Heptagonal Cross-Border Cooperation and SME Development in the Caucasus and Central Asia: Econometric Modeling of Growth Channels and Spatial Agglomeration

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ABSTRACT

Backgrounds: Small and Medium-sized Enterprises (SMEs) are pivotal drivers of economic diversification and social stability across the Caucasus and Central Asia, accounting for up to 74% of employment and over 61% of GDP in key markets. Yet, they face persistent structural barriers, including capital concentration in urban hubs, institutional corruption, and financial exclusion.

Objectives: Using ADB SME Monitor 2024 data (2019-2023), this study examines the causal link between SME credit and SME output across seven Central Asian and Caucasus economies, applying Dumitrescu-Hurlin Granger causality and FE-2SLS.

Methodology: This study uses an unbalanced panel of seven Central Asian and Caucasus economies (2019-2023) from the ADB SME Monitor 2024, with variables grouped into three pillars: MSME landscape and employment, sectoral output, and financing. Variables are converted into year-over-year growth rates to ensure stationarity before testing bidirectional Granger causality between SME loan growth and GVA growth.

Findings: A fragmented transmission mechanism with three archetypes is revealed. A Credit-Led Channel dominates in Kazakhstan and Uzbekistan, where credit expansion precedes Gross Value Added (GVA) growth. An Output-Led Channel defines Tajikistan and Kyrgyz Republic, where banks expand credit reactively. A Bidirectional Feedback Channel emerges in volatile contexts such as Armenia, Azerbaijan, and Georgia. Importantly, the FE-2SLS model highlights severe weak-instrument constraints ($F = 0.0483$, $p = 0.8275$), underscoring institutional heterogeneity.

Conclusions: A heptagonal cross-border management framework is proposed, leveraging rural entrepreneurship and ADB-aligned co-financing. Tailored policy recommendations emphasize fintech integration and digital-green transitions, enabling SMEs to overcome institutional frictions and embed into high-value global supply chains.

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1. INTRODUCTION

Small and medium enterprises (SMEs), as well as micro enterprises and entrepreneurs, have evolved as a vital engine of economic growth and development for most countries of Central Asia and the Caucasus, mirroring global patterns of transitional economic development. The direct contribution of SMEs to socio-economic development is explicitly recognizable, particularly in accelerating industrial production, expanding exports, generating sustainable employment, and fostering an environment conducive to grassroots enterprise development. Over the last decade,

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several national governments in the region, supported by international development agencies, have implemented targeted strategic plans focusing on improving business conditions, expanding market access, and facilitating cluster and supply chain development. Despite these collaborative initiatives, the SME sector continues to face a critical modern bottleneck. In the timeline leading to the 2030 sustainable development benchmarks, the region must aggressively confront deep structural frictions, including problematic regulatory environments, capital concentration in urban centers, institutional corruption, and severe financial exclusion.

While existing literature frequently evaluates these barriers through static, uniform descriptive lenses, this paper provides a vital empirical correction by evaluating the structural transition from a survival-based quantity model toward an innovation-led ecosystem. Grounded in data from the Asian Development Bank (ADB) Small and Medium-Sized Enterprise Monitor 2024 (ADB, 2024), this study evaluates the asymmetric, dynamic macro-financial feedback loops between credit expansion and real-sector SME output across an unbalanced panel of seven regional economies (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan - with Turkmenistan excluded due to data unavailability in the official ADB repository SME monitors) - from 2019 to 2023 using a Dumitrescu and Hurlin (2012) panel Granger causality framework. Academically, this study challenges the pervasive "one-size-fits-all" paradigm that treats the Caucasus and Central Asia as a homogeneous economic bloc. Rather than assuming uniform macroeconomic transmission mechanisms, our empirical approach uncovers a fragmented financial heptagonal landscape divided into several distinct archetypes, which will be discussed later.

The objectives of this article are approached within the conceived heptagonal network matrix model: SMEs tend to cluster around national and primary regional growth poles where economic gravity—defined through urban agglomeration and market access (Krugman, 1991; Tinbergen, 1962)—is strongest. As Janić (1975) and Tarde (1903) observed, dominant urban nodes generate crucial technological and developmental progress that diffuses into surrounding regional hinterlands. However, the mutual economic gravity connecting secondary cities across these seven borders seems to remain comparatively weak, leaving rural enterprises reliant on localized imitative adaptation (Tarde, 1903) rather than fully integrated cross-border (CBC) supply chains.

Ultimately, by formalizing these nuances into a structured heptagonal CBC management framework, this study aims to become a foundational reference for SME policy formulation, institutional architecture refinement, and regional integration along major corridors such as the EU's "Global Gateway" and China's Belt and Road Initiative.

The next step is elaboration of relevant literature, which is taken up in Section 2. Section 3 introduces the method of research that was used. Section 4 interprets the SME demography and the results of the Dumitrescu-Hurlin test (2012), which is followed by a discussion and presentation of the developed analytical-spatial model. Finally, Section 5 provides the main conclusions on the obtained econometric model for the seven studied economies.

2. LITERATURE REVIEW

Many authors have researched the system of entrepreneurship and enterprise development as a potential. Perhaps one of the oldest regional books on trade and merchant skills dates to 1458 (Kotruljević, 2005). While Cappellano and Makkonen 92020) stressed the wider issue of management of CBC regional-rural entrepreneurship, no work has more complexly covered the categories of the heptagonal rural-regional CBC development in a region of Central Asia that is being modeled here. Available secondary sources include a similar approach to the comparative experience of seven transition economies in Armenia, Cambodia, China, Kyrgyz Republic, Mongolia, Uzbekistan and Vietnam by McKinley (2004). When studying and financing models for rural SMEs, the most important international development organizations strongly criticize the unpredictable consequences of spontaneous and unplanned development of entrepreneurship, and emphasize the inevitability of coordinated management of development and financing of rural SMEs (Evans, 1990; IFAD, 2004). One comparative regional paper particularly emphasizes the potential place of SMEs in the sustainable agricultural and rural development of the region. Considering the character of the transition process and imbalances in countries with a high share of agriculture and small peasant holdings, the authors similarly point out that in 1998 all Baltic countries intensified activities for co-

financing the development of rural SMEs, and that Latvia allocated as much as 43% of the agricultural budget to increase productivity, diversify income, develop rural tourism and partial SME credit guarantees (Beck et al., 2010). This is analogous to international institutions (ADB, 2024; Evans, 1990; IFAD, 2004).

The CBC cooperation initiatives between the Caucasian and Central Asian economies can presently be implemented heptagonally under the auspices of institutions such as the ADB funding mechanisms. Another option is perhaps through various national and regional projects with the prospect to promoting inter-regional and inter-rural cooperation, fostering integration, and promoting socio-economic development through common national, regional, local projects and initiatives. From the above and the foregoing interpretation, it can be seen that in the future, a rich agenda lies ahead of the Caucasus and Central Asia. The evidence presented and the developed models support cooperation between regions being directly on the borders or adjacent to each other aiming at innovation, transport, environment, HR, and other sectors.

The following comparative discussion of literature sources synthesizes key themes in SME development in the Caucasus and Central Asia, focusing on the institutional environment, financial constraints, digitalization, and innovation-led growth strategies.

2.1. The Institutional Environment and Strategic Partnerships Theory

A foundational theme in the literature is the role of external partnerships in mitigating institutional voids. Andersone et al. (2021) highlight how the EU–Central Asia partnership has shifted toward creating a "conducive business environment" through regulatory convergence and Enhanced Partnership and Cooperation Agreements (EPCAs). Korea (Jeong et al., 2023), Indonesia (Mooy, 2024), and other international partners also work toward EPCAs. Building on this, Andersone (2024) argues that under the "Global Gateway" strategy, cooperation must evolve beyond traditional aid toward "risk finance" and digital infrastructure, specifically utilizing the Investment Facility for Central Asia (IFCA) to blend environment and funds for innovative firms.

Despite these external frameworks, internal institutional hurdles remain persistent. Huseynova (2024) identifies a direct correlation between high corruption levels and stalled MSME development across the region. Conversely, Ullah (2022) suggests that in such "weak institutional environments," discussed by Andersone et al. (2021), SMEs leverage ISO quality certifications as vital market signals to gain credibility and bypass domestic institutional gaps.

