CATALYST OR CONSTRAINT? RETHINKING GOVERNMENT SUPPORT FOR INNOVATION COMMERCIALIZATION IN WESTERN BALKAN INNOVATION ECOSYSTEMS AT A CROSSROADS

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Abstract - The Western Balkan economies remain incomplete in their transition toward fully functioning market systems and are still at an early stage in building entrepreneurial innovation ecosystems. To narrow the gap with more advanced economies, governments in these small transitional states have adopted a variety of systemic measures to promote knowledge transfer and open innovation, thereby seeking to accelerate the commercialization of sustainable innovations. This study examines the relationships between latent constructs relevant to innovation support and commercialization in the Western Balkans. Employing a Structural Equation Modelling (SEM) framework that integrates Confirmatory Factor Analysis (CFA) with path analysis, the research simultaneously estimates both measurement and structural models. The empirical investigation is based on a quantitative research design informed by four Delphi studies and conducted on a sample of 100 firms across four Southeast European countries. The findings provide empirical evidence on how systemic innovation support can influence commercialization outcomes in a transitional context. By addressing a region where structural barriers coexist with growing entrepreneurial potential, this study advances theoretical debates on innovation ecosystems while offering actionable policy recommendations for strengthening the commercialization of innovation in the Western Balkans.

JEL Classification: H25

Keywords - Intellectual Protection Rights, Technology Transfer, Incentives, Transitional Economies, Open Innovation Strategies

I. INTRODUCTION

In recent years, the Western Balkans (WB) region has made notable advances in strengthening its science, technology, and innovation capabilities. However, the region still faces significant challenges that must be addressed to unlock its transformative potential fully, in catching up with other European regions, the focus of innovation effortsshould be enhanced (Matusiak & Kleibrink, 2018; OECD, 2024a). At the current average growth levels for both the Western Balkans and the EU, full convergence would only beachieved in 2074 (OECD, 2025, p. 23). The research systems in the WB are highly fragmented, comprising many small, underfunded public research institutes and universities, which hinders the efficient allocation of resources and the development of a critical mass in key research areas (OECD, 2024a). While several WB economies have significantly increased spending on scientific research in recent years, overall investments in the sector remain negligible and show little evidence of converging towards EU levels. The region's Research and Development (R&D) expenditure as a percentage of GDP ranges from just 0.2% in Kosovo* to 0.9% in Serbia, well below the OECD average of around 2.4%, whereby this underinvestment is particularly evident in the business enterprise sector, where R&D accounts for less than 0.5% of GDP in most economies (OECD, 2024a).Innovation is widely recognized as a key driver of sustainable economic growth, competitiveness, and social well-being (OECD, 2024a). In the context of emerging economies, particularly in the WB, fostering innovation is essential not only for catching up with advanced economies but also for overcoming structural weaknesses such as fragmented markets, limited R&D capacity, and institutional instability (Matusiak & Kleibrink, 2018). Low investment in R&D in the WBcontinues to limit innovation and the development of new competenciesneeded for future-proofing economies (OECD, 2025, p. 16). However, while innovation inputs—such as public support and entrepreneurial activity—are increasingly present in these economies, the challenge lies in transforming them into commercially successful outputs that generate long-term development benefits (Autio & Rannikko, 2016; Howell, 2017).Theoretical and empirical research highlights several determinants of successful innovation commercialization. First, government support, in the form of subsidies, grants, tax incentives, or regulatory facilitation, provides critical resources for firms in capital-constrained environments (Howell, 2017; Lee et al., 2024). Second, organizational and systemic factors—including product adaptation to market needs, market orientation, intellectual property protection (IPP), and entrepreneurship support—are fundamental in shaping the internal capabilities and external ecosystem conditions that enable innovation to reach the market (Narver et al., 2004; Papageorgiadis&Sofka, 2020). Third, open innovation strategies (OIS) increasingly mediate knowledge flows between firms, universities, and government institutions, thus playing a central role in TT processes (Chesbrough & Bogers, 2014).Open innovation (OI) can plausibly claim to be one of the first coherent explanations for thisshift from a relatively centralized innovation system driven by the largest organizationsin the United States to a more distributed system that involved organizationsof all sizes—and increased the importance of external knowledge fromdiverse sources such as universities, research institutes, and individuals (Chesbrough, 2024). Yet, the application of these determinants in the WB is not straightforward. Institutional weaknesses, fragile legal frameworks, and fragmented entrepreneurial ecosystems limit the effectiveness of government support, systemic factors, and OIS (Brander et al., 2017; World Bank, 2013). While certain studies argue that policy support and organizational adaptation can foster successful commercialization in emerging economies (Prifti&Alimehmeti, 2017)), others suggest that weak enforcement, lack of absorptive capacity, and risks of knowledge leakage undermine these mechanisms (Hossain &Kauranen, 2016; Spithoven et al., 2013).

This study examines the relationships between latent constructs relevant to innovation support and commercialization in the Western Balkans. Employing a Structural Equation Modeling (SEM) framework that integrates Confirmatory Factor Analysis (CFA) with path analysis, the research simultaneously estimates both measurement and structural models. The empirical investigation is based on a quantitative research design informed by four Delphi studies and conducted on a sample of 100 firms across four Southeast European countries.Specifically, it investigates: (1) the direct role of government support in fostering TT, (2) the effect of organizational and systemic factors on the successful commercialization of innovations, and (3) the mediating role of OIS in linking policy support with commercialization outcomes. By focusing on a transitional region where systemic barriers coexist with growing entrepreneurial potential, the study contributes to both the theoretical literature on innovation ecosystems and the practical design of policies aimed at strengthening sustainable and inclusive innovation in the WB. The rest of this study is organized as follows. In the next section, we provide the literature review related to government interventions,the key organizational and systemic factors of the TT and successful commercialization of innovations, as well as mediating role of OIS. The following section presents the methodology by explaining the sample, model specification and the empirical strategy as well as empirical results,the discussion section followed by the main conclusions, limitations and ideas for future research.

II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Government interventions—such as tax credits, grants, subsidies, and regulatory facilitation—are widely recognized as effective catalysts for collaborative TT and innovation, particularly in emerging entrepreneurial ecosystems (IMF, 2024; Xia & Jia, 2023; Zhang, 2019). Targeting is essential: sector-specific support maximizes spillovers and minimizes misallocation, while firm-level tailoring enhances innovation outcomes (IMF, 2024; Xia & Jia, 2023). Institutional readiness also plays a critical role, with the Triple Helix model underscoring that alignment between universities, industry, and government strengthens TT, whereas misalignment reduces effectiveness (Etzkowitz&Leydesdorff, 2000; Abramo & D'Angelo, 2018). Finally, poorly designed subsidies risk displacement effects, as shown in Shenzhen where welfare costs offset productivity gains, and in cases where excessive support encourages rent-seeking behavior (Koster et al., 2018; Zhang, 2019).However, the attention of policy-makers in the region has been focused on questions of economic growth and competitiveness, although less so on using Research & Innovation (R&I) to achieve broader societal goals (Matusiak & Kleibrink, 2018).Sustainable innovation is broadly understood as the integration of economic, social, and environmental dimensions into technological and organizational advancements that create value while reducing ecological harm (Knapp et al., 2025). Empirical studies confirm that regulatory support and government incentives, such as subsidies and tax reliefs, play a decisive role in stimulating firms to adopt green and sustainable practices (Aldawsari, 2025). In addition, OIEs facilitate sustainable innovation by fostering collaboration, knowledge exchange, and joint risk-taking among firms and stakeholders (Costa, 2020). Despite these insights, the literature highlights several research gaps: existing studies predominantly focus on developed economies, with limited attention to transitional contexts (Aldawsari, 2025), there is a lack of integrated analyses combining institutional drivers and firm-level capabilities (Teixeira, 2025), and further research is needed on stakeholder collaboration and sector-specific applications of sustainable open innovation (Bigliardi et al., 2022). Addressing these gaps is particularly relevant for regions such as the WB, where systemic barriers coexist with emerging entrepreneurial potential.

