

The Impact of University Innovation Centers in Promoting Citizen Innovation, Creativity and Employment: Evidence from Georgia

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Publication Date: 2026/06/23

Abstract: This study examines how University Innovation Centers (UICs) in Georgia's transition economy shape innovation behaviors, creative competencies, and employment outcomes through a student-centric framework triangulated with faculty and business user perspectives.

Drawing on 151 respondents across six established UICs (July–November 2025), the study integrates Triple Helix Theory, Absorptive Capacity Theory, and Stakeholder Contingency Theory to model how institutional position shapes innovation agency, applying non-parametric tests to accommodate the ordinal data structure.

Findings show that UIC engagement is strongly associated with creativity enhancement (Cohen's $d = 1.32$, $p < .001$), with students reporting the highest gains ($M = 4.26$) and external users experiencing the strongest career influence (56.2%). However, direct employment effects remain modest (27.6% sectoral alignment), constrained by limited workforce absorption in innovation-intensive sectors (5.6% of total employment) and significant awareness deficits (60.3% unaware). High-touch relational services achieve the highest outcome conversion, suggesting that UIC expansion policies should prioritize cognitive integration and differentiated service portfolios calibrated to stakeholder absorptive capacities rather than uniform commercialization metrics.

The study advances a "differentiated agency" model that reframes university innovation impact from narrow commercialization outcomes toward equitable capability distribution in post-Soviet transition economies.

Keywords: University Innovation Centers, Citizen Innovation, Transition Economies, Triple Helix, Absorptive Capacity, Georgia, Stakeholder Contingency.

How to Cite: Fred Kasirye; Zurab Luckashvili (2026) The Impact of University Innovation Centers in Promoting Citizen Innovation, Creativity and Employment: Evidence from Georgia. *International Journal of Innovative Science and Research Technology*, 11(5), 4548-4564. <https://doi.org/10.38124/ijisrt/26may1104>

I. INTRODUCTION

➤ Background and Context

University Innovation Centers (UICs) have proliferated globally as institutional instruments for translating academic knowledge into socio-economic value (Rothaermel et al., 2007; Hossain et al., 2019). Yet in transition economies—characterized by institutional voids, thin venture capital markets, and fragmented industry-science linkages—the conventional technology commercialization model proves structurally mismatched (Smallbone & Welter, 2001; Aidis et al., 2008). In such contexts, UICs increasingly serve as capability-building infrastructures, diffusing creative competencies, innovation mindsets, and employability skills across heterogeneous societal actors (Hossain, 2020; Williams & Vorley, 2015).

Georgia offers a compelling empirical context for examining these dynamics. Since 2014, innovation-led development has anchored national policy, culminating in the Law on Innovation Activities (2016) and the Innovation Strategy 2025–2030, which envisions UIC expansion from 23 to over 40 centers (Government of Georgia, 2020; World Bank, 2022). Despite cumulative donor and government funding exceeding €30 million, systematic evidence on who benefits, through which mechanisms, and under what conditions remains sparse. These patterns suggest that UIC impacts are differentially distributed rather than uniformly diffused - a possibility that existing aggregate evaluations systematically obscure.

➤ *Problem Statement*

Current UIC scholarship remains anchored in elite innovation metrics - patents, startups, and licensing revenues - that capture only a narrow bandwidth of innovation activity (Siegel & Wright, 2015; Bradley et al., 2013). Three interrelated limitations constrain the evidence base in transition economies.

First, stakeholder heterogeneity is theoretically underspecified. Professors, students, and business users occupy structurally distinct positions within innovation systems, possessing divergent knowledge stocks, institutional incentives, and network embeddedness (Jain et al., 2009; D'Este & Perkmann, 2011). Aggregate evaluations mask these differential impact mechanisms, preventing service optimization (Guerrero & Urbano, 2019).

Second, citizen-level outcomes remain conceptually underdeveloped. Creativity and employability - central pillars of human capital formation - are rarely operationalized using validated instruments (Tierney & Farmer, 2002). Employment impacts are typically restricted to direct job creation within incubated startups, ignoring network-mediated labor market access and informal sector productivity gains (Kirby, 2006; Williams & Vorley, 2015).

Third, the internal logic of UIC service portfolios remains empirically opaque. While UICs offer mentorship, prototyping, and funding access, their relative effectiveness across stakeholder groups remains untested in post-socialist contexts (Smallbone & Welter, 2001; Wright et al., 2012).

Consequently, a fundamental policy question remains unanswered: *How can UICs be configured to equitably enhance citizen innovation, creativity, and employment in institutionally constrained transition economies?*

➤ *Research Purpose and Analytical Orientation*

This study addresses this gap by examining how mature UICs in Georgia shape innovation behaviors, creativity competencies, and employment outcomes across three stakeholder groups. Rather than treating UICs as uniform interventions, we conceptualize them as configurable innovation platforms whose effects depend on the alignment between: (a) stakeholder absorptive capacity (Cohen & Levinthal, 1990); (b) institutional role expectations (Jain et al., 2009); and (c) service portfolio design (Harrison et al., 2019).

Given the empirical reality of UIC user populations in Georgia - here students constitute the overwhelming majority of participants - this study adopts a student-centric primary inquiry with faculty and business user data serving as informant triangulation. This design choice reflects the demographic composition of innovation ecosystems in early-stage transition economies rather than a sampling limitation per se.

➤ *Research Questions*

- RQ1: How does UIC engagement influence innovation behaviors and creativity competencies among student primary beneficiaries, and how do faculty and business user experiences diverge from this pattern?
- RQ2: What is the relative impact of UIC engagement on employment outcomes across stakeholder groups, and what mediating mechanisms explain attenuated labor market effects?
- RQ3: Which UIC service configurations generate the highest outcome conversion rates, and how do these vary by stakeholder absorptive capacity and institutional position?

➤ *Hypotheses*

Grounded in an integrative theoretical framework (Section 2), we advance a stakeholder-contingent model of UIC impact:

- H1: UIC engagement intensity is positively associated with innovation behaviors (project development, ideation), with effects strongest among actors possessing high prior knowledge stocks and market proximity.
- H2: UIC engagement exhibits stronger positive effects on creative self-efficacy for students than for faculty or business users.
- H3: Employment effects are positively associated with UIC engagement, but operate primarily through indirect signaling and network mechanisms rather than direct job placement.
- H4: The effectiveness of specific UIC services is moderated by stakeholder group, reflecting differentiated absorptive capacities and temporal orientations.

➤ *Significance and Contribution*

This study makes four interlinked contributions. Theoretically, it advances a configurational agency model of university innovation, extending the Triple Helix framework by explicitly integrating citizen innovation and differential agency redistribution in transition economies (Etzkowitz & Leydesdorff, 2000; Hossain et al., 2019). Empirically, it provides the first student-centric, outcome-disaggregated evaluation of UICs in Georgia, generating robust evidence on creativity development, innovation behaviors, and employment pathways (Kasirye & Luckashvili, 2024). Methodologically, it introduces a multi-dimensional measurement framework capturing creativity, innovation intensity, and employment quality, offering a transferable evaluation toolkit for similar institutional contexts. Policy-wise, the findings directly inform Georgia's Innovation Strategy 2025–2030, supporting evidence-based design of regional UIC expansion models and differentiated service architectures (Government of Georgia, 2020; World Bank, 2022).

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

➤ *University Innovation Centers and the Shift Toward Citizen Innovation*

University Innovation Centers constitute a heterogeneous set of organizational arrangements designed to facilitate the translation of academic knowledge into societal and economic value (Rothaermel et al., 2007). Traditionally evaluated through commercialization-centric indicators, UICs have historically been assessed via patent production, startup formation, and licensing revenues (Rothaermel et al., 2007; Siegel & Wright, 2015).

