to innovative startups and spin offs through the KOBİ Venture Capital Investment Partnership (KOBİ VCIP); access to global trade through ITD Carnet and transit document services; support to rapidly growing companies through the TOBB Türkiye 100 Program; support to SMEs to be integrated into large company supply chains though the Supplier Development Program and access to funding for green transformation and digitalization through cooperation with the EU and global organizations.

Bulgaria

Fund of Funds Bulgaria (FoF)

- Mission: State-owned financial institution managing public funds to support startups, including deep-tech ventures.
- Operations: Provides grants, seed funding, and venture capital co-investments; oversees a €60M deep-tech transfer fund.
- Impact: Managed €146.5M in venture capital, attracting €244M in startup investments in 2022.

Sofia Tech Park

- Mission: A technology park fostering innovation, collaboration between academia and industry, and startup growth.
- Operations: Provides infrastructure, incubators, Proof of Concept funding, and organizes networking events.
- Impact: Supports startups, hosts over 50 testing labs, and collaborates with CERN and universities for R&D commercialization.

Bulgarian Patent Office (BPO)

- Mission: National authority for intellectual property rights, supporting IP commercialization and technology transfer.
- Operations: Offers patent filing services, IP training, and works with WIPO & EPO for resources.
- Impact: Increased electronic IP services (92%), improved IP commercialization, and expanded university training programs.

National Innovation Fund (NIF)

- Mission: Supports R&D, innovation, and commercialization of research in Bulgaria.
- Operations: Provides grants for technology transfer, facilitating business-research collaborations.
- Impact: Funded hundreds of projects, enabling companies to develop market-ready technologies.

Romania

Ministry of Research and Innovation (MCI) - Romania

MCI plays a crucial role in advancing Romania's research landscape, supporting innovation-driven businesses, and integrating technology into the economy through strategic policies and funding initiatives. The MCI supports the creation of Technology Transfer Centres in Romania. Currently, at the national level, 38 authorized Technology Transfer Centers (TTCs) and 10 provisionally authorized entities are operational. The Ministry administers national and European Funds for Research and Innovation (i.e. PNCDI III - National Plan for Research, Development and Innovation) that provides financial support for projects that encourage collaboration between the public and private sectors. MCI administers also funds for the development of Research Infrastructures. Moreover, the Ministry collaborates with several specialized services and organizations (i.e. Executive Unit for the Financing of Higher Education, Research, Development and Innovation, National Authority for Scientific Research and Innovation Regional Development Agencies) that provide support for collaborative projects between academia and private industry/SMEs at national and regional/local levels, support for spin offs creation and for business incubation and acceleration programs. Finally, the MCE encourages and facilitates international innovation development projects by promoting opportunities provided by Horizon Europe and other Bilateral and multilateral partnerships.

The Institutional Development Fund (FDI)

The FDI is relatively recent component (mechanism) of Romanian institutional funding in the form of a project-based competition with the purpose of supporting public higher education institutions (HEIs) in implementing their institutional strategic plans in their pursuit of the national strategic objectives. This policy aims to encourage universities to formulate their own answers (through institutional projects) to current challenges such as internationalization, regional development, supporting the entrepreneurship

Ministry of Education

In addition to the basic funding provided to universities, complementary (also called supplementary) funding is granted by the Ministry of Education through funds allocated on competitive basis for academic scientific research among others. This is distributed according to the results obtained by universities on a series of performance indicators and the main role of the supplementary funding is linked to boosting performance in several major areas one of which is research.

ReNITT: National Network for Innovation and Technology Transfer (Romania)

ReNITT is a coordinating initiative under the Ministry of Research and Innovation, designed to enhance the visibility and commercialization of R&D results while improving SME competitiveness through technology transfer. It includes ~50 organizations, such as Technology Transfer Centers (CTTs), Technology Information Centers (CITs), Technology & Business Incubators (ITAs), Science & Technology Parks

ARoTT: Romanian Association of Technology Transfer and Innovation

ARoTT is a non-governmental, non-profit professional organization supporting Technology Transfer Offices (TTOs) and innovative businesses. Main activities include training, international events, and best practice transfer.

Danube Transfer Centres Network (DTC)

DTC is an international network spanning the Danube Region, dedicated to fostering innovation and knowledge transfer between academia and the economic environment. With 13 members, present in 9 countries, the services DTC provides include technology transfer, intellectual property management, management of innovation projects and value proposition consultancy. Romania has 4 hubs, in Craiova, Bucharest, Iasi, Cluj-Napoca, with each hub having regional partners.

Enterprise Europe Network (EEN)

EEN is the largest European network that supports businesses to incorporate innovation. Within Romania there are four EEN regional networks: BisNetTransilvania (with centres at: Alba Iulia, Sfantu Gheorghe, Cluj-Napoca, Brasov, Covasna); ERBSN (which covers Bacau, Botosani, Braila, Buzau, Constanta, Galati, Iasi, Neamt, Tulcea, Vaslui and Bucharest) and RO_BOOST (with centers at Timisoara and Craiova).

Accelerators & Incubators for TT

At least 20 accelerators are active in Romania, together with six incubators and 33 coworking spaces. Some of them combine TTO functions with incubation activities such as the TT and Business Incubator Centre”Gh. Asachi” University of Iasi.

4.2 Main Conclusions on TT Processes and Practices

Technology Transfer (TT) processes and practices across Greece, Bulgaria, Türkiye, and Romania reveal common trends as well as unique national challenges. By examining the mechanisms through which TT is conducted in these countries, we can identify best practices, inefficiencies, and key areas for policy intervention.

- **Greece:** TT ecosystem is characterized by strong academic research output but low commercialization rates. While some universities have well-established Technology Transfer Offices (TTOs), many institutions lack structured TT mechanisms. Regulatory frameworks are underdeveloped, and funding constraints hinder the scaling of innovations.
- **Bulgaria:** faces challenges in aligning research outputs with industry needs. Despite producing high-quality research, much of it remains underutilized due to weak industry linkages. Funding for innovation and support for spin-offs are inadequate, and policy fragmentation limits TT effectiveness.
- **Türkiye:** has made notable progress in institutionalizing TT processes, with the expansion of TTOs and technology development zones. However, inefficiencies in commercialization, standardization issues, and limited coordination among stakeholders remain challenges.
- **Romania:** TT ecosystem is fragmented, with weak collaboration between academia, industry, and the public sector. Despite growing research quality, TT infrastructure remains underdeveloped, and human resource shortages in R&D persist.