2.1. Government incentives as a catalyst for technology transfer amongst actors in emerging innovation ecosystems

Public intervention in innovation systems generally assumes that well-designed incentives can change the behaviour of targeted actors. However, innovation systems are complex and require appropriate mixes of innovation policies to induce meaningful change (Matusiak & Kleibrink, 2018). Numerous studies confirm that government incentives positively influence TT and collaboration. For example, subsidiaries of foreign-owned multinational firms significantly contribute to national research and development (R&D) in many host countries, particularly small, open economies (Cunningham et al., 2020). Policymakers often support these subsidiaries' R&D through grants and tax credits (Landman et al., 2022; Lenihan et al., 2024).Fiscal incentives such as R&D tax credits and subsidies alleviate financial constraints and encourage collaborative R&D, significantly boosting innovation and enterprise growth. A recent study of China's new energy automobile industry (2018–2023) found that government subsidies and tax incentives have a positive impact on green technology innovation and enterprise development (Shi & Ge, 2025). Similarly, Dechezleprêtre et al. (2023) demonstrated that R&D tax relief increases patenting and R&D spending, with effects lasting up to seven years, especially for financially constrained firms. These incentives also facilitate knowledge spillovers: foreign-owned subsidiaries supported by grants and tax credits contribute to host country innovation ecosystems through TT and local linkages (Lenihan et al., 2024).

Grants and funding programs for collaborative research further catalyze TT. Howell (2017) demonstrated that one-time direct subsidies to small, financially constrained firms enhance innovation outcomes, such as patent development, by reducing uncertainty and facilitating the development of prototype technologies. An early-stage award approximately doubles the probability that a firm subsequently receives venture capital, positively impacting patenting and revenue. Recent studies emphasize that public grants and funding programs play a critical role in enabling collaboration for TT, though effects depend strongly on program design and context. Large-scale evaluations of EU programs demonstrate that transnational R&I grants foster collaborations that would not otherwise emerge, thereby strengthening transfer pathways (European Commission, 2024a). Empirical analyses of publicly funded research centers show that structured, multi-stakeholder consortia are effective in generating patents, licenses, and spinoffs (Zarea et al., 2025). Similarly, proof-of-concept grants significantly increase the likelihood of licensing agreements and commercialization outcomes (Bailey et al., 2025). In the United States, programs like STTR mandate university–industry partnerships, directly embedding collaboration requirements into the funding mechanism (NIH, n.d.; Cohen et al., 2025). Sectoral surveys further reveal rising inter-institutional agreements, underscoring the growing operational significance of collaborative deals in practice (AUTM, 2024). However, evidence from middle-income countries suggests that while collaboration programs boost innovation inputs and cooperative behavior, measurable outcomes, such as patents and licensing, require complementary capacity-building measures (Pluvia-Zúñiga, 2024).

In the WB, Serbia's Innovation Fund "Collaborative Grant Scheme" mandates SME–SME-research-organization consortia; independent evaluations reported that awardees' profits and employment outpaced non-awardees after three to four years, while the Fund's Technology Transfer Facility deployed 11 service lines and initiated 43 transactions (Innovation Fund of Serbia, 2024; World Bank, 2022). North Macedonia's academia–business cooperation was boosted by a special grant programme launched in early 2024 (European Commission, 2024b), and Montenegro's Collaborative Grants programme explicitly targets MSME–research co-development and TT, marking the first large-scale national support for such partnerships (European Commission, 2024c; Innovation Fund of Montenegro, 2024). Region-wide, OECD (2024b) notes that co-creation remains the "weakest link," but highlights Serbia's mix of innovation vouchers, joint-research grants, proof-of-concept support, and TT instruments as good practice.

Countries differ widely in how their legal institutions enable innovative firms to capture economic value from new products or technologies through effective intellectual property rights (IPR) enforcement (Teece, 1998). Variations in national patent and IPR protection systems significantly influence firm decisions, particularly in emerging economies (Brander et al., 2017; Brandl et al., 2019; Papageorgiadis&Sofka, 2020; Peng et al., 2017).Regulatory support, including streamlined IPP processes, is crucial. For example, Germany's strong IPP regime encourages firms to invest in R&D by safeguarding innovations, thereby promoting collaboration with local actors (Papageorgiadis&Sofka, 2020). Government fiscal and tax incentives are also crucial in promoting green technology innovation and sustainable business development. To optimize their impact, improvements in policy implementation—especially addressing regional disparities—are necessary (Shi & Ge, 2025).The information and communication technology (ICT) sector in the WB has emerged as a key driver of economic growth and innovation. ICT exports now stand at nearly 90% of the EUaverage, thanks to a combination of targeted incentivesto attract investment, improved infrastructure for startupsand a skilled youth workforce (OECD, 2025, p. 18).

Despite these benefits, studies in developing and transition economies highlight persistent challenges that can limit policy impact. Poor targeting, weak monitoring, and political capture may produce rent-seeking and misallocation rather than additional innovation (Zúniga, 2023). Bloom et al. (2019) argue that tax incentives may lead firms to relabel existing costs as R&D, reducing effectiveness. While tax credits and direct public funding appear most effective in the short term, increasing the supply of human capital is more impactful in the long term.Place-based or firm-targeted subsidies may generate displacement or crowding-out effects, shifting activity without net gains (Koster et al., 2018). Moreover, low absorptive capacity, fragmented innovation systems, and limited evaluation practices—challenges particularly notable in the WB—reduce the likelihood that incentives lead to sustained TT and local linkages (Matusiak & Kleibrink, 2018; World Bank, 2013). To maximize effectiveness, incentive programs must be paired with strengthened institutions, transparent selection and monitoring, and rigorous impact evaluation.Based on this discussion, we formulate the following hypothesis:

H1.Government support has a positive influence on collaboration in technology transfer within emerging entrepreneurial innovation ecosystems.

2.2. Key organizational and systemic factors of the successful commercialization of innovations

The commercialization of innovations in emerging innovation ecosystems (IEs) depends heavily on organizational and systemic factors. Supportive evidence indicates that product adaptation to market needs and market orientation are strongly associated with higher innovation performance. In an era of OI, firms increasingly seek insights and expertise outside their organizational boundaries, including customer participation (Wang et al., 2020), the integration of the industrial customer firm into the new product development (NPD) process of the developer firm to share demand and solution-related information (Chang & Taylor, 2016). In a study of 243 firms of varying sizes across 14 different industries, Morgan et al. (2018) investigate the effect of customer participation on new product development performance, and they confirm that overall customer participation is positively related to new product development performance and that the effect is mediated by innovativeness. Chang and Taylor (2016) revealthat involving customers in the ideation and launch stages of NPD improves new product financial performance directly as well as indirectly through acceleration of time to market, whereas customer participation in the development phase slows down time to market, deteriorating new product financial performance.

