

JAAN LOOGA

The Role of Small Peripheral Local
Governments in Farm Innovation:
Land Consolidation as a Spatial Planning
Instrument in Estonia



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TABLE OF CONTENTS

LIST OF ABBREVIATIONS	7
LIST OF AUTHOR'S PUBLICATIONS AND CONFERENCE PRESENTATIONS	8
1. INTRODUCTION	9
1.1 Motivation for the research	9
1.2 Research design and the research gap	13
1.3 The structure of the thesis	20
1.4. Brief overview of the studies	21
1.5 Author's contribution to the publications	24
1.6 Acknowledgements	24
2. THEORETICAL BACKGROUND: LAND CONSOLIDATION AS A SPATIAL PLANNING INSTRUMENT ENABLING FARM INNOVATION ACTIVITIES IN PERIPHERAL SMALL LGs	26
2.1 Theoretical framework: innovation activities in agricultural contexts	26
2.2 Farm structure, labour productivity, innovation activities, and land consolidation as an enabling instrument	29
2.3 Path dependency and regional development factors: building the causal chain	36
2.3.1 Path-dependent regional development and the role of small peripheral LGs	36
2.3.2 Path-dependent constraints on small peripheral LG capacity in Estonia	43
3. DATA AND METHODS	50
3.1 Case selection: Estonia as a critical case	50
3.2 Data sources and analytical methods	54
4. EMPIRICAL STUDIES	61
5. DISCUSSION AND CONCLUSION	105
5.1 Summary of the studies	105
5.2 Practical and policy implications for small peripheral LGs	112
5.3 Limitations	119
5.4 Future research	123
5.5 Policy recommendations for small peripheral LGs in Estonia	125
6. ANNEXES	129
Annex 1. Small and peripheral local government role in the land consolidation process drawn from the German experience	131
Annex 2. The definition of land consolidation	133
Annex 3. The theoretical mechanism linking farm structure to labour productivity	134
Annex 4. Regional development theories used in the thesis	136

Annex 5. Estonian small local government intervention actions related to factors from regional development theories	137
Annex 5. Estonian small local government intervention actions related to factors from regional development theories (continued)	139
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital.	140
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital. (continued)	141
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital. (continued)	142
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to cooperation and linkages. (continued)	143
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to competition and economic structure. (continued)	144
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to natural resources and infrastructure. (continued)	145
Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to natural resources and infrastructure. (continued)	146
7. REFERENCES	147
SUMMARY IN ESTONIAN	157
CURRICULUM VITAE	163
ELULOOKIRJELDUS	165

LIST OF ABBREVIATIONS

ARIB	Agricultural Registers and Information Board
CEE	Central and Eastern Europe
CP	Cohesion Policy
ESPO	European Observation Network for Territorial Development and Planning
EU	European Union
GDP	Gross Domestic Product
GIS	Geographic Information System
ICT	Information and Communication Technology
LC	Land Consolidation
LF	Land Fragmentation
LG	Local Governments
NUTS	Nomenclature des unités territoriales statistiques [Classification of Territorial Units for Statistics]
PPS	Purchasing Power Standard
R&D	Research and Development
RIS	Regional Innovation Systems
SME	Small and Medium-sized Enterprises

LIST OF AUTHOR'S PUBLICATIONS AND CONFERENCE PRESENTATIONS

The thesis is based on Study 1, Study 2 and Study 3, listed below:

Papers in peer-reviewed journals

1. **Study 3.** Looga, J., Maasikamäe, S., Rasva, M., Matveev, E., & Jürgenson, E. (2023). Land consolidation as one of the innovation policy instrument for small LGs: The case of Estonian agricultural farms. *Research in Globalization*, 7, 100162.
2. **Study 2.** Looga, J., Jürgenson, E., Sikk, K., Matveev, E., Maasikamäe, S. (2018). Land fragmentation and other determinants of agricultural farm productivity: The case of Estonia. *Land Use Policy*, 79, 285–292. 10.1016/j.landusepol.2018.08.021.
3. **Study 1.** Duba, W., Loewen, B., Looga, J., Zdražil, P. (2018). Regional development in Central-Eastern European countries at the beginning of the 21st century: path dependence and effects of EU Cohesion Policy. *QUAESTIONES GEOGRAPHICAE*, 37(2)
4. Friedrich, P.J, Looga, J. (2016). Public Enterprises in Estonia as Instruments of Foreign Trade Policy. *Estonian Discussions on Economic Policy*, 24 (2), 51–81.
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Conference presentations

1. 03.04.16 – 06.04.16, RSA Annual Conference, Graz, Austria. Building Bridges: Cities and Regions in a Transnational World. Presented articles: Looga, J. Actions for Innovation: How Can Local Government Intervene? Raagmaa, G., Looga, J. Local innovation systems and leadership in a socio-spatial context: the impact of territorial identity, social capital and leadership on innovation performance of economic peripheries
2. 09.10.16 – 13.10.16, Master Class on EU Cohesion Policy, Brussels, Belgium. European Week of Regions and Cities 2016. Presented article: Looga, J. Actions for Innovation: How Can Local Government Intervene?
3. 2.06.21–18.06.21, Regions in Recovery Global E-Festival, RSA. Presented article: Looga, J. Jürgenson, E., Maasikamäe, S., Rasva, M., Matveev, E. Land Consolidation as one of the Innovation Policy Instrument for Small Local Governments: The Case of Estonian Agricultural Farms

1. INTRODUCTION

1.1 Motivation for the research

The economic welfare of the region depends partly on the innovativeness of local firms (Etzkowitz and Ranga, 2015, Asheim and Gertler 2005). Especially in countries with democratic decentralized systems and federal democratic systems, a region depends partly on one or multiple local governments (LGs)¹, which are responsible for local development. Such systems – federal or highly decentralized unitary system – are the focus of this thesis. In these systems, if local firms innovate, then LGs budget increase and it possible to allocate resources² to improve local economic and social conditions. Profit-maximizing firms decide to increase its innovativeness by investing in R&D or devote time to search for new knowledge sources or cooperation partners if the expected revenue of innovation exceeds the costs (Nelson, 1959). The motivation of firms to invest in knowledge production to increase innovativeness is low because of the indivisibility and inappropriability of the revenues and information asymmetry (Nelson, 1959; Arrow, 1962). In addition, it is found that all knowledge production is related to tacit knowledge (Polanyi 2009). This type of knowledge can be viewed as know-how, which cannot be easily codified and diffuses usually within a network or community. Therefore the localised tacit knowledge plays a major role in innovation of firms. Due to these imperfections the knowledge has the properties of a public good², and central and LG intervention is necessary to overcome the regional imbalances of available knowledge providers.

Path-dependent processes, including the globalisation of the economy and various political decisions, have significantly impacted how local economies are structured. The author explored regional development theories, especially the regional innovation system (RIS) approaches, to illustrate how historical technological choices, institutional frameworks, and geographical factors lead to unique path dependencies that shape local economic structures. These path-dependent

¹ This thesis defines local governments (LGs) as the lowest tier of elected government within the state. While the literature uses various terms (rural LGs, rural districts, subnational governments), and RIS approaches typically analyse cities, metropolitan regions, or aggregate units (Doloreux and Parto, 2005), this thesis focuses specifically on small peripheral LGs. LGs are categorized as small if they have fewer than 10,000 inhabitants (Isaksen and Onsager, 2010) and PERIPHERAL according to Tödtling and Trippel's (2005) definition of organizationally thin regions. In Estonia, most LGs meet these criteria (Ministry of Finance, 2018). The Estonian legal framework defines local government as “the right, authority and duty of the democratically formed bodies of power...to independently organise and manage local issues pursuant to law” (Local Government Organisation Act, 2023, § 2-1). This legal definition establishes both the competencies and constraints shaping small peripheral LG capacity to enable innovation activities examined throughout this thesis.

² A public good is characterized by two essential features (Stiglitz, 1999): non-rivalry in consumption – where one person's use of the good does not diminish its availability or value for others; and non-excludability – where it is challenging or impractical to prevent individuals from accessing or benefiting from the good.

processes are crucial in determining which industries thrive in local economies. They also affect how knowledge is diffused, the capacity for innovation, and the level of organisational connectivity. Ultimately, these factors limit the feasible development paths available to smaller local governments (see Annex 4).

For example, neoclassical theories typically emphasize market-driven factor allocation and give limited attention to place-based institutional factors or the role of LGs interventions in enhancing regional productive capabilities and comparative advantages³. Models from this school of thought (Solow, 1956; Swan, 1956) generally operate under assumptions of perfect competition, complete information, and free movement of resources. These assumptions suggest that market forces will automatically work to reduce regional disparities by equalising prices and convergence. However, this view fails to recognise that each region has its historical trajectory, institutional context, and resource availability, leading to ongoing differences and path dependencies. In addition, institutional frameworks, and resource endowments create persistent differences and path dependencies.

