Drivers and Barriers Shaping Regional Food Systems Innovation: A Quadruple Helix Perspective

Background

Transforming European food systems is essential for achieving the European Green Deal, Food 2030 and climate neutrality objectives. However, innovation across European regions remains constrained by fragmented governance, regulatory complexity, limited investment, uneven technology adoption, insufficient stakeholder collaboration, and persistent skills shortages. These systemic barriers particularly affect SMEs, rural actors and regional innovation ecosystems seeking to accelerate sustainable and circular food system transitions.

Despite increasing policy attention, comparative evidence on how political, economic, social and technological (PEST) factors shape regional food innovation remains limited. Understanding both common European trends and region-specific dynamics is therefore essential for designing effective place-based research and innovation (R&I) policies.

Objective

1. Identify and compare the political, economic, social and technological (PEST) drivers and barriers influencing regional food system transformation across five EU pilot regions.
2. Examine how Quadruple Helix stakeholders perceive innovation challenges, opportunities and governance needs.

Method

- **A structured literature review:** In total 419 documents were analyzed using a PEST framework (political, economic, social, technological) to identify structural obstacles such as regulatory complexity, limited digital capacity, risk aversion, and lack of funding, as well as enabling factors including EU policy alignment, government subsidies, consumer demand for sustainable products, and digital innovation.
- **Semi-structured interviews:** In total 35 semi-structured interviews with Quadruple Helix (QH) stakeholders in the pilot regions and on EU level were carried out and thematically coded, following the overarching PEST dimensions.

Key QH Perspectives in the EU regions

POLAND

CIVIL SOCIETY
- Fragmented governance limits the influence of civil society (e.g. associations, NGOs etc.)
- Administrative complexity constrains small initiatives and communities
- Growing demand for local, ethical food supports sustainability initiatives
- Informal networks and research links enable knowledge sharing

INDUSTRY
- Policies enable innovation infrastructure, but bureaucracy hinders long-term planning
- Rising costs and reliance on foreign capital constrain investment
- Workforce shortages drive education-industry partnerships
- Digitalisation improves efficiency, but high implementation costs remain

ACADEMIA & RESEARCH
- Funding supports research, but regulatory instability limits long-term planning
- Weak intermediaries and short funding cycles hinder knowledge transfer
- Co-creation and lifelong learning strengthen collaboration, but capacity is limited
- Living labs and open data enable innovation, yet access remains uneven

PUBLIC AUTHORITY
- EU strategies provide direction, but compliance burdens and centralised governance limit flexibility
- Administrative complexity restricts SME access to funding and slows innovation diffusion
- Capacity shortages and fragmented stakeholder engagement weaken implementation
- Demonstration projects and peer learning support adoption, but smaller actors lack skills and capital

FINLAND

CIVIL SOCIETY
- Fragmented multi-level governance and limited advocacy capacity
- Economic uncertainty, unstable budgets, and weak market competitiveness
- Misalignment between policy, public perceptions, and agricultural realities
- Limited data access constrains advocacy
- Multi-stakeholder collaboration drives transformation

INDUSTRY
- Entrepreneurship-friendly and green transition policies support innovation, but regulatory complexity and non-uniform standards create operational burdens
- Slow public procurement and bureaucratic funding slow innovation
- New distribution models and partnerships address labour and market shifts
- Digitalisation and automation improve efficiency

ACADEMIA & RESEARCH
- Stable regional collaborations and strong industry ties enable applied, practice-oriented research
- Short-term and fragmented funding complicates long-term planning and limits sustainable SME engagement
- Educational programmes and research networks strengthen innovation capacity and knowledge exchange
- Technology development advances through demonstration projects, but low SME participation remains a bottleneck

PUBLIC AUTHORITY
- EU funding plays a key role in enabling experimentation, digitalisation, and sustainability initiatives
- Fragmented regulations and rigid administrative procedures hinder implementation and small-actor participation
- Workforce shortages and demographic decline, challenge long-term system capacity
- Digital advisory platforms, precision agriculture, and regional innovation projects support optimism around future transition

ITALY

CIVIL SOCIETY
- Smart Specialization Strategies and EU funding, support innovation but R&I gaps remain
- Small firms face high innovation costs, while big organizations pool resources
- Education partnerships support skills and youth entrepreneurship, but shortages persist
- Living labs and innovation networks support transition, though knowledge transfer is uneven