Market access and marketing orientation are decisive factors for the successful commercialization of innovations. Strong market access enables firms to overcome adoption barriers and accelerate the diffusion of innovations, particularly for SMEs that often struggle with scaling innovations beyond local boundaries (Brem et al., 2016; European Commission, 2024a). A market-oriented culture, defined by continuous customer and competitor analysis, ensures that innovations address real market needs and improves commercialization outcomes (Narver& Slater, 1990). Evidence from transition economies shows that marketing orientation significantly enhances both firm performance and the likelihood of successful innovation commercialization (Prifti&Alimehmeti, 2017). In the context of open innovation, firms that integrate customer and partner feedback achieve higher commercialization rates (Chesbrough & Bogers, 2014). However, in the Western Balkans, weak marketing capabilities and limited international market access remain critical barriers, underscoring the need for integrated support mechanisms that combine innovation funding with export and market development programs (OECD, 2024).

Additionally, access to external financing—such as venture capital (VC) and innovation grants—has been found to accelerate commercialization processes by reducing financial barriers and enabling scale-up activities (Autio&Rannikko, 2016; Howell, 2017;). Well-known angels causally improve venture survival and commercial traction (web traffic/sales), supporting a commercialization channel via reputation and networks (Blaseg&Hornuf, 2023). Angels predominantly affect TT by bridging the "valley of death"—improving survival and commercial traction —and by mobilizing additional capital via syndication and signaling. The quality and reputation of angels, as well aspolicy design, condition the magnitude of these effects (Berger & Gottschalk, 2025; Blaseg&Hornuf, 2023; Solodoha et al., 2023).VC enables patenting among firms that hadn't patented pre-investment and, when investors are highly involved/reputable, can accelerate inventive output among already-patenting firms (Gill et al., 2024).In contrast, among newly public companies, VC-backed firms show fewer patents and citations in the first years post-IPO—consistent with VC timing exits near innovation peaks (Aldatmaz&Çelikyurt, 2023). So, for TT, VC access matters most during pre- and early-growth stages, less as a simple "more patents forever" lever (Aldatmaz&Çelikyurt, 2023;Gill et al., 2024;).

Crowdfunding is a relatively new gateway for entrepreneurs to access capital for creative and innovative ideas and it allows individuals to start experiments with new products and technologies where the outcome is distant (Kaminski et al., 2019). Equity crowdfunding (ECF) serves as a validation and commercialization bridge for academic spin-offs. University spin-offs use ECF not only for financing but also to gain legitimacy and test the market—though challenges persist around investor management and data control (Troise et al., 2023). In turn, crowdfunding activity frequently precedes VC investment and correlates with expert evaluations, positioning it as an effective de-risking and signalling mechanism in the TT ecosystem (Kaminski et al., 2019). Access to affordablefinancing in the WB remains a major bottleneck, particularly forsmall and medium-sized enterprises (SMEs). Highborrowing costs, stringent collateral requirements andlimited availability of alternative financing mechanismscontinue to constrain the ability of businesses to expand and innovate (OECD, 2025, p. 17).

IPP further provides firms with mechanisms to safeguard returns from innovation, thereby encouraging greater investments into R&D and commercialization (Papageorgiadis&Sofka, 2020).However, opposing evidence highlights that these factors may not yield the same outcomes in transition economies. Weak institutional frameworks and limited absorptive capacity in the WB often constrain the effective use of venture capital or IP protection (Matusiak & Kleibrink, 2018; OECD, 2024a). For example, studies suggest that excessive focus on IPP can hinder knowledge diffusion in contexts where legal enforcement mechanisms are weak (Brander et al., 2017). Moreover, entrepreneurship support programs in developing countries sometimes generate only short-term intentions rather than long-term commercialization outcomes (Liñán&Fayolle, 2015). This is particularly relevant in the WB, where fragmented ecosystems and underfunded institutions may reduce the systemic impact of organizational and systemic factors (World Bank, 2013).This leads to the following:

H2. Key organizational and systemic factors positively influence the successful commercialization of innovations within emerging entrepreneurial innovation ecosystems.

2.3. Open innovation strategies and technology transfer

OIS are widely regarded as enablers of effective knowledge flows and TT. The definition of OI is based on "purposive inflows and outflows of knowledge," which hearkens back to a vibrant economic literature on spillovers that arise from a firm's investment in R&D (Chesbrough, 2024). Supporting evidence shows that OIS foster collaboration between universities, firms, and governments, thereby enhancing absorptive capacity and accelerating innovation outcomes (Chesbrough & Bogers, 2014). Artificial intelligence (AI) can enhance, enable, or replace traditional OI practices, changing the scope and efficiency of both outside-in and inside-out OI (Holgersson et al., 2024). Empirical research demonstrates that government support combined with OI strengthens SMEs' ability to transfer knowledge into marketable technologies (Xia & Jia, 2023). A case study of the Korean biopharmaceutical industry found that government R&D support positively moderated the relationship between OI and firm performance, indicating that OIS may indeed act as a mediator in the policy–innovation nexus (Lee et al., 2024).

Research from the last decade highlights that leadership and management support are essential for the successful implementation of OIS. Strong leadership provides vision and legitimacy for OI, reducing organizational resistance and aligning openness with strategic goals (Chesbrough & Bogers, 2014; West & Bogers, 2017). Management support ensures resources, governance, and cross-functional processes are in place, thereby fostering absorptive capacity and effective knowledge sharing (Bogers et al., 2018). Empirical evidence confirms that top management commitment significantly predicts the adoption and success of OI strategies, particularly in building external partnerships and TT pathways (Chen,Cai, Luo, & Mao, 2025; Chen, Lu, & Tongnoy, 2025). In emerging economies, including the WB, managerial prioritization is often decisive: firms with leadership actively championing collaboration report stronger outcomes from OI initiatives, while weak managerial engagement remains a key barrier (OECD, 2024a).Costs and return on investment (ROI) play a decisive role in shaping TT outcomes. High upfront expenses for proof-of-concept development, IPP, and administrative processes can limit the extent to which institutions and firms engage in TT (Siegel et al., 2004; Markman et al., 2005). While strong expected ROI motivates licensing, spinoffs, and collaborative projects, uncertain or long-horizon returns often discourage investment, particularly for early-stage technologies (AUTM, 2024). Universities and firms therefore adopt a portfolio logic, where only a small share of technologies generate substantial financial returns, but broader benefits such as industry partnerships, student training, and regional development also justify engagement (Geuna & Rossi, 2011; European Commission, 2024a). Evidence from the Western Balkans further suggests that SMEs are especially sensitive to cost and ROI concerns, requiring public support to overcome resource constraints and de-risk collaborative transfer (OECD, 2024).

Technological infrastructure underpins collaborative platforms (e.g., crowdsourcing portals, virtual co-design environments, online innovation marketplaces). Research shows that companies that invest in digital platforms for co-creation are more successful in engaging external stakeholders and integrating external ideas into their innovation processes (Dodgson et al., 2015).Castillo et al. (2023) conducted a quantitative analysis of over 1,100 large Spanish firms and found that IT resource investments significantly enable the development and execution of open innovation initiatives, which in turn improve firms' product and process innovation performance. IT investment also shows a mediated effect via OI initiative capability.Zhao and Dong (2025), using a Difference-in-Differences (DID) approach in the context of China's Broadband China initiative, demonstrate that digital infrastructure development significantly increases corporate innovation efficiency. Overall, the study demonstrates that technological infrastructure is not merely supportive but transformational, as it amplifies firms' ability to absorb and utilize external knowledge, thereby strengthening both innovation output and OI capacity (Zhao & Dong, 2025).Chen, Cai, Luo, and Mao (2025) surveyed 157 companies and reports that digital trust significantly enhances OI, with knowledge sharing mediating this relationship.Digital trust is a critical intangible infrastructure for OI, complementing physical digital infrastructure (like broadband or IT systems) and it enhances not only the willingness to collaborate but also the quality of external knowledge flows, thereby boosting innovation performance (Chen, Cai, Luo, and Mao, 2025).Chen, Lu & Tongnoy (2025) claim that technological infrastructure is a critical enabler of open innovation, as it provides both the digital foundation and organizational mechanisms necessary to support external collaboration and knowledge flows. Firms that combine strong IT capabilities with practices like digital trust and knowledge sharing are more likely to translate open innovation strategies into sustained innovation performance (Chen, Lu, & Tongnoy, 2025).The presence of trusted digital systems is crucial for achieving collaborative innovation outcomes.Hussain et al. (2024) explored SMEs in China. They found that digital infrastructure has a significant positive effect on innovation performance, with e-knowledge (digital literacy/competency) acting as a strong moderator. At the same time, in the WB Fewer than 30% ofindividuals use the internet to interact with publicauthorities. This reflects both the limited availabilityand awareness of e-government services, as well as a lack of digital skills across the population, indicating a broader unpreparedness to fully capitalize on the opportunities presented by digitalization (OECD, 2025, p. 18).