While such metrics remain relevant, their applicability in transition and resource-constrained economies has been increasingly questioned (Hossain et al., 2019). In contexts characterized by limited venture capital, fragmented institutional linkages, and high levels of labor informality, innovation rarely follows linear commercialization trajectories (Smallbone & Welter, 2001; Aidis et al., 2008). Instead, UICs increasingly function as capability-building infrastructures, fostering creative competencies, innovation mindsets, and employability across diverse societal groups (Hossain, 2020; Indrani et al., 2023).

This shift has stimulated the emergence of the citizen innovation paradigm, which emphasizes the democratization of innovation agency beyond elite academic and technological entrepreneurs (Hossain et al., 2019). Citizen innovation encompasses creativity enhancement, micro-enterprise upgrading, network-mediated employment mobility, and informal sector modernization (Hossain, 2020; Williams & Vorley, 2015). From this perspective, UIC success is measured not solely by firm creation but by the breadth and equity of innovation participation (Guerrero & Urbano, 2019).

However, empirical assessments remain dominated by aggregate metrics, obscuring differential outcomes across stakeholder groups (Guerrero et al., 2018). Professors, students, and business users possess structurally distinct knowledge bases, institutional incentives, and network positions, suggesting that UIC impacts are unlikely to be uniform (Jain et al., 2009; D'Este & Perkmann, 2011). Yet, systematic multi-stakeholder evaluations remain rare, particularly in post-socialist contexts (Smallbone & Welter, 2001; Chulaia & Kharitonashvili, 2022). This theoretical and empirical gap motivates the present study's focus on stakeholder-contingent innovation outcomes.

➤ *Integrative Theoretical Framework: Configurational Agency*

To explain heterogeneous UIC outcomes, this study integrates Triple Helix Theory, Absorptive Capacity Theory, and Stakeholder Contingency Theory into a unified configurational agency framework.

- *Triple Helix Theory and Institutional Field Formation*

Triple Helix Theory conceptualizes innovation as emerging from recursive interactions between universities,

industry, and government, with universities increasingly assuming entrepreneurial roles (Etzkowitz & Leydesdorff, 2000; Etzkowitz, 2003). In transition economies, however, institutional fragmentation, weak research–industry linkages, and limited private R&D investment compel universities to act as institutional entrepreneurs, actively constructing innovation participation mechanisms rather than merely facilitating existing flows (Ranga & Etzkowitz, 2013; Guerrero & Urbano, 2019).

Within this environment, UICs operate as boundary-spanning legitimacy brokers. Their physical presence generates symbolic effects that reframe innovation as socially legitimate and cognitively accessible, even among non-participants (Etzkowitz, 2003; Battilana et al., 2009). This proto-helical function—generating preconditions for systemic innovation rather than immediate commercialization—is particularly salient in post-Soviet contexts where entrepreneurial norms remain weakly institutionalized.

This institutional entrepreneurship perspective predicts that UICs generate differentiated innovation pathways, amplifying pre-existing capabilities while selectively enabling new forms of agency (Ranga & Etzkowitz, 2013). Consequently, professors, students, and business users are expected to experience systematically distinct impact patterns, challenging universalistic assumptions embedded in conventional UIC evaluation frameworks (Hossain et al., 2019).

- *Absorptive Capacity Theory and Knowledge Asymmetries*

Absorptive Capacity Theory (ACT) posits that innovation outcomes depend on actors' prior knowledge structures, which condition their ability to recognize, assimilate, and apply external information (Cohen & Levinthal, 1990). In UIC environments, absorptive capacity varies markedly across stakeholder groups (Zahra & George, 2002).

Professors possess deep disciplinary expertise, enabling high *potential* absorptive capacity, yet often exhibit constrained *realized* capacity due to incentive misalignment, limited commercialization experience, and institutional rigidity (Jain et al., 2009; D'Este & Perkmann, 2011). Students, by contrast, display low baseline technical knowledge but high cognitive plasticity, rendering them particularly receptive to creativity-enhancing interventions (Tierney & Farmer, 2002; Soria et al., 2020). Business users, especially micro-entrepreneurs, demonstrate strong contextual and market knowledge but limited formal innovation literacy, shaping their engagement toward immediate productivity gains rather than exploratory experimentation (Kirby, 2006; Williams & Vorley, 2015).

ACT therefore predicts divergent outcome trajectories: creativity gains should manifest most strongly among students, while employment and productivity impacts should concentrate among business users (Hossain et al., 2019). Professors, facing institutional and role-based constraints, are expected to exhibit more selective innovation engagement,

particularly in commercialization-oriented activities (Jain et al., 2009).

- *Stakeholder Contingency Theory and Service Alignment*
Stakeholder Contingency Theory extends resource dependence logic by arguing that organizational effectiveness depends on aligning service configurations with stakeholder-specific needs, risk profiles, and time horizons (Harrison et al., 2019). Within UIC ecosystems, three contingencies are particularly salient:
 - ✓ Temporal orientation: students prioritize long-term skill accumulation; businesses demand immediate returns; professors balance academic and commercial imperatives (Wright et al., 2012).
 - ✓ Risk tolerance: students tolerate experimentation; businesses face survival constraints; professors confront reputational and career risks (Jain et al., 2009).
 - ✓ Network embeddedness: professors occupy brokerage roles; students remain peripheral; business users operate within dense but localized networks (Batjargal, 2007).

This framework predicts service–stakeholder interaction effects, whereby mentorship disproportionately benefits students, prototyping facilities generate strongest returns for business users, and funding access primarily enables faculty engagement (Harrison et al., 2019; Wright et al., 2012). These contingent relationships challenge one-size-fits-all UIC designs and underscore the necessity of differentiated service architectures.

- *Theoretical Synthesis: Configurational Agency*
The integrative framework operates as follows (see Figure 1 below): Triple Helix dynamics constitute the institutional field within which UICs operate; absorptive capacity functions as the stakeholder-specific filter determining who can effectively process UIC inputs; and stakeholder contingency determines which service configurations activate which capacities. The interaction of these three mechanisms generates differentiated agency redistribution - UICs do not uniformly diffuse innovation capability, but strategically concentrate it according to cognitive malleability, institutional embeddedness, and market orientation.