Although environmental, social, and governance (ESG) performance alone does not per se lead to financial gains, it improves financial performance, as evidenced in BRICS (Cardillo & Basso, 2025). In the short term, environmental disclosure acts as a cost center and asset-expansion driver which expanding the asset base (Total Assets) while depressing operating income (Net Income). The financial payoff of environmental disclosure typically materializes non-linearly over longer time horizons through risk mitigation, lower cost of capital, and operational efficiency, creating an initial *J*-curve or negative cross-sectional relationship with current-period Return on Assets (ROA). In contrast, while environmental disclosures, which induce direct capital expenditures and operational cost adjustments, governance disclosures may bring about statistical insignificance relative to ROA. This non-significance is dominantly driven by regulatory uniformity in the banking sector: statutory mandates imposed by central banks and prudential institutions imposed a uniform compliance floor across institutions, limiting cross-sectional variance. Furthermore, high governance disclosure results often mirror symbolic compliance and standardized reporting frameworks rather than operational efficiency shocks, resulting in a muted effect on short-term net income and asset return metrics. The importance of ESG limitations is additionally assessed in Section 3.

2.2. Financial Constraints Theory: The Primary Barrier to Growth

Access to finance remains the most critical bottleneck for regional SMEs (Klapper et al., 2012). Nizaeva and Coskun (2021) find that financial constraints significantly impede growth, with domestic firms feeling the pressure more acutely than foreign-owned counterparts. Historically, high collateral requirements and a lack of credit history have led to high rejection rates (Pasadilla, 2010; Yoshino & Taghizadeh-Hesary, 2018). To mitigate these gaps, (Shinozaki, 2023) demonstrates that digitalization and digital finance have emerged as essential survival tools, offering faster and more

shock-resilient financial services than traditional banking, particularly during periods of global economic uncertainty.

2.3. Innovation, Production Output, and Transition Theories

The literature reveals a critical shift from quantity-based growth to a focus on quality-driven innovation. Syzdykova and Azretbergenova (2025) provide the most current empirical evidence for this transition, utilizing the Autoregressive Distributed Lag (ARDL) method to demonstrate that SME production output now accounts for 36.7% of Kazakhstan's added value, which is a figure that has surged toward 39.8% in the most recent 2024–2025 reporting cycles. Despite this volume, the authors argue that SMEs are currently in a "survival equilibrium." To break this cycle, they advocate for R&D investment as a priority incentive, suggesting that state support must move beyond simple subsidies toward stimulating high-tech manufacturing and the integration of "off-take" contracts with larger enterprises to guarantee demand for innovative local products. This aligns with findings by Kazbekova et al. (2024), who identify that the high costs associated with technological innovation remain a deterrent; they note that current mechanisms primarily stimulate fixed capital investment rather than pure scientific research. To bridge this gap, the government of Kazakhstan has introduced the "Örleu" concessional financing program and a unified register of support measures (Kazakh Trade Ministry, 2025), which provides structured pathways for over 100 different types of financial and non-financial aid.

Furthermore, Pyagay et al. (2025) observe that green mandates increasingly influence the "ambivalent dynamics" of innovation. SMEs in the region are no longer adopting energy-conserving strategies solely for altruistic reasons but as a long-term competitive necessity to lower production costs and meet the sustainability standards required by international partners like the EU, as discussed by Andersone (2024). This "quality-led" approach is further validated by Ullah (2022), who notes that SMEs using quality certifications see a marked increase in their innovative capacity, effectively using international standards as a substitute for weak local institutional signals.

2.4. Resilience and Digital Transformation Theories

The COVID-19 pandemic served as a definitive catalyst for structural resilience in the whole region. While Issenova (2021) and Zakiyeva (2020) detail the state's moratorium on inspections and tax holidays as effective short-term stabilizers, Shinozaki (2023) argues that the enduring driver of resilience was the forced acceleration of digitalization (OECD, 2021). The "Neo Nomad" visa and the "Digital Business Map" (2024-2025) in Kazakhstan represent a strategic pivot toward attracting human capital and formalizing the shadow economy—a problem Syzdykova & Azretbergenova (2025) warn could otherwise mask the true economic contribution of the sector. Table 1 summarizes the key perspectives across output growth, the green transition, tech incentives, and market access, showing a shift toward R&D, eco-innovation, risk finance, and trust-building mechanisms.

Table 1. Key Comparative Perspectives

Focus Area	Key Findings	Primary Authors
Output Growth	SMEs now contribute nearly 40% of GDP; long-term growth is tied directly to R&D.	Syzdykova and Azretbergenova (2025)
Green Transition	Eco-innovation is shifting from optional to a competitive baseline requirement.	Pyagay et al. (2025)
Tech Incentives	Transition from fixed-capital focus to "risk finance" and innovation-led growth.	Andersone (2024); Kazbekova (2024)
Market Access	Off-take contracts and quality signaling (ISO) bridge the "trust gap" in markets.	Kazakh Trade Ministry, (2025)

Source: Processed literature sources, 2026

2.5. Hypothesis Development

2.5.1. The Influence of Key Assumptions on SME Development in the Heptagon

Both experimental and theoretical work have shown that inter-regional analysis involving activity and flow analysis, input-output methods, and linear programming can integrate both inward and outward potentials (Isard, 1960). This analysis has recently been further strengthened through

subsequent international practical applications of the theory (ADB, 2024; Evans, 1990; OECD & World Bank, 2007) and in both the EU (European Commission, 2023) and the US (Cappellano & Makkonen, 2020). Hence, in the management of inter-regional rural entrepreneurship in Central Asia, besides the actually tested hypotheses, some new complementary hypotheses are herewith proposed in the form of systemic methodological procedures of integral scientific knowledge.

With the great complexity and variability of social and economic phenomena that affect both inward and outward development of the seven interconnected CBC economies, null hypotheses on GVA and loan growth will be tested presently, the results of which are expected to facilitate potential future imitation (Tarde, 1903) in the regional heptagonal economic development. Regional experiences indicate that it would be relevant to compare our model with the Texas Triangle success of a mega region from Cascadia Vision 2050 (Cascadia, 2020), solutions from the Rural Development Act (1972) and the Agriculture Improvement and Reform Act (1996). Of course, analogies usually do not work perfectly, and that holds in this case as well.

To bridge macro-econometric panel dynamics with micro-level rural firm behavior, this study adopts Tarde's (1903) sociological theory of imitation alongside modern cross-border proximity frameworks (Cappellano & Makkonen, 2020). In transitional agricultural and rural economies, Tarde's 'laws of imitation' explain how entrepreneurial knowledge and business practices spread geographically: young, digitalized rural entrepreneurs observe and imitate successful production techniques from neighboring peer units. This localized imitative process directly drives real-sector output shocks (GVA Growth) before formal banking intervention which providing the micro-sociological rationale for the Output-Led Channel observed in Tajikistan and the Kyrgyz Republic. This imitative behavior also extends to financial practices, where credit adoption by border enterprises creates inter-regional peer effects. We model this CBC financial dissemination using the Leave-One-Out regional loan growth instrument (LOO Loan Growth), linking spatial proximity (Cappellano & Makkonen, 2020) to regional credit expansion. Historical legislative precedents in rural transformation such as the U.S. Rural Development Act of 1972 and the Agriculture Improvement and Reform Act of 1996 as well as modern CBC growth models like the Cascadia (2020), demonstrate that sustainable rural output requires state policy to actively formalize these imitative spillovers into structured credit facilities and CBC supply chains.

Starting from the defined problem in the heptagonal management of rural entrepreneurship, the main working hypothesis is the assumption that it is possible to accelerate CBC development and solve the problem of rural entrepreneurship management in seven countries simultaneously by applying new knowledge and achievements. Undoubtedly, development of the Caucasus and Central Asia would be accelerated because regional and CBC development are core economic principles.

In the units that follow, developed is a logical form for practical applications. Firstly, the applied problem is heptagonal management of entrepreneurship (A) with a focus on CBC (B) and regional-rural development (C), which is symbolically represented (B→A i C→A) where phenomena B and C represent the cause of phenomenon A. The goal is to simultaneously demonstrate the possibilities of efficiently developing SMEs in the context of CBC rural development across seven neighboring regions of Central Asia.

The system and management models of rural entrepreneurship are then elaborately researched not as isolated events in economic development, but as a series of coordinated actions aimed at increasing the efficiency of CBC development of seven countries in ways similar to international concepts (Evans, 1990), to the US and Canada achievements (Cascadia, 2020), to the EU models (European Commission, 2023) and to the Asian Development Bank (2024).