In the WB, where resources are scarce, OI could compensate for institutional weaknesses by pooling external knowledge and sharing infrastructure (Matusiak & Kleibrink, 2018).Nevertheless, contradictory evidence points to significant challenges. In traditional SMEs, OI often faces barriers such as lack of absorptive capacity, cultural resistance, and weak intellectual property regimes (Hossain &Kauranen, 2016; Spithoven et al., 2013). In transition economies, OI may even exacerbate risks of knowledge leakage, reducing incentives for firms to invest in collaborative R&D (Zúniga, 2023). Empirical studies show that SMEs in low-institutional-quality environments tend to rely more on internal innovation strategies, as weak contracts and enforcement undermine trust in external partnerships (Papageorgiadis&Sofka, 2020). In the WB, fragmented research systems and limited technological infrastructure further constrain the implementation of OIS (OECD, 2024). While OIS can potentially mediate the relationship between government support and TT, their impact in the WB is conditioned by institutional readiness and the strength of collaborative networks.Therefore, we formulate that:

H3. The implementation of open innovation strategies mediates the relationship between government support and the effectiveness of technology transfer within emerging entrepreneurial innovation ecosystems.

III. METHODOLOGY AND RESEARCH RESULTS

3.1. Theoretical Framework

A theoretical model was developed based on a systematic review of the relevant literature conducted in May and June 2024. The review encompassed more than 40 recent and high-quality publications in reputable journals, as well as official policy documents. The literature review focused on TT, open innovation, and IPR, with the dual purpose of (i) providing a robust theoretical foundation for the research hypotheses and objectives, and (ii) informing the design of the Delphi study.

3.2. Delphi Study Design and Implementation

The Delphi study was designed to gain in-depth insights into the challenges and opportunities of TT and sustainable entrepreneurship within emerging open innovation ecosystems (OIEs) in transitional economies. Its ultimate objective was to generate recommendations for training programs and policy measures aimed at strengthening entrepreneurial skills and know-how. These efforts are expected to enhance youth employability, support the development of innovative start-ups, and foster collaborative networks among industry, academia, and government institutions.

Objectives. The Delphi process was structured to address five key tasks:
1. Identify the principal actors in open innovation ecosystems.
2. Map the channels and stages of knowledge spillovers across ecosystem participants.
3. Recognize obstacles and challenges in the IPP system.
4. Explore potentials for policy changes to support TT and sustainable entrepreneurship within a quadruple helix framework.
5. Assess both potentials and limitations for TT in emerging innovation ecosystems.

Implementation and timeline
- Round I: Conducted 3–7 June 2024; structured interviews with expert panelists.
- Data analysis and preparation of Round II questionnaire: 10–11 June 2024.
- Round II: 12–19 June 2024; questionnaire distributed to the same experts to consolidate opinions and reach consensus.
- Final report: Completed 28 June 2024.

The results of the second round served as input for the subsequent needs analysis. Anonymity of experts was guaranteed throughout both Delphi rounds.

Expert panel. The panel consisted of 20 experts: six entrepreneurs, four environmental and sustainability managers, four CEOs or senior managers, three technology officers, and three data engineers/IT developers. Of the participants, 13 were male and seven were female. Consensus criteria. In the second round, experts evaluated items on a five-point Likert scale (1 = completely insignificant; 5 = very significant). If at least 70% of experts rated an item as significant or very significant, consensus was considered to have been achieved. Several questions were consolidated or reformulated to account for overlapping responses from the first round.

3.3. Needs Analysis Survey
Building upon the Delphi findings, a questionnaire was designed to capture the business community’s perspective on TT, OI, sustainable entrepreneurship, and IPR. The survey was conducted between June 24 and July 8, 2024, in four transitional countries: Serbia, Albania, Bosnia and Herzegovina, and North Macedonia. A total of 100 responses were collected (25 per country) using purposeful sampling.The needs analysis aimed to identify the most pressing challenges faced by firms, irrespective of industry or size, and to highlight areas where academic institutions and regional innovation ecosystems can provide targeted support.

3.4. Variables and Constructs
Within the analytical model, Key Technology Transfer and Commercialization of Innovations Enablers were identified as the dependent variable. Institutional and regulatory support, as well as Open innovation capacity and Strategies, were classified as independent variables.The domains of these constructs were defined on the basis of prior literature, with measurement scales drawn from a curated pool of items validated in previous studies. This pool was refined through expert feedback and pilot testing, ensuring the robustness and contextual relevance of the measurement instruments. The qualitative findings from the Delphi study, combined with insights from the literature review, provided the conceptual grounding for the needs analysis survey instrument.

3.5. The structure of the sample
The research sample consists of 100 companies. In each widening country, 25 questionnaires were collected. The following table describesthe sample according to company size in each country.

		Company size			Total
		Large	Medium	Small	
Country	Albania	16	8	1	25
	Bosnia and Herzegovina	8	11	6	25
	North Macedonia	5	10	10	25
	Serbia	4	10	11	25
	Total	33	39	28	100

Table 1 - Number of companies per country
Notes. Authors’ presentation.

From the total number of companies in the sample, the majority refers to medium companies (39), then large (33) and small (28).Considering the company's activities, the largest representation in the sample is from the fields of Information and Communications (34%), Manufacturing industry (30%), and Financial and Insurance activities (8%).

Activity	Frequency	Percent	Valid Percent	Cumulative Percent
Area C: Manufacturing industry	30	30.0	30.0	30.0
Area D: Production and supply of electricity, gas, steam and air conditioning	4	4.0	4.0	34.0
Area E: Water supply, sewerage, waste management and environmental rehabilitation (remediation) activities	2	2.0	2.0	36.0
Area F: Construction	3	3.0	3.0	39.0
Area G: Wholesale and retail trade, repair of motor vehicles and motorcycles	1	1.0	1.0	40.0
Area J: Information and Communications	34	34.0	34.0	74.0
Area K: Financial and insurance activities	8	8.0	8.0	82.0
Area L: Real estate business	2	2.0	2.0	84.0
Area M: Professional, scientific and technical activities	1	1.0	1.0	85.0
Area N: Administrative and auxiliary service activities	1	1.0	1.0	86.0
Area O: Public administration and defence, compulsory social insurance	3	3.0	3.0	89.0
Area P: Education	3	3.0	3.0	92.0
Area Q: Health care and social work activities	5	5.0	5.0	97.0
Area S: Other service activities	1	1.0	1.0	98.0
Area U: Organization of extraterritorial organizations and bodies	2	2.0	2.0	100.0
Total	100	100	100	

Table 2 - Company's activity
Notes. Authors' presentation.