4.2.1. Key Challenges in TT Processes across the Four Countries

Institutional and Policy Gaps

All four countries exhibit weak regulatory frameworks for technology transfer. Unlike advanced TT ecosystems such as those in the United States, Germany, or the UK, which have well-defined policies encouraging research commercialization (Speser, 2006), these Southeast European countries struggle with inconsistent legal frameworks.

Weak Academia-Industry Linkages

Successful TT requires strong ties between universities and industry, as demonstrated in Silicon Valley and Cambridge (Butler & Gibson, 2011). In contrast,

Greece, Bulgaria, Türkiye, and Romania suffer from limited collaboration between academic institutions and businesses, leading to low commercialization rates.

Limited Funding and Investment Mechanisms

Access to funding is a significant barrier. While countries like the USA and Germany have robust venture capital ecosystems supporting startups (Jolly, 1997), the studied countries depend heavily on EU funding, with limited local private sector investment in R&D and technology commercialization.

Insufficient IP Management and Commercialization Support

Advanced TT ecosystems have structured IP management and patenting strategies (Conti & Grimaldi, 2024). However, in the four countries analyzed, researchers lack sufficient support in IP protection, licensing, and commercialization strategies.

Skills and Human Resource Gaps

Many researchers and PhD graduates leave Romania, Bulgaria, and Greece for better opportunities abroad, reducing the local talent pool (European Commission, 2024, as cited in the Romania country report). Countries like the USA and Germany retain high-skilled talent through well-funded TT institutions and industry partnerships (Hytti, 2021).

4.2.2 Comparison with More Advanced TT Ecosystems

Factor	Greece, Bulgaria, Türkiye, Romania	Advanced TT Ecosystems (e.g., USA, Germany, UK)
Regulatory Frameworks	Underdeveloped, fragmented policies	Strong legal structures supporting innovation (e.g., Bayh-Dole Act in the USA) (Speser, 2006)
University-Industry Collaboration	Weak partnerships, limited engagement	Robust collaboration with clear pathways for research commercialization (Butler & Gibson, 2011)
Funding and Investment	EU-dependent, limited local VC funding	Diverse funding sources, strong VC presence (Jolly, 1997)

IP and Commercialization Support	Limited institutional support, low patenting rates	Strong IP frameworks, proactive patenting strategies (Conti & Grimaldi, 2024)
Human Capital and Skills	Brain drain, limited entrepreneurship culture	High retention of skilled talent, strong TT education programs (Hytti, 2021)

4.2.3 Recommendations for Enhancing TT Processes

Strengthening Policy and Institutional Frameworks

- Introduce legislation similar to the Bayh-Dole Act in the USA to facilitate research commercialization (Speser, 2006).
- Develop national TT strategies to unify fragmented initiatives.

Enhancing Academia-Industry Collaboration

- Foster joint research projects and industry-sponsored research programs.
- Implement incentives for universities and businesses to co-develop technologies (Butler & Gibson, 2011).

Increasing Funding and Investment

- Establish national VC funds focused on technology startups.
- Encourage private sector participation through tax incentives for R&D investments (Jolly, 1997).

Improving IP and Commercialization Support

- Develop specialized training programs for researchers and SMEs on patenting and licensing.
- Strengthen university TTOs with dedicated legal and business support (Conti & Grimaldi, 2024).

Addressing Human Resource Gaps

- Introduce policies to retain skilled researchers through competitive salaries and career development programs.
- Promote entrepreneurship education in universities to cultivate innovation-driven mindsets (Hytti, 2021).

4.2.4 Key TT Processes and Practices

From a comparative perspective, the following TT processes and practices emerge as pivotal across the four countries:

1. **University-Industry Collaboration Models:**
    - Greece: The PRAXI Network supports academia-industry partnerships, but engagement is inconsistent.
    - Bulgaria: The National Innovation Fund offers incentives for university-industry projects.
    - Türkiye: TÜBİTAK actively funds research and development activities in companies of all sizes, including university spin-offs and startups, through targeted programs.
    - Romania: ReNITT provides networking opportunities but lacks industry engagement mechanisms.
2. **Technology Licensing and Patent Management:**
    - Greece: Lengthy bureaucratic procedures slow down patent applications and licensing.
    - Bulgaria: IP protection is weak, leading to a lack of confidence in commercializing research.
    - Türkiye: A patent law providing the opportunity to act in accordance with European standards is in force in Türkiye. However, while the law opens up a comprehensive field of application in patent management, there are areas for improvement in the areas of commercialization and sharing of patent rights.
    - Romania: Researchers often lack legal expertise to navigate IP commercialization.
3. **Innovation Funding and Investment Mechanisms:**
    - Greece: Heavy reliance on EU funds with limited private investment.
    - Bulgaria: Low venture capital activity and insufficient seed funding for startups.

- Türkiye: Well-developed public funding mechanisms but gaps in early-stage financing.
- Romania: EU structural funds play a crucial role, but administrative delays hinder their impact.

4.2.5 Critical Reflections and Policy Implications

The findings from this study align with key insights from academic literature on technology transfer. According to Speser (2006), effective TT requires streamlined legal frameworks, industry-academic alignment, and sustainable funding mechanisms. Jolly (1997) emphasizes the importance of commercialization pathways, which remain underdeveloped in Greece and Bulgaria but are more structured in Türkiye. Furthermore, findings from "Ecosystems and Technology" suggest that an interconnected TT network, as proposed by T3N-BSB, could improve knowledge-sharing and reduce inefficiencies across the region.

To improve TT effectiveness in the Black Sea region, governments should focus on:

- Strengthening public-private partnerships to increase private-sector involvement in TT.
- Simplifying IP protection and patenting procedures to accelerate commercialization.
- Enhancing TT office capacities by providing specialized training for technology managers.
- Expanding cross-border initiatives like T3N-BSB to foster knowledge exchange and collaboration.

By addressing these issues, Greece, Bulgaria, Türkiye, and Romania can create a more dynamic and sustainable TT ecosystem that benefits both academia and industry.

- **Greece & Bulgaria:** Struggle with weak university-industry ties and limited funding opportunities, making commercialization efforts slower.
- **Türkiye & Romania:** More structured and agile TT frameworks should be created, but regulatory processes on the state side need to be as fast and agile as private sector dynamics.
- **Joint Challenges:** IP protection inconsistencies, a shortage of TT professionals, and limited R&D investment from the private sector.

