Entrepreneurial Ecosystems and Regional Economic Resilience: A Multi-Level Empirical Analysis

Dr. Govindaswamy P[1], Dr. Thirupathi KTM[2]

[1]Lincoln University College, Petaling Jaya, Malaysia; Professor & Director, Dept. of Management Studies, Adhiparasakthi College of Engineering, Ranipet, India.

[2]Faculty, School of Maritime Management, Indian Maritime University, Chennai Campus, India.

Email: apgswamy1972@gmail.com; ktmthirupathi@gmail.com;

Abstract:

Purpose: This study investigates the impact of institutional quality, human capital, access to venture capital and inter-firm network density (dimensions of the entrepreneurial ecosystem - EE) on regional economic resilience across its dimensions (shock resistance and recovery speed). **Design/Methodology:** Applying hierarchical linear models and instrumental variable regressions on an unbalanced panel of 214 NUTS-2 regions for 22 OECD countries between 2004 and 2022, we examine the effects of the Global Financial Crisis (2008-2010) and the COVID-19 pandemic (2020-2021) shocks on EE. Findings. One standard deviation improvement in composite EE index results in 0.31 standard deviations improvement in shock resistance and approximately 11 months' faster recovery. Institutional quality and network density are the main drivers of EE impact, venture capital availability moderates EE-recovery interactions and national regulatory quality is a country-level enhancer for EE-resilience outcomes. **Originality/Value:** This is the first multi-shock multi-country analysis of EE-resilience interrelations that relies on a theory-based multi-level design and provides direct policy guidance for evidence-informed innovation policy.

Keywords: *entrepreneurial ecosystems; regional economic resilience; multi-level analysis; institutional quality; venture capital; network density; OECD regions; shock resistance; economic recovery*

JEL Classification: R11, L26, O43, R58, C33

1. Introduction

The asymmetric regional recovery process after the 2008-2010 global financial crisis clearly demonstrated how economies located in areas characterized by a strong entrepreneurial culture and intensive inter-firm linkages-Stockholm, Munich and the North Carolina Research Triangle, among others-are far more dynamic and recover much faster than economies concentrated in industrial monoculture and anemic entrepreneurial cultures. Even more rapid dynamics after the 2020-2021 COVID-19 pandemic confirmed the finding. Entrepreneurial ecosystem (EE) concept that emerged with Isenberg's (2010) seminal work and that has been subsequently developed by Stam (2015) and Spigel (2017) became the principal framework for analysis of such divergences.

In the absence of single-country studies, cross-sectional designs unable to show the directionality and treating resilience as an unanalyzable, undifferentiated factor, rather than decomposing into resistance and recovery, three limitations characterize the current body of literature on the role of entrepreneurial ecosystems during the crises. We overcome all three by examining the dynamic, multi-country, multi-shock panel of 214 NUTS-2 regions across 22 OECD countries for the period 2004–2022 using three-level hierarchical linear models and Bartik instrumental variables.

2. Theoretical Foundations and Hypotheses

EE theory takes on the mantle from evolutionary economic geography, systems of innovation and complexity theory. Stam (2015) provides the classic structure where a region has frame conditions (institutions, infrastructure, demand) and systemic conditions (networks, finance, human capital, knowledge) that have an effect on outputs leading to welfare. The system consists of four aspects to resilience (Martin and Sunley, 2014) resistance, recovery, re-orientation and renewal. Resistance and recovery is what is being tested in this research

given their empirical attainability. The theoretical justification for EE-resilience relationship is given by inter firm networks that allow for a smoother reallocation of resources post-shock; human capital allowing opportunity to be seized in light of the shock and venture capital allowing for shock-absorbing patient money, and quality of institutions leading to low transaction costs for entrepreneurial activity (North, 1990; Audretsch et al., 2022).

Table 1: Research Hypotheses Summary

Hypothesis	Statement (abbreviated)	Theoretical Grounding
H1	Higher composite EE quality → greater regional shock resistance	EE as adaptive buffer (Stam, 2015)
H2	Higher composite EE quality → faster post-shock recovery	Network recombination; Boschma (2014)
H3	Institutional quality is the dominant EE element for resilience	Transaction cost economics; Audretsch et al. (2022)
H4	Venture capital availability moderates EE–recovery positively	Patient capital; Bertoni et al. (2011)
H5	National regulatory quality amplifies regional EE–resilience (cross-level)	Multi-level governance; OECD (2025)

3. Data and Methodology

The empirical unit is the NUTS-2 region (214 regions, 22 OECD countries, 2004-2022). We construct the EE index as a composite of four sub-indices-quality of institutions (30%), human capital (25%), availability of venture capital (20%), and density of networks (25%)-following Stam (2015) and Iacobucci and Perugini (2021). Real GDP per capita is from Eurostat and OECD Regional Statistics. The baseline estimator is a three-level hierarchical linear model (HLM), where Level 1 is shock-period observations, Level 2 is regions and Level 3 is countries. Endogeneity is handled using a Bartik shift-share IV strategy (all first-stage F-statistics>15). Control variables are industrial diversity (inverse HHI), trade openness, public R&D, regional population and shock-period fixed effects.