3.6. Structural Equation Modelling (SEM)

Structural Equation Modelling (SEM) was employed to analyze relationships between latent constructs relevant to innovation support and commercialization in the WB. In our SEM approach, we integrate Confirmatory Factor Analysis (CFA) with path analysis, a practice that allows the simultaneous estimation of both the measurement model and the causal (structural) model (Almansoori et al., 2025; Hair et al., 2019). The intention is to allow the simultaneous estimation of both the measurement model and the causal (structural) model. The first part of the model defines how observed variables reflect latent constructs. The second one specifies the relationships among those latent constructs (Bollen, 1989; Kline, 2015). Observed variables are those that are measurable directly, and they are used as indicators included in the measurement part of the model. The measurement model specifies how indicators load on latent constructs. Following Rosseel (2012), the measurement model is defined as:

$$x = \Lambda x \xi + \delta$$
$$y = \Lambda x \xi + \delta$$

where ξ is the vector of latent exogenous variables, η is the vector of latent endogenous variables, Λx and Λy are the factor loading matrices, and δ and ε are measurement errors. We have three latent variables.

The first latent variable captures the systemic and policy-level support mechanisms provided by the governments' institutions. We referred to it as Institutional and Regulatory Support (latent 1). It is measured indirectly through the following indicators:

- A_6: Tax credits and deductions for R&D activities(Landman et al., 2022; Lenihan et al., 2024; Shi & Ge, 2025)
- B_6: Grants and funding programs for collaborative research programmes (Howell, 2017; Zarea et al., 2025; Bailey et al., 2025)
- C_6: Subsidies for technology commercialization efforts (Howell, 2017; Koster et al., 2019)
- D_5, D_6: Tax incentives for R&D (Howell, 2017; Lee et al., 2024; Shi & Ge, 2025) and IPP(Papageorgiadis&Sofka, 2020)
- A_7, B_7: Additional elements of institutional and regulatory support: Collaboration with universities and external partners (Chesbrough & Bogers, 2014; Cohen & Godinho, 2025) and Establishing research centers focused on innovation (Zarea et al., 2025).

This construct reflects the institutional and regulatory framework that facilitates TT and protects innovation outputs.

The second latent variable represents the effectiveness of innovation commercialization efforts. We referred to it as Key Technology Transfer and Commercialization of Innovations Enablers. It is measured through:

- C_1: Importance of government bodies that support funding and policy in open innovation ecosystem(Etzkowitz&Leydesdorff, 2000; Abramo & D'Angelo, 2018)
- C_3: Significance of product adaptation to market needsfor successful commercialization of innovations?(Chang & Taylor, 2016; Morgan et al., 2018; Wang et al., 2020)
- D_3: Significance of support for entrepreneurship and start-up companies for successful commercialization of innovations(Narver et al., 2004; Chesbrough, 2024; Papageorgiadis&Sofka, 2020)
- C_5: Access to investors (VCs, angel investors, crowdfunding) (Berger & Gottschalk, 2025; Gill et al., 2024; Kaminski et al., 2019)
- D_5: Regulatory aspects related to commercialization of innovation (Tax incentives for research and development)(Howell, 2017; L0065e et al., 2024; Shi & Ge, 2025)

This construct reflects the outcomes and enablers of successful innovation transfer into marketable products and services.

The third latent variable captures the internal organizational ability to engage in open innovation practices. We referred to it as Open Innovation Capacity and Strategies. It is measured through:

- B_2: Technological infrastructure for open innovation strategies (Dogson, 2015; Castillo et al., 2023; OECD, 2024; Zhao & Dong, 2025; Chen, Cai, Luo, & Mao, 2025)
- C_2: Leadership and managerial supportfor the implementation of open innovation strategies(Bogers et al., 2018; Chesbrough&Bogers, 2014; Chen, Cai, Luo, & Mao, 2024; Chen, Lu, & Tongnoy, 2025; West & Bogers, 2017);
- E_5: Costs and return on investmentinfluence TT(Siegel et al., 2004; Markman et al., 2005)
- D_1: Institutional procedures- support for entrepreneurship and start-up companies for successful commercialization of innovations(Etzkowitz&Leydesdorff, 2000; Abramo & D'Angelo, 2018; Chesbrough, 2024)
- A_3: Organizational practices: market access and marketing orientation(Kohli&Jaworski, 1990; Narver et al., 2004; Prifti&Alimehmeti, 2017)

3.6.1. Variables

This construct reflects the absorptive capacity and readiness of firms to collaborate externally and integrate diverse knowledge sources. More specifically, it refers to Open innovation strategies. The structural model specifies the directional relations between latent variables:

$$\eta = B\eta + \Gamma\xi + \zeta$$

WhereB is the matrix of regression coefficients among endogenous constructs, Γ is the matrix of regression coefficients relating exogenous to endogenous constructs, and ζ is the vector of structural disturbances.

The SEM was estimated using Maximum Likelihood (ML), which is the default in most SEM software, including the lavaan package in R (Rosseel, 2012). ML estimation assumes multivariate normality of the observed indicators (Kline, 2015). To address potential non-normality, robust standard errors and scaled test statistics were considered (Satorra&Bentler, 1994). Model fit was evaluated using multiple indices, including the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Recommended cutoff values are CFI/TLI $\geq$ 0.90, RMSEA $\leq$ 0.08, and SRMR $\leq$ 0.08 (Hu & Bentler, 1999; Hair et al., 2019).
Briefly, our analysis shows that institutional and regulatory support (latent1) strengthens the internal capacity of organizations for open innovation (latent3). This capacity indirectly affects the success of TT (latent2). Not all direct effects are statistically significant. Hence, results are presented in table 1, and the scheme of our model is given with a path diagram below:

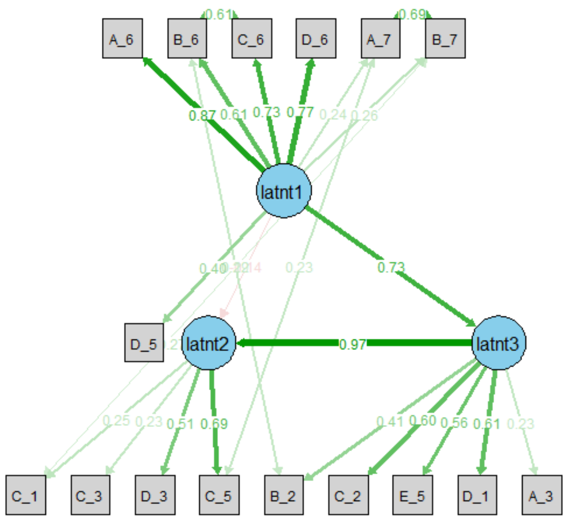

Figure 1 - Initial Theoretical Model

Notes. Authors' proposal of the initial theoretical model based on research results.

Hence, the structural equation model tested the relationships between three latent constructs: Institutional and Regulatory Support (latent1), Open Innovation Capacity and Strategies (latent3), and the Key Technology Transfer and Commercialization of Innovations Enablers (latent2).

3.7. Research results

The SEM analysis results indicate a strong and statistically significant effect of institutional support on open innovation capacity, or to be specific,latent1 → latent3 ($\beta = 0.732$, $p < 0.001$). This suggests that institutional and regulatory mechanisms significantly influence the internal capabilities of organizations to engage in open innovation practices. However, the subsequent path from open innovation capacity to TT success was positive but not statistically significant, or to be specific, latent3 → latent2 ($\beta = 0.973$, $p = 0.118$). The direction of the effect aligns with theoretical expectations. But the lack of statistical significance implies that, within the sample of 100 respondents, the internal innovation capacity does not reliably translate into successful commercialization outcomes.