4.3 SWOT Analysis

The SWOT analysis identifies the key internal and external factors affecting the technology transfer (TT) ecosystems in Greece, Bulgaria, Türkiye, and Romania. This detailed assessment allows for a deeper understanding of strengths, weaknesses, opportunities, and threats at both national and regional levels.

Strengths

- **Greece:** Strong research output from institutions like CERTH and the National and Kapodistrian University of Athens. EU funding opportunities through Horizon 2020 and NSRF enhance TT capabilities.
- **Bulgaria:** Presence of the Bulgarian Academy of Sciences (BAS) and Sofia Tech Park as innovation drivers. Strong academic research base.
- **Türkiye:** Well-established TT structures, supported by TÜBİTAK's 1513 and 1601 programs. Technoparks and incubation centers such as METU Teknokent play a significant role in commercialization.
- **Romania:** Innovation hubs like Măgurele Science Park and ReNITT foster TT collaborations. EU-backed funding opportunities available to research institutions.

Weaknesses

- **Greece:** Bureaucratic inefficiencies delay patenting and commercialization. Limited private-sector involvement in TT initiatives.
- **Bulgaria:** Weak IP protection and limited expertise in commercializing research. Fragmented TT ecosystem.
- **Türkiye:** Limited early-stage funding for TT startups. Regulators' demands for long-term commercialization forecasts are impacting TT venture capital investment.
- **Romania:** Low private-sector engagement and underdeveloped R&D funding mechanisms. Weak coordination between industry and academia.

Opportunities

- **Greece:** Expansion of public-private partnerships could increase industry participation in TT. Digitalization and Industry 4.0 trends present growth potential.
- **Bulgaria:** Strengthening innovation policies and increasing venture capital investment. Regional collaboration with EU partners.

- **Türkiye:** Leveraging technoparks and research centers to attract international investors. Expansion of technology-based entrepreneurship.
- **Romania:** Improved policy coordination and increased investment in green and digital innovations. Cross-border TT initiatives, such as T3N-BSB, offer regional synergies.

Threats

- **Greece:** Economic instability threatens long-term TT funding. Stronger TT ecosystems in other EU nations pose competitive challenges.
- **Bulgaria:** Brain drain of skilled researchers to Western Europe. Weak enforcement of innovation policies.
- **Türkiye:** High dependence on public funding. Economic fluctuations impact R&D investments.
- **Romania:** Delays in accessing EU structural funds. Administrative inefficiencies hinder effective TT policy implementation.

4.4 TOWS Analysis and Strategic Recommendations

Building on the SWOT analysis, a TOWS (Threats, Opportunities, Weaknesses, Strengths) matrix helps identify strategic actions to strengthen the TT ecosystem across the Black Sea region. The following strategies are informed by insights from academic literature on technology transfer, including Speser (2006) and Jolly (1997), as well as empirical findings from the country reports.

SO Strategies (Strengths-Opportunities)

- **Leverage EU funding mechanisms** to expand TT networks and research commercialization in Greece and Romania, following models outlined in Speser's (2006) work on structuring TT offices effectively.
- **Expand technoparks and research centers** in Türkiye to attract foreign investments and enhance global competitiveness, aligning with Jolly's (1997) roadmap for commercialization pathways.
- **Develop national innovation clusters** in Bulgaria, fostering industry-academia collaboration to improve commercialization rates, inspired by the cluster-based TT approach seen in Western Europe.

WO Strategies (Weaknesses-Opportunities)

- **Address bureaucratic delays** in Greece by introducing streamlined IP and patenting procedures, as recommended in Speser's (2006) findings on legal efficiency in TT.
- **Enhance private-sector involvement** in Romania and Bulgaria through tax incentives and targeted funding programs, drawing from case studies in successful EU TT frameworks.
- **Promote regional knowledge-sharing platforms** to compensate for gaps in commercialization expertise across all four countries, aligning with Jolly's (1997) findings on knowledge diffusion in TT networks.

ST Strategies (Strengths-Threats)

- **Develop cross-border TT policies** under T3N-BSB to mitigate economic instability and funding uncertainties, drawing from successful EU models for transnational TT collaboration.
- **Enhance legal protections for IP and TT** in Bulgaria and Romania to prevent talent loss and increase industry engagement, incorporating insights from Speser (2006) on legal barriers to TT.

WT Strategies (Weaknesses-Threats)

- **Increase training programs for TT professionals** to address expertise gaps and reduce reliance on external consultants, following Jolly's (1997) model of TT professionalization.
- **Introduce TT-focused policy reforms** in all four countries to improve efficiency and reduce administrative bottlenecks, inspired by best practices from high-performing TT ecosystems in Europe.

Conclusion and Future Outlook

The findings from this TOWS analysis indicate that while Greece, Bulgaria, Türkiye, and Romania have strong academic research foundations, their TT ecosystems face commercialization, policy coordination, and private-sector engagement challenges. The insights from Speser (2006) and Jolly (1997) suggest that fostering long-term strategic initiatives, such as cross-border collaborations, improved IP protections, and sustainable TT office structures, is essential for success.

To maximize the impact of TT in the Black Sea region, cross-border initiatives such as T3N-BSB should be further strengthened. Regional strategies focused on policy harmonization, investment in digital innovation, and transnational TT collaborations will be key to achieving a more integrated and sustainable TT ecosystem.

Building on the SWOT analysis, a TOWS (Threats, Opportunities, Weaknesses, Strengths) matrix helps identify strategic actions to strengthen the TT ecosystem across the Black Sea region.

4.5 Comparative Analysis: Technology Transfer Ecosystems in Greece, Bulgaria, Türkiye, and Romania in the Context of Advanced Models

The technology transfer (TT) ecosystems of Greece, Bulgaria, Türkiye, and Romania have undergone significant evolution in recent decades. However, in comparison with leading global TT models such as those in the United States, Germany, the United Kingdom, and Israel, structural limitations and systemic inefficiencies persist. This section presents a critical comparative analysis, identifying key deficiencies and outlining strategic pathways for alignment with advanced TT paradigms.

1. University-Industry Collaboration: Bridging the Gap

The degree of engagement between academia and industry remains a defining determinant of a successful TT ecosystem.