4. Empirical Results

4.1 Descriptive Statistics

The composite EE index displays strong regional clustering (SD = 0.87). Scandinavian, Dutch, and German regions fall in the highest quartile, whilst Greek, Southern Italian and Central/Eastern European regions in the lowest. Decomposition of variance indicates 34.7% between-country (Level 3), 41.2% between-region within-country (Level 2) and 24.1% within-region across-shock variance (Level 1) and thus that multi-level modeling is justified.

Table 2: Descriptive Statistics (N = 214 Regions, 428 Shock Observations)

Variable	N	Mean	SD	Min	Max	Skew
Shock Resistance (SD units)	428	0.00	1.00	-3.42	2.87	-0.11
Recovery Speed (years)	428	3.24	2.18	1	12	1.43
EE Index (composite, z-scored)	428	0.00	0.87	-2.31	2.44	0.06
Institutional Quality (z-scored)	428	0.00	1.00	-2.64	2.19	-0.23

Variable	N	Mean	SD	Min	Max	Skew
Human Capital (%)	428	34.7	10.3	12.1	61.4	0.31
Venture Capital (USD pc, log)	428	4.21	1.74	0.00	8.36	0.72
Network Density (z-scored)	428	0.00	1.00	-2.18	3.11	0.54
National Regulatory Quality (z)	428	0.00	1.00	-1.87	1.96	-0.09

Note: Recovery Speed in years; lower = faster recovery. Venture Capital log-transformed before z-scoring.

4.2 Main HLM Results

Both hypotheses H1 and H2 have robust evidence. There are positive effects on resilience with EE composite index (resistance: = 0.31, p<0.01; recovery: = 0.47, p<0.01; on average, 11 months less recovery time at the mean value of 3.24 years). H4 has strong EE VC interaction effects (resistance: =0.11, p<0.05; recovery: =0.16, p<0.05). H5 also holds up, country-level regulation quality strengthensEE effects significantly (resistance: =0.14, p<0.05; recovery: =0.19, p<0.05). Effects of EE quality on shock resistance span from 0.13 SD in countries withlowregulation quality to 0.41 SD in countries with high regulation quality.

Table 3: EE Element Decomposition — Relative Contributions to Regional Resilience

EE Sub-Component	Shock Resistance β	SE	Recovery Speed β	SE	Dominance Rank
Institutional Quality	0.19***	(0.06)	−0.28***	(0.08)	1st
Network Density	0.16***	(0.05)	−0.24***	(0.07)	2nd
Human Capital	0.11**	(0.05)	−0.17**	(0.07)	3rd
Venture Capital Availability	0.09*	(0.05)	−0.13*	(0.07)	4th
F-test (elements equal)	F(3,21) = 4.17**		F(3,21) = 3.88**		—

*Note: All four sub-components entered simultaneously with full control vector. *** p<0.01, ** p<0.05, * p<0.10.*

5. Discussion

There are three theoretical contributions. Firstly,EE impact on resilience exists beyond newly registered firm rate, and implies that EE should be seen as a system level construct, rather than as simply an aggregate of the rates of entrepreneurial activity. Secondly,the cross-level interaction effect between regional quality of EE and national level institutional environment adds value to the multilevel theorising developed by Audretsch et al. (2019): Quality of regional EE development cannot be assessed independently of the national institutional environment. Thirdly, the empirical hierarchy order of EE element's contributions (institutions > networks > human capital > venture capital) gives a first large scale EE component ranking, identifying concrete and more focused directions for theory and policy development.

Direct and practical policy implications can be derived. The dominant role of institutions indicates the importance of streamlining registration of businesses, insolvency, reduction of administrative load. The positive impact of strong network density highlights the value of programs to foster cluster formation, university business liaison centers, and intermediaries for open innovation. The venture capital interaction finding indicates the rationale of national or EU co-investment schemes (e.g., European Investment Fund regional venture capital schemes) to spark private investment into low EE regions which lack capital. The cross-level interaction finding

implies that reforms in the national legal-institutional environment will lead to higher benefits from investments in regional EE development.

6. Conclusions

For the first time, this paper rigorously tests EE-resilience relationships empirically across 214 NUTS-2 regions and two distinct economic shocks in a multi-country multi-shock design. All 5 hypotheses are validated: composite EE quality significantly affects resistance to and speed of recovery from the shocks (H1, H2), institutions constitute the most important factor of EE (H3), venture capital has a positive moderating effect on the EE-recovery relationship (H4), and national quality of regulations boosts the impact of EE at the region level (H5). Policy lessons for promoting economic resilience via investments in EE are twofold: (i) the main components in which policy should invest to build EE resilience are institutions and networks and (ii) the growth of the VC market is an important complementarity and the influence of national quality of regulations on EE must go hand in hand with the strategy of regional EE development. The limitations of the paper lie in the partial use of national variables to approximate some EE sub-indices, the limitation of the analysis on two dimensions of economic resilience, and the assumptions on Bartik IV which might be partially violated if the industries were too concentrated at the national level.

SDG Impact Statement: These findings reinforce SDG 8 (Decent Work and Economic Growth) through their explanation of how quality of institutions, human capital, and density of network support stable jobs and rapid recovery post-crisis; SDG 9 (Industry, Innovation and Infrastructure) through their evidence that innovation systems and inter-firm cooperation reinforce regional resilience; and SDG 11 (Sustainable Cities and Communities) through the implication that resilient development strategies will allow regions to survive crises of the magnitude that have been presented.

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