Component	Path / Indicator	Estimate (β)	P-value	Significance
Fit Index	Chi-square (χ^2)	128.426	0.013	Significant
	CFI	0.934	-	Acceptable
	TLI	0.916	-	Acceptable
	RMSEA	0.059	-	Acceptable
	SRMR	0.090	-	Marginal
Regression	latent1 → latent3	0.732	< 0.001	Significant
	latent3 → latent2	0.973	0.118	Not significant
	latent1 → latent2	-0.141	0.640	Not significant
Residual Correlation	A_7 ~~ B_7	0.870	< 0.001	Significant
	B_6 ~~ C_6	0.286	< 0.001	Significant
	A_7 ~~ C_5	0.157	0.008	Significant
	B_6 ~~ B_2	0.098	0.008	Significant
	B_7 ~~ C_1	0.208	0.013	Significant

Table 3 - SEM Results

Notes. SEM results include model fit indices, standardized regression paths, and residual correlations. Fit indices are within acceptable thresholds except SRMR. Only the path from latent1 to latent3 is statistically significant.

Similarly, the direct effect of institutional support on TT success was weak and statistically insignificant, or to be specific latent1 → latent2 ($\beta = -0.141$, $p = 0.640$). This suggests that institutional mechanisms do not directly drive commercialization success, Therefore, their influence may be better understood as operating through organizational innovation capacity.

Additionally, to enhance model fit and account for unexplained associations, several residual correlations were introduced between indicators. These reflect meaningful empirical links not captured by the latent constructs. For example, A_7 and B_7 are strongly correlated, both representing regulatory support.

Further, B_6 and C_6 often appear together, indicating the co-occurrence of grants and subsidies. Additionally, A_7 and C_5 suggest that institutional support may be tied to access to capital, and B_6 and B_2 show that financial support is linked to infrastructure. Lastly, B_7 and C_1 imply that regulatory support influences market orientation.

Initially, we also considered mediation analysis. The focuswas on the effect of government support on the commercialization of innovations and how it is transmitted through open innovation strategies. Preliminary model testing revealed that the proposed mediation structure did not fit the data adequately. Fit indices were below recommended thresholds.

We have applied a Bayesian SEM to test the mediation framework(Merkle et al., 2021).The measurement model defined three latent constructs: institutional and regulatory support, organizational innovation capacity, and open innovation strategies. Using MCMC estimation with diffuse priors in blavaan, the model converged well ($\hat{R} \approx 1.00$). Results showed that GS positively predicted OIS ($a = 0.35$, 95% CI [0.08, 0.67]), and OIS in turn predicted CI ($b = 0.63$, 95% CI [0.14, 1.86]). The direct path from GS to CI was small and not credible ($c = –0.05$, 95% CI [–0.37, 0.14]). The Bayesian posterior for the indirect effect (a*b) was positive (ind = 0.22), although the 95% credible interval included zero (–0.10, 0.55), suggesting partial but uncertain mediation.

The Delphi panel confirmed that experts across the WB possess solid knowledge of the innovation ecosystem and TT processes. Consistent with the empirical survey results, they identified universities, research institutions, start-ups, SMEs, large corporations, government agencies, investors, and incubators as the principal actors within open innovation systems. In terms of knowledge acquisition, experts emphasized traditional channels such as conferences, trade fairs, scientific journals, and industry associations. However, they noted limited reliance on alternative sources, including patent databases, standardization documents, social networks, open business platforms, and crowdsourcing, which were also underrepresented in the empirical findings.

With respect to intellectual property (IP) protection, the experts highlighted persistent challenges, namely high costs and complexity of the patent system, insufficient awareness and education on IP rights, weak enforcement mechanisms, delays in patent and trademark registration, and a lack of regional harmonization. These findings resonate with the survey-based evidence pointing to systemic barriers in the IP environment.Regarding TT and sustainable entrepreneurship, the Delphi results underscored several structural constraints: shortage of qualified workforce, inadequate financial resources and investment levels, weak university–industry collaboration, regulatory uncertainties, and limited commercialization and market-entry strategies. At the same time, experts stressed a set of potential enablers that could strengthen the ecosystem, such as government-funded research and innovation grants, stronger university–industry partnerships, investments in research infrastructure and technology parks, targeted tax incentives, and public–private partnerships. Finally, there was a consensus that proactive government measures to stimulate collaboration and knowledge spillovers are critical for enhancing business capacity to engage effectively in R&D and innovation activities.

IV. DISCUSSION

The SEM results reveal notable dynamics between government support, open innovation capacity, and commercialization outcomes. Institutional and regulatory support shows a strong positive effect on firms' open innovation capacity (latent1 → latent3: $\beta = 0.732$, $p < 0.001$), indicating that public interventions significantly bolster the internal capabilities of organizations to engage in collaborative innovation. This finding aligns with evidence from other contexts that well-designed government incentives (e.g., grants, tax credits) can stimulate firm-level innovation activities and knowledge exchange (Dechezleprêtre et al., 2023; Shi & Ge, 2025). Speckbacher&Wabnegg (2020) argue that well-designed explicit incentives—such as grants and tax credits—can effectively support knowledge exchange and distal search behaviors within firms, both of which are critical for innovation. Their empirical study, based on survey and patent data from 282 firms in the chemical and pharmaceutical industries, supports the idea that incentives foster innovation by encouraging collaborative and exploratory behaviors.However, the subsequent path from open innovation capacity to successful technology transfer and commercialization was positive but not statistically significant in our sample (latent3 → latent2: $\beta = 0.973$, $p = 0.118$). In addition, the direct effect of institutional support on commercialization outcomes was negligible and insignificant (latent1 → latent2: $\beta = -0.141$, $p = 0.640$). In practical terms, while government support clearly enhances firms' ability to pursue open innovation, that enhanced capacity has not reliably translated into greater innovation commercialization success in the Western Balkans (WB) context.

These results must be interpreted against the backdrop of the WB's institutional, economic, and entrepreneurial environment. The finding that open innovation capacity did not significantly improve commercialization outcomes suggests the presence of systemic barriers that inhibit the conversion of innovation inputs into marketable outputs. The Delphi expert panel provides critical insight here. Experts uniformly pointed to structural constraints in the WB: a shortage of qualified human capital, inadequate financing and investment levels, weak university–industry linkages, regulatory uncertainties, and limited commercialization know-how and market-entry support. Such conditions likely attenuate the effectiveness of open innovation. Firms may increasingly collaborate and absorb external knowledge, but without a supportive ecosystem, those efforts can stall before yielding commercial products. For instance, if firms lack access to skilled talent or expansion capital, or if legal/regulatory frameworks are unstable, even high levels of open innovation activity will struggle to produce successful innovations in the marketplace. This interpretation is consistent with the region's known challenges – the WB innovation ecosystem remains nascent and fragmented, with R&D underinvestment and institutional weaknesses well-documented (OECD, 2024a). Thus, our quantitative finding of a non-significant open-innovation → commercialization path is likely symptomatic of these contextual hurdles rather than an indictment of open innovation itself.

When compared with other transitional and emerging economies, our findings align with a growing body of literature that emphasizes the context contingency in the innovation–commercialization relationship. In environments with robust institutions and higher absorptive capacity, engaging in open innovation tends to correlate with better innovation performance. For example, Thai SMEs that developed strong absorptive capacity and agility saw a significant boost in new product development outcomes through the adoption of OI(Puriwat&Tripopsakul, 2021).