- **Greece & Bulgaria:** Exhibit a fragmented landscape of university-industry partnerships, where research institutions predominantly assume passive roles in technology commercialization. Despite initiatives such as the creation of TTO networks from Universities and Research organizations in Greece and the National Innovation Fund in Bulgaria, the private sector's engagement remains limited, thereby restricting the effective mobilization of research output.
- **Türkiye & Romania:** Türkiye benefits from a more structured framework facilitated by TÜBİTAK, which actively promotes university-industry synergies. Similarly, Romania's Regional Network for Innovation and Technology Transfer (ReNITT) seeks to bridge the gap between research and commercialization, although with inconsistent outcomes due to bureaucratic and structural impediments (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Best Practices from Advanced Models:** In contrast, innovation ecosystems such as Silicon Valley and Germany's Fraunhofer Institutes integrate structured incentives for collaboration between academic institutions and industries. In the United States, the Bayh-Dole Act has played a transformative role in ensuring research commercialization through well-defined legal and financial mechanisms (Speser, 2006).

2. Technology Licensing and Intellectual Property (IP) Commercialization

The robustness of intellectual property frameworks significantly influences the efficiency of TT processes.

- **Challenges in Greece & Bulgaria:** Both countries contend with protracted patenting processes, bureaucratic inertia, and weak enforcement mechanisms, which serve as deterrents for researchers seeking to commercialize their innovations (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Türkiye & Romania:** Although intellectual property protection legislation in Türkiye is in line with EU directives, the fact that the TRLs of technologies are not ready for the market delays investments and supports R&D studies processes. In Romania, researchers often lack the requisite legal and commercial acumen to navigate the complexities of IP commercialization, resulting in suboptimal patent utilization (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Lessons from Advanced Models:** The UK's TT ecosystem demonstrates the efficacy of well-resourced and professionally managed Technology Transfer Offices (TTOs) that are equipped with dedicated commercialization specialists. Likewise, the U.S. and Germany have developed streamlined patenting procedures that significantly reduce barriers to technology licensing and accelerate market entry (Jolly, 1997).

3. Innovation Financing and Investment Mechanisms

Access to financial resources is a crucial determinant of an ecosystem's ability to sustain TT activities.

- **Greece & Bulgaria:** These nations rely extensively on EU structural funds such as Horizon 2020 and the National Strategic Reference Framework (NSRF). However, the scarcity of private investment constrains their ability to sustain long-term TT initiatives (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Türkiye & Romania:** Türkiye possesses well-established public funding structures but exhibits gaps in early-stage financing, particularly for high-risk technological ventures. In Romania, while EU-backed initiatives provide crucial financial support, bureaucratic inefficiencies often delay the disbursement of funds, hindering the timely execution of TT projects (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **International Benchmarks:** The venture capital ecosystems in the United States and Israel provide robust funding mechanisms that drive innovation

and commercialization. Israel's Innovation Authority, for instance, implements government-backed investment strategies that de-risk early-stage technologies while ensuring substantial private-sector participation (Butler & Gibson, 2011).

4. The Role of Technology Transfer Offices (TTOs) and Innovation Infrastructure

The institutional capacity of TTOs directly affects the commercialization potential of academic research.

- **Greece & Bulgaria:** Many TTOs remain underdeveloped, with inadequately trained personnel and insufficient business development expertise. This severely limits their capacity to facilitate research-market transitions effectively (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Türkiye & Romania:** Türkiye has established a well-developed TT infrastructure, including technoparks, yet commercialization rates vary significantly across regions. Romania, despite promising developments such as the Măgurele Science Park, still grapples with the challenge of creating an integrated national innovation framework (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Global Comparisons:** The U.S. and German TT models illustrate the advantages of treating TTOs as professionalized, business-oriented entities. These offices often employ seasoned industry executives with expertise in IP management and commercialization, ensuring a seamless interface between research institutions and market actors (Speser, 2006).

5. Transnational Collaboration and Knowledge Networks

Cross-border collaboration is an essential component of a dynamic and globally competitive TT ecosystem.

- **Current Status in Greece, Bulgaria, Türkiye, and Romania:** Regional TT collaborations remain underdeveloped, although initiatives such as the T3N-BSB project aim to foster transnational partnerships in the Black Sea region (Comprehensive Study of the Technology Transfer Ecosystem, 2024).
- **Best Practices from Leading Models:** Institutions such as the European Institute of Innovation and Technology (EIT) and the U.S. National Science Foundation (NSF) actively fund cross-border research and commercialization initiatives. These networks enhance knowledge-sharing and create synergies

between disparate innovation ecosystems, ultimately strengthening TT processes.

6. Policy Recommendations

To bridge the gap between emerging and advanced TT ecosystems, the following strategic interventions are recommended:

1. **Enhancing University-Industry Synergies:** Establish performance-based incentives for research institutions that actively engage in industry collaboration, similar to the Fraunhofer model in Germany.
2. **Strengthening IP and Licensing Frameworks:** Streamline patent application processes and introduce standard training programs to equip researchers with commercialization expertise.
3. **Expanding Innovation Financing Channels:** Develop government-backed venture funds to mitigate investment risks and attract private-sector capital for TT activities.
4. **Professionalizing TTOs:** Transform TTOs into high-performance entities by recruiting industry professionals and offering structured training programs in technology commercialization.
5. **Deepening Transnational Innovation Networks:** Leverage EU-funded programs to integrate Black Sea region TT activities with leading global innovation hubs.

By implementing these targeted strategies, Greece, Bulgaria, Türkiye, and Romania can cultivate a more resilient, efficient, and globally competitive TT ecosystem, fostering sustained economic growth through innovation and technology commercialization.

5. Conclusion

The comparative analysis of technology transfer (TT) ecosystems in Greece, Bulgaria, Türkiye, and Romania highlights both shared challenges and country-specific limitations that hinder efficient research commercialization. While all four countries have made notable progress in establishing Technology Transfer Offices (TTOs) and adopting policies aligned with European Union (EU) directives, significant structural inefficiencies, funding gaps, and regulatory inconsistencies continue to obstruct the full realization of their innovation potential (Butler & Gibson, 2011; Conti & Grimaldi, 2024; Speser, 2006).

5.1 Key Takeaways from the Analysis

1. **Policy and Institutional Fragmentation:**
    - Inconsistent legal frameworks and policy fragmentation across the region create barriers to commercialization, particularly in Bulgaria and Romania (Speser, 2006).
    - While Türkiye benefits from a more structured policy environment, Greece's bureaucratic inefficiencies limit TT effectiveness (Jolly, 1997).
    - A regional coordination mechanism could help align policies and streamline TT practices across borders (Hytti, 2021).
2. **Weak Academia-Industry Collaboration:**
    - Despite strong academic research outputs, there is limited private-sector engagement, particularly in Greece and Bulgaria (Butler & Gibson, 2011).
    - In Türkiye, government incentives promote university-industry partnerships, but funding challenges remain (TÜBİTAK, 2021).
    - Romania's Regional Network for Innovation and Technology Transfer (ReNITT) shows promise but lacks full industry integration (Popescu, 2020).
3. **Funding and Investment Challenges:**
    - Greece and Romania heavily rely on EU funds, but bureaucratic inefficiencies slow their deployment (European Commission, 2024).