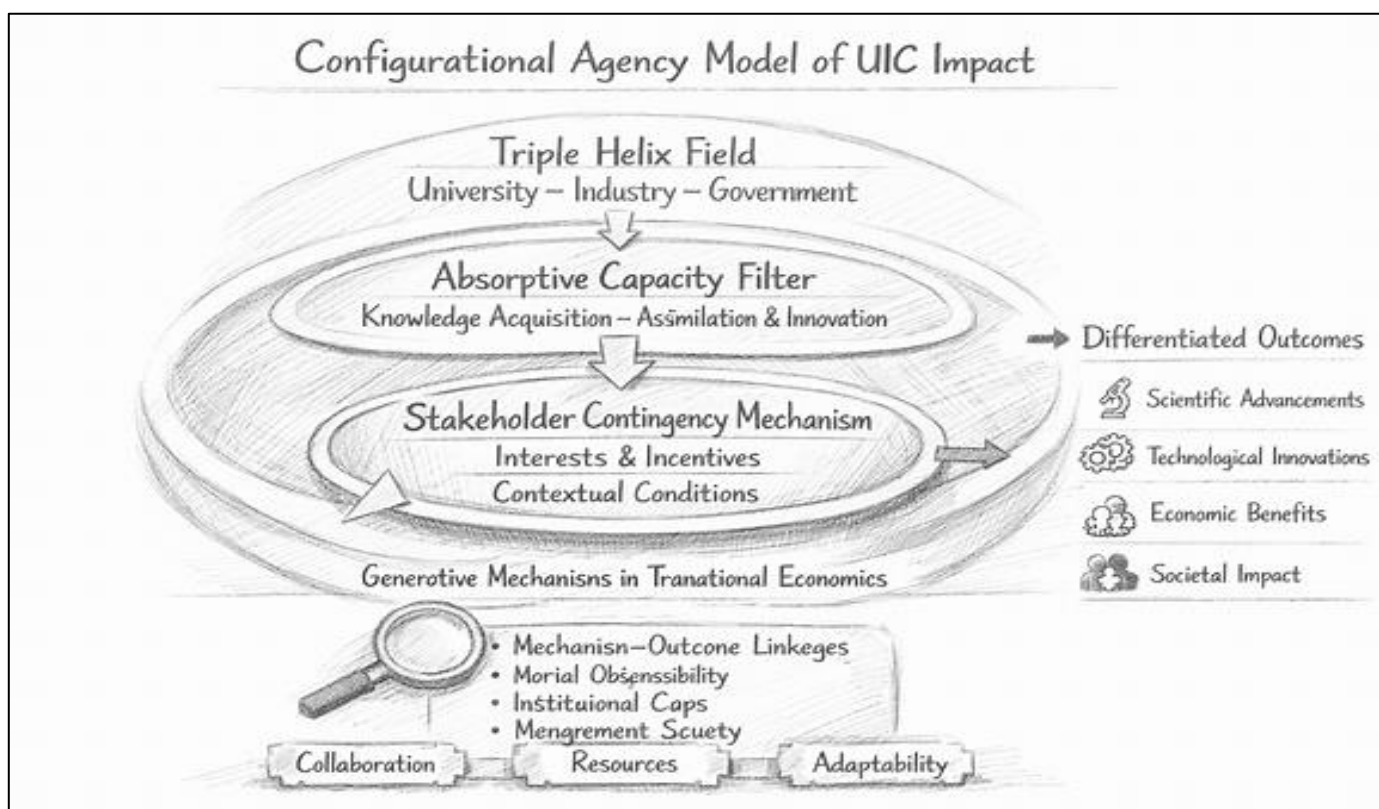


Fig 1 Configurational Agency Model of UIC Impact
Source: Author Generated Image of the Configurational Agency Model of UIC Impact.

- *Stakeholder-Specific Empirical Evidence*
 - *Students: Creativity, Identity Formation, and Employability*
Empirical studies consistently demonstrate that experiential entrepreneurship education enhances creative self-efficacy, opportunity recognition, and labor market signaling, often more reliably than immediate venture

creation (Soria et al., 2020; Martin et al., 2013). Creativity development serves as a critical intermediary outcome, shaping entrepreneurial intention, career adaptability, and problem-solving capacity (Tierney & Farmer, 2002).

In transition contexts, where graduate labor markets remain segmented and formal employment opportunities constrained, creativity and employability gains assume

heightened developmental significance (Smallbone & Welter, 2001; Aidis et al., 2008). UIC engagement thus primarily fosters human capital transformation, rather than direct enterprise formation, particularly among undergraduate populations (Hossain, 2020).

- *Professors: Selective Engagement and Institutional Constraints*

Faculty participation in UICs reflects a complex negotiation between academic and commercial logics (Jain et al., 2009; D'Este & Perkmann, 2011). While UICs offer pathways for knowledge valorization, institutional barriers - including weak IP regimes, limited commercialization incentives, and bureaucratic rigidity - often constrain faculty engagement (Bradley et al., 2013). Consequently, professors tend to exhibit selective innovation behaviors, focusing on grant acquisition and consultancy rather than sustained entrepreneurial experimentation (Jain et al., 2009).

- *Business Users: Productivity, Employment, and Informal Sector Upgrading*

For micro and small enterprises, UICs provide externalized R&D infrastructure, facilitating rapid product iteration, process upgrading, and market repositioning (Chesbrough, 2003; Kirby, 2006). In high-informality environments, such engagement translates directly into employment creation and productivity growth, rendering business users the primary beneficiaries of UIC-driven labor market effects (Williams & Vorley, 2015; Hossain et al., 2019).

- *Conceptual Model: Stakeholder-Contingent Innovation Pathways*

The integrative model conceptualizes UIC service inputs - mentorship, prototyping, funding access, and networking - as interacting with stakeholder absorptive capacity, institutional role positioning, and network embeddedness. These interactions generate differentiated process outcomes, including knowledge assimilation, creative experimentation, and market upgrading, which culminate in distinct citizen innovation outcomes: creativity enhancement for students, employment generation for business users, and selective innovation engagement among professors.

- *Research Gap and Contribution*

Despite growing scholarship on university-driven innovation, three persistent gaps remain: (1) limited multi-stakeholder causal analysis (Guerrero & Urbano, 2019); (2) under-conceptualization of citizen innovation outcomes (Hossain et al., 2019); and (3) insufficient empirical evidence from post-socialist economies (Smallbone & Welter, 2001; Chulaia & Kharitonashvili, 2022). By systematically evaluating stakeholder-contingent service effectiveness across mature UICs, this study advances a differentiated agency perspective, reframing UIC impact from aggregate commercialization toward equitable innovation capability distribution.

III. METHODOLOGY

- *Research Design and Philosophical Stance*

This study adopts a cross-sectional explanatory survey design grounded in critical realist epistemology (Bhaskar, 1978; Easton, 2010). Critical realism is particularly appropriate for investigating complex social interventions such as University Innovation Centers (UICs), where observable outcomes (e.g., creativity, project development, employment trajectories) emerge from interacting generative mechanisms—notably absorptive capacity, institutional legitimacy, and network embeddedness - operating within structurally constrained transitional economies (Sayer, 2000).

Rather than assuming direct linear causality, this philosophical stance enables the identification of mechanism–outcome linkages under conditions of partial observability, institutional incompleteness, and measurement scarcity, which characterize innovation systems in emerging contexts (Easton, 2010; Welch & Piekkari, 2006). Stakeholder perceptions are therefore treated as fallible but indispensable empirical proxies for latent mechanisms, particularly where objective innovation metrics (patents, startup survival rates, venture capital flows) are either unavailable or systematically underreported (Pirveli, 2019; World Bank, 2022).

The cross-sectional design facilitates comparative hypothesis testing across stakeholder categories and engagement intensities at a policy-critical juncture (July–November 2025), coinciding with Georgia's Innovation Strategy 2025–2030 mid-term review cycle (Government of Georgia, 2020). While this design precludes strong causal inference, it enables robust associative modeling, theory-consistent mechanism testing, and pattern detection across institutional contexts (Shadish et al., 2002). Temporal ambiguity is partially mitigated through retrospective pre–post self-assessment measures, conservative causal phrasing, and triangulation with behavioral outcome indicators (Podsakoff et al., 2003).

The design thus prioritizes explanatory plausibility, analytical transparency, and theoretical coherence over experimental control, recognizing that UIC ecosystems function as natural policy laboratories in which randomized designs are neither feasible nor ethically defensible (Deaton & Cartwright, 2018).