Likewise, a study of Korean biopharmaceutical firms found that government R&D subsidies amplified the benefits of open innovation on firm performance, suggesting a complementary effect of policy support and open collaboration (Wang et al., 2024). In such settings, public support and OI work in tandem to drive commercialization. By contrast, in many transition economies, scholars have observed exactly what we find in the WB: OI is possible but often fails to generate the expected commercial payoffs due to institutional and market deficiencies. Weak IPP and enforcement, for instance, can deter firms from fully committing to external knowledge sharing and R&D partnerships, as they fear knowledge leakage or imitation. Chaudhary et al. (2022) document that OI initiatives frequently falter when IP rights are weak or partner trust is low, as sensitive knowledge can leak and erode competitive advantage. Similarly, Dabić et al. (2023) identify the "limits of open innovation" in practice, finding that high collaboration risks and costs can outweigh benefits in less-developed innovation systems. These issues are highly pertinent to the WB, where legal frameworks and contract enforcement remain fragile. Indeed, recent analyses note that SMEs in low-institutional-quality environments tend to rely more on internal innovation because weak enforcement undermines trust in external partnerships. Studies confirm the importance of a trustworthy partner providing local market knowledge and access, financial and operational synergies, and resource complementarities (Du & Williams, 2017, as cited in Tse et al., 2024).

Our Delphi experts echoed this, highlighting persistent problems in the WB IPP regime: high patenting costs, slow and complex procedures, and weak enforcement across the region. Such conditions make firms cautious about OI and dilute its impact on commercialization. Furthermore, limited absorptive capacity in firms – the ability to assimilate and apply external knowledge – may be a critical bottleneck. Although our construct "open innovation capacity" captures some aspects of this, many WB companies (especially SMEs) may lack the internal R&D staff, innovation management skills, or market knowledge necessary to turn externally sourced ideas into successful products. Prior research underscores that without sufficient absorptive capacity, the fruits of OI cannot be fully realized (Puriwat&Tripopsakul, 2021).

On the positive side, our study suggests that government support is functioning as intended in the initial stage, significantly strengthening firms' openness and collaborative innovation capacity. This is an encouraging sign for policymakers – it means that interventions like innovation grants, tax incentives, or innovation funds have successfully prompted firms to reach out to universities, research institutes, and other companies for knowledge and technology exchange. The WB have seen a proliferation of such measures (e.g. Serbia's Collaborative Grant Scheme, North Macedonia's innovation vouchers), and our evidence of a strong latent1 → latent3 path confirms that these policies are making firms more "open" innovators.The disconnect occurs in the next stage: translating collaborative innovation into market success. One plausible interpretation is that the time lag and magnitude of effects are beyond the scope of our cross-sectional data – it may simply take more time for OI investments to pay off in terms of new products or ventures, especially in economies where the innovation-to-market pipeline is slow. Another interpretation, supported by the Delphi findings, is that additional interventions are needed at the ecosystem level. For instance, experts emphasized the need for better university–industry partnerships, improved research infrastructure (labs, science and technology parks), and more active intermediaries(incubators, accelerators) to bridge the gap between idea and market. They also pointed to the importance of the government's role as a catalyst beyond funding – such as facilitating connections, improving regulatory clarity, and even acting as an initial customer for innovative products. In transitional economies, it often takes a concerted push on multiple fronts for innovations to reach commercial fruition. Our findings thus call for a more holistic approach to innovation support in the WB: one that not only provides funding and incentives (the "supply" side of innovation) but also strengthens demand and the capacity to absorb innovation. We discuss specific policy recommendations below.

Policy recommendations for the Western Balkans

Building on the above insights, several priority actions emerge to enhance open innovation capacity and commercialization success in the WB:

- Bridge the R&D–market gap with targeted support. Introduce commercialization grants, innovation vouchers, and proof-of-concept funding that specifically help firms transform prototypes into market-ready products. These programs should de-risk the later stages of innovation (testing, scaling, market entry), complementing existing early-stage R&D subsidies.
- Strengthen university–industry linkages and networks. Develop more joint R&D centers, consortium projects, and innovation clusters that connect firms with universities and research institutes. Policies could include incentives for collaborative projects, support for technology transfer offices (TTOs), and regional innovation hubs to facilitate knowledge flow across academia and business (A2B).
- Invest in human capital and absorptive capacity.Expand training programs, mentorship,

and managerial education focusing on innovation management and commercialization skills. Scholarship and internship initiatives can help retain and upskill talent in STEM and entrepreneurship. Addressing the skilled workforce shortage will improve firms' ability to absorb external knowledge and exploit innovations.

- Enhance the innovation ecosystem infrastructure. Establish and support incubators, accelerators, and science and technology parks that provide start-ups and SMEs with access to laboratories, equipment, and mentorship. Coupled with this, improving digital infrastructure and e-governance tools can facilitate wider collaboration and access to markets through better connectivity and digital platforms.
- Reform institutional and regulatory frameworks. Continue harmonizing IPP laws with EU standards and streamline patenting and licensing procedures across the region. Strengthen enforcement of IPP rights and contracts to build trust in OI collaborations. Additionally, simplify business regulations and improve predictability (e.g. consistent tax incentives, stable innovation policies) to encourage private investment in innovative ventures.

By implementing these measures, policymakers can create an environment where the Western Balkans' growing open innovation capacity is more effectively channelled into sustainable commercial success. The emphasis must shift from just fostering innovation inputs to building the conditions that allow those inputs to generate impactful outputs.

V. CONCLUSIONS AND IMPLICATIONS

This study examined how government support, organizational innovation capacity (particularly open innovation strategies), and systemic factors influence the commercialization of innovations in the Western Balkans. Our SEM analysis and Delphi insights yield two main findings. First, institutional support catalyzes OI: firms that receive greater public support (funding, incentives, regulatory assistance) exhibit significantly higher open innovation capacity, reflecting stronger engagement in external collaboration and knowledge sourcing. This highlights the positive impact of government interventions in fostering innovation capabilities within firms. Second, we found no significant direct relationship between heightened open innovation capacity and the achievement of successful innovation commercialization (e.g., bringing new products to market or achieving commercial viability) in the WB sample. Likewise, the direct path from government support to commercialization outcomes was not significant. In essence, while public support clearly boosts firms' openness and collaborative innovation activities, those efforts have not (yet) translated into markedly higher commercialization success in this transitional context. This highlights a persistent gap between innovation inputs and outputs in the WB, underscoring the influence of contextual barriers identified by the expert panel.

5.1. Theoretical implications

Our findings contribute to the literature on innovation ecosystems in emerging and transition economies by elucidating the conditions under which government support and OI translate into performance. The results challenge any simplistic, linear view of the innovation process in transitional contexts. The fact that open innovation capacity alone did not drive commercialization success suggests that classic theories linking collaboration to performance need to incorporate contextual moderators (such as institutional quality and ecosystem maturity). In line with an institution-based view of innovation, our study confirms that the efficacy of open innovation is contingent on the broader system – weak institutions can mute or nullify relationships that are taken for granted in developed economies. We extend OI theory by highlighting a boundary condition: in fragmented, resource-constrained ecosystems, OI may require a threshold level of absorptive capacity and network infrastructure to yield benefits. This nuance helps explain mixed results in prior research on emerging markets and calls for more theoretical work on innovation system failures (and not just successes). Additionally, the integration of a Delphi study with quantitative SEM is a methodological contribution. It demonstrates how combining expert perspectives with statistical modeling can enrich theory – in our case, by providing a deeper understanding of why a mediation expected by theory (open innovation mediating the effect of support on outcomes) did not fully materialize. The experts' input highlighted the need for systemic links, suggesting that future theory-building should explicitly factor in elements such as talent mobility, cultural attitudes, and intermediary institutions when explaining innovation commercialization in transition economies. In summary, this study advances the theoretical discourse by emphasizing context-specific mechanisms, supporting the notion that innovation models (such as the Triple Helix or open innovation paradigm) must be adapted to the institutional realities of post-transition economies, where government support alone is a necessary but insufficient driver of commercialization.