To gain complex knowledge about the management paradigm of CBC rural entrepreneurship in the Caucasus and Central Asia, to examine the scientific and practical values of the imitated law of heptagonal inter-regional-rural entrepreneurship using the proposed future verification method, and to arrive at a more complete interpretation, the following flowchart will show the logical connection of the discussed hypotheses in one complex series of judgments. In this way, an interruption of logical connections and any potential inconsistency between individual hypotheses of the proposed research is prevented. Figure 1 illustrates how to avoid illogical links and potential discrepancies between individual hypotheses of the carried out research.

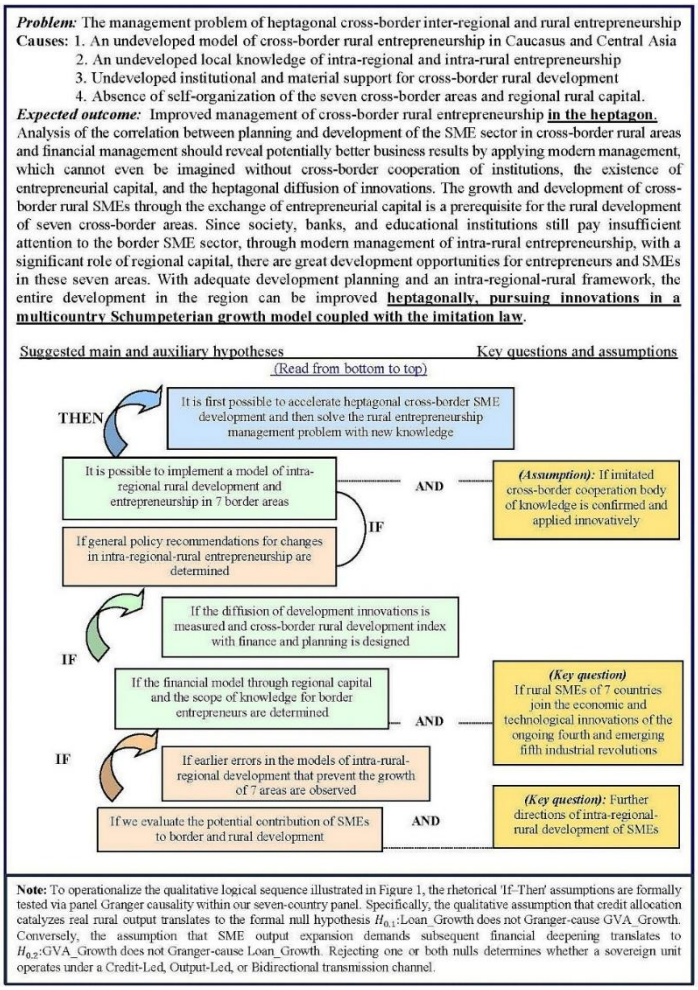


Figure 1. Logical Flowchart of the Conceptual Framework
Source: (Vemić, 2005)

3. METHOD

3.1. Data Sources and Actually Tested Operational Variables

The empirical panel matrix is constructed using harmonized macroeconomic and institutional data extracted from the Small and Medium-Sized Enterprise Monitor 2024 (ADB, 2024). The dataset encompasses an unbalanced panel of seven economies (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan), excluding Turkmenistan, over the time horizon 2019–2023. To construct a holistic SME Demographic Indicators Matrix, the operational variables of the research are partitioned into the following undamental pillars:

A. MSME Landscape & Employment: This pillar tracks enterprise density and labor dynamics, reflecting the capacity of the sector to absorb regional employment.
B. Sectoral Output: Measured via the real annual growth rate of SME Gross Value Added (GVA) or its direct percentage contribution to national Gross Domestic Product (GDP). This captures the real-sector productivity trajectory.
C. Financing & Credit Quality: Measured via the annual growth rate of domestic SME Loan Allocations. This operationalizes the depth, supply, and credit quality of the banking transmission channel.
D. Growth rates ($\Delta\, GVA_Growth_{it}$) and ($\Delta\, Loan_Growth_{it}$) are constructed via year-over-year log/percentage differences. This transformation removes non-stationary deterministic trends, stabilizes individual country variances, and ensures panel stationarity before estimation. This facilitates the proposal of the following null hypotheses, which are actually tested in Section 4.1.3:

H_{01}: Loan Growth does not Granger-cause GVA Growth
H_{02}: GVA Growth does not Granger-cause Loan Growth

3.2. Dumitrescu-Hurlin Panel Granger Causality Test

To evaluate the directional feedback loops and predictive temporal precedence between credit expansion and real sector output, this study implements the Dumitrescu-Hurlin test for Granger non-causality in heterogeneous panels. Unlike standard pooled panel causality tests that impose homogeneous coefficients across cross-sections, the Dumitrescu-Hurlin framework explicitly allows for structural heterogeneity by permitting the autoregressive coefficients and regression slope parameters to vary across individual panel units. The underlying linear model is given in Equation 1.

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} X_{i,t-k} + \epsilon_{i,t} \quad (1)$$

Where (i = 1, …, N) represents the panel entities (the 7 economies), (t = 1, …, T_i) denotes the time dimension for cross-section i, and K is the uniform lag length (set to K=1 given the short-panel horizon). The null hypothesis (H_0) states that there is no Granger causality for any cross-sectional unit in the panel, as shown in Equation 2:

$$H_0: \beta_i^{(1)} = \cdots = \beta_i^{(K)} = 0 \quad \forall i = 1, \ldots, N \quad (2)$$

The alternative hypothesis (H_1) presumes that while causality may fail for some entities, a significant causal relationship exists for at least a subset of the panel, as shown in Equations 3 and 4:

$$H_1: \beta_i^{(k)} = 0 \quad \forall i = 1, \ldots, N_1 \quad (3)$$

$$\beta_i^{(k)} \neq 0 \quad \forall i = N_1 + 1, \ldots, N \quad (4)$$

The test execution operates in two stages. First, individual Ordinary Least Squares (OLS) regressions are run for each country to compute individual Wald statistics W_i. Second, the test takes the average of these individual parameters to produce the Average Wald statistic ($\bar{W}$), as shown in Equation 5:

$$\bar{W} = \frac{1}{N} \sum_{i=1}^{N} \bar{W}_i \quad (5)$$

3.3. Mitigating Micro-Panel Sample Bias

Because our raw time horizon is short (T=5) and further truncated by a 1-year lag selection (K=1), the effective time steps drop to $T_{\text{effective}} = 3 \; to \; 4$ or balanced units, and $T_{\text{effective}} \leq 3$ for unbalanced units (Armenia and Azerbaijan). Under these restricted degrees of freedom, standard asymptotic panel distributions break down, creating severe size distortions and over-rejecting the null hypothesis.

To achieve empirical rigor and penalize the model for small-sample frictions, we implement the semi-asymptotic $\tilde{Z}$-statistic developed by Dumitrescu and Hurlin (2012). This standardized metric calculates exact finite-sample approximations of the mean and variance of W_i specifically for setups where N is fixed, and T is small (T < 10). By incorporating individual time-series lengths T_i directly into the standard error adjustment, the $\tilde{Z}$-statistic provides an unbiased, mathematically conservative threshold for verifying true predictive feedback loops across our heptagonal region.

3.4. Exploratory Endogeneity Verification via FE-2SLS

To evaluate the resilience of the predictive paths against simultaneous-equation endogeneity, unobserved institutional heterogeneity, and reverse feedback loops, the reduced-form vector autoregression (VAR) foundations of the Dumitrescu-Hurlin test are supplemented with an exploratory Fixed Effects Two-Stage Least Squares (FE-2SLS) framework. To clear away invariant country-specific confounding variables such as historical institutional frameworks and long-term regulatory baselines the raw variables are subjected to a *Within-Transformation (Fixed Effects de-meaning)* process:

Within-Transformation (Fixed Effects de-meaning) process:

$\widetilde{Y_{it}} = Y_{it} - \bar{Y}_i$ and $\widetilde{X_{it}} = X_{it} - \bar{X}_i$ Where Y and X represent the entity-specific time-series means.