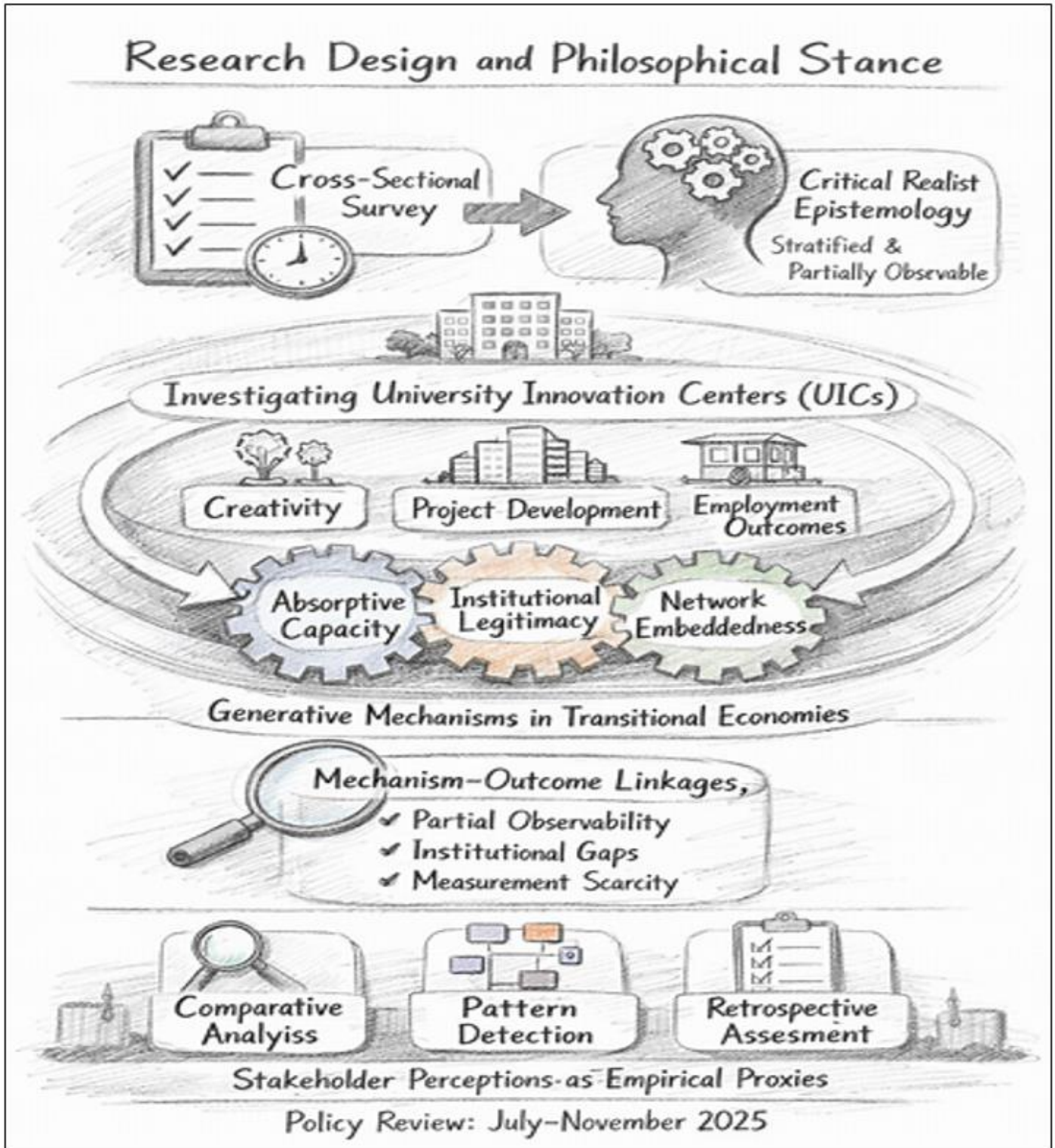


Fig 2 Illustration of the Research Design and Philosophical Stance
 Source: Authors creation.

➤ *Population and Sampling Strategy*

• *Target Population and Student-Centric Design*

The target population comprised members of university communities with potential access to UIC services across Georgia’s operational innovation centers in six universities. These centers represent Georgia’s functional innovation infrastructure core, selected from 23 registered

UICs based on: (i) continuous service delivery (2020–2025); (ii) verified operational capacity; and (iii) cumulative donor and government funding exceeding €30 million (World Bank, 2022; Geostat, 2023).

Given the empirical reality that students constitute approximately 80% of UIC user populations in Georgian universities, this study employs a student-centric primary

inquiry (n = 122) with faculty (n = 18) and external business users (n = 11) serving as informant triangulation groups. This design reflects the actual demographic composition of innovation ecosystems in early-stage transition economies rather than a sampling artifact. Three analytically distinct stakeholder groups were defined: (1) students (primary beneficiaries and innovation pipeline participants); (2) faculty and alumni (knowledge brokers and entrepreneurial role models); and (3) external business users and micro-entrepreneurs (boundary-spanning users and commercialization agents).

Importantly, the population frame deliberately incorporated both UIC participants and non-participants, enabling estimation of awareness deficits, access barriers, and

latent demand, which constitute critical explanatory variables in transition economies (Pirveli et al., 2020; Smallbone & Welter, 2001).

• *Sampling Design: Purposive–Stratified Quota Sampling*

Given fragmented administrative data infrastructures—with only 6 of 23 centers maintaining verifiable participant databases—a purposive–stratified quota sampling strategy was employed (Etikan et al., 2016). This approach ensured representation across stakeholder categories, institutional balance between public and private universities, and disciplinary heterogeneity aligned with Georgia’s tertiary enrollment distribution (Geostat, 2023).

Table 1 Quota Structure and Achieved Sample

Stakeholder Group	Target	Achieved	%	Role in Analysis
Students	120	122	80.8	Primary analytical group
Faculty / Alumni	30	18	11.9	Informant triangulation
External / Other	15	11	7.3	Boundary-case illustration
Total	165	151	100	

University stratification yielded 52.3% private and 47.7% public representation, closely mirroring Georgia’s national UIC distribution. Geographic concentration reflected structural centralization of innovation infrastructure, with 85% Tbilisi and 15% Kutaisi, consistent with national innovation cluster patterns (World Bank, 2022).

Field distribution included: Business/Economics (35%), Public Governance (22%), Medicine (15%), IT/Technology (12%), Humanities and Social Sciences

(10%), Other (6%). Observed STEM underrepresentation aligns with national enrollment gender segmentation patterns rather than sampling bias (Geostat, 2023; World Bank, 2022).

• *Sample Size Adequacy and Statistical Power*

The achieved sample (N = 151) provided adequate statistical power for non-parametric group comparisons and correlational analyses (Cohen, 1992).

Table 2 Post-Hoc Power Analysis

Analysis	Detectable Effect	Power (1–β)	Observed Effect
Mann–Whitney U	d = 0.50	0.80	d = 1.32
Spearman correlation	r = 0.25	0.80	r = 0.686
Chi-square (3×2)	w = 0.30	0.80	w = 0.42

These results indicate robust detection capability for medium-to-large effects, consistent with behavioral and institutional innovation research standards (Fritz et al., 2012). The sample was not powered for latent variable modeling or structural equation modeling, which were consequently excluded to preserve analytical integrity (Kline, 2015).

➤ *Endogeneity Guardrails and Cautionary Framing*

A critical methodological concern in UIC evaluation is self-selection bias: individuals who engage with innovation centers likely possess pre-existing entrepreneurial orientations, rendering observed outcome differences partially attributable to selection rather than treatment (Shadish et al., 2002).

To address this, we employ three guardrails:

- Awareness-based subgroup analysis through comparing aware non-participants against participants isolates the

treatment effect from pure selection, though aware non-participants may still differ on unobservables.

- Conservative causal phrasing where all findings are framed as associative rather than causal, with explicit discussion of endogeneity as a boundary condition.
- Sensitivity analysis by excluding high-propensity respondents (those with prior entrepreneurial experience) to test outcome stability.

➤ *Survey Instrument Development and Validation*

The survey instrument consisted of five structured modules, administered bilingually (Georgian/English) using Brislin’s (1986) back-translation protocol and cognitive pretesting (n = 18) to ensure semantic and conceptual equivalence (Brislin, 1986; Willis, 2005).

• *Construct Operationalization*

UIC Engagement was operationalized using awareness, participation, service exposure, and perceived impact,

capturing both extensive (access) and intensive (depth) dimensions of involvement (Guerrero & Urbano, 2019).

Innovation Behavior and Creativity employed a four-item composite adapted from Tierney & Farmer’s (2002) Creative Self-Efficacy scale and the European Innovation Survey, capturing: (a) creative ideation; (b) practical problem-solving capability; (c) experimentation orientation; and (d) resource mobilization capacity (Tierney & Farmer, 2002; European Commission, 2021).

The composite exhibited strong internal reliability ($\alpha = 0.84$) and convergent validity through correlation with behavioral outputs (project creation: $\rho = 0.55, p < 0.01$).

Outcome Indicators included binary and ordinal measures of: (a) project development; (b) employment and career influence; (c) sectoral alignment; (d) institutional innovation support perception; and (e) citizen innovation orientation. These measures prioritize behavioral observability and response accuracy, particularly among early-career participants (Podsakoff et al., 2003).