The uneven distribution of productive resources across regions, including LG units, often goes unnoticed by economists in various fields. Neoclassical theories assume that technology-information diffuses freely, costlessly and evenly throughout the economy, with firms having equal capabilities to incorporate technologies regardless of location (Laranja et al. 2008). In this view, space and location are treated as irrelevant to innovation outcomes, as economic growth is assumed to take place in a 'neutral' space with no regard to regional preconditions or specific contexts. The intangible assets and institutional characteristics that distinguish one location from another are not considered in neoclassical frameworks (Capello, 2016). Recent approaches challenge this aspatial view. For example, regional innovation systems (RIS), place-based development, and evolutionary-structuralist approach all argue that interventions for local firm innovations must be tailored to specific locations with their unique institutional and economic characteristics. Interestingly, these peripheral regions sometimes retain traditional technical and production knowledge and other local assets, which have declined in more urbanized settings. This preserved knowledge can present opportunities for developing unique and specialized products when integrated with modern technologies and market strategies.

Nevertheless, the primary challenge remains the geographical isolation of these firms. The transfer of tacit knowledge relies heavily on frequent face-to-face interactions (Polanyi, 2009) among representatives from firms, research and development (R&D) institutions, or universities. In peripheral areas, such interactions often occur within a limited network of actors, as essential knowledge providers like universities, R&D facilities, and larger companies are generally absent. Small peripheral LGs are crucial in supporting innovation infrastructure, which consists of three elements according to regional innovation systems (RIS)

³ While international trade theories such as the Heckscher-Ohlin model explain comparative advantage based on factor endowments, this thesis does not focus on international trade patterns but rather on endogenous regional development.

research (Doloreux and Dionne, 2008; Andersson and Karlsson, 2002): science parks for new industrial ventures, higher education systems that offer scientific expertise and training, and small peripheral LG bodies that promote local firm innovation. In peripheral spaces where science parks and universities are lacking, the role of small peripheral LGs becomes even more significant.

This situation leads to the central research question of this thesis: given that small peripheral LGs are often the only remaining support for innovation infrastructure in these regions – where the other two key components (universities and science parks) are largely absent – it is crucial to explore how they can enhance effectiveness through targeted practical interventions that address the innovation gap and strengthen local firm competitiveness despite geographical and resource challenges. To tackle inefficiencies related to their local resources, small peripheral LGs should implement innovation policies (Barca, 2009) to maximize their production potential and drive economic growth. At the same time, knowledge development is vital but not the sole factor affecting local firms' innovation ability. The place-based development approach⁴ (Barca, 2009) advocates that small peripheral LGs should aim to mitigate persistent inefficiencies – stemming from underutilization of resources that result in suboptimal income – and combat social exclusion, which often manifests through a high number of individuals living below established well-being standards. For small peripheral LGs to enable firm innovation activities, it is essential to comprehend the local resources at their disposal and find ways to enhance their efficiency through these innovations.

Inefficiencies can manifest differently within small peripheral LG areas, hindering local firms' ability to innovate. It affects local businesses if these governments do not effectively carry out their key functions – such as infrastructure development, land planning, and social services. For instance, without adequate infrastructure like local roads, companies may have trouble obtaining essential resources, such as water needed for building hydroelectric power stations. Furthermore, sound land planning by small peripheral LGs is vital to enable local businesses to use land efficiently.

From the viewpoint of the evolutionary-structuralist framework (Nelson and Winter, 1982, 1977), there are valuable recommendations for small local governments. They need to tackle not just market failures (as noted by Laranja et al., 2008), but also the impacts of path-dependent processes discussed previously. Local governments should strive to overcome situations where they feel locked in, reform technological setups, and diversify the economic sectors within their jurisdictions through various practical interventions. These path-dependent processes have a considerable influence on the local economy, including the scale of local firms, the variety of sectors, and the degree of globalization among these entities.

In more remote areas, small and medium-sized enterprises (SMEs) usually take the lead, often prioritizing process innovations over heavy investments in

⁴ Location theories (see Annex 4) and other static theories help to explain why small peripheral LGs have challenges regarding local firms' innovativeness and productivity, and the thesis focuses on what small peripheral LGs can do despite locational disadvantages.

research and development. The focus should be on boosting knowledge transfer among local firms and on enhancing networking opportunities with external clusters and knowledge providers. For local governments aiming to encourage innovation, it is important to expand their focus beyond just their basic responsibilities.

When creating interventions to enable local firm innovation activities, this thesis draws on criteria from the Estonian legal framework related to both central and local governance, as well as examining the economic investments of small peripheral LGs – including their reliance on EU funding, budgets, development strategies, and policy documentation (as referenced in Looga, 2016). Local governments ought to seek methods to improve local firms' access to international supply networks and distribution systems while also promoting the diffusion of tacit knowledge within the community. These kinds of initiatives can heighten demand for local products and set the stage for both process and product innovations. Notably, businesses situated in remote areas often have specialized expertise related to certain production processes, developed with support from both local and external networks.

The RIS approach is not operational (Komninaki, 2015) because it primarily provides a descriptive framework for understanding RIS but fails to offer concrete, actionable guidance on how small peripheral LGs, particularly those situated in peripheral (and organizationally "thin") regions where RIS components are absent or underdeveloped, can effectively create conditions enabling firm innovation adoption within their resource constraints and institutional limitations. It is necessary to conduct an explorative study to provide possible interventions for small peripheral LGs, which this thesis aims to do. Organisational thinness was described as an innovation system where some supporting infrastructure elements are missing, the networks are not developed, and geographical isolation exists. Small peripheral LGs are the only supporting element that can intervene, which has challenges considering their functions, resources, and path dependency (see chapter 2.3), making it essential to understand how they can foster innovation despite operating in an incomplete and resource-constrained innovation ecosystem.

While the theoretical arguments above apply broadly to local firms across sectors, this thesis focuses empirically on agricultural farms in peripheral regions for several reasons. First, agriculture remains the dominant economic activity in peripheral LGs in Central and Eastern European (CEE) countries (Copus and Noguera, 2010) where other innovation infrastructure (universities, science parks) is absent – making farms the primary private sector actors that small peripheral LGs can influence. Second, spatial planning (land consolidation) is a well-established policy instrument with clear legal frameworks, making it an ideal test case for examining how small peripheral LGs can enable local farm innovation activities within their existing competencies. Third, Estonian agriculture faces severe post-socialist land fragmentation, creating spatial constraints that clearly hinder innovation adoption – providing a context where small peripheral LG spatial intervention can demonstrably affect innovation outcomes. Thus, while

the RIS framework and path dependency concepts apply generally, farms provide the empirically tractable case for investigating small peripheral LG roles in innovation processes.

1.2 Research design and the research gap

The aim of this thesis is to examine whether and how small peripheral local governments in Estonia can enable farm innovation activities and labour productivity improvements through spatial planning interventions, specifically land consolidation, despite operating in organizationally thin regional innovation systems with limited institutional capacity and in the absence of traditional innovation infrastructure.

To achieve this aim, the following research question and subquestions were formulated:

Research question:

How can small peripheral local governments in Estonia enable farm innovation activity and labour productivity through spatial planning interventions in organizationally thin regional innovation systems?

Sub-questions:

- To what extent does EU Cohesion Policy (CP) enable CEE countries (including Estonia) to overcome historical development patterns and promote innovation, and how do national CP allocation decisions affect small peripheral local government capacity to implement spatial planning interventions?
- What is the relationship between farm spatial structure and farm labour productivity in Estonia's post-socialist fragmented land tenure contexts, and can small peripheral local governments influence this relationship through land consolidation as a spatial planning intervention?
- Does improved farm spatial structure increase the probability of farm-level innovation activities in Estonia, and can small peripheral local government-initiated land consolidation create spatial prerequisites enabling innovation adoption?

The theoretical framework of the thesis is presented in Figure 1 below. This figure establishes the causal logic underlying this thesis: how path-dependent historical processes (Section 2.3, Study 1) constrain the options for small peripheral local governments to enable local farm innovation activities, necessitating alternative instruments like land consolidation (Section 2.2, Study 2/3) that operate within existing LG competencies rather than requiring absent RIS elements. The framework flows from left to right, demonstrating how historical lock-in creates organizational thinness (peripheral RIS in Section 2.3.1), which produces specific small peripheral LG constraints (limited fiscal autonomy and centralized innovation policy, discussed in Sections 1.1 and 3.1, respectively), thereby narrowing policy choices to the four regional development factors (Section 2.2)

that small peripheral LGs can actually influence: knowledge and human capital, cooperation and linkages, competition and economic structure, and natural resources and infrastructure. Land consolidation interventions, operating through Hall's (1993) policy change orders (Section 2.3.1), enable local farm outcomes (productivity improvements, innovation activities, and the causal relationship in Section 2.2 and Study 2/Study 3) that feed back to enhance regional development and small peripheral LG budget capacity, potentially breaking path dependency through cumulative positive feedback loops.