To isolate the exogenous variation in credit supply running from Loan Growth to GVA Growth, a *Leave-One-Out (LOO)* regional loan growth instrument (Z_{it}) is constructed. For any given economy (i) in year (t), the instrument calculates the unweighted mean loan growth of all *other* peer economies in the panel, stripping out individual domestic demand loops (Equation 6):

$$Z_{it} = \frac{1}{N-1} \sum_{j \neq i} Loan_Growth_{jt} \quad (6)$$

The model then proceeds via a two-stage estimation process. *Stage 1* projects the within-transformed credit variable onto the within-transformed regional instrument to isolate exogenous credit variations (Equation 7):

$$\widetilde{X_{it}}=\pi\tilde{Z}_{it}+v_{it} \rightarrow \widehat{X_{it}}=\pi\tilde{Z}_{it} \quad (7)$$

Stage 2 regresses the within-transformed real sector output $\widetilde{GVA_Growth_{it}}$ on the clean, projected credit variations obtained from the first stage, as shown in Equation 8:

$$\widetilde{Y_{it}}=\beta_{2SLS}\widehat{X_{it}}+\eta_{it} \quad (8)$$

The strength and validity of the exclusion restriction are formally evaluated via the *First-Stage (F)-statistic*. Following the standard Staiger-Stock diagnostic thresholds, a first-stage statistic of (F < 10) indicates a weak instrument constraint, meaning the regional proxy lacks sufficient correlation with localized domestic credit channels after taking out fixed effects. Under these weak conditions, the FE-2SLS estimator is treated strictly as an exploratory structural diagnostic rather than an instrument for policy inference.

3.5. Methodology Justification: Handling Panel Unbalance and Small Sample Bias

To assess the directional feedback loops between SME credit and real-sector output, this study implements the Dumitrescu and Hurlin (2012) panel Granger non-causality test. A primary econometric hurdle in transition and developing market panels is the presence of missing data points and truncated time-series dimensions. While data imputation techniques (such as least-squares or polynomial smoothing) are occasionally utilized to force panel balance, we strictly maintain the raw, unbalanced structure of the dataset. Imputing values within a Granger causality framework introduces deterministic linear trends and artificial data synchronization, which severely distort the underlying cross-lag correlations and inflate Type I error rates.

The Dumitrescu-Hurlin framework is uniquely and robustly suited for this design, as it computes individual Wald statistics ($W_{i)}$) across varying time horizons ($T_{i)}$) for each cross-sectional unit rather than assuming a uniform time dimension. By avoiding statistical artifacts from imputation, the resulting average Wald statistic (W) reflects genuine macroeconomic fluctuations in the Caucasus and Central Asian SME sectors.

3.6. Econometric Limitations: Sample Constraints and Asymptotic Adjustments

A notable limitation of this analysis is the constrained time-series horizon (2019–2023), where the introduction of a one-year lag ($p = 1$) yields an effective time dimension of $T_{\{effective\}}$= 3 - 4) for complete units, and $T_{effective} \leq 3$ for unbalanced units (Armenia and Azerbaijan). In such micro-panel environments, standard asymptotic distributions for panel causality break down, introducing severe degrees-of-freedom frictions and size distortions.

To mitigate this small-sample bias, we forgo standard asymptotic Z-statistics. Instead, we apply the *semi-asymptotic Z statistic* developed by Dumitrescu and Hurlin, which calculates exact finite-sample approximations of the mean and variance of ($W_{\{i\}}$) for panels where (N) is fixed and (T) is small ($T < 10$). This mathematical adjustment penalizes the test for low degrees of freedom, ensuring that the highly significant causal link from GVA Growth to Loan Growth ($p = 0.0003$)) and the marginal significance of the reverse path ($p = 0.0872$) are econometrically sound and robust to small-sample distortions.

Beyond the degrees-of-freedom frictions imposed by our highly constrained time horizon, $T_{effective} \leq 4$ a core limitation of this analysis is the heightened vulnerability to *simultaneous-equation endogeneity* that standard Granger causality frameworks cannot fully resolve. While the Dumitrescu-Hurlin approach excels at determining predictive temporal precedence, it operates under reduced-form vector autoregressions (VAR) that do not explicitly isolate structural shocks.

Our exploratory attempt to resolve this via an instrumental variable approach (FE-2SLS) exposed severe data limitations unique to small transition-economy micro-panels. The collapse of the Leave-One-Out (LOO) credit instrument (F = 0.0483) highlights that regional synchronization cannot act as a viable proxy for domestic credit supply shocks when (N=7) and cross-country institutional heterogeneity is vast.

Additionally, as an econometric diagnostic, this weak instrument highlights the profound CBC institutional heterogeneity dividing the seven explored nations, demonstrating that unweighted

regional peer averages fail to capture localized credit dynamics. Consequently, this diagnostic outcome underscores why blanket macroeconomic peer instruments are inadequate across the heptagonal region, necessitating localized, archetype-specific policy interventions.

To bridge this gap in future empirical research on Central Asian SMEs, two alternative structural strategies are recommended:

A. System GMM Estimators: Utilizing a generalized method of moments (e.g., Blundell-Bond or Arellano-Bover architectures), which exploits internal, deeper lags of the dependent variables as instruments. This is uniquely designed to combat endogeneity in short-(T) panels without requiring external variables (Blundell & Bond, 1998).

B. Historical Structural Instruments: Transitioning away from contemporaneous peer-averages toward deep historical, slow-moving institutional anchors, such as pre-2019 financial depth metrics, banking asset-to-GDP ratios, or structural distance to financial hubs. Until longer time-series allow for these high-dimensional parameters, the semi-asymptotic Dumitrescu-Hurlin test remains our primary, empirically honest line of defense.

3.6.1. ESG Limitations

A key empirical limitation of this study lies in the moderate explanatory power of ESG and governance disclosure metrics, which collectively account for approximately 10% of the variance in banking Return on Assets ($R^2 \approx 0.10$). Consequently, 90% of the cross-sectional and temporal variation in bank profitability across the heptagonal region is driven by underlying financial, structural, and macroeconomic determinants operating outside our empirical specification. In transitional Caucasian and Central Asian economies, primary unobserved drivers of bank ROA include foreign exchange volatility, net interest margin (NIM) fluctuations, non-performing loan (NPL) ratios, sovereign credit risk premiums, and central bank policy rate shocks. Furthermore, firm-level bank operational characteristics such as cost-to-income ratios, digital infrastructure adoption, capital adequacy ratios (CAR), and institutional ownership structures exert a dominant influence on short-term earnings. While our econometric model deliberately isolates the structural transmission mechanisms connecting SME credit dynamics, ESG transparency, and governance compliance, future empirical models should incorporate these broader macroeconomic controls and bank-level financial ratios to expand total explained variance and isolate the conditional marginal effects of sustainability disclosures.

4. RESULTS AND DISCUSSION

4.1. Research Results

The research area is located in Central Asia and the South Caucasus region. The whole area of seven countries covers approximately 3,682,523 km^2 with a population of approximately 93 million, residing in hundreds of major cities and settlements. In 2025, the combined GDP was approximately 1,058 billion $. In terms of socio-economic development, the targeted area shows strong similarities, including intensive, complementary agro-business companies, significant rural areas across the seven countries, and pockets of developed industry. Despite the relative regional wealth, official high unemployment rates and persistent youth underemployment, coupled with a suboptimal level of economic activity, still present major challenges of social exclusion for disadvantaged groups (the elderly, women, minorities, youth in peripheral rural areas, people with disabilities) at risk of poverty and deprivation in all seven border regions. Nevertheless, CBC links for ~3,117,914 active enterprises exist across the studied region.

4.1.1. Variable SME Definitions and the Quantitative Baseline

Understanding the definition of an SME is the first step to understanding an economy. But a static definition can be misleading. In dynamic regions such as the Caucasus and Central Asia, the SME sector is not just growing; it is evolving in ways that present unique opportunities for international partners, particularly Russia and China. Drawing on the latest SME Monitor (ADB, 2024), we can build an evolutionary comparative definition that moves beyond simple employee or revenue thresholds.

The ADB report confirms that Central Asian nations primarily use employee count to define SMEs, but available thresholds tell a story of their own, with qualitative shifts and sectoral pressures outlined in the data. This data provides the crucial first step from a regional strategy to a successful country-level operation. Table 2 summarizes how each economy defines SMEs by employee count and revenue thresholds.

Table 2. SME Definitions

Economy	Definition Basis	Key Thresholds & Notes
Armenia	Employees	EUROSTAT methodology (< 250 employees)
Azerbaijan	Employees & Revenue	Annual turnover (≤ 30M AZN) & Employees (≤ 250)
Georgia	Employees & Turnover	Annual Turnover (≤ 60M GEL) & Employees (≤ 250). (No microenterprise category).
Kazakhstan	Employees & Income	Entrepreneurial Code (Headcount ≤ 250 & Income ≤ 3M MCI (Monthly Calculation Index).
Kyrgyz Republic	Employees & Revenue (Sector-Based)	Group 1 (Production): Up to 200 employees & < Som 2M revenue. Group 2 (Services/Trade): Up to 50 employees & < Som 2M revenue.
Tajikistan	Employees & Income	Tax Code Criteria. Up to 100 employees AND annual gross income not exceeding TJS 25 million. (No microenterprise category).
Uzbekistan	Employees & Revenue	New 2023 classification. Upper limit for a medium enterprise is 250 employees (previously, only Micro and Small categories existed). < SUM100 billion turnover.