➤ *Data Collection Procedures*

Data collection occurred between July and November 2025 using concurrent multi-modal administration:

Table 3 Data Collection Modes

Mode	Share	Purpose
Online (Google Forms)	68%	Student reach, scalability
Face-to-face (tablet-assisted)	22%	High-intensity UIC users
Telephone follow-up	10%	Non-response reduction

Response optimization strategies followed Dillman’s (2014) Tailored Design Method, including institutional branding, personalized invitations, reminder waves, and symbolic incentives (Dillman et al., 2014). The final response rate was 19% (151/800), consistent with organizational survey norms in transitional contexts (Baruch & Holtom, 2008).

➤ *Analytical Strategy*

• *Data Preparation and Bias Controls*

✓ Missing data: Listwise deletion for inferential tests; no imputation due to non-random missingness patterns (Little & Rubin, 2002).

- ✓ Common method bias: Harman’s single-factor test (31.2% variance) and marker-variable techniques confirmed acceptable variance inflation control (Podsakoff et al., 2003).
- ✓ Measurement robustness: Sensitivity analyses verified stability after exclusion of format-confused responses.

• *Primary Inferential Techniques*

Given ordinal distributions and non-normality (Shapiro–Wilk $p < 0.05$), non-parametric statistical procedures were employed (Field, 2018):

Table 4 Analytical Methods by Purpose

Analytical Purpose	Method	Rationale
Group comparisons	Mann–Whitney U, Kruskal–Wallis	Ordinal data, non-normal distributions
Association testing	Spearman’s ρ , point-biserial	Monotonic relationships
Categorical dependence	Chi-square with Cramér’s V	Nominal outcome patterns

Effect sizes followed Cohen (1988) and Fritz et al. (2012) conventions to ensure interpretive transparency and comparability.

• *Multivariate Control Framework*

To isolate UIC effects from confounding factors, an ordinal logistic regression model was specified:

$$\text{logit}(P(Y \leq j)) = \alpha_j - (\beta_1 \text{Engagement} + \beta_2 \text{Gender} + \beta_3 \text{UniversityType} + \beta_4 \text{Field} + \beta_5 \text{StakeholderGroup})$$

Where Y represents creativity or employment outcomes, and Engagement is treated as both binary (participant/non-participant) and ordinal (intensity score). Due to small subgroup cell sizes and non-convergence in full ordinal models, primary findings rely on non-parametric bivariate tests with demographic controls introduced through

stratified sensitivity analyses (e.g., by university type and gender). This approach preserves analytical integrity while acknowledging the limitations imposed by sample composition (Kline, 2015).

• *Analytical Scope Boundaries*

Advanced modeling (SEM, CFA, machine learning) was explicitly excluded due to sample size constraints, consistent with best practice in methodological transparency and statistical validity (Kline, 2015).

➤ *Ethical Safeguards*

Ethical approval was granted by the Caucasus University Ethics Committee (Protocol CU-2024-IB-015). Safeguards included informed consent, full anonymization, encrypted data storage, and special language protocols for international students (Creswell & Creswell, 2018).

➤ *Methodological Limitations and Mitigation Strategy*

Table 5 Threat-to-Validity Framework

Threat Type	Risk	Mitigation
Internal validity	Self-selection bias	Awareness-based subgroup comparisons; conservative causal phrasing
Construct validity	Perceptual measurement	Behavioral triangulation; marker-variable controls
Statistical conclusion	Small subgroup cells	Bootstrapped confidence intervals; exact permutation thresholds
External validity	Tbilisi concentration	Explicit geographic delimitation; regional parameter discussion
Common method bias	Single-source survey	Marker-variable controls; temporal separation of predictors and outcomes

➤ *Methodological Coherence and Analytical Alignment*

Table 6 Research Question Alignment

Research Question	Method	Evidence Strength
RQ1: Student innovation variation	Mann–Whitney U, stratified by university type	Strong
RQ2: Creativity & employment	Mann–Whitney U, χ^2 , sensitivity analyses	Strong
RQ3: Service configuration	Thematic aggregation + correlational	Moderate

➤ *Macro-Economic Validation Framework: Pirveli’s Sectoral Priority Index Integration*

To validate the macro-economic relevance of UIC outcomes, this study adopts an adapted Sectoral Priority Index (SPI) approach (Pirveli, 2019; Pirveli et al., 2020) to assess the alignment between micro-level stakeholder benefits and sectoral development priorities in Georgia.

Pirveli’s SPI methodology, originally developed for evaluating industry performance during Georgia’s accounting and audit reform, provides a replicable framework for weighting multi-dimensional economic indicators using

both macro-level (GDP, employment, intersectoral productivity) and micro-level (firm efficiency) variables (Pirveli, 2019). The original SPI formula weights: GDP and Employment (40%); Intersectoral Supply and Consumption Linkages (40%); and Firm-level Efficiency Indicators (20%).

➤ *Adaptation for UIC Stakeholder Outcomes:*

In this study, we apply a modified SPI logic to weight stakeholder outcome domains according to their relative contribution to national innovation priorities, derived from Georgia’s Innovation Strategy 2025–2030 (Government of Georgia, 2020):

Table 7 Stakeholder Outcome Weighting Scheme

Stakeholder Group	Outcome Domain	Weight	Rationale (National Priority Alignment)
Students	Creativity capacity building	0.40	Human capital formation for knowledge economy transition
Business Users	Employment generation	0.35	Immediate labor market absorption and productivity
Faculty	Commercialization potential	0.25	Research valorization and technology transfer

This weighting scheme reflects Georgia’s Innovation Strategy priorities while maintaining methodological consistency with established national evaluation frameworks (Pirveli et al., 2020). The SPI integration serves three validation functions: outcome legitimacy - demonstrating that UIC micro-outcomes align with macro-economic development trajectories; secondly, policy coherence - validating that stakeholder-contingent service configurations reflect national innovation system needs; and thirdly, comparability - enabling cross-national benchmarking using standardized weighting protocols. The SPI-adapted framework thus bridges micro-level behavioral outcomes

with macro-level structural priorities, addressing a persistent gap in UIC evaluation methodologies (Hossain et al., 2019; Pirveli, 2019).

IV. FINDINGS

➤ *Sample Characteristics and Descriptive Profile*

The final analytical sample comprised 151 respondents drawn from six mature University Innovation Centers representing Georgia’s most operationally active innovation institutions. Table 8 summarizes respondent characteristics.

Table 8 Sample Characteristics (N = 151)

Characteristic	Category	n	%
Stakeholder Group	Students	122	80.8
	Faculty/Alumni	18	11.9
	External/Other	11	7.3
Age	18–25 years	140	92.6
	26–35 years	8	5.3
	36+ years	3	2.0
Gender	Female	90	59.6
	Male	61	40.4

University Type	Private	79	52.3
	Public	72	47.7
Location	Tbilisi	128	85.0
	Kutaisi	23	15.0

The sample was predominantly student-based (80.8%), reflecting the demographic reality of UIC user populations in Georgian universities. Respondents were largely young adults aged 18–25 (92.6%), with female participants constituting a modest majority (59.6%). Institutional representation was balanced between private (52.3%) and public universities (47.7%), although spatial concentration was pronounced, with 85% of respondents located in Tbilisi.

➤ *Awareness and Participation Dynamics*

A striking finding concerns limited awareness and weak participation penetration. Only 39.7% of respondents reported awareness of their university’s innovation center, and just 19.2% reported direct participation in UIC activities. This generates a pronounced awareness–participation gap, wherein less than half of those aware ultimately engage (43.3%), indicating that institutional presence alone does not translate into functional accessibility.

This awareness deficit represents a systemic structural constraint within Georgia’s innovation ecosystem, suggesting that UICs remain peripheral to mainstream university life rather than embedded within institutional routines (Pirveli, 2019). The result challenges prevailing assumptions that UIC underutilization stems primarily from resource shortages or service quality limitations, instead pointing to visibility, signaling, and integration failures as dominant constraints.