- Bulgaria struggles with low venture capital (VC) activity, while Türkiye has strong public funding but limited early-stage investment (OECD, 2021).
- The absence of sustainable financing mechanisms hinders the scaling of innovations beyond research prototypes (Jolly, 1997).

4. **Intellectual Property (IP) and Commercialization Gaps:**
   - Greece and Bulgaria have weak IP enforcement and low patent utilization, deterring researchers from pursuing commercialization (Speser, 2006).
   - Türkiye is compatible with EU standards, but the low TRLs of the technologies prolong the commercialization processes.
   - Romania lacks structured commercialization pathways, leaving many innovations without clear market entry strategies (Conti & Grimaldi, 2024).
5. **Human Capital and Talent Retention Issues:**
   - A persistent brain drain affects all four countries, with highly skilled researchers moving to Western Europe or the United States (European Commission, 2024).
   - Limited entrepreneurial training in universities prevents researchers from commercializing innovations (Hytti, 2021).
   - Türkiye demonstrates stronger engagement in fostering entrepreneurship, while Greece, Bulgaria, and Romania need cultural shifts in academic incentives (Butler & Gibson, 2011).
6. **Opportunities in Green and Digital Technology Transfer:**
   - Sustainability-driven TT initiatives are emerging, particularly in Greece and Romania, aligning with EU Green Deal objectives (OECD, 2021).
   - Türkiye is advancing in digital transformation and Industry 4.0, but commercialization of high-tech solutions is still developing (TÜBİTAK, 2021).
   - Bulgaria lags in green innovation commercialization despite EU climate policies supporting sustainability-focused R&D (European Commission, 2024).

5.2 Strategic Pathways for Improvement

To enhance TT effectiveness and increase global competitiveness, the following strategic recommendations should be prioritized:

1. Strengthening Policy Coordination and Reducing Bureaucratic Barriers

- Create a regional TT framework under T3N-BSB to harmonize national policies and regulatory standards (Butler & Gibson, 2011).
- Simplify IP and patenting procedures to accelerate commercialization (Speser, 2006).
- Establish centralized TT coordination bodies to enhance public-private collaboration (Conti & Grimaldi, 2024).

2. Increasing Private-Sector Engagement and Sustainable Funding Mechanisms

- Expand public-private partnerships (PPPs) to increase private-sector R&D investments (Jolly, 1997).
- Introduce tax incentives and risk-sharing models for firms engaging in university-led innovation (OECD, 2021).
- Develop venture capital-backed technology funds to support deep-tech startups and spin-offs (European Investment Fund, 2022).

3. Enhancing Technology Commercialization Pathways

- Invest in TTO professionalization programs to improve IP management and licensing strategies (Hytti, 2021).
- Encourage cross-border TT collaborations to leverage knowledge-sharing across research institutions (Conti & Grimaldi, 2024).
- Establish dedicated technology incubators focusing on market-driven R&D applications (OECD, 2021).

4. Addressing Brain Drain and Fostering Entrepreneurial Culture

- Offer competitive salaries and career development programs to retain skilled researchers (European Commission, 2024).
- Integrate entrepreneurial training into academic curricula to foster research-driven startups (Hytti, 2021).
- Strengthen researcher-industry mobility programs to enhance industry-academic collaboration (Butler & Gibson, 2011).

5. Leveraging Green and Digital Innovation for Competitive Advantage

- Develop targeted funding for clean-tech and digital startups to support sustainability-driven TT (OECD, 2021).
- Encourage cross-border innovation hubs focused on Industry 4.0, AI, and renewable energy technologies (Conti & Grimaldi, 2024).
- Promote transnational R&D projects to integrate the Black Sea region into global innovation networks (European Commission, 2024).

5.3 Summary of Short-Term and Long-Term Measures for Technology Transfer in Greece, Bulgaria, Türkiye, and Romania

The following table provides a clear and actionable roadmap for each country's TT ecosystem, making it easier for stakeholders to prioritize initiatives.

Country	Current Readiness & Key Challenges	Short-Term Measures (1-3 years)	Long-Term Measures (3+ years)
Greece	**Moderate Readiness**: Strong research institutions but weak commercialization, limited industry collaboration.	- **Policy & legal reforms** to improve IP ownership frameworks. - Strengthen university **TTOs with specialized training & funding**. - Create **regional innovation clusters** for key sectors (e.g., maritime, energy). - Enhance **cross-border cooperation** with EU innovation hubs.	- Develop **fast-track funding schemes** for research-industry collaborations. - **Policy & legal reforms** to improve IP ownership frameworks. - Establish **large-scale TT-focused venture funds**.
Bulgaria	**Low to Moderate Readiness**: Emerging innovation ecosystem, but weak infrastructure & funding for spin-offs.	- Launch **TTO staff training programs** to enhance TT capabilities. - Increase **seed funding** & **small grants** for start-ups and spin-offs. - Strengthen **public-private collaboration through matchmaking events**.	- Develop **national TT strategy & funding mechanisms**. - Improve **R&D tax incentives** to attract private-sector investment. - Establish **international partnerships** with stronger TT ecosystems.

Türkiye	**High Readiness in Key Sectors**: Strong industry-academia partnerships in technology, but policies that require agility. Limited intellectual property revenue.	- **Streamline TT policies** across universities & industries. - Offer **financial incentives for patents & licensing**. - Expand **university-led incubators** to support early-stage startups.	- Develop **sector-focused TT hubs** (biotech, AI, fintech, aerospace). - Strengthen **international R&D collaborations** & licensing deals. - Improve **IP commercialization frameworks** & investment incentives.
Romania	**Moderate Readiness with Regional Variations**: Some innovation clusters exist, but weak regulatory frameworks & underdeveloped TT culture.	- **Reduce bureaucratic barriers** to TTO operations. - Introduce **researcher incentives** for IP & commercialization efforts. - Foster **regional TT clusters** with industry-specific focus (e.g., IT, agritech).	- Strengthen **IP legislation & commercialization pathways**. - Promote **PPP (Public-Private Partnerships) for long-term TT sustainability**. - Invest in **digital infrastructure & TT knowledge platforms**.