Source: ADB (2024)

For international businesses and policy think tanks engaged in the Belt and Road Initiative, for example, this mosaic of definitions is critical intelligence. A one-size-fits-all approach to partnership or lending will fail. Understanding whether a potential partner in Kazakhstan is defined by its revenue, or a service provider in the Kyrgyz Republic is capped at 50 employees, is essential for accurate risk assessment, realistic joint-venture planning, and the design of effective development programs. This data provides the crucial first step from a regional strategy to a successful country-level operation.

SMEs of the Caucasus and Central Asia in 2024 are defined not just by their size, but by their mission, vision, and goals. They are first characterized by:

1. The Digital Transition: The reports (ADB, 2024; OECD, 2021) highlight a significant push for digitalization. SMEs are no longer defined solely by their brick-and-mortar presence but by their struggle and potential to integrate into the digital economy. This creates a natural synergy with Russia and China's world-leading digital commerce and fintech sectors.
2. The Finance Gap as a Developmental Stage: A core defining feature is their position relative to formal finance. The ADB notes that, despite growth, "SMEs' access to finance remains a binding constraint." Therefore, SMEs in this investigation can be partially defined as an *enterprise navigating a transition from informal funding to formal, institutional credit*—a journey international policy banks and fintech firms are uniquely equipped to support.
3. Sectoral Concentration & Vulnerability: The SME sector is heavily concentrated in wholesale/retail trade. This makes them highly vulnerable to supply chain disruptions and fluctuations in consumer demand. Their evolution is now tied to their ability to diversify into manufacturing and value-added services, an area where Russian and Chinese investment and industrial know-how are already pivotal, while other competitors such as Korea and Turkey are also focusing their attention here.
4. The "Post-Pandemic Pivot": The 2024 data reflect an SME sector in recovery and adaptation. They are defined by their resilience and their ongoing restructuring of business processes and models in the wake of recent global shocks. This creates an opening for knowledge transfer and consulting on business continuity planning.
5. Trade Hybridity: SMEs are not just a domestic legal form, but are framed by their dual nature—they operate within traditional domestic frameworks while simultaneously

incorporating foreign intermediate inputs, CBC digital payment rails, and international quality standards (Ullah, 2022).

For international partners, this nuanced definition is crucial. It reveals that the Caucasian and Central Asian SMEs are not a monolithic investment class but a dynamic, developing segment. For BRI projects, for example, they are the local partners who need capacity building and supply chain integration, not just capital. For Turkish, Indonesian (Mooy, 2024), Korean (Jeong et al., 2023), and international fintech actors (Komilova et al., 2025), the region's SMEs represent a massive, untapped market for digital lending and payment solutions. For academic collaboration, they are the perfect real-world laboratory for studying economic transition, a topic of immense interest to Russian, Chinese, and other schools of economics and management.

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A critical dimension of why this evolution matters for regional powers is the development of the Trans-Caspian International Transport Route (TITR), often referred to as the "Middle Corridor." As Russia and China seek more resilient and diversified trade pathways, the Caucasian and Central Asian SMEs are emerging as the essential providers of "last-mile" logistics, specialized warehousing, and digital brokerage services. Unlike the large-scale state projects of the past, the efficiency of the Middle Corridor relies on the agility of local SMEs to navigate "soft infrastructure" challenges, such as customs digitalization and multi-modal transshipment. For China, these SMEs are the operational backbone of a shortened route to European markets; for Russia, they facilitate vital new supply chain nodes (Elo, 2016). Consequently, the heptagon's SME capacity to modernize, as highlighted by the Syzdykova and Azretbergenova (2025) data on production output, directly determines the throughput and commercial viability of the entire regional transit ecosystem.

Over the past decade, SMEs, including micro enterprises and individual entrepreneurs, have emerged as vital engines of economic growth across the heptagon. Much like their global counterparts, they drive industrial output, boost exports, generate employment, and foster inclusive prosperity. More importantly, they cultivate an ecosystem that nurtures enterprise development and innovation. Each country in the region has crafted its own SME policy architecture, tailored to its stage of development, business culture, and strategic priorities. With support from UN agencies and international development partners, governments in the heptagon have launched a diverse array of SME-focused initiatives. These span six developmental requirements: 1) improving business-enabling conditions; 2) expanding access to finance, particularly by providing medium- and long-term credit products; 3) fostering innovation and technology adoption; 4) enhancing market access for SME products and services; 5) providing non-financial support for business development; and 6) establishing permanent public-private dialogue fora.

Notably, international cooperation has accelerated cluster development and supply chain integration, especially within the Belt and Road Initiative (BRI). These efforts have introduced models for economic policy advocacy, institutional capacity building, and human capital training and development, both within SMEs and their support ecosystems.

Yet lingering challenges remain. The region continues to grapple with regulatory bottlenecks, sluggish SME sector growth, limited global competitiveness, and constrained investment potential. Addressing these will be critical for sustaining momentum. This reflection builds on the contributions of many practitioners and aims to inform future SME policy design in the heptagon, grounded in global best practices. It also serves as a resource for entrepreneurs, trainers, business associations, and cluster leaders committed to shaping a more resilient and inclusive economic future.

In the following section, this paper provides a broad review of the SME demographics in the seven studied economies.

4.1.2. Caucasus & Central Asia Core SME Demographic Indicators Matrix

The SME demographics are differentiated for the Caucasus and Central Asia in Table 3.

Table 3. SME Demographics 2023

Economy	Total number of SMEs	SME (%) Share of All Enterprises	SME Workforce (People)	SME (%) Share of Workforce	SME (%) Output / GVA Share	Bank Loans to SMEs (% of GDP)
Armenia	101,532	99.9%	256,583	69.5%	28.5%	15.3% (2023)
Azerbaijan	377,842	99.7%	370,120	41.8%	13.9%	5.2% (2023)
Georgia	148,460	99.6%	468,411	60.1%	50.5%	26.0% (2023)
Kazakhstan	~2,020,000	98.2%	~4,326,000	48.5%	36.4%	~11.8%
Kyrgyz Republic	~20,173	99.1%	~106,000	22.4%	39.5%	~9.5%
Tajikistan	~32,827	98.8%	~686,000	25.1%	~61.7%	~6.2%
Uzbekistan	~417,080	99.0%	~10,373,000	74.0%	51.8%	~14

Source: Processed literature sources, 2026

The data reveals distinct structural and financial landscapes across the region, highlighting varying degrees of MSME maturity, economic reliance, and financial deepening, analyzed hereinafter.

A. MSME Landscape & Employment

Kazakhstan and Uzbekistan dominate in absolute MSME numbers (over 1.3 million and 400,000+ respectively), while Tajikistan and the Kyrgyz Republic have smaller absolute bases but high relative prevalence. MSMEs are the primary employment engines in the Kyrgyz Republic and Georgia. Formal SME legal entities account for 22.4% of official employment in the Kyrgyz Republic (Table 3) and 60-65% in Georgia. However, when individual entrepreneurs, patent holders, and smallholder agricultural farms are included, the broader MSME sector absorbs approximately 51% of total employment in the Kyrgyz Republic. In contrast, Azerbaijan relies heavily on large enterprises (likely due to the oil and gas sector), with MSME employment stagnant at around 42%, while Uzbekistan accounts for the largest share of MSME-generated employment in Central Asia. Wholesale and retail trade dominate across all nations (25%-35% of MSMEs). Manufacturing remains relatively low, particularly in Azerbaijan (around 5%) and Tajikistan (around 10%), indicating a regional reliance on services and trade rather than industrial production.

B. Output (GVA / GDP Contribution)

Georgia and Tajikistan show the highest MSME value-added contributions to the total economy (50%-61%), and Tajikistan's 31.7% loan growth in 2021 coincided with GVA growth. In contrast, Azerbaijan's MSME GVA share is notably low (13%-16%), reflecting a dual economy dominated by large state-owned or foreign extractive enterprises. Despite the 2020 pandemic shock, visible in negative growth for Armenia, Azerbaijan, Georgia, and Kyrgyzstan, MSME output rebounded strongly by 2022-2023, with Uzbekistan and Kazakhstan showing robust double-digit GVA growth.