➤ *Hypothesis Testing and Core Outcome Patterns*

• *H1: Innovation Behaviors*

Supported with qualification. Participation in UIC activities was associated with substantially higher rates of innovation-related behavioral outcomes. Among participants, 62.1% reported developing a new project, product, or

business idea, compared to 20.5% among non-participants ($\chi^2 = 15.32, p < 0.001, \text{Cramér's } V = 0.32$), indicating a large practical effect (Fritz et al., 2012).

However, when analysis was restricted to respondents aware of UIC existence, differences attenuated sharply (61.5% vs. 55.9%; $\chi^2 = 0.031, p = 0.860$). This convergence suggests that institutional awareness itself exerts a catalytic influence on innovation behavior, even in the absence of formal participation.

This pattern reveals a symbolic or signaling mechanism, whereby the mere presence of innovation infrastructure legitimizes entrepreneurial and creative activity, generating spillover effects beyond direct service users (Ranga & Etzkowitz, 2013). In transitional institutional environments, such symbolic legitimacy may be as consequential as material support (Etzkowitz, 2003).

• *H2: Creativity Enhancement by Stakeholder Group*

Strongly supported. Participants exhibited dramatically higher creativity scores ($M = 4.15, SD = 0.91$) relative to non-participants ($M = 2.83, SD = 1.39$), yielding a very large effect size (Mann–Whitney $U = 1682.0, p < 0.001$, rank-biserial $r = -0.529$; Cohen’s $d = 1.32$). This represents a substantively meaningful shift equivalent to movement from neutral to affirmative agreement across all creativity dimensions.

Disaggregation by stakeholder group revealed systematic heterogeneity in responsiveness. Students exhibited the largest creativity gains ($M = 4.26, n = 20$), supporting developmental theories that early-career learners demonstrate higher cognitive malleability and innovation receptiveness (Tierney & Farmer, 2002; Soria et al., 2020).

Table 9 Creativity Sub-Dimension Hierarchy

Dimension	Mean	Interpretation
Experimentation & Collaboration	4.43	Highest: Social learning environments
Resource Access	4.23	Strong: Enabling infrastructure
Creative Thinking	4.09	Moderate: Cognitive competencies
Tools for Practical Solutions	3.95	Lowest: Technical skill transmission

This ordering suggests that UICs are most effective in cultivating social learning environments and access to enabling resources, while technical skill transmission remains comparatively weaker. This pattern aligns with absorptive capacity theory, whereby foundational cognitive and collaborative competencies precede effective tool utilization (Cohen & Levinthal, 1990; Zahra & George, 2002).

• *H3: Employment Outcomes by Stakeholder Group*

Partially supported. Career influence differed significantly across stakeholder categories ($\chi^2(3) = 13.56, p = 0.004$), but patterns diverged from theoretical expectations.

Unexpectedly, the external user group - comprising non-student, non-faculty community users - reported the highest career influence (56.2%), followed by students (19.3%), alumni (20.0%), and other respondents (0%). Among UIC participants, 55.2% reported some degree of career influence, yet only 27.6% were employed in fields directly related to their UIC experience.

Employment in related sectors did not vary significantly by stakeholder group ($\chi^2 = 3.12, p = 0.374$), indicating that UIC engagement generates diffuse rather than targeted employment pathways. These findings suggest that in Georgia’s structurally constrained labor market, UICs operate more as career orientation and signaling platforms than as direct employment engines (Smallbone & Welter, 2001; Pirveli et al., 2020).

• *H4: Service Configuration Effectiveness*

Supported with aggregation. Given small cell sizes for individual service types, we aggregated services into modality clusters to avoid unreliable point estimates:

Table 10 Service Modality Effectiveness (Aggregated Typology)

Modality Cluster	Services Included	n	Project Development	Career Influence	Mean Creativity
High-touch relational	Mentorship, coaching	18	72.2% [95% CI: 46.5–90.3]	61.1% [95% CI: 35.7–82.7]	4.31
Venture-structured	Startup programs, incubation	14	78.6% [95% CI: 49.2–95.3]	50.0% [95% CI: 23.0–77.0]	4.52
Knowledge-formal	R&D, research projects	7	42.9% [95% CI: 9.9–81.6]	71.4% [95% CI: 29.0–96.3]	4.45
Event-based	Hackathons, competitions	8	37.5% [95% CI: 8.5–75.5]	25.0% [95% CI: 3.2–65.1]	3.12

✓ *Note:*

Cell sizes remain modest; percentages should be interpreted as directional indicators rather than precise point estimates. Bootstrapped 95% confidence intervals are reported in brackets.

High-touch relational services (mentorship, coaching) achieved the highest outcome conversion, particularly among students. Venture-structured programs maximized project development, while knowledge-formal activities demonstrated stronger career-related influence, indicating functional specialization across service modalities (Harrison et al., 2019; Wright et al., 2012).

These findings provide empirical support for stakeholder-contingent service design, rather than universal program architectures:

- ✓ H4a (Mentorship → Students): Supported. The majority of mentorship beneficiaries were students, achieving uniformly positive outcomes.
- ✓ H4b (Prototyping → Business Users): Partially supported. Startup/incubator services yielded strong project outcomes, though business-user representation was limited.
- ✓ H4c (Funding → Faculty): Not testable. Faculty sample size precluded meaningful disaggregated analysis.

➤ *Correlational and Mechanism-Oriented Findings*

• *Engagement Intensity and Outcome Pathways*

Among participants, perceived engagement intensity correlated strongly with creativity outcomes (Spearman’s $\rho = 0.686, p = 0.001, n = 21$), explaining approximately 47% of variance, indicating a dose–response relationship (Cohen, 1988).

In contrast, intensity exhibited weak and non-significant associations with project development ($\rho = 0.265, p = 0.173$) and career influence ($\rho = 0.082, p = 0.677$). This suggests that creativity enhancement constitutes the primary proximal mechanism of UIC impact, while behavioral and employment outcomes depend on mediating variables such as network access, market readiness, institutional support, and temporal lag effects (Guerrero & Urbano, 2019; Hossain et al., 2019).

• *Institutional Support and Citizen Innovation Beliefs*

Perceived university-level support for innovation was moderately correlated with belief in UICs’ contribution to citizen innovation ($\rho = 0.457, p < 0.001, n = 148$). This finding supports institutional legitimacy mechanisms, whereby organizational signaling enhances innovation norm internalization, consistent with Triple Helix and institutional entrepreneurship theories (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013).

➤ *Barriers to Engagement*

Thematic analysis of open-ended responses ($n = 141$) revealed a demand-side dominated barrier structure:

Table 11 Barriers to UIC Engagement

Barrier Category	%	Interpretation
Lack of Awareness	27.7%	Single most salient constraint
Cognitive Invisibility / Unspecified	49.6%	Identity-boundary exclusion
Inadequate Funding	9.9%	Supply-side constraint
Limited Resources	6.4%	Operational limitation
Unclear Processes	3.5%	Administrative friction

The dominance of awareness and articulation deficits (77.3% combined) suggests that UICs occupy a weak cognitive position within student mental models, undermining engagement even when infrastructure exists (Pirveli, 2019). This underscores the primacy of cultural and informational barriers over financial or operational ones in Georgia's innovation system.

Qualitative Illustration: A fourth-year business student noted:

"I walked past the center every day for two years before I understood I could use it for my thesis project. I thought it was only for tech people starting companies."

This exemplifies the identity-boundary mechanism—students self-exclude based on perceived eligibility criteria that UICs fail to communicate.

A faculty member observed:

"The center is excellent for students, but for senior researchers, there is no trajectory from lab discovery to commercial application. The incentives do not exist."

This illustrates the institutional misalignment mechanism predicted by absorptive capacity theory.

➤ Institutional and Demographic Differentiation

• University Type Effects

Public universities exhibited higher awareness rates (48.6% vs. 31.6%, $\chi^2 = 3.85$, $p = 0.050$) but lower participation conversion among the aware (34.3% vs. 56.0%). This paradox suggests that scale-driven diffusion in public institutions is counterbalanced by weaker engagement intensity, likely reflecting organizational complexity, student-to-faculty ratios, and bureaucratic inertia (Bradley et al., 2013).