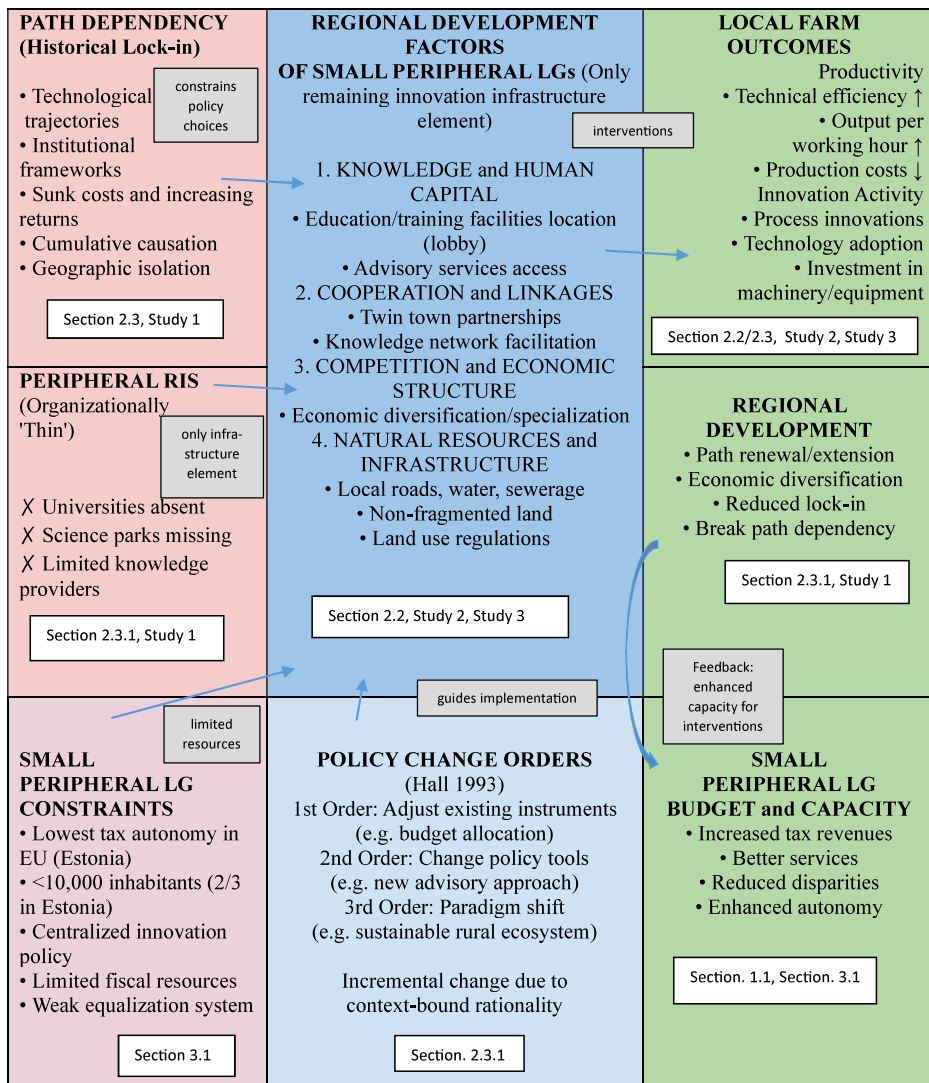


Figure 1. Conceptual framework: Land consolidation as a spatial planning instrument enabling farm innovation activities in peripheral small LGs. Author's compilation.

Collectively, the three studies trace the complete causal chain specified in the theoretical framework (Figure 1). Study 1 examines whether external policy interventions (EU Cohesion Policy) can enable CEE regions to overcome path-dependent development patterns through beta-convergence analysis and examination of CP allocation patterns across thematic objectives. This macro-level analysis establishes how path dependency and peripheral RIS characteristics constrain small peripheral LG implementation capacity – the context within which Studies 2 and 3 operate.

Study 2 establishes the empirical mechanism linking farm spatial structure (small peripheral LG-controllable through land consolidation as a spatial planning intervention) to farm productivity through regression analysis, demonstrating whether spatial reorganization measurably affects technical efficiency and output per working hour. Study 3 tests whether this spatial intervention translates into enhanced probability of farm innovation activities through panel data analysis with fixed effects, examining land consolidation as a viable practical intervention for small peripheral LGs operating in organizationally thin peripheral regions. Together, Studies 2 and 3 help to understand whether land consolidation addresses multiple regional development factors simultaneously: natural resources and infrastructure (consolidated spatial organization), knowledge and human capital (improved absorptive capacity), cooperation and linkages (multi-stakeholder planning processes), and competition and economic structure (different economic sectors competing for available land).

The framework specifies a feedback loop whereby improved farm outcomes generate increased small peripheral LG tax revenues and enhanced implementation capacity, enabling higher-order policy changes (Hall, 1993). This feedback mechanism – essential for achieving third-order paradigm shifts necessary to break path dependency – remains theoretically specified but empirically untested, representing a critical direction for future research on whether cumulative positive effects can enable peripheral small LGs to overcome organizational thinness constraints.

The research gap addressed by this thesis emerges from three deficiencies in the existing literature. First, while RIS theory extensively documents innovation infrastructure requirements – universities, research institutions, science parks, and intermediary organizations (Cooke et al., 1997; Asheim and Gertler, 2005) – these frameworks assume institutional presence, rendering them inapplicable to organizationally thin peripheral regions where such elements are systematically absent (Tödting and Trippel, 2005). Existing RIS literature on LG roles focuses predominantly on cluster facilitation, networking, and R&D coordination (Benneworth and Dassen, 2011; Isaksen and Onsager, 2010), implicitly assuming fiscal capacity and institutional sophistication that resource-constrained small peripheral LGs lack – particularly acute in post-socialist CEE contexts where municipal autonomy remains limited (Dąbrowski, 2014; Swianiewicz, 2014). Study 1’s CEE comparison contextualizes whether Estonia’s CP allocation patterns represent regional norms or country-specific choices, establishing whether findings hold broader post-socialist relevance. Second, CP literature examines

funding effectiveness (Barca, 2009; Rodríguez-Pose and Garcilazo, 2015) but rarely analyses whether CP enables peripheral regions to overcome path-dependent constraints, particularly examining capacity building versus infrastructure investment trade-offs in organizationally thin contexts, which Fratesi and Wislade (2017) identify as under-researched. Third, while land fragmentation's productivity impacts are documented (Rahman and Rahman, 2008; Latruffe and Piet, 2014), research examining which fragmentation dimensions small peripheral LGs can influence through spatial planning interventions remains limited, and existing indices inadequately capture post-socialist restitution patterns (Demetriou et al., 2013; Hartvigsen, 2014). Furthermore, literature examining whether local government spatial planning authority can enable innovation activities in the absence of traditional RIS infrastructure remains scarce. Tödting and Tripl (2005) explicitly note that “policy recommendations for peripheries often assume institutional capacities that do not exist.” This thesis addresses these gaps through three empirical studies examining how small peripheral LGs in Estonia – characterized by organizational thinness, fiscal constraints (lowest tax autonomy in EU; Dąbrowski, 2014), and path-dependent land fragmentation (Hartvigsen, 2014) – can enable farm innovation activities through spatial planning interventions (land consolidation) operating within existing legal competencies.

The research gap addressed by this thesis centres on the absence of practical innovation policy instruments for small peripheral LGs within standard RIS frameworks, focusing on the case of Estonia (see the reasoning in Section 3.1). While RIS theory identifies small peripheral LGs as crucial innovation infrastructure elements, it fails to operationalize how these entities can effectively function when other system components – universities, research institutions, science parks – remain systematically absent due to path-dependent constraints. This “organizational thinness” creates fundamental implementation challenges in peripheral areas where tacit knowledge diffusion is limited by geographic isolation and where the fiscal capacity of small peripheral LGs cannot substitute for missing institutional elements through direct R&D investments or science park construction.

Table 1 below provides a short overview of the studies included in this thesis.

Table 1. Overview of the studies included in this thesis.