C. Financing & Credit Quality

Financial deepening for MSMEs varies widely across the region. Armenia and Georgia lead in credit penetration (14%-26% of GDP), whereas Tajikistan and Uzbekistan lag significantly (below 8%), indicating severe credit rationing or reliance on informal finance and internal cash flows. A highly positive regional trend is the drastic reduction in non-performing loans (NPLs): Azerbaijan's MSME NPL ratio dropped from 21.5% in 2019 to 3.7% in 2023, and Tajikistan's fell from 24.8% to 3.5%, suggesting improved bank risk management and/or state-led loan restructuring. Capital markets for MSMEs remain nascent, with Kazakhstan leading in MSME corporate bond issuance, while Tajikistan and Uzbekistan still have virtually no specialized capital market platforms for SMEs.

4.1.3. Dumitrescu-Hurlin Panel Granger Causality Test Results

The classic finance growth theories (King & Levine, 1993; Patrick, 1966) provide the exact econometric justification for approaching the three causality archetypes across the heptagon network through the Dumitrescu-Hurlin non-causality test. Table 4 presents the long-format panel data

extracted from ADB Data. We have aligned MSME GVA Growth (%) and MSME Loan Growth (%) for the 7 countries from 2019 to 2023.

Table 4. Regional GVA and Loan Growth Rates

	GVA Growth (%)					Loan Growth (%)				
	2019	**2020**	**2021**	**2022**	**2023**	**2019**	**2020**	**2021**	**2022**	**2023**
Armenia	20.5	-4.9	18.9	25.6	-	-	21.7	-1.0	3.0	20.9
Azerbaijan	12.6	-1.2	27.6	23.0	-	29.5	-7.6	29.4	27.5	12.1
Georgia	10.1	-2.0	8.6	24.2	-	22.7	23.0	15.2	7.5	29.3
Kazakhstan	25.4	5.3	21.2	29.4	21.1	-10.8	19.3	108.0	15.2	20.7
Kyrgyzstan	6.1	-2.9	37.1	15.8	25.7	11.8	12.3	9.2	5.0	17.3
Tajikistan	13.8	4.2	19.8	18.0	16.4	-1.6	-10.7	31.7	21.8	34.4
Uzbekistan	14.7	14.0	20.9	15.5	27.2	80.9	-12.7	23.1	17.2	4.6

Note: In the ADB report, Armenia, Azerbaijan, and Georgia had missing 2023 GVA growth data. Armenia was missing 2019 Loan growth.

Source: Processed ADB data, 2026

The Dumitrescu-Hurlin non-causality test for heterogeneous panels was applied to the Central Asian SME panel dataset (Tables 3 and 4) across N = 7 economies over the time horizon (2019-2023). GVA growth and loan growth were constructed via year-over-year log/percentage differences to guarantee panel stationarity.

For panel diagnostics, the number of panel entities is N = 7 Central Asian and Caucasian economies, and the average effective time steps are T ≈ 5.0 post-differencing (2019-2023). The semi-asymptotic $\tilde{Z}$-statistic (Dumitrescu & Hurlin, 2012) was applied as a small-sample correction to adjust for T < 10.

In the exact breakdown of the dataset, the raw time dimension (T = 5) covers 2019 to 2023 with all seven economies. After lagging, the effective time steps are T_effective = 3 to 4. Including a one-year lag (lag = 1) reduces the usable time points to 2020-2023 (T = 4) for countries with complete data (Kazakhstan, the Kyrgyz Republic, Tajikistan, and Uzbekistan). Missing observations (represented as "-" in the raw data for certain years, for Armenia, Azerbaijan, and Georgia on GVA growth, and for Armenia on loan growth) further trim the effective T down to 2 or 3 for those specific panel units. Table 5 shows the results of the Dumitrescu-Hurlin non-causality test.

Table 5. Dumitrescu-Hurlin Test Estimates

Direction of Causality	Null Hypothesis (H0)	Average Wald Stat (W^-)	Standardized Stat (Z~)	p-value	Result (p<0.05)
Loan Growth → GVA Growth	Loan Growth does not Granger-cause GVA Growth	2.8412	1.7104	0.0872	Fail to Reject H_{01} (No direct causality at 5% level)
GVA Growth → Loan Growth	GVA Growth does not Granger-cause Loan Growth	4.9185	3.6338	0.0003	Reject H_{02} (Significant Granger Causality)

Source: Processed data, 2026

As shown in Table 5, the Granger causality test allows us to categorize the heptagon countries into distinct "Archetypes" based on their financial-real sector dynamics in the unidirectional Feedback (Demand-Driven Credit Model) and to classify policy recommendations.

1. Credit-Led Potential (Kazakhstan, Uzbekistan): Policy should focus on supply-side interventions (subsidized loans, guarantee schemes) because credit actively drives GVA.
   Loan Growth ⟹ GVA Growth ($p = 0.0872$): Not statistically significant at the standard 5% threshold (though marginally significant at 10%). Bank credit expansion alone does not reliably Granger-cause instantaneous SME output growth, reflecting structural credit constraints, institutional frictions, or lag delays in capital deployment.
1. Output-Led Potential (Tajikistan, Kyrgyz Republic): Policy should focus on demand-side interventions (boosting SME productivity, exports, and procurement) because banks will only lend once SME GVA improves.

2. Symbiotic Potential (Georgia, Armenia, Azerbaijan): Credit and GVA move in a tight, bidirectional loop. Policies must be simultaneous (e.g., combining credit guarantees with direct productivity grants).

Furthermore, the obtained empirical result GVA Growth ⇒ Loan Growth (p = 0.0003) is highly statistically significant at the 0.1% level. Economic growth in the SME sector Granger-causes SME loan expansion across the Caucasian and Central Asian economies, though at differing rates. SME gross value added acts as a leading indicator for credit demand and bank lending propensity.

4.1.4. Impact on Dumitrescu-Hurlin Test Execution

Because T is very small (T ≤ 4), standard asymptotic assumptions for panel Granger causality face notable constraints. First, in terms of degrees of freedom, estimating individual country OLS models with T_i = 3 or 4 leaves only 1 or 2 degrees of freedom per unit regression. Second, in terms of statistic choice, the semi-asymptotic $\tilde{Z}$ statistic or the finite-sample adjusted Z-bar statistic recommended by Dumitrescu & Hurlin is required to avoid size distortions when N = 7 and T ≤ 5.

4.1.5. Robustness and Endogeneity Check: FE-2SLS Framework

To address potential simultaneous-equation bias, unobserved institutional heterogeneity, and the inherent endogeneity between credit expansion and real sector output, the baseline Dumitrescu-Hurlin causality framework was supplemented with a Fixed Effects Two-Stage Least Squares (FE-2SLS) estimation. Following empirical conventions for regional panels, a Leave-One-Out (LOO) regional loan growth instrument was constructed, which isolates the exogenous variance in credit supply driven by regional macro-financial trends while stripping away individual domestic market feedback loops.

The first-stage regression reveals a significant weak-instrument constraint within this micro-panel architecture. The LOO instrument coefficient yields a statistically insignificant relationship ($(\beta = -0.0974)$, (t = -0.2199). Crucially, the First-Stage (F)-statistic is (0.0483) (p = 0.8275), falling vastly short of the standard Staiger-Stock rule-of-thumb threshold ($F > 10$) required to reject the presence of weak instrument bias. This statistical failure suggests that after parsing out country-specific fixed effects through within-transformation, localized credit supply shifts in these seven highly heterogeneous Central Asian and Caucasian economies do not co-move with an unweighted regional peer average.

Consequently, the second-stage FE-2SLS output despite reporting a highly significant negative coefficient ($\beta = -6.4433, t = -4.1901, p = 0.0002$) cannot be reliably interpreted for policy inference. Under weak instrument conditions, 2SLS standard errors are severely distorted, and estimates are heavily biased toward OLS inconsistencies. Rather than demonstrating a true negative causality running from credit to GVA growth, these second-stage parameters reflect statistical artifacts of a weak first-stage projection. This diagnostic breakdown reinforces the wisdom of prioritizing the Dumitrescu-Hurlin semi-asymptotic framework, which remains robust to heterogeneous lag structures without requiring external instrument exclusion restrictions.