5.2. Policy andmanagerial implications

The study offers clear guidance for policymakers aiming to strengthen innovation-led growth in the Western Balkans. The positive impact of institutional support on open innovation capacity validates current policy efforts – it suggests that grants, innovation funds, and collaborative programs are indeed building momentum for innovation within firms. However, the weak link to commercialization outcomes indicates that policy must go further. Policymakers should adopt a more holistic, end-to-end approach to innovation policy. In practice, this means designing programs that not only stimulate knowledge creation but also facilitate the commercial application of that knowledge. Governments might, for example, expand funding schemes to cover later stages of the innovation cycle (e.g. pilot production, market testing, scaling up). The introduction of targeted commercialization support – such as matchmaking services between innovators and investors, or subsidies for first-of-a-kind product deployment – could help address the "valley of death" where many WB innovations currently stall.

Improving theinnovation ecosystem is another imperative. Our findings underscore the need to invest in the enablers of commercialization: skill development, institutional capacity, and networking platforms. Policymakers should strengthen university–industry collaboration frameworks by funding joint research centers and incentivizing academia to engage in entrepreneurship (for instance, supporting faculty start-ups or student innovation challenges). Strengthening the IPP regime is also crucial: even if perfect enforcement is hard to attain quickly, streamlining patent registration and offering legal aid or education on IPP for entrepreneurs can incrementally improve the environment (Papageorgiadis&Sofka, 2020). Simplified regulations and one-stop-shop services for innovation commercialization (covering certifications, licensing, etc.) would reduce bureaucratic friction for new products coming to market. Furthermore, regional policymakers should collaborate – a regional market approach could provide WB innovators with a larger customer base and more opportunities to scale, partially offsetting the limitations of each small national market. Aligning with EU programs (like Horizon Europe, EIT Knowledge and Innovation Communities) can also integrate WB start-ups and researchers into broader value chains, increasing their commercialization prospects. In summary, the policy implication is that supporting innovation is not just about funding R&D – it is about building an integrated ecosystem where ideas can flow freely and find fertile ground to grow into commercial ventures. The Western Balkans' governments stand to gain by rethinking their role not just as funders but as facilitators, connectors, and champions of innovation all the way to market. This study's insights into the current bottlenecks can help in refocusing policies to ultimately turn the region's innovation potential into tangible economic and social benefits.

For entrepreneurs and managers in the Western Balkans and similar emerging markets, our findings carry essentiallessons. First, building internal capacity is crucial – managers cannot rely solely on government support to ensure commercial success. Firms should invest in strengthening their own R&D competencies, absorptive capacity, and market orientation. Developing skills to effectively assimilate external knowledge (through training or hiring talent) will help firms better leverage collaborative projects and public resources for tangible outcomes. Second, while engaging in OI, managers must be strategic in how they manage partnerships and knowledge flows. The WB context of weak IPP enforcement means firms should implement due diligence and protective measures (e.g., phased knowledge sharing) when collaborating, to safeguard their competitive advantages (Chaudhary et al., 2022).

A proactive approach to intellectual property management – even under imperfect conditions – can mitigate risks of knowledge leakage. Third, managers should seek out networks and cross-sector partnerships as a way to compensate for gaps in the ecosystem. Given weak formal institutions, informal networks (industry associations, diaspora connections, mentorship circles) can provide support in areas like financing, mentorship, and market access. Our expert panel noted that entrepreneurial successes often hinge on personal networks in the WB. Cultivating these networks and participating in innovation clusters or hubs can expose firms to new opportunities and resources that government programs alone might not provide. Ultimately, managers must maintain amarket-focused mindset throughout the innovation process. One explanation for the lack of observed commercialization impact is that some WB firms may focus on technology development without sufficiently aligning it with market needs or crafting viable business models. Managers should conduct thorough market research, engage customers early (to validate demand), and remain agile in pivoting innovations toward market feedback. In essence, the onus is on firm leadership to turn the "raw material" provided by OI and public support into marketable innovations. Those firms that combine external support with strong internal execution – including sound project management, effective marketing strategy, and customer engagement – are more likely to overcome regional challenges and achieve commercial success. This managerial focus on coupling innovation with commercialization strategy is critical in transitional environments where systemic support is evolving but not fully mature.

5.3. Limitations and suggestions for future research

Like in most studies, ours has limitations that open avenues for further inquiry. One limitation is the sample scope – we surveyed 100 firms across four WB countries, which may not capture the full heterogeneity of the region's firms or allow fine-grained country-specific analysis. Future research could expand the sample size and include additional WB economies (or similar transitional regions) to improve generalizability and explore any intra-regional differences. Another limitation is our measure of "commercialization success," which was based on enablers and self-reported indicators. Subsequent studies should consider more direct performance metrics (e.g. number of new products launched, innovation revenue growth, or patent licensing deals) to assess commercialization outcomes more objectively. Additionally, the cross-sectional design of the SEM means we captured a snapshot in time. Longitudinal studies would be valuable to observe how the relationships between support, open innovation, and commercialization play out over more extendedperiods – it may be that the benefits of OI on commercialization have a lag that our study could not detect. A dynamic analysis could also account for feedback loops (e.g. successful commercialization leading to more support or collaboration in the future). The Delphi component, while strengthening our interpretations, was limited to 20 experts; broader stakeholder engagement (for instance, including policymakers, investors, and end-users) in future Delphi rounds or qualitative interviews could enrich the understanding of systemic issues.

Building on these limitations, we suggest several directions for future research. Comparative studies would be particularly illuminating – for example, comparing the WB findings with data from Central Eastern European EU members or other emerging economies in Asia or Latin America. Such studies could test whether the "support → open innovation → commercialization" pattern holds elsewhere or if the WB are an outlier. Investigating the role of firm characteristics is another fruitful avenue: future research could examine whether certain firms in the WB do, in fact, translate OI into success – perhaps those with higher absorptive capacity, stronger leadership commitment, or operating in specific high-tech industries. This might involve multigroup SEM or case-study approaches to identify best practices and success factors at the micro level.

Additionally, further work is required on the mediation and moderation mechanisms at play. Our attempt at a mediation model suggested that open innovation strategies might partially mediate the effect of support on outcomes, albeit with considerable uncertainty. Researchers could explore this further, possibly using advanced techniques (e.g. Bayesian SEM or qualitative comparative analysis) to unpack complex causal chains. It would also be worthwhile to examine moderators such as institutional quality or network centrality – for instance, does the model behave differently in countries with better governance, or do more networked firms regionally see more potenteffects? Finally, given the importance of ecosystem factors, future studies might adopt an innovation systems approach, looking at the interplay of universities, government agencies, financial institutions, and firms in the WB. Such research, potentially through mixed methods, can provide deeper insight into how to orchestrate an ecosystem where government support and open innovation collectively drive sustainable commercialization. Addressing these questions will not only build on our findings but also guide policymakers and practitioners in fostering innovation-driven growth in transitional economies.

Institutional Review Board Statement

Ethical review and approval were waived for this study, as it was not required under national regulations. The research was conducted in compliance with the ethical standards for social science research, the principles of the Declaration of Helsinki, and the Horizon USE IPM project ethical guidelines.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. All participants in the focus group discussions, the Delphi study, and the needs analysis survey signed consent forms prior to their involvement and agreed to the use of their responses for research purposes.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy and confidentiality agreements with participants.

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