5.4 Final Thoughts

To unlock the full potential of TT in Greece, Bulgaria, Türkiye, and Romania, policymakers, universities, and industry leaders must embrace a more integrated, innovation-driven approach. Cross-border collaboration, policy harmonization, and sustained investments in TT infrastructure will be critical drivers of economic growth and technological leadership in the Black Sea region (Butler & Gibson, 2011; Speser, 2006).

By addressing the structural weaknesses and building on existing strengths, these nations can establish a dynamic and globally competitive TT ecosystem, fostering sustainable economic development through innovation and commercialization.

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ANNEX

Main elements of the Comprehensive Study of the Technology Transfer Ecosystem in Greece, Bulgaria, Türkiye, and Romania – Joint Report in tables and graphic representations

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1. Political Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Key Policies & Legislative Frameworks	Government Support & Initiatives	Challenges & Barriers	Impact on TT Ecosystem
Greece	☑ **Law 4864/2021** – Regulates spin-offs & IP commercialization ☑ **National Strategic Reference Framework (NSRF) (2014–2027)** – Funds TTOs in universities & research centers	💰 Strong public investment in **Technology Transfer Offices (TTOs)** 🔹 Government prioritizes innovation-driven economic growth	⚠ **Fragmented policy implementation** affects efficiency ⚠ **Bureaucratic inefficiencies** slow down research commercialization	🏭 **Political will exists,** but inefficiencies hinder rapid research-to-market transitions
Bulgaria	☑ **National Innovation Strategy** – Strengthens TT & R&D ☑ **Recovery and Resilience Plan (RRP)** – Supports innovation landscape	🏢 Development of **Centers of Competence (CoCs) & Centers of Excellence (CoEs)** 📈 Government-backed initiatives to improve R&D collaboration	⚠ **Regulatory fragmentation** across ministries ⚠ **Uncertainties in Decree No. 61 (2020)** limit university spin-offs & IP ownership	🏭 **Limited coordination** affects national TT strategies & spin-off formation
Türkiye	☑ **Higher Education Law No. 2547** – Facilitates university involvement in commercialization ☑ **Industrial Property Law No. 67698** – Strengthens IP protection	💎 **TÜBİTAK, KOSGEB, and regional development agencies** offer R&D funding 🏭 Strong push for **University-Industry Collaboration (UIC)** & **Technology Development Zones (TDZs)**	⚠ **Bureaucratic inefficiencies** Improving administrative processes of policies ⚠ **The gap between legislation and implementation** in the TT ecosystem	🚀 **Strong financial incentives,** but administrative challenges slow TT growth

Romania	☑ **National Research, Development, and Innovation Strategy (2022–2027)** – Supports research investments ☑ **EU funding programs** – Horizon Europe & Regional Operational Program (ROP)	🔗 **Public-private collaboration** encouraged 🇪🇺 **EU funds available** for R&D	⚠ **Low R&D funding** – Among the lowest in Europe ⚠ **Frequent policy changes & administrative restructuring** delay implementation	📉 **Delays in funding & TT initiatives** due to inefficient execution

2. Economic Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Funding & Investment	Challenges	Impact on Technology Transfer
Greece	☑ **EU & National Funding** Horizon Europe, Elevate Greece boost startup growth ☑ **Venture Capital (VC)** EquiFund supports startups, though deep-tech struggles to attract investors	⚠ **Limited private R&D funding** slows commercialization ⚠ **Weak industry-driven R&D demand** limits patent licensing	🏛 **Public investment is rising**, but **private-sector engagement remains low**, slowing research-driven innovation scaling
Bulgaria	☑ **Proof-of-Concept (PoC) Grants** – Early-stage funding initiatives ☑ **Growing ICT startup investment** through VC-backed funds	⚠ **Short-term TTO funding** leads to instability ⚠ **Deep-tech & life sciences remain underfunded**	🏭 **Early-stage funding exists**, but **scaling mechanisms are weak**, limiting commercialization success
Türkiye	☑ **Growing VC** investments & SME incentives ☑ **Government-backed** R&D funding via TÜBİTAK & KOSGEB	⚠ **Early-stage funding gaps** for startups ⚠ **Regional economic disparities** affect TT opportunities	🚀 **Strong public funding**, but **overreliance on government resources** slows sustainable innovation growth
Romania	☑ **Growing tech startup ecosystem** in Bucharest-Ilfov ☑ **Foreign investment in IT & automotive industries**	⚠ **Low R&D investment (0.48% of GDP)** compared to EU average (2%) ⚠ **Limited VC funding outside major cities**	🗺 **Regional disparities & weak national R&D investment** hinder broader innovation-driven growth

3. Social Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Strengths & Opportunities	Challenges	Impact on Technology Transfer
Greece	☑ **Highly educated STEM workforce** ☑ **Strong academic and research base**	⚠ **Low entrepreneurial culture in academia** – Focus on publications over commercialization ⚠ **Brain drain** due to limited career prospects	🔲 **Underutilized academic potential** – Few researchers engage in entrepreneurship, slowing research commercialization
Bulgaria	☑ **Growing STEM & sustainability awareness** ☑ **Expanding ICT and green tech workforce**	⚠ **Brain drain of skilled researchers** weakens the innovation ecosystem ⚠ **Limited commercialization incentives** for academics	🏭 **Talent loss & lack of structured rewards** hinder university-industry collaboration and TT success
Türkiye	☑ **Strong entrepreneurial engagement** in tech hubs ☑ **Young, dynamic workforce**	⚠ **Deepen the impact of entrepreneurship** and innovation within the education system ⚠ **Cultural gaps** between academia & industry slow collaboration	🚀 **High innovation potential**, but **uneven regional participation** limits nationwide TT effectiveness
Romania	☑ **Growing tech sector & strong academic base**	⚠ **STEM education gap** – Only 15% of graduates are from STEM fields ⚠ **Brain drain** reduces high-tech workforce ⚠ **Low academic entrepreneurship**	🔲 **Underutilized research potential** – Low commercialization incentives & talent migration slow innovation