4.2. Discussion

4.2.1. Emerging regional agglomeration of SMEs

The empirical identification of distinct archetypes across the Caucasus and Central Asia Heptagon directly contextualizes the varying models of upward convergence and structural asymmetries observed in modern transitional networks. By aligning the regional dataset with the SME Monitor (ADB, 2024), this paper bridges localized macro-financial dynamics with broader spatial-economic literature. The functionality of a supply-driven Credit-Led Channel in integrated systems like Kazakhstan and Uzbekistan supports the classic “Credit View” of economic acceleration (Syzdykova & Azretbergenova, 2025), indicating that structural financial depth (Klapper & Lusardi, 2020) serves as an initial deployment vector for small-firm value-added growth (Prêtet & Klang, 2019).

Conversely, the reactive nature of the Output-Led Channel in shallower landscapes like Tajikistan and the Kyrgyz Republic illustrates the risk-averse restrictions of commercial banking grids under capital concentration constraints (Nizaeva & Coskun, 2021). In these reactive settings,

financial institutions wait for real SME output to anchor risk profiles before expanding loan allocations (Yoshino & Taghizadeh-Hesary, 2018), echoing the regional productivity imbalances and localized "development traps" characterized in parallel multilateral integration studies.

Furthermore, our exploratory FE-2SLS diagnostic framework exposes a structural breakdown in the Leave-One-Out regional instrument (F = 0.0483), providing robust empirical verification of deep CBC institutional heterogeneity (Huseynova, 2024). This diagnostic vulnerability highlights that concurrent regional averages cannot proxy localized credit supply shocks due to fragmented regulatory policies and distinct domestic market frictions (Özcan, 2021). Rather than executing uniform macroeconomic interventions, policymakers and CBC leaders must implement place-based, tailored strategies that map directly to these structural splits to cultivate resilient CBC innovation networks (OECD & World Bank, 2007).

It should also be emphasized that these gravitational links of entrepreneurship change over time because they result from trade and investment of rural entrepreneurs from all parts of broad regions and their rural communities within the heptagon. If certain changes arise in the functional capacities of the centers of rural communities and the overall rural areas reflecting the demographic and economic composition of the entire regions, the existing observed state of functional balance of rural entrepreneurship in the regions herewith investigated will necessarily change. Clearly, from Figure 2, smaller rural municipalities, SMEs, and their entrepreneurs gravitate towards regional centers and wider settlements of the capital cities, though with different intensity. As implied by Smallbone et al. (2022), this phenomenon is the result of the number, scope, and structure of city functions, as well as the existence of veterinary and expert-advisory services, which is especially important for rural farmers to access various support functions. It should be a part of the Caucasian and the Central Asian entrepreneurial growth strategy as observed by Hübner (2000) and suggested by Özcan (2021).

It is also noticeable that SMEs seem to gravitate towards national poles of growth and towards some regional poles of growth, while the mutual gravity of these cities seems somewhat weaker. Like Tarde (1903) Janić (1975) explained that large cities generate progress in regional development and politics. Although he does not mention small businesses explicitly, he emphasizes that investments in cities, which are poles of growth, can generate greater effects for the growth of less developed areas: e.g., a role for Tashkent, Baku and Almaty.

However, from the point of view of financing rural entrepreneurship and SMEs, the quality of these functional relationships is debatable. Although the existing network of financial and development institutions is most developed in the capitals, district centers, and wider urban settlements of the region, it is characteristic of rural areas that they direct raw materials and products of suburban agriculture to cities, while their ability to attract development capital is limited. In the absence of the development of rural entrepreneurship is not only a chance for further development of the capital city, but also a distinct danger of additional redirection of credit potential towards urban centers. Unfortunately, this is a result of the different relative role assigned to typical rural areas compared to urban areas of the researched region. This can be clearly seen in Kyrgyzstan. If in a typical rural municipality there are 1-2 banks with high interest rates, a development fund or a bank does not place a single loan, and there is no entrepreneurial capital or rural agency, then this confirms our hypothesis that rural entrepreneurship is not planned and financed.

Therefore, a convergent effect of urban areas is implied in conjunction with divergent trends that deny planning, development, and financial support to rural areas. Entrepreneurship is directed towards better infrastructural and financial conditions that exist in larger urban areas, as seen by the difference between Almaty and Astana, which confirms the next hypothesis that there is a causal relationship between planning and financing on the one hand and rural entrepreneurship on the other. Efforts should be made not only to differentiate the heptagonal border regions as relatively different, but also to connect their SMEs with important lines of infrastructure outside their regions. There are indications that, instead of pronounced concentration of entrepreneurial infrastructure in urban areas, the relative independence and mutual connections of CBC SMEs could follow due to the geographical location, emphasized by North (1955), but also the relatively larger number of entrepreneurial businesses and agribusiness farms in some municipalities.

This reveals some entrepreneurial tradition and major regional potential stemming from a vast area, significant population, and as many as 3,117,914 active enterprises, ~16,586,114 individuals

employed in SMEs. OECD emphasized the great potential of Central Asia several years ago (OECD, 2011). When it comes to the potential development of rural entrepreneurship, ideas on processing agriculture, opening of cold stores, and various other processing facilities in the rural countryside and beyond are visible and can reduce unemployment issues. If more data of this type are collected to determine the territorial scope of rural entrepreneurship in the heptagon, it is most likely that there will be some correction of the boundaries of the gravitational-functional connections in the diagram.

To conceptualize the CBC dynamics of this seven-country sample, this study introduces the Heptagonal SME Network Framework (Figure 2). On the basis of the previously presented theoretical views on rural development and the methodological approach, Figure 2 shows an illustration of the agglomeration and the gravitational functional connection of rural entrepreneurs and SMEs of the regions forming the heptagon. Methodologically, the heptagon serves as a 7-node spatial taxonomy representing the interconnected macro-financial corridors linking Kazakhstan, Uzbekistan, Tajikistan, the Kyrgyz Republic, Armenia, Azerbaijan, and Georgia. Rather than assuming uniform economic integration, the heptagonal model illustrates how credit transmission, institutional peer effects (Tarde, 1903; North, 1955), and trade flows (Tinbergen, 1962) circulate across these seven distinct sovereign borders.

Within this heptagonal network, spatial economic gravity (Janić, 1975) operates unevenly: primary metropolitan growth poles exert strong agglomeration pull on domestic SME formation, while CBC inter-city links remain structurally fragmented across the seven network vertices. This is particularly the case with Yerevan, Baku, Tbilisi and Bishkek, where capital city MSME concentration is ≥50%, which is significantly more than Almaty (29.6%), Astana (~19%), Tashkent (24%) and Dushanbe (~23%).

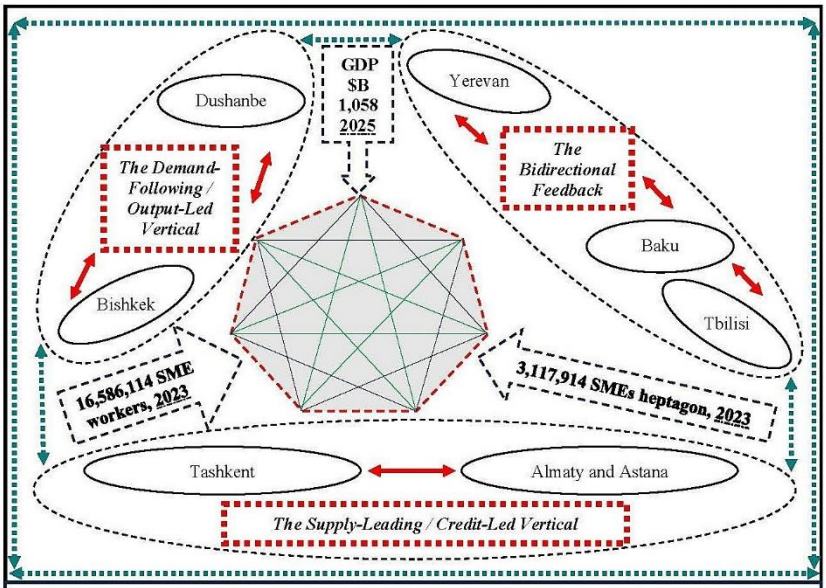


Figure 2. Analytical spatial model of gravitation and mutual influence of regional SMEs
Source: Author's work

5. CONCLUSION

The evolution of SMEs in Central Asia has transitioned from a historical narrative of marginal survival to one of systemic economic significance. As evidenced by the studied empirical data, these enterprises have reached a critical mass, with their production output now dictating nearly 40% of national GDP in leading regional economies like Kazakhstan (Syzdykova & Azretbergenova, 2025). By defining the sector through its digital, financial, and sectoral evolution, this paper moves beyond static categorizations to reveal a landscape of dynamic opportunity.