INDUSTRY
- Complex and rigid regulation limits flexibility and alignment with farming realities
- Fragmented governance and weak infrastructure planning reduce climate resilience
- Credit guarantees support investment, but small scale and climate risks deter investors
- Collaboration with universities supports innovation, yet applied testing and continuity remain limited

ACADEMIA & RESEARCH
- Funding timing shapes research, but misalignment with industry persists
- Value-chain collaboration supports applied research, though supply constraints remain
- Multi-actor networks foster knowledge exchange and co-creation
- Project-based technology transfer supports usability, but scaling is limited

PUBLIC AUTHORITY
- EU and regional frameworks support sustainability, but bureaucracy slows implementation
- Public financial instruments enable investment, yet small farms face access barriers
- Coordination networks support dialogue, though workforce challenges persist
- Digital tools and precision farming support innovation, but clarity remains critical

GREECE

CIVIL SOCIETY
- EU and public funding enable sustainable operations, but regulatory rigidity limits scalability
- Bureaucratic delays and reliance on complex networks constrain microfinance flexibility
- NGO–academia collaboration supports skills and knowledge sharing
- Digital and circular innovations enable progress, but gaps in diffusion remain

INDUSTRY
- Policy frameworks support innovation, but regulatory complexity slows SMEs
- Demand for sustainable and AI-driven solutions boosts competitiveness, but costs remain high
- Collaboration supports innovation, yet alignment is limited due to resource constraints
- Digitalisation and emerging technologies drive change, but skills gaps persist

ACADEMIA & RESEARCH
- Public funding supports research, but but long term financial uncertainty hinders market uptake
- TRL gaps limit research commercialization
- Industry collaboration improves research, but bureaucracy constrains impact
- Spin-offs and data sharing support innovation, but transfer capacity is limited

PUBLIC AUTHORITY
- EU and national strategies support transition, but bureaucracy slows adoption
- Investment incentives exist, yet smallholders face access barriers
- Training and trust-building platforms (e.g. living labs) support diffusion, but skills gaps persist
- Precision agriculture and AI enable change, though uptake remains uneven

SPAIN

CIVIL SOCIETY
- Localized EU funding access supports rural innovation
- Rising demand for sustainable and traceable food drives innovation (for microenterprise, SMEs)
- Innovation funding and collaboration enable technological upgrading and viability
- SME funding barriers limit competitiveness and technology uptake

INDUSTRY
- Regulatory and administrative complexity burdens SMEs
- Funding programmes enable investment, but uncertainty and high initial costs limit uptake
- Skills shortages and rural depopulation constrain innovation capacity
- Digital and circular technologies offer potential, but adoption remains uneven

ACADEMIA & RESEARCH
- Aligned EU, national, and regional strategies support research and knowledge transfer
- Administrative fragmentation and regulatory rigidity hinder implementation and collaboration
- Applied research funding enables innovation but lacks long-term continuity
- Living labs and digital platforms support experimentation, though access remains unequal

PUBLIC AUTHORITY
- Centralized governance and limited regional autonomy constrain innovation
- EU policy frameworks provide direction, but regulatory rigidity and compliance burden SMEs
- Public funding and subsidies support modernization, though bureaucratic complexity persist
- Technological infrastructure enables digitalization, but skills gaps and fragmented data governance limit scale-up

Key Results

Cross-cutting barriers:
- Fragmented innovation ecosystems and limited QH stakeholders involvement: limited formal structures to maintain sustained partnership and coordination
- Insufficient support for SME participation, particularly in rural areas
- Regulatory misalignment between EU and national levels
- Skills and technology adoption gaps across stakeholder groups

Cross-cutting enablers:
- Consumer-driven demand for sustainable and traceable food
- Circular economy business models taking root in pilot regions
- Regional innovation platforms and smart specialisation strategies
- Strong commitment to co-creation and inclusive governance models

Conclusions

Regional food system transformation is driven by interactions between governance, economic conditions, social engagement, and technological innovation. While common challenges exist across Europe, regional differences highlight the need for context-specific innovation strategies. Strengthening collaboration among academia, industry, public authorities, and civil society is essential for building resilient and sustainable regional food systems.

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