Study	Aim	Research Question	Literature Gap Addressed	Contribution
<p>Study 1. Duba, W., Loewen, B., Looga, J., Zdražil, P. (2018). Regional development in Central-Eastern European countries at the beginning of the 21st century: path dependence and effects of EU Cohesion Policy</p>	<p>Investigate whether EU CP 2007–2013 enabled CEE regions to overcome path-dependent development patterns through strategic funding allocation</p>	<p>To what extent does CP enable CEE countries (including Estonia) to overcome historical development patterns and promote innovation?</p>	<p>While CP literature examines funding effectiveness (Barca, 2009; Rodríguez-Pose and Garcilazo, 2015), few studies analyse whether CP enables peripheral regions to overcome path-dependent constraints, particularly examining capacity building versus infrastructure investment trade-offs in organizationally thin contexts (Fratesi and Wishlade, 2017)</p>	<p>Beta-convergence analysis demonstrates that EU CP contributes to CEE regional convergence, yet CP allocation patterns reveal critical structural imbalance: Estonia allocated 19% to Innovation and R&D (highest among CEE countries) but only 2% to capacity building (lowest in CEE). This creates abundant national innovation supply while severely under-resourcing the institutional capacity of small peripheral LGs needed to implement spatial planning interventions enabling farm-level innovation adoption.</p>
<p>Study 2. Looga, J., Jürgenson, E., Sikk, K., Matveev, E., Maasikamäe, S. (2018). Land fragmentation and other determinants of agricultural farm productivity: The case of Estonia.</p>	<p>Identify which farm productivity factors small peripheral LGs can influence through spatial planning interventions in post-socialist fragmented land tenure contexts</p>	<p>What is the relationship between farm spatial structure and agricultural productivity in post-socialist fragmented land tenure contexts?</p>	<p>Agricultural economics literature documents the productivity impacts of land fragmentation (Rahman and Rahman, 2008; Latruffe and Piet, 2014) but rarely distinguishes fragmentation dimensions amenable to LG spatial planning interventions versus farm-level solutions; existing indices inadequately capture post-socialist restitution patterns (Demetriou et al., 2013; Hartvigsen, 2014)</p>	<p>Cross-sectional regression analysis develops area-weighted mean size of parcels metric capturing Estonian plot-by-plot restitution patterns; demonstrates that spatial configuration significantly influences productivity controlling for capital and labour, validating natural resources and infrastructure as a feasible domain for small peripheral LG intervention</p>

Table 1 (continued). Overview of the studies included in this thesis.

Study	Aim	Research Question	Literature Gap Addressed	Contribution
<p>Study 3. Looga, J., Maasikamäe, S., Rasva, M., Matveev, E., & Jürgenson, E. (2023). Land consolidation as one of the innovation policy instrument for small LGs: The case of Estonian agricultural farms.</p>	<p>Test whether small peripheral LG-initiated LC (spatial planning intervention) increases farm innovation activities probability in organizationally thin RIS</p>	<p>Does improved farm spatial structure increase the probability of farm-level innovation activities?</p>	<p>Literature examining whether local government spatial planning authority can enable innovation activities in the absence of traditional RIS infrastructure remains scarce; Tödtling and Trippel (2005, p. 1203) note that “policy recommendations for peripheries often assume institutional capacities that do not exist”</p>	<p>Panel data fixed-effects logistic regression validates land consolidation as an effective spatial planning instrument: improved farm structure increases the probability of farm innovation activities; establishes dual-pathway mechanism (productivity → capital; spatial prerequisites → technology feasibility); and reveals tenure effects</p>

Source: based on Studies 1–3.

Study 1 addresses the initial research gap by exploring developmental trajectories of Central and Eastern European regions, analysing whether EU Cohesion Policy 2007–2013 enabled regions to overcome path-dependent historical patterns or reinforced existing development trajectories. The study employs beta-convergence analysis to examine GDP per capita growth patterns across CEE NUTS II regions, testing whether economically lagging regions grew faster than more developed regions during the programming period.

To examine whether CP effects vary across different types of regions, the analysis applies k-means clustering to development indicators – gross fixed capital formation (GFCF), employment (EMP), participation in education and training (PET), and business and non-business R&D expenditures (GERB, GERN) – identifying distinct regional development patterns. This clustering approach allows examination of whether regions with similar development trajectories respond differently to CP interventions. Spearman correlation analysis then tests relationships between CP expenditures per capita and changes in development indicators within each identified regional cluster, revealing whether CP funding correlates with improvements in traditional economic factors (capital, labour) versus knowledge-based factors (education, R&D).

The analysis examines CP allocation patterns across thematic objectives at the country level, comparing how CEE countries prioritized different development factors through funding distribution. This examination of differential resource allocation – particularly comparing Innovation and R&D investments versus capacity building investments – establishes the macro-level policy environment affecting small peripheral LG capacity to implement spatial planning interventions. The study thus provides contextual understanding of how national CP allocation decisions create enabling or constraining conditions for local-level implementation capacity that Studies 2 and 3 examine through farm-level land consolidation interventions.

Study 2 tackles the theoretical limitation of neoclassical productivity approaches that cannot adequately address path-dependent lock-in situations constraining local farm performance in peripheral regions. By investigating land fragmentation and other determinants of Estonian agricultural farm productivity at the micro-level, this study identifies which factors small peripheral LGs can realistically influence given their constrained fiscal autonomy and limited regulatory authority. The study's development of a new land fragmentation index contributes methodologically by capturing the unique spatial distribution of Estonian farm parcels resulting from 1990s plot-by-plot restitution, demonstrating empirically that local spatial factors – particularly parcel configuration, accessibility, and shape regularity – significantly influence productivity even when controlling for traditional production function variables (capital, labour). This validates the framework's emphasis on natural resources and infrastructure (Section 2.3, factor 4) as a feasible intervention domain: small peripheral LGs cannot create universities or science parks, but they possess legal authority over land consolidation, local roads, and spatial planning that directly affects farm structure and thereby productivity.

The theoretical mechanism linking farm structure to labour productivity operates through multiple channels: fragmentation increases transaction costs (plot-to-plot travel time), irregular shapes constrain technical efficiency in machinery use, and poor accessibility limits technology adoption. These spatial inefficiencies directly reduce output per working hour – the key productivity measure for labour-constrained peripheral regions (see Annex 3 for the theoretical mechanism linking farm structure to labour productivity and definitions of productivity used in this thesis).

Study 3 explores the critical link between small peripheral LG-initiated spatial interventions and farm-level innovation activities, testing whether land consolidation – operating as a second-order policy instrument change in Hall’s (1993) framework – affects the probability of farms undertaking innovation activities (technology adoption, machinery investments). The study examines whether changes in farm structure create framework conditions enabling innovation activities, even when small peripheral LGs cannot directly influence innovation outcomes through traditional instruments like R&D grants, university-industry collaboration programmes, or technology transfer offices. The empirical analysis tests whether better farm structure demonstrates higher innovation activity probabilities, thereby validating land consolidation as a practical intervention that operates through enabling activities rather than determining outcomes – consistent with the framework’s distinction between small peripheral LG influence on framework conditions versus farmer decisions about actual innovation investments.

1.3 The structure of the thesis

The research aim is to examine whether and how small peripheral local governments in Estonia can enable farm innovation activities and productivity improvements through spatial planning interventions, specifically land consolidation, despite operating in organizationally thin regional innovation systems with limited institutional capacity and in the absence of traditional innovation infrastructure.

Research tasks:

1. Establish theoretical foundations for land consolidation as a spatial planning instrument enabling farm innovation in peripheral contexts (Chapter 2)
2. Describe methodological approaches and empirical context across three complementary studies (Chapter 3)
3. Present empirical evidence on: (Study 1) EU Cohesion Policy’s role in addressing path-dependent constraints; (Study 2) farm spatial structure-productivity relationships; and (Study 3) spatial structure effects on innovation activities (Chapter 4)
4. Synthesize findings and articulate theoretical and empirical contributions (Sections 5.1, 5.2)

5. Acknowledge limitations and propose future research directions (Section 5.3)
6. Derive policy recommendations for small peripheral LGs (Section 5.5)

1.4. Brief overview of the studies

This section provides a brief overview of the studies included in the empirical chapter of this thesis (Chapter 4). See Table 1 (pp. 17–18) for details about the aim, research question, literature gap and contribution of each study.