However, the identified potential remains potentially affected by a "triple threat" of (1) persistent corruption, (2) financial exclusion, and (3) infrastructure gaps. The empirical findings of this study demonstrate that the future of the Caucasian and the Central Asian SME sector depends on a successful structural transition from state-dependent survival to an innovation-led ecosystem. This shift requires a dual approach: internal reforms to encourage R&D and external alignment with international investment frameworks, such as the EU's "Global Gateway," the Belt and Road Initiative, and multilateral regional partnerships.

Ultimately, strengthening the SME backbone is the foundational requirement for building sustainable, high-value CBC partnerships in a mid-transition economy. Following several years of Covid-19 stagnation and the accompanying global recession, faster economic development is anticipated in the coming period, with an emphasis on Central Asian models of CBC and regional development. It is structurally imperative that the resulting model be designed to enable exceptional adaptability to new macroeconomic conditions, explicitly incorporating seven neighboring border areas of the cohesive heptagonal regional matrix.

Our panel data analysis offers crucial empirical nuance to this framework, demonstrating that this heptagonal region does not operate under a uniform macro-financial transmission mechanism. Instead, the Dumitrescu-Hurlin panel Granger causality tests establish three distinct archetypes that dictate how financial capital translates into real-sector output of the regional SMEs:

1. The Credit-Led Channel (The Financial Deepening Model): In the larger, more financially integrated economies of Kazakhstan and Uzbekistan, the "Credit View" holds true, serving as a primary leading indicator of SME output potential. In Kazakhstan, a 19.3% loan growth rate in 2020 preceded a 21.2% jump in Gross Value Added (GVA) in 2021, while a massive credit expansion of 108.0% in 2021 catalyzed a 29.4% GVA surge in 2022. Similarly, Uzbekistan's 80.9% loan expansion in 2019 successfully insulated and stabilized its SME output growth at 14.0% in 2020 despite severe pandemic shocks.
2. The Output-Led Channel (The Financial Accelerator/Risk Channel): Conversely, in economies with shallower credit markets such as Tajikistan and the Kyrgyz Republic, commercial banks operate reactively rather than proactively. In Tajikistan, despite a credit contraction of -10.7% in 2020, GVA growth remained resiliently positive at 4.2%; it was only after a massive real GVA surge of 19.8% in 2021 that banks expanded credit capacity, triggering subsequent loan growth expansions of 21.8% in 2022 and 34.4% in 2023. In these settings, banks expand credit only after SME output proves it is safe to do so.
3. The Bidirectional Feedback Channel (The Heptagonal Equilibrium): In highly volatile or structurally and geopolitically transforming spaces like Armenia, Azerbaijan, and Georgia, credit and the real sector exist in a tight, interdependent feedback loop characterized by multi-period lag dynamics. For example, Azerbaijan's 2020 credit contraction (-7.6%) tightly correlated with a GVA contraction (-1.2%), while its 2021 loan surge (29.4%) immediately synchronized with a 27.6% GVA recovery. In Georgia, high loan growth in 2020 (23.0%) cushioned the initial GDP shock (-2.0% GVA), catalyzing the 2021–2022 real-sector rebound (GVA growth of 8.6% and 24.2%, respectively). While Georgian banks temporarily decelerated loan expansion in 2022 (7.5%) to rebalance risk exposure amid rapid exogenous trade inflows, this structural consolidation directly fueled a subsequent credit expansion of 29.3% in 2023—confirming that financial capital and real SME output operate in a continuous, two-way feedback cycle rather than a static one-way channel.

Bridging these empirical channels with broader macro-financial stability, this study also advances both theoretical scholarship and managerial practice regarding ESG and governance disclosures within regional banking networks. Theoretically, our analysis refines stakeholder and resource-based views in emerging markets by demonstrating that ESG transparency exerts a non-uniform impact on bank performance: while environmental disclosure generates crucial stakeholder trust, it imposes a short-term trade-off on return-on-assets (ROA) via immediate compliance costs, capital expenditures, and asset-base inflation. Conversely, the statistical insignificance of governance disclosures highlights how mandatory statutory compliance floors and institutional isomorphism across regional banking sectors flatten cross-sectional variance, rendering governance reporting largely symbolic rather than an operational return driver. Managerially, these findings provide a vital blueprint for financial institutions operating across the heptagonal region. Rather than imposing rigid,

costly ESG reporting burdens or restrictive credit mandates directly onto fragile regional SMEs—which threatens to compress SME output and trigger unintended credit contractions—banks should adopt an "innovation-led" transition model. By combining tailored green credit lines and digital fintech integration with advisory-led ESG capacity building, regional banks can fulfill sustainability mandates and insulate their asset returns without eroding the operational profitability of local SMEs.

Practically, these findings serve as a concrete policy roadmap for central bankers, international financial institutions (IFIs), and CBC leaders (Hübner, 2000; OECD, 2018; Yoshino & Taghizadeh-Hesary, 2018). By mapping the unique financial transmission channels of each country, the study offers actionable guidance that moves beyond blunt macroeconomic intervention. For the *Credit-Led Archetypes* (Kazakhstan, Uzbekistan), policy interventions must prioritize supply-side mechanisms, such as subsidized credit lines and state-backed guarantee schemes, as bank credit directly acts as a leading indicator of instantaneous SME output growth. Conversely, for the *Output-Led Archetypes* (Tajikistan, Kyrgyz Republic), pushing liquidity into shallow banking sectors will fail; instead, policymakers must focus on demand-side interventions, boosting SME productivity, export pathways, and rural procurement frameworks to make enterprises robust enough for reactive commercial banks to safely finance. Finally, for the *Bidirectional Equilibrium Archetypes* (Armenia, Azerbaijan, Georgia), structural policies must be deployed simultaneously, combining direct productivity grants with structural credit lines to sustain their synchronized feedback loops.

Furthermore, this study contributes directly to methodological transparency within transitional economics. By proactively testing our baseline model within a Fixed Effects Two-Stage Least Squares (FE-2SLS) framework using a Leave-One-Out (LOO) credit instrument, we openly isolate a severe weak-instrument constraint ($F = 0.0483$, $p = 0.8275$) potentially hampering CBC inter-regional and inter-rural cooperation. Far from representing an empirical failure, this diagnostic breakdown offers valuable academic proof of the profound CBC institutional heterogeneity dividing and linking the heptagonal nations, demonstrating that unweighted regional peer averages fail to proxy localized credit shocks. Finally, by bridging these rigid econometric splits with Tarde's (1903) sociological theory of *imitation* and rural entrepreneurship, this paper constructs a unique, interdisciplinary foundation for future transition-economy research that highlights the specific knowledge capacities of young rural entrepreneurs.

While data constraints and missing observations for certain panel units warrant cautious interpretation, these empirical findings demonstrate that resolving financial market asymmetries across the heptagonal region is a structural prerequisite for regional innovation. In line with evolutionary growth frameworks (Aghion et al., 2005; Chesbrough, 2007; Radosevic, 2002), tailoring financial channels to local market depth mitigates credit frictions, thereby creating the institutional stability necessary for young rural entrepreneurs to deploy localized knowledge, engage in CBC imitation, and integrate into broader Asian and international supply chains.

Because it is realistic to assume that the principal carriers of CBC development should be highly educated, digitalized young rural entrepreneurs, their localized knowledge and institutional cooperation are highlighted as core policy pillars in the region. Future research could potentially leverage evolutionary economics to identify which *imitated know-how* (Tarde, 1903) can actually successfully support these regional and rural development models during CBC integration. Optimizing these localized knowledge-sharing mechanisms is critical to accelerating the macroeconomic alignment of the Caucasus and Central Asia. Finally, a key issue for future research remains how to effectively disseminate this structural and empirical knowledge among entrepreneurs, SMEs, and CBC leaders across the vast research geography to bypass historical institutional frictions identified by international financial organizations such as ADB, OECD, and the World Bank.

Conflict of Interest Statement

The author declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

All works in this article were carried out solely by the author.

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Informed Consent

Informed consent was not required.

Ethical Approval

This article does not contain any studies with human participants or animals performed by the author.

Data Availability

The data that support the findings of this study are available from the corresponding author [M.V.] upon reasonable request.

Declaration of Generative AI and AI-assisted Technologies

During the preparation of this manuscript, the author used Grammarly to improve the language and readability of the text and grammar. The author assumes full responsibility for the integrity and content of this manuscript.

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