4. Technological Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Strengths & Opportunities	Challenges	Impact on Technology Transfer
Greece	☑ **Advanced R&D capabilities** – Leading research centers like CERTH & NCSR "Demokritos" ☑ **Strong presence in biotech, energy, and ICT sectors**	⚠ **Limited commercialization pathways** – Universities lack structured TT mechanisms ⚠ **Understaffed TTOs** with weak IP management expertise	📉 **Strong R&D ecosystem, but weak commercialization channels** limit research-to-market translation
Bulgaria	☑ **Growing ICT & AI sectors** – Strong software development and AI innovation ☑ **Industry collaboration potential** in digital technologies	⚠ **Underdeveloped infrastructure** in biotech, materials science, and clean energy ⚠ **Capacity constraints in TTOs** – Limited expertise in commercialization	💻 **Strong digital innovation, but limited TT in non-ICT fields**
Türkiye	☑ **Well-developed technoparks & R&D centers** ☑ **Emphasis on Industry 4.0 & local technology development**	⚠ **Uneven technology adoption** across industries ⚠ **Regional disparities in R&D infrastructure**	🚀 **Growing digital transformation**, but **patenting & commercialization efforts still evolving**
Romania	☑ **Growing tech sector & skilled workforce**	⚠ **STEM education gap** – Only 15% of graduates in STEM fields ⚠ **Brain drain & low entrepreneurial engagement in academia**	📉 **High research potential, but weak commercialization incentives hinder TT growth**

5. Environmental Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Strengths & Opportunities	Challenges	Impact on Technology Transfer
Greece	☑ **EU Green Transition alignment** – Focus on renewable energy and sustainability-driven TT ☑ **Government backing for green startups**	⚠ **Slow commercialization of green tech** due to low investment in clean-tech startups	📉 **High potential, but market readiness and funding barriers limit commercialization**
Bulgaria	☑ **EU policies promoting green innovation** offer a strong regulatory framework ☑ **Opportunities in climate tech and renewable energy**	⚠ **Weak commercialization mechanisms** – Green tech remains underdeveloped ⚠ **Limited funding for eco-entrepreneurs**	📈 **Growing awareness, but lack of investment slows green TT adoption**
Türkiye	☑ **Sustainable development initiatives** – Government incentives for clean energy ☑ **Regulatory push for green technologies**	⚠ **Early-stage development of TT projects in sustainability**	🚀 **TT is developing in green technology, but applications must be expanded**
Romania	☑ **Alignment with EU Green Deal** – Strong policy direction towards renewable energy ☑ **Focus on circular economy & sustainable agriculture**	⚠ **Low investment in clean technology** despite EU policies	📉 **Growing green initiatives, but investment barriers slow down commercialization**

6. Legal Factors Influencing TT in Greece – Bulgaria – Türkiye – Romania

Country	Strengths & Opportunities	Challenges	Impact on Technology Transfer
Greece	☑ **Improved spin-off policies** under Law 4864/2021 ☑ **Strengthened IP rights** to support commercialization	⚠ **Low patent utilization** – Most university patents remain unlicensed ⚠ **Weak institutional IP management** – Lack of clear commercialization strategies	🗺 **Stronger legal framework for spin-offs, but patent enforcement and licensing remain weak**
Bulgaria	☑ **Alignment with EU and WIPO IP treaties** ☑ **Growing awareness of IP protection**	⚠ **Weak IP management systems** – Universities lack patenting strategies ⚠ **Legal ambiguity for spin-offs** – Decree No. 61 creates ownership and revenue-sharing uncertainties	🏞 **Legal framework is evolving, but unclear regulations limit commercialization success**
Türkiye	☑ **Stronger patent protection and licensing laws** ☑ **Tax incentives for R&D firms and startups**	⚠ **Intellectual property rights grant process take a long time** ⚠ **Effectiveness of TTOs varies by institution**	🚀 **Legal incentives support entrepreneurship, but stronger enforcement is needed for tech transfer success**
Romania	☑ **Recent spin-off regulations (Ministerial Order No. 28/2021)** ☑ **Efforts to improve IP protection**	⚠ **Low patent activity** – Only 58 EPO applications in 2022 ⚠ **Bureaucratic complexity in tech transfer processes**	🗺 **Unclear regulations and weak enforcement hinder commercialization and public-private collaboration**

7. Technology Transfer (TT) Landscape across Greece – Türkiye – Bulgaria – Romania

Factor	Greece	Türkiye	Bulgaria	Romania
Political	★★ Government supports TT but needs better coordination	★★★ Strong state-driven TT policies with better coordination	★ Fragmented policies with weak execution	★ Lack of policy cohesion and weak institutional coordination
Economic	★★ Underfunded TT, weak private sector participation, VC initiatives	★★ Robust R&D incentives, VC initiatives	★★ Growing proof-of-concept funding, but deep-tech struggles	★ Chronic underfunding limits innovation growth
Social	★★ Low researcher interest in commercialization, Brain drain issue	★★ Entrepreneurial culture with strong innovation hubs	★★ Low commercialization incentives, talent exodus	★★ Weak entrepreneurial engagement, brain drain issue
Technological	★★ Strong R&D ecosystem but lacks commercialization pathways	★★ Good R&D but weak TTO resources	★ Strong academia, but patents rarely commercialized	★ Limited research-market integration
Environmental	★★ Aligns with EU Green Transition, but slow private adoption	★★ Moderate sustainability efforts	★ Minimal private investment in green tech	★★ Green initiatives exist, but funding gaps slow progress
Legal	★★★ Clear IP framework,	★★★ Solid IP regulations	★ Weak IP enforcement,	★

	relatively strong enforcement		unclear spin-off rules	Regulatory uncertainty hinders TT

8. Conclusions on TT Processes and Practices

Aspect	Greece	Bulgaria	Türkiye	Romania
Academic Research Quality	★★★ Strong research output	★★★ High-quality research	★★★ Strong research & innovation ecosystem	★★★ Growing research quality
Commercialization Rate	★ Low commercialization	★ Underutilized research	★★ Moderate but with inefficiencies	★ Weak market integration
Technology Transfer Offices (TTOs)	★★ Some universities have strong TTOs, but many lack structured mechanisms	★ Weak industry linkages, few TTOs	★★ Expanding TTOs & tech zones	★ Underdeveloped TT infrastructure
Industry Collaboration	★★ Limited engagement	★ Weak industry-research alignment	★★ Growing collaboration	★ Poor coordination between academia & industry
Funding & Investment	★★ Adequate funding for scaling & insufficient funding for early-stage innovation	★ Inadequate support for spin-offs	★★★ Government-backed VC initiatives & R&D incentives	★ Chronic underfunding in R&D
Regulatory & Policy Support	★★ Recently updated regulatory framework	★ Policy fragmentation, limiting effectiveness	★★ Structured policies but standardization issues	★ Fragmented policies with weak enforcement
Human Capital & Expertise	★★ Skilled researchers, but	★★ Strong academic base,	★★★ Entrepreneurial mindset &	★

	low entrepreneurship participation	but lack of commercialization skills	innovation hubs	R&D human resource shortages
Spin-off & Start-up Support	★★★ Existence of incubators / accelerators	★★ Few successful spin-offs due to weak support	★★★ Technology development zones & incubators	★ Low support for research commercialization