Study 1, “Regional development in Central-Eastern European Countries at the beginning of the 21st century: Path dependence and effects of EU Cohesion Policy”, is included in this thesis to investigate whether EU Cohesion Policy 2007–2013 offered CEE countries mechanisms to deviate from their predetermined historical development patterns and whether the developmental effects varied across different CEE regions. The study carried out Beta-convergence analysis and k-means clustering procedure on NUTS II level regional data across ten CEE countries (53 regions, excluding outliers) to examine economic convergence patterns and the connections between EU Cohesion Policy expenditures and relevant socio-economic indicators including gross fixed capital formation, employment, participation in education and training, and gross expenditure on research and development. This approach addresses the regional-level context of path-dependent development trajectories to provide a comparison of aggregate effects across CEE regions with different historical legacies stemming from socialist industrialization and imperial pasts. Study 1 serves an essential role in the context of this thesis – to demonstrate that while CEE regions achieved economic convergence toward EU-15 levels between 2007–2014, the effects of cohesion policy differed significantly across region types, with EU funding showing positive correlations with business sector R&D expenditures but mixed results for traditional growth factors. The study contributes to understanding that Estonia allocated the highest percentage among CEE countries to “Innovation and R&D” thematic objective, but simultaneously allocated the lowest percentages to “capacity building” and the “urban and territorial dimension”, creating a potential imbalance where small peripheral LGs lack the institutional capacity to effectively implement practical interventions despite strong national commitment to R&D advancement. The findings have practical implications for demonstrating that external funding alone cannot overcome path-dependent constraints without building local government capacity, and that slower-developing regions (like Estonia) showed innovation potential strongly influenced by EU funding levels but paradoxically received less CP support, indicating untapped potential if small peripheral LGs can access targeted support and develop stronger capacity-building mechanisms.

Study 2, “Land fragmentation and other determinants of agricultural farm productivity: The case of Estonia”, is included in this thesis to investigate whether land fragmentation has an impact on farm productivity. The study analysed the relationship between farm spatial structure and labour productivity measured as

output per working hour in Estonian agriculture. Previous studies have shown mixed results regarding productivity effects of land fragmentation – some demonstrating substantial efficiency losses from parcel dispersion, with others observing minimal or even positive effects depending on measurement approaches and contexts. Given that farm structure represents a framework condition that small peripheral LGs can influence through land consolidation within their spatial planning competencies, the study addresses an important gap by developing a comprehensive fragmentation measure appropriate for the Estonian post-socialist context. The chosen method for Study 2 was regression analysis combining farm-level data from the Farm Accountancy Data Network and the Estonian Agricultural Registers and Information Board for 435 Estonian agricultural holdings in 2015. The study examined whether land fragmentation measured by the Januszewski index affects labour productivity, whether a new indicator – area-weighted mean size of parcels – better captures farm structure effects, and whether farm characteristics (size, production type, farmer education) significantly influence productivity across different farm size categories. The evidence provided in the study shows that labour productivity was substantially affected by the area-weighted mean size of parcels, which proved to be a statistically significant determinant of farm productivity even when controlling for traditional production factors. The study found a U-shaped relationship between the Januszewski fragmentation index and productivity – both larger farms with many scattered parcels and smaller farms with few consolidated parcels could be productive, but the area-weighted mean parcel size indicator provided superior explanatory power for productivity differences. Agricultural training and conventional production type were found to increase productivity significantly, while organic production showed lower productivity levels. The fragmentation effect remained significant in multivariate regression models. Therefore, the study contributes to understanding farm structure as a critical regional precondition for productivity improvements and provides small peripheral LGs with a concrete target variable (area-weighted mean size of parcels) for land consolidation interventions aimed at productivity enhancement. The findings emphasize the importance of coordination between local and central authorities within the regional innovation system, particularly regarding educational initiatives and EU structural funds implementation, and they indicate that small peripheral LGs should consider commodity-specific approaches when supporting innovation through land consolidation since productivity varies significantly across different production types.

Study 3, “Land consolidation as one of the innovation policy instrument for small LGs: The case of Estonian agricultural farms”, is included in this thesis to investigate whether changes in farm structure impact the probability of implementing innovation activity. Innovation activities and technology upgrading are essential to agricultural competitiveness and rural economic development, but the causal mechanism linking improved farm structure through land consolidation to innovation activity enablement remains theoretically under-specified and empirically unclear, particularly for small peripheral LGs lacking conventional

innovation policy instruments in organizationally thin peripheral contexts. Study 3 addresses whether farm structure improvements can enable innovation in environments where traditional RIS elements (universities, research institutions, science parks) are systematically absent. The chosen method for Study 3 was panel data econometric analysis using a fixed-effects regression model with 392 Estonian farms over six years (2014–2019) to examine the relationship between farm structure measured by the area-weighted mean size of parcels and the probability of undertaking innovation activities while controlling for time-invariant farm characteristics and temporal variation. The study examined whether improved farm structure increases innovation activity probability, how farm characteristics (size, production type, manager education) influence this relationship, and whether productivity levels affect innovation activity. The evidence provided in the study shows that farm structure significantly impacts innovation activity – farms with better spatial structure (their area-weighted mean parcel size has increased) demonstrated substantially higher probabilities of undertaking innovation activities.

The study also found that productivity per working hour significantly influenced innovation activity, suggesting that enhancing farm labour productivity should be central to small peripheral LG strategies, while previous capital investments and employment numbers also impacted innovation probability. The relationship operated through enabling activities – improved farm structure removed spatial constraints that would otherwise prevent technology adoption and process improvements – rather than determining specific innovation outcomes, consistent with the distinction between small peripheral LG influence on framework conditions versus farmer autonomy over investment decisions. Therefore, the study contributes to understanding land consolidation as a viable practical intervention for small peripheral LGs – one that builds on existing spatial planning competencies and requires minimal or no involvement from universities or research institutions. The findings demonstrate that small peripheral LGs can strategically influence agricultural development through land consolidation projects that create farm structures more conducive to innovation, reducing operational costs, facilitating energy-efficient machinery adoption, and protecting agricultural land from fragmentation. The study suggests small Estonian small peripheral LGs can draw inspiration from Western European multi-purpose land consolidation practices that balance agricultural productivity with environmental protection through Environmental Impact Assessments, allowing small peripheral LGs to foster farm innovation activity while addressing sustainability goals and concerns like food security in the face of climate change and geopolitical challenges.

1.5 Author's contribution to the publications

Study 1 was co-authored with three researchers. Wojciech Dyba coordinated the paper and formulated the conclusions. Jaan Looga contributed the part on EU Cohesion Policy. Bradley Loewen contributed the section on path dependence and the historical context of regional development in CEECs and contributed to the conceptualization and argumentation of the paper. Pavel Zdražil contributed the econometric analysis.

The leading author of Study 2 and Study 3 is Jaan Looga, who coordinated the paper (conceptualization, methodology, formal analysis, writing original draft), and colleagues from the Estonian University of Life Sciences (Evelin Jürgenson, Siim Maasikamäe, Kristiin Sikk, Marii Rasva, and Eduard Matveev) contributed the section on land consolidation and the analyses of land fragmentation indexes (data investigation, data curation, review of the draft).

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2. THEORETICAL BACKGROUND: LAND CONSOLIDATION AS A SPATIAL PLANNING INSTRUMENT ENABLING FARM INNOVATION ACTIVITIES IN PERIPHERAL SMALL LGs

2.1 Theoretical framework: innovation activities in agricultural contexts

This section introduces the integrated theoretical framework that Chapter 2 develops across multiple sections, positioning land consolidation as a practical intervention for small peripheral local governments. The framework addresses a critical gap in innovation policy literature: how can small peripheral local governments with limited fiscal capacity, centralized innovation policy, and without traditional innovation infrastructure (universities, science parks, research institutions) nonetheless create conditions enabling agricultural innovation?

This framework emerges from a specific historical-institutional context: small peripheral LGs in post-socialist CEE countries facing severe path-dependent constraints. Section 2.3 demonstrates how historical processes – 1990s land reforms creating extreme fragmentation, weakened planning systems from transition-era institutional disruption, and organizational thinness from peripheral location – created conditions where traditional innovation policies (university-industry linkages, R&D grants, technology transfer offices) remain structurally infeasible, necessitating the alternative approach developed in this thesis.

The framework integrates four theoretical streams. First, the agricultural innovation systems (AIS) concept (OECD, 2013; Klerkx et al., 2012) broadens innovation beyond R&D to include organizational, marketing, and institutional innovations, recognizing that agricultural innovation occurs within complex systems involving multiple actors and framework conditions. Second, the perspective of systemic innovation policy instruments (Edquist, 2001; Smits and Kuhlmann, 2004) establishes that regulations and resource access serve as critical innovation enablers, revealing that small peripheral LGs possess intervention capacity through land-use planning, spatial resource allocation, and infrastructure provision even without direct R&D investment capability. Third, Schumpeter's (1934) innovation typology operationalized through the Oslo Manual (OECD and Eurostat, 2018) provides the conceptual foundation for measuring innovation activities across product, process, organizational, and marketing dimensions. Fourth, Hall's (1993) policy change orders framework (detailed in Section 2.2) provides an implementation pathway distinguishing first-order adjustments, second-order instrument changes, and third-order paradigm shifts.