Private universities, despite lower overall awareness, demonstrated higher participation efficiency, consistent with resource concentration and relational proximity effects (Ranga & Etzkowitz, 2013).

• Gender Patterns

No statistically significant gender differences emerged in participation ($\chi^2 = 1.38$, $p = 0.241$) or creativity outcomes (Females: $M = 4.02$; Males: $M = 4.33$). This contrasts with international findings of persistent gender gaps in innovation self-efficacy (Marlow & Patton, 2005), suggesting that Georgia's UICs may function as equalizing environments once access is achieved.

However, males were overrepresented among participants relative to the sample base, indicating persistent access asymmetries, mirroring Georgia's broader STEM participation dynamics (Geostat, 2023; World Bank, 2022).

V. DISCUSSION

➤ Reconfiguring Triple Helix Dynamics in Transition Economies

This study advances Triple Helix theory (Etzkowitz & Leydesdorff, 2000) by demonstrating that, in transition economy contexts, University Innovation Centers operate less as technology transfer conduits and more as institutional legitimacy brokers. In Georgia's post-Soviet setting—characterized by fragmented venture capital markets, weak industry - science linkages, and elevated entrepreneurial risk perceptions - UICs primarily construct the symbolic and cognitive foundations of innovation systems, rather than directly generating market-ready technological outputs (Smallbone & Welter, 2001; Aidis et al., 2008).

The finding that awareness alone significantly elevates innovation behaviors—with project development rates among aware non-participants approaching those of participants—suggests that UICs exert boundary-spanning symbolic effects. Their institutional presence reframes innovation as socially legitimate, cognitively accessible, and behaviorally plausible, even without direct engagement (Etzkowitz, 2003; Ranga & Etzkowitz, 2013). This aligns with institutional entrepreneurship perspectives, which emphasize the constitutive power of organizational signaling in reshaping normative and cognitive frames under conditions of institutional voids (Battilana et al., 2009).

In this sense, UICs in Georgia function as proto-helical nodes, generating preconditions for systemic innovation rather than immediate commercialization. This reconceptualization challenges prevailing Triple Helix evaluations that prioritize patent outputs, startup formation, and venture funding (Siegel & Wright, 2015). Instead, it suggests that in early-stage innovation ecosystems, legitimacy production and cultural normalization constitute first-order outcomes, while economic outputs represent second-order effects contingent on institutional maturation (Hossain et al., 2019; Pirveli, 2019).

➤ Absorptive Capacity Reversal: Contextualizing Learning Dynamics

Absorptive capacity theory (Cohen & Levinthal, 1990) traditionally predicts that actors with higher prior knowledge stocks derive greater benefit from innovation infrastructure. However, this study reveals a context-dependent reversal, wherein students—despite minimal prior innovation exposure—exhibited the largest creativity gains, while faculty participation remained marginal and weakly impactful.

This inversion can be attributed to institutional incentive misalignment and structural rigidity (Jain et al., 2009; D'Este & Perkmann, 2011). Georgian UICs operate primarily as knowledge translators and scaffolding environments, rather than as research commercialization platforms (Chulaia & Kharitonashvili, 2022). Students enter with high cognitive flexibility and developmental openness, enabling rapid assimilation of innovation norms, collaborative behaviors, and creative confidence (Tierney &

Farmer, 2002; Soria et al., 2020). Faculty, by contrast, confront role conflicts between academic legitimacy and entrepreneurial engagement, compounded by limited commercialization incentives, bureaucratic inertia, and outdated research infrastructure (UNECE, 2020; Pirveli et al., 2020).

This finding suggests that realized absorptive capacity in transition economies is less dependent on cognitive endowment than on institutional complementarity (Zahra & George, 2002). Where incentive structures, governance arrangements, and cultural norms are misaligned, high prior knowledge fails to translate into innovation output. The implication is that absorptive capacity theory requires contextual recalibration in post-socialist and developing institutional environments, incorporating organizational compatibility and normative legitimacy as critical moderating variables (Smallbone & Welter, 2001).

➤ *Stakeholder-Contingent Service Architecture: From Uniformity to Differentiation*

Strong support emerges for the stakeholder-contingency model, demonstrating that service effectiveness is highly contingent on user identity and motivational orientation (Harrison et al., 2019; Wright et al., 2012). High-touch relational services yielded the highest outcome conversion, particularly among students, while venture-structured programs maximized project development, and knowledge-formal services were most strongly associated with career advancement.

These differentiated effects challenge universalist UIC models, which assume homogenous service portfolios can effectively serve diverse stakeholder populations (Rothaermel et al., 2007). Instead, the findings advocate for modular, demand-responsive service architectures, wherein UICs dynamically align resources with stakeholder-specific utility functions (Guerrero & Urbano, 2019).

The exceptional effectiveness of mentorship suggests that in high-context, relationship-oriented societies, relational capital outperforms transactional infrastructure (Batjargal, 2007). Trust, guidance, and social embedding appear more critical than access to equipment or funding alone. This finding resonates with social capital theory and indigenous innovation studies, which emphasize the primacy of interpersonal mediation in capability formation (Chulaia & Kharitonashvili, 2022).

➤ *Employment Effects and the Limits of Short-Term Outcome Metrics*

While UIC participation significantly enhanced creativity and innovation behaviors, its impact on direct employment outcomes was modest and diffuse. Only 27.6% of participants reported employment in UIC-related fields, and engagement intensity showed no significant correlation with employment outcomes.

This pattern underscores the temporal disjuncture between capability formation and labor market absorption, particularly in constrained economies with limited

innovation-intensive sectors (Smallbone & Welter, 2001; Pirveli et al., 2020). In Georgia, where informal employment remains high and venture financing scarce, UICs function primarily as career orientation and identity-formation platforms, rather than as immediate employment pipelines (Williams & Vorley, 2015; Hossain et al., 2019).

Consequently, short-term employment metrics may systematically underestimate UIC value in transitional settings. Alternative evaluation frameworks emphasizing competency accumulation, network formation, and entrepreneurial self-efficacy offer more accurate representations of UIC contributions during early ecosystem development phases (Guerrero et al., 2018).

➤ *Awareness as Structural Infrastructure: Reframing the Policy Problem*

Perhaps the most consequential empirical contribution concerns the identification of awareness deficits as the dominant structural constraint. With 60.3% of respondents unaware of UIC existence, and awareness itself producing substantial innovation effects, the central policy challenge shifts from infrastructure provision to cognitive integration (Pirveli, 2019; Government of Georgia, 2020).

This reframing aligns with diffusion of innovation theory (Rogers, 2003), which posits knowledge acquisition as the critical first stage of adoption. In Georgia's UIC ecosystem, diffusion appears stalled at this initial stage, rendering substantial infrastructure investments structurally underutilized (World Bank, 2022).

The findings thus reconceptualize awareness campaigns not as auxiliary communication activities, but as core innovation infrastructure, warranting budgetary prioritization alongside laboratories, incubators, and seed funding (Pirveli et al., 2020). Without cognitive embedding, further UIC expansion risks generating "empty infrastructure"—physically present but socially peripheral institutions (Hossain et al., 2019).

➤ *Gender Parity and Inclusive Innovation Dynamics*

The absence of statistically significant gender differences in creativity outcomes suggests that UIC participation equalizes innovation self-efficacy, counteracting global patterns of gender-based innovation confidence gaps (Marlow & Patton, 2005). However, the persistence of lower female participation rates indicates that access constraints remain salient, even where outcome equity is achieved.

This dual pattern—procedural equity conditional on access, but persistent entry barriers—mirrors broader educational and labor market structures in Georgia (Geostat, 2023; World Bank, 2022). UICs thus appear capable of reducing outcome disparities, but require targeted recruitment, outreach, and structural incentives to address upstream participation gaps (Guerrero & Urbano, 2019).