9. Key Takeaways from the Analysis

Policy and Institutional Fragmentation	• Inconsistent legal frameworks and policy fragmentation across the region create barriers to commercialization, particularly in **Bulgaria** and **Romania**. • While **Türkiye** benefits from a more structured policy environment, **Greece's** bureaucratic inefficiencies limit TT effectiveness. • A regional coordination mechanism could help align policies and streamline TT practices across borders.
Weak Academia-Industry Collaboration	• Despite strong academic research outputs, there is limited private-sector engagement, particularly in **Greece** and **Bulgaria**. • In **Türkiye**, government incentives promote university-industry partnerships, but funding challenges remain. • **Romania's** Regional Network for Innovation and Technology Transfer (ReNITT) shows promise but lacks full industry integration.
Funding and Investment Challenges	• **Greece** and **Romania** heavily rely on EU funds, but bureaucratic inefficiencies slow their deployment. • **Bulgaria** struggles with low venture capital (VC) activity, while **Türkiye** has strong public funding but limited early-stage investment. • The absence of sustainable financing mechanisms hinders the scaling of innovations beyond research prototypes.
Intellectual Property (IP) and Commercialization Gaps	• **Greece** and **Bulgaria** have weak IP enforcement and low patent utilization, deterring researchers from pursuing commercialization. • **Türkiye** aligns with EU standards, and the patent support programs implemented in the country support the country's innovative ecosystem. • **Romania** lacks structured commercialization pathways, leaving many innovations without clear market entry strategies.
Human Capital and Talent Retention Issues	• A persistent brain drain affects all four countries, with highly skilled researchers moving to Western Europe or the United States. • Limited entrepreneurial training in universities prevents researchers from commercializing innovations. • **Türkiye** demonstrates stronger engagement in fostering entrepreneurship, while **Greece**, **Bulgaria**, and **Romania** need cultural shifts in academic incentives.
Opportunities in Green and Digital Technology Transfer	• Sustainability-driven TT initiatives are emerging, particularly in **Greece** and **Romania**, aligning with EU Green Deal objectives. • **Türkiye** is advancing in digital transformation and Industry 4.0, but commercialization of high-tech solutions is still developing. • **Bulgaria** lags in green innovation commercialization despite EU climate policies supporting sustainability-focused R&D.

10. Strategic Pathways for Enhancing TT Processes in the Black Sea Basin

Strengthening Policy Coordination and Reducing Bureaucratic Barriers	• Streamline regulatory frameworks and inter-ministerial collaboration to ensure efficient TT implementation. • Establish national coordination bodies to align TT policies with EU directives and industry needs. • Simplify IP and patenting procedures to accelerate commercialization
Increasing Private-Sector Engagement and Sustainable Funding Mechanisms	• Expand public-private partnerships (PPPs) to increase private-sector R&D investments. • Introduce tax incentives and risk-sharing models for firms engaging in university-led innovation. • Develop venture capital-backed technology funds to support deep-tech startups and spin-offs.
Enhancing Technology Commercialization Pathways	• Invest in TTO professionalization programs to improve IP management and licensing strategies. • Encourage cross-border TT collaborations to leverage knowledge-sharing across research institutions. • Establish dedicated technology incubators focusing on market-driven R&D applications.
Addressing Brain Drain and Fostering Entrepreneurial Culture	• Offer competitive salaries and career development programs to retain skilled researchers. • Integrate entrepreneurial training into academic curricula to foster research-driven startups. • Strengthen researcher-industry mobility programs to enhance industry-academic collaboration.
Leveraging Green and Digital Innovation for Competitive Advantage	• Develop targeted funding for clean-tech and digital startups to support sustainability-driven TT. • Encourage cross-border innovation hubs focused on Industry 4.0, AI, and renewable energy technologies. • Promote transnational R&D projects to integrate the Black Sea region into global innovation networks.

11. Short-Term and Long-Term Measures for TT in Greece, Bulgaria, Türkiye, and Romania

Country	Current Readiness & Key Challenges	Short-Term Measures (1-3 years)	Long-Term Measures (3+ years)
Greece	**Moderate Readiness**: Strong research institutions but weak commercialization, limited industry collaboration.	🚀 **Policy & legal reforms** to improve IP ownership frameworks. 🚀 Strengthen university **TTOs with specialized training & funding**. - Create **regional innovation clusters** for key sectors (e.g., maritime, energy). - Enhance **cross-border cooperation** with EU innovation hubs.	🏛 Develop **fast-track funding schemes** for research-industry collaborations. 🏛 **Policy & legal reforms** to improve IP ownership frameworks. 🏛 Establish **large-scale TT-focused venture funds**.
Bulgaria	**Low to Moderate Readiness**: Emerging innovation ecosystem, but weak infrastructure & funding for spin-offs.	🚀 Launch **TTO staff training programs** to enhance TT capabilities. 🚀 Increase **seed funding** & **small grants** for start-ups and spin-offs. 🚀 Strengthen **public-private collaboration through matchmaking events**.	🏛 Develop **national TT strategy & funding mechanisms**. 🏛 Improve **R&D tax incentives** to attract private-sector investment. 🏛 Establish **international partnerships** with stronger TT ecosystems.
Türkiye	**High Readiness in Key Sectors**: Strong industry-academia partnerships in tech, but limited IP monetization.	🚀 **Streamline TT policies** across universities & industries. 🚀 Offer **financial incentives for patents & licensing**. 🚀 Expand **university-led incubators** to support early-stage startups.	🏛 Develop **sector-focused TT hubs** (biotech, AI, fintech, aerospace). 🏛 Strengthen **international R&D collaborations** & licensing deals. 🏛 Improve **IP commercialization frameworks** & investment incentives.

Romania	**Moderate Readiness with Regional Variations**: Some innovation clusters exist, but weak regulatory frameworks & underdeveloped TT culture.	🚀 **Reduce bureaucratic barriers** to TTO operations. 🚀 Introduce **researcher incentives** for IP & commercialization efforts. 🚀 Foster **regional TT clusters** with industry-specific focus (e.g., IT, agritech).	🏢 Strengthen **IP legislation & commercialization pathways**. 🏢 Promote **PPP (Public-Private Partnerships) for long-term TT sustainability**. 🏢 Invest in **digital infrastructure & TT knowledge platforms**.