Critically, the framework distinguishes between innovation outcomes (actual new or improved products, processes, methods successfully implemented) and innovation activities (developmental, financial, and commercial steps intended to result in innovation, regardless of immediate success). This distinction is funda-

mental to understanding small peripheral LG innovation policy capacity: small peripheral LGs cannot directly produce innovation outcomes – these emerge from entrepreneurial decisions at the farm level. What small peripheral LGs can influence is the propensity and capacity for innovation activities by creating spatial prerequisites, physical infrastructure, and organizational support enabling farmers to attempt innovation through investments and experimentation.

The Oslo Manual (OECD/Eurostat, 2018) defines innovation activities as “the developmental, financial, and commercial steps undertaken that are intended to result in innovation, even if they do not always succeed” (p. 68), including machinery acquisition, training, and market introduction preparations – investments representing firms’ innovation efforts regardless of immediate outcomes (Eurostat, 2019). This distinction, rooted in Schumpeter’s (1934) conceptualization of innovation as entrepreneurial experimentation preceding market introduction, has methodological implications operationalized through the Community Innovation Survey (CIS).

Agricultural innovation differs fundamentally from manufacturing in being predominantly incremental and technology adoption-driven rather than R&D-intensive (OECD, 2013). The Oslo Manual explicitly recognizes that “innovation activities vary across sectors and may emphasize equipment acquisition over formal R&D in traditional industries” (OECD/Eurostat, 2018, p. 72). In agriculture, purchasing modern machinery, investing in buildings and equipment, and acquiring improved production technologies represent the primary measurable forms of innovation activity – tangible efforts embodying farmers’ attempts to implement Schumpeter’s “new combinations.”

Innovation types in agricultural contexts encompass four categories. Process innovations involve adopting new production methods improving efficiency – for example, precision agriculture techniques such as GPS-guided variable-rate fertilizer application becoming viable when consolidated field sizes exceed minimum thresholds (Rose et al., 2021). Product innovations entail introducing new or significantly improved goods requiring specialized production conditions – organic producers requiring consolidated parcels with buffer zones to prevent contamination (Sutherland et al., 2022). Organizational innovations involve new business practices enhancing firm performance – consolidated farms participating in producer cooperatives for joint machinery ownership or pursuing vertical integration with on-farm processing facilities (Klerkx et al., 2012). Marketing innovations encompass new methods for product promotion – consolidated farms establishing direct-to-consumer sales channels requiring accessible parcels (Knickel et al., 2009).

This thesis adapts the Oslo Manual’s innovation activity framework to agricultural contexts by operationalizing innovation activity through farm investment in buildings, machinery, equipment, and inventory (Study 3), capturing tangible innovation efforts consistent with the Oslo Manual’s sector-specific guidance.

This framework positions small peripheral LGs as innovation activity enablers operating through spatial planning competencies. Agricultural innovation policy remains a primarily EU and national competence through Common Agricultural

Policy (CAP) and national R&D programmes (European Commission, 2021). The complementary roles operate as follows: CAP and national programmes design what innovations are available (new crop varieties, precision agriculture technologies, organic certification schemes), while small peripheral LGs influence whether local farms can physically adopt these innovations through spatial planning and infrastructure provision within multi-level governance structures.

The causal mechanisms linking farm structure to productivity and innovation are detailed in Section 2.2, which establishes the dual-pathway relationship through which land consolidation operates. Section 2.2 also examines land consolidation as the specific spatial planning instrument available to small peripheral LGs, analysing the three regulatory mechanisms through which it reduces barriers to farm-level innovation investments. Section 2.3 positions this framework within the path dependency literature, demonstrating how historical processes created the constraints necessitating this alternative approach and deriving the four regional development factors that small peripheral LGs can influence. Section 3.1 applies the framework to Estonia as a critical case, demonstrating how extreme contextual conditions validate the theoretical mechanisms under most stringent test conditions.

Path dependency analysis (detailed in Section 2.3) reveals that historical processes constrain small peripheral LG policy choices by determining which development factors they can realistically influence. From systematic analysis of regional development theories and Estonian legal frameworks (see Annexes 4–6), four regional development factors emerge as domains where small peripheral LGs retain intervention capacity despite organizational thinness and fiscal constraints: (1) knowledge and human capital (education/training facilities location, advisory services access); (2) cooperation and linkages (twin town partnerships, knowledge network facilitation); (3) competition and economic structure (land use regulations, fair competition frameworks); and (4) natural resources and infrastructure (local roads, water/sewerage, land consolidation). Land consolidation primarily addresses the natural resources and infrastructure factor while indirectly strengthening the other three through multi-stakeholder planning processes, knowledge exchange platforms, and improved spatial prerequisites enabling farm cooperation and competition. These four factors represent the conceptual bridge between path-dependent constraints (what small peripheral LGs cannot do) and practical interventions (what they can do), organizing the analysis in Section 2.3 and providing the framework within which Studies 2–3 test land consolidation effectiveness.

This thesis examines these theoretical propositions through three complementary empirical studies. Study 1 analyses EU Cohesion Policy fund allocation patterns across CEE countries during 2007–2013, investigating whether external funding mechanisms offer pathways to overcome path-dependent development patterns. Study 2 investigates the relationship between farm structure and farm productivity at the micro-level, establishing the productivity-structure linkage fundamental to the framework’s dual-pathway mechanism. Study 3 directly tests the framework’s core proposition by examining whether changes in farm struc-

ture affect the probability of farms implementing innovation activities, validating whether small peripheral LG spatial planning interventions translate into measurable farm-level innovation activity adoption.

2.2 Farm structure, labour productivity, innovation activities, and land consolidation as an enabling instrument

The relationship between farm spatial structure, labour productivity, and innovation activities operates through interconnected causal pathways that create either self-reinforcing virtuous cycles or self-perpetuating poverty traps. Understanding this mechanism requires recognizing that causality flows in multiple directions simultaneously rather than following a simple linear sequence. Farm structure operates as the foundational input that shapes both labour productivity outcomes (output per working hour) and innovation activity capacity, while labour productivity and innovation subsequently influence each other through feedback mechanisms (Van Dijk, 2003; Hartvigsen, 2014).

Three distinct but interconnected pathways link farm structure to labour productivity and innovation outcomes:

Pathway 1 – Direct labour productivity effect (farm structure → labour productivity):

Farm spatial structure directly affects labour productivity through transaction costs and time efficiency independent of innovation adoption. Fragmented land divided into numerous scattered parcels requires farmers to move equipment and labour between dispersed plots, reducing output per working hour through increased transportation time, setup time at each parcel, and reduced effective working time on productive tasks (Wan and Cheng, 2001; Gonzalez et al., 2007). The same labour input (hours worked) produces less output because substantial time is consumed in non-productive activities – travelling between parcels, repositioning equipment, and managing logistical complexity rather than actual farming operations. At the same time, irregular parcel shapes constrain time efficiency by preventing optimal deployment of modern agricultural machinery designed for regular geometric fields, meaning farmers waste working hours on inefficient field patterns and manual operations in corners and edges that machinery cannot reach (Latruffe and Piet, 2014). This pathway operates without requiring any innovation adoption – simply reorganizing existing parcels into consolidated configurations improves labour productivity by enabling farmers to allocate more working hours to productive activities rather than parcel-to-parcel transitions (Rahman and Rahman, 2008).

Pathway 2 – Innovation enablement effect (farm structure → innovation activities → labour productivity):

Farm spatial structure determines the physical and economic feasibility of labour-saving innovation activities by creating or eliminating spatial prerequisites necessary for technology adoption. Consolidated parcels with regular geometries and adequate size make labour productivity-enhancing innovations – precision agriculture systems reducing manual intervention, large-scale mechanization replacing hand labour, and automated irrigation eliminating manual watering – economically viable by ensuring sufficient operational scale to recover fixed investment costs (Demetriou et al., 2012; Crecente et al., 2002). These technologies specifically increase output per working hour by either reducing labour requirements for the same output or enabling higher output with the same labour input. Conversely, fragmented holdings prevent profitable deployment of labour-saving technologies even when farmers possess financial resources to purchase equipment, as the spatial configuration makes adoption economically irrational when time savings cannot be realized across too many small, scattered parcels (Van Dijk, 2003). This pathway operates through removing binding constraints on labour productivity-enhancing innovation activities: farmers who cannot adopt time-saving technologies due to fragmentation remain trapped at low output per working hour regardless of available capital, knowledge, or subsidies (Hartvigsen, 2014).