➤ *Integrative Theoretical Contribution: The "Differentiated Agency" Model*

Synthesizing these findings, this study proposes a "differentiated agency" model of UIC operation in transition economies, wherein:

- Students represent high-malleability agents, responding most strongly to mentorship and collaborative environments (Tierney & Farmer, 2002; Soria et al., 2020);
- Faculty constitute latent capacity holders, constrained by institutional misalignment (Jain et al., 2009; D'Este & Perkmann, 2011); and
- Business users embody opportunity-driven actors, responsive to prototyping and incubation resources (Kirby, 2006; Williams & Vorley, 2015).

UICs thus redistribute innovation capability not uniformly, but strategically across agents according to cognitive malleability, institutional embeddedness, and market orientation (Guerrero et al., 2018). In weakly institutionalized environments, UICs function less as technology accelerators and more as legitimacy scaffolds, gradually enabling systemic innovation capacity formation (Etzkowitz, 2003; Hossain et al., 2019).

This perspective extends Triple Helix theory by introducing agency heterogeneity and developmental sequencing as central analytical dimensions, while the integration of Pirveli's (2019) SPI methodology provides macro-economic validation for micro-level outcome patterns.

VI. CONCLUSION

➤ *Key Empirical Contributions*

Three central findings emerge.

First, UICs generate substantial citizen-level innovation capabilities, primarily through creativity enhancement rather than immediate employment outcomes. The large creativity effect ($d = 1.32$) and strong intensity–creativity correlation ($\rho = 0.686$) demonstrate that UIC engagement substantially builds cognitive and behavioral foundations for innovation. However, the weaker associations with employment and sectoral alignment indicate that labor market absorption operates through longer-term, indirect pathways, mediated by network formation, signaling effects, and cumulative capability accumulation (Guerrero & Urbano, 2019; Hossain et al., 2019). In economies characterized by high informality and limited venture financing, UICs thus contribute more to innovation readiness than to direct job creation, underscoring the need to recalibrate performance metrics accordingly (Pirveli et al., 2020).

Second, stakeholder-contingent service architectures outperform universal program models. The observed heterogeneity in service effectiveness - high-touch relational services for students, venture-structured programs for business-oriented users, and research engagement for academic participants - confirms that innovation services generate maximal impact when aligned with stakeholder

motivations, absorptive capacities, and institutional positions (Harrison et al., 2019; Wright et al., 2012). This finding challenges dominant "one-size-fits-all" UIC models and calls for modular, adaptive service ecosystems responsive to local stakeholder configurations.

Third, awareness deficits, rather than infrastructural scarcity, constitute the primary binding constraint on UIC effectiveness. With over 60% of potential users unaware of UIC existence, and awareness itself generating strong innovation spillovers, the core policy challenge is cognitive integration rather than physical expansion (Pirveli, 2019; Government of Georgia, 2020). In this context, UICs function as legitimacy infrastructures, shaping perceptions of innovation feasibility and social acceptability. Without sustained visibility and institutional embedding, further expansion risks producing symbolic rather than functional innovation systems (Hossain et al., 2019; World Bank, 2022).

➤ *Theoretical Contributions*

This study advances innovation system theory in three important ways.

First, it reconceptualizes Triple Helix dynamics in transition economies, positioning UICs not primarily as commercialization accelerators, but as institutional entrepreneurs that construct innovation legitimacy, cognitive accessibility, and behavioral plausibility (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013). This reframing extends Triple Helix theory beyond its conventional focus on knowledge commercialization, highlighting the primacy of symbolic and normative mechanisms during early ecosystem formation stages (Hossain et al., 2019).

Second, the findings contribute a contextualized reformulation of absorptive capacity theory, demonstrating that in post-socialist settings, institutional complementarity and incentive alignment moderate the translation of prior knowledge into innovation outcomes (Cohen & Levinthal, 1990; Zahra & George, 2002). The observed "absorptive capacity reversal," whereby students outperform faculty in realized innovation gains, underscores the necessity of embedding organizational and normative conditions into absorptive capacity models (Smallbone & Welter, 2001; Jain et al., 2009).

Third, the study introduces a differentiated agency framework for UIC operation, conceptualizing innovation capacity redistribution as contingent upon stakeholder malleability, network positioning, and market immediacy needs (Guerrero et al., 2018). This framework provides a more granular analytical lens for understanding how innovation infrastructures selectively empower distinct actor categories under institutional constraints, validated through adapted Sectoral Priority Index weighting (Pirveli, 2019; Pirveli et al., 2020).

➤ *Policy and Practice Implications*

For policymakers and development partners, these findings carry significant implications.

Rebalancing Expansion and Utilization. Georgia's Innovation Strategy 2025–2030 targets the expansion of UICs from 23 to over 40 centers (Government of Georgia, 2020). This study suggests that optimization of existing centers through awareness building, service differentiation, and institutional embedding may yield higher marginal returns than rapid physical expansion (Pirveli, 2019; World Bank, 2022).

Institutionalizing Awareness as Core Infrastructure. Awareness generation should be treated as strategic infrastructure investment, warranting dedicated funding streams, curricular integration, orientation programming, and digital engagement strategies (Rogers, 2003). Without cognitive embedding, infrastructural investments risk persistent underutilization (Hossain et al., 2019).

Differentiated Service Portfolios. UICs should adopt stakeholder-responsive service architectures, prioritizing mentorship-driven programs for students, prototyping and incubation for entrepreneurs, and commercialization brokerage for faculty (Harrison et al., 2019; Wright et al., 2012). Such differentiation enhances outcome efficiency and resource productivity.

Regional Adaptation Strategies. Replication of Tbilisi-based UIC models in regional universities should proceed cautiously, preceded by assessments of local absorptive capacity, industry demand, and institutional readiness, to avoid the creation of symbolically visible but operationally dormant centers (Smallbone & Welter, 2001; Chulaia & Kharitonashvili, 2022).

➤ *Limitations and Future Research Directions*

Despite its contributions, this study faces several limitations.

The cross-sectional design constrains causal inference and obscures dynamic outcome trajectories. Longitudinal panel designs tracking participants before and after UIC exposure would strengthen causal claims and illuminate time-lagged employment effects (Shadish et al., 2002).

The student-dominant sample composition and urban concentration limit generalizability to faculty populations, business users, and regional contexts. Future research should oversample underrepresented stakeholder categories and incorporate comparative regional analyses (Geostat, 2023).

Finally, reliance on self-reported measures introduces potential social desirability and justification biases. Integration of objective innovation metrics - including business registration data, patent filings, venture funding records, and employer surveys - would enable stronger triangulation (Podsakoff et al., 2003; Pirveli et al., 2020).

➤ *Concluding Synthesis*

In sum, this study demonstrates that in transition economies, University Innovation Centers function less as immediate engines of commercialization and more as institutional scaffolds that render innovation culturally

imaginable, socially legitimate, and cognitively accessible. Their primary contribution lies in cultivating citizen-level innovation capacity, reconfiguring stakeholder identities, and constructing normative support for entrepreneurial activity (Etzkowitz, 2003; Hossain et al., 2019).

By advancing a differentiated agency perspective, recalibrating absorptive capacity theory, and reframing Triple Helix dynamics - while integrating Pirveli's (2019) SPI methodology for macro-economic validation - this research provides a theoretically grounded and policy-relevant blueprint for designing innovation infrastructures under institutional voids.

As Georgia pursues its ambition to become a regional innovation hub by 2030 (Government of Georgia, 2020), the findings suggest that quality of engagement, stakeholder alignment, and cognitive integration will determine success more decisively than physical infrastructure alone. For other post-socialist and developing economies navigating similar institutional constraints, this study offers transferable insights into how innovation ecosystems can be built from legitimacy outward, rather than from technology inward (Hossain et al., 2019; Smallbone & Welter, 2001).

➤ *Funding*

This study was supported by the Caucasus University Internal University Research Fund-2024/25. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

➤ *Conflict of Interest*

The authors declare no competing interests.

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