Pathway 3 – Labour productivity feedback effect (labour productivity → innovation activities → further labour productivity):

Labour productivity level determines available investment capital for financing innovation activities, creating a feedback loop where labour productivity influences innovation capacity, which subsequently affects future labour productivity. Farms operating at low labour productivity due to fragmentation generate insufficient surplus capital per working hour invested to finance innovation investments in labour-saving machinery, equipment, buildings, or technology adoption (Reimers and Klasen, 2013). This financial constraint creates a poverty trap: low output per working hour prevents innovation investment in labour-saving technologies, which perpetuates low labour productivity by blocking adoption of mechanization and automation that would increase output per hour worked (Rizov et al., 2013). Conversely, farms achieving higher labour productivity through consolidated spatial structure generate capital surplus more efficiently per working hour, enabling innovation investments in labour-saving technologies, which further increase labour productivity through mechanization, automation, and improved time efficiency (Alvarez and Arias, 2004).

These three pathways operate simultaneously and interdependently, creating either vicious cycles (fragmentation → low labour productivity → no capacity for labour-saving innovation → perpetual low output per hour) or virtuous cycles (consolidation → labour productivity gains → capacity for labour-saving innovation → further labour productivity improvements). Land consolidation interventions achieve transformative effects precisely because they activate all three

pathways concurrently: reducing time waste through spatial reorganization (Pathway 1), creating spatial prerequisites enabling previously inaccessible labour-saving innovations (Pathway 2), and generating labour productivity gains that finance further labour-saving innovation investments (Pathway 3). This multi-pathway mechanism distinguishes land consolidation from single-intervention approaches addressing only labour productivity or innovation in isolation – it targets the foundational spatial structure that simultaneously conditions both outcomes (Louwsma et al., 2020).

Beyond the direct productivity and innovation effects, fragmented parcels create inherent uncertainty about long-term farm configuration that independently deters innovation investment. This uncertainty stems from the unpredictable nature of fragmented holdings: parcels may be distant from each other, accessible only through neighbouring properties, or have irregular boundaries that complicate efficient land use planning. Such structural ambiguity makes farmers hesitant to commit capital to innovation investments, as the return on investment depends heavily on stable spatial configurations that fragmentation cannot guarantee. Even when farmers possess financial capacity and technical knowledge, the inability to predict future farm configuration creates risk that rational actors avoid by deferring innovation investments until spatial stability is achieved through consolidation (Van Dijk, 2003).

The relationship between structure, labour productivity, and innovation (see Annex 3) is therefore neither linear nor unidirectional. Farm structure shapes labour productivity directly through time efficiency from spatial reorganization gains and indirectly through its effect on innovation adoption capacity. Labour productivity influences innovation by determining available investment capital and signalling whether efficiency improvements are economically viable. Innovation feeds back to structure by making certain spatial configurations more or less advantageous – precision agriculture increases the value premium of regular geometries, while organic production heightens the importance of buffer zone management. Land consolidation policy leverages these interconnections by targeting the foundational element – farm spatial structure – that conditions both labour productivity outcomes and innovation possibilities.

Following Smits and Kuhlmann’s (2004) typology of policy instruments, land consolidation can be classified as a “systemic instrument” that shapes framework conditions rather than providing direct support. Building on Van Dijk’s (2003) and Hartvigsen’s (2014) work on land consolidation, this research defines land consolidation (see detailed definition in Annex 2) as a spatial planning and regulatory instrument for small peripheral LGs: a tool designed to reorganize fragmented land parcels into spatially coherent units, thereby creating conditions that enable farmers to undertake innovative agricultural activities through improved access to productive resources and infrastructure, while recognizing that actual innovation adoption decisions and outcomes depend on farm-level entrepreneurial choices.

Land consolidation emerges as a viable intervention for small peripheral LGs precisely because it operates within their existing legal competencies and path-

dependent constraints: it leverages small peripheral LG spatial planning authority granted under the Land Consolidation Act 2024, requires minimal local fiscal capacity (relying on EU/national co-funding), and addresses infrastructure prerequisites rather than attempting to design agricultural innovation policies or create absent RIS elements. German experience over 150 years demonstrates how small peripheral LGs can operationalize land consolidation despite capacity constraints. The German model shows that small local governments play dual roles as both participants in decision-making and beneficiaries of infrastructure improvements, but they require supra-local institutional support (state-level Rural Development Agencies) to compensate for organizational thinness (see Annex 1 for detailed analysis of German LG roles and their implications for the Estonian context, based on Thomas, 2023).

This definition positions land consolidation as an innovation activity enabler rather than an innovation outcome producer or an agricultural innovation policy instrument. It creates necessary spatial and infrastructural conditions for farm innovation activities. The distinction is critical: land consolidation provides spatial prerequisites, infrastructure access, and organizational platforms that make innovation activities physically and economically feasible, but it cannot determine which innovations farmers will adopt or guarantee that such investments will succeed – those remain farm-level entrepreneurial decisions shaped by agricultural innovation policies designed at EU and national levels through CAP and R&D programmes.

Land consolidation interventions break the vicious cycle of fragmentation by fundamentally altering the spatial framework within which farms operate. Building on Van Dijk's (2003) and Hartvigsen's (2014) work, these interventions create larger, consolidated parcels with regular shapes and improved accessibility, eliminating the structural uncertainty that previously deterred investment. Farmers can now confidently predict returns on innovation investments because the spatial preconditions for those investments are stable and known. The improved farm structure does not merely reduce transaction costs; it physically enables innovations (see Annex 2) that fragmented configurations rendered impossible, while simultaneously removing the uncertainty premium that previously discouraged long-term capital commitments.

Land consolidation enables farm innovation activities not primarily through farm size increase but through three specific spatial reorganization mechanisms that directly correspond to the three causal pathways:

- (1) Reducing transaction costs and time waste (activating Pathway 1): Consolidated parcel configurations allow farmers to deploy equipment more efficiently, reducing the time and fuel costs of moving machinery between scattered plots, making precision agriculture economically viable even without farm enlargement (Crecente et al., 2002). This transaction cost reduction changes the economic calculus for investing in modern equipment: technologies that were unprofitable under fragmented conditions become viable investments after spatial reorganization. Empirically, Dutch evidence shows consolidated farms of identical size exhibit 15–20% higher inno-

vation adoption rates than fragmented counterparts, demonstrating that spatial configuration – not farm size – drives the effect (Van Dijk, 2003).

- (2) Enabling infrastructure coordination and spatial prerequisites (activating Pathway 2): Infrastructure investments in drainage systems, rural roads, or water access require coordinated spatial planning across multiple property boundaries (Demetriou et al., 2012). Small peripheral LG-led consolidation projects can coordinate these improvements in ways that individual farmers cannot, solving collective action problems and creating the infrastructural prerequisites that make certain innovation activities possible (e.g. irrigation-dependent specialty crops, machinery requiring improved road access). This mechanism addresses the physical and economic feasibility constraints identified in Pathway 2.
- (3) Creating multi-stakeholder platforms for knowledge exchange (supporting Pathways 2 and 3):

The participatory planning processes inherent in consolidation projects create social infrastructure for knowledge exchange, complementing the technical infrastructure improvements (Louwsma et al., 2020). Farmers learn about innovations being adopted by neighbours, observe demonstration effects, and receive informal advice during stakeholder consultations, facilitating knowledge diffusion beyond formal extension services. This knowledge exchange mechanism supports both innovation adoption decisions (Pathway 2) and productivity improvements enabling further investment capacity (Pathway 3).

Borrás and Edquist (2013) argue that regulatory instruments function as both demand-side instruments (creating markets for innovations) and supply-side instruments (enabling access to resources necessary for innovation). Extending this framework to innovation activities, land consolidation operates through three primary regulatory mechanisms available to small peripheral LGs that reduce spatial and infrastructural barriers to farm-level innovation investments:

LGs exercise spatial planning authority that enables or constrains specific agricultural activities requiring particular spatial configurations (Demetriou et al., 2012). Spatial planning decisions within consolidation projects can facilitate farmer investments in renewable energy installations (biogas plants, solar arrays requiring contiguous land), organic agriculture systems requiring specific spatial arrangements (buffer zones, rotation schemes) (Sutherland et al., 2022), or precision agriculture infrastructure (GPS guidance systems requiring regular field shapes) (Rose et al., 2021) by creating consolidated parcels with appropriate geometries and sizes. Consolidated parcel configurations make these labour productivity-enhancing innovations economically viable by ensuring sufficient operational scale to recover fixed investment costs (Crecente et al., 2002). These planning decisions shape the physical feasibility of innovation activities rather than determining which innovations farmers ultimately adopt or whether they succeed commercially (Van Dijk, 2003).

Land consolidation projects must integrate EU environmental requirements – including Nitrates Directive buffer strips (91/676/EEC), Water Framework Direc-

tive protection zones (2000/60/EC), and biodiversity preservation measures – into spatial reorganization (Hartvigsen 2022; Veršinskas et al., 2020). Strategic placement of these mandated environmental features within consolidation design can create parcel configurations where eco-innovation investments become economically viable by maintaining productive areas while ensuring regulatory compliance (Porter and van der Linde, 1995). Multi-purpose land consolidation approaches demonstrate how environmental protection goals can be achieved alongside agricultural development objectives through coordinated spatial planning (Pasakarnis and Maliene, 2010; Hartvigsen, 2014). For example, consolidation projects organizing field boundaries to accommodate required buffer strips can create regular geometries where precision application equipment becomes attractive by reducing the trade-off between environmental compliance and operational efficiency (Demetriou et al., 2012). These spatial coordination approaches create conditions favouring certain innovation activities without determining agricultural production methods or innovation policy priorities (which remain EU Common Agricultural Policy competencies).

Property rights frameworks and transaction facilitation: legal frameworks enabling land transactions, establishing clear property boundaries through cadastral updates, and reducing administrative barriers to consolidation facilitate long-term innovation investment (OECD, 2013). Secure property rights clarified through consolidation processes give farmers confidence to invest in fixed improvements (buildings, drainage systems, permanent crops) and mobile capital (machinery, equipment) that constitute innovation activities. Small peripheral LG coordination of cadastral updates and boundary clarifications reduces transaction costs that otherwise prevent farmers from restructuring their holdings to enable innovation adoption.

These regulatory and spatial planning mechanisms available to small peripheral LGs create enabling conditions for innovation activities without requiring direct fiscal expenditure on innovation outcomes or involvement in agricultural innovation policy design, making them particularly suitable for resource-constrained small peripheral LGs. They operate on the physical and economic feasibility of innovation activities (removing spatial constraints, reducing transaction costs, coordinating infrastructure) rather than attempting to determine which specific innovations succeed or designing agricultural innovation policies that promote particular technologies – those remain EU and national competencies through CAP and agricultural research systems.

This causal mechanism validates land consolidation as a spatial planning instrument enabling farm innovation activities rather than merely an agricultural land management tool. Operating through Hall's (1993) policy change orders, land consolidation functions as a second-order instrument change – modifying the policy tools available to influence farm behavior – that can enable third-order paradigmatic shifts when combined with complementary capacity-building and institutional support. The intervention operates by removing spatial constraints that prevent farmers from adopting innovations designed by national and EU agricultural policies through CAP programmes and R&D initiatives. Land

consolidation does not create new technologies or production methods; instead, it eliminates the structural barriers preventing their local adoption, positioning small peripheral LGs as enablers of innovation activities designed at higher governance levels.

This framing clarifies the division of labour between policy levels: EU and national institutions design agricultural innovation policies (determining R&D priorities, providing adoption subsidies, establishing regulatory frameworks) through CAP and agricultural research programmes, while small peripheral LGs implement spatial planning interventions (land consolidation, local infrastructure coordination, property rights clarification) that determine whether farms can physically and economically adopt the innovations promoted through these higher-level policies.

Land consolidation does not substitute for or duplicate agricultural innovation policy – it creates the local spatial and infrastructural prerequisites that make nationally/EU-promoted innovations actionable at farm level. A farmer may receive CAP subsidies for precision agriculture equipment and access to university-developed precision farming protocols, but fragmented parcels with irregular shapes prevent profitable deployment of this technology regardless of subsidy levels or available knowledge. Small peripheral LG-led consolidation removes this binding spatial constraint, enabling the farmer to act on the innovation opportunities created by national/EU policies.

This complementarity explains why land consolidation belongs within the research scope despite small peripheral LGs not designing agricultural innovation policy: the spatial planning intervention enables innovation activities that would otherwise remain infeasible, functioning as a critical bottleneck in peripheral regions where extreme fragmentation constrains technology adoption independent of agricultural innovation policy quality.

For small peripheral local governments, this mechanism offers a viable and practical intervention that operates within their existing competencies and legal authority. Unlike traditional innovation policies requiring universities, research institutes, or science parks, land consolidation utilizes spatial planning powers that small peripheral LGs already possess under Land Consolidation Act (2024). Critically, land consolidation operates through a local government regulatory authority over spatial planning and resource allocation – competencies explicitly granted under Estonian law – making it a viable instrument for small peripheral LGs despite their fiscal and institutional constraints. It requires minimal direct fiscal expenditure from small peripheral LGs (leveraging EU/national co-funding mechanisms, particularly CAP Pillar II funds) while creating substantial enabling effects for farm innovation activities that are promoted through national and EU agricultural innovation policies.

The intervention addresses system failures in organizationally thin regional innovation systems by substituting spatial optimization for absent institutional infrastructure. In peripheral contexts where tacit knowledge diffuses through localized networks and communities (Polanyi, 2009), and where geographic isolation limits access to external knowledge providers, land consolidation creates

the physical conditions enabling knowledge exchange through multi-stakeholder platforms embedded in the consolidation process itself (Louwsma et al., 2020). Where larger municipalities might foster innovation through university-industry partnerships or technology transfer programmes, small peripheral LGs can achieve comparable innovation enablement through strategic land consolidation that removes the spatial constraints binding farm labour productivity and innovation capacity in peripheral agricultural contexts.

2.3 Path dependency and regional development factors: building the causal chain

Sections 2.1–2.2 established the theoretical framework: innovation as activities, land consolidation as an instrument, systemic approaches, and policy change orders. This framework is not arbitrary – it emerges from specific historical-institutional conditions in peripheral regions. The following sections demonstrate how path-dependent processes created the constraints necessitating this alternative practical intervention approach, using Estonia as empirical validation of the theoretical mechanisms.

This section establishes the causal chain underlying the framework: how path-dependent historical processes create peripheral RIS conditions, which constrain small peripheral LG policy options, necessitating focus on the four regional development factors (knowledge and human capital, cooperation and linkages, competition and economic structure, natural resources and infrastructure) that small peripheral LGs can actually influence through land consolidation interventions.

2.3.1 Path-dependent regional development and the role of small peripheral LGs

The concept of path development is introduced in Study 1. This study discusses and empirically shows that economic trajectories are not random but are shaped by previous historical decisions. Also, initial economic choices tend to create “increasing returns” – meaning early decisions can have long-lasting effects. Regions can become technologically “locked in” to certain economic patterns. Multiple potential economic outcomes can emerge from historical circumstances. Different studies (Isaksen, 2001; Tödting and Trippel, 2005) show that these path-dependent processes are especially important in shaping regional innovation systems. These innovation systems are now seen as critical drivers of economic growth, particularly in theories of endogenous growth and place-based development approaches. These concepts suggest that understanding a region’s economic present requires the understanding of the cumulative effect of historical choices and experiences made in the past. The European Commission has introduced policies to overcome negative effects of path-dependency by introducing cohesion policy, which aims to change existing development paths by measures

fostering human capital, innovation, and other factors of development (Bachtler and Gorzelak, 2014). Study 1 analyses the impact of these policies in CEE countries.

This chapter provides insight into how the concept of path dependency is used to understand the role of small peripheral LGs in farms' innovation processes. The conceptual framework of this thesis integrates institutional and economic aspects of development in small peripheral LGs. Path dependency is a concept which describes social, economic, and political processes that shape the current state of development in small peripheral LGs. Douglass North (1990) formulated path dependency as a process which sets constraints to future choices: *“At every step along the way there are choices – political and economic – that provide...real alternatives. Path dependence is a way to narrow conceptually the choice set and link decision-making through time. It is not a story of inevitability in which the past neatly predicts the future.”*

Historical social and economic structures and political decisions constitute the local environment in which the current economic activity of local farms occurs. These structures set conditions for the behaviour of local farms and other actors in the present day by determining an initial distribution of resources (Martin and Sunley, 2006).

The main criticism related to this concept is that development paths can be defined retrospectively, making future predictions difficult. Defining development paths retrospectively is problematic because it creates a false sense of inevitability about past events while providing little predictive power for local policymakers who need to make forward-looking decisions about which innovation policies they should choose. Historical processes do not repeat themselves; they occur once in a particular context and time. The literature on path dependency assumes that political decisions are made based on the principle of context-bound rationality. For example, a small peripheral LG in Estonia with a history of dairy farming might decide to invest in infrastructure like roads, rural broadband networks, and storage facilities that local farmers can collectively use, rather than trying to compete with urban areas in high-tech industries. This decision reflects context-bound rationality because it leverages the specific historical strengths of small peripheral LGs in agriculture, addresses the practical needs of existing local farmers, and builds upon established cooperative relationships, even though objectively other investments might generate higher returns in a different regional context. Decision-making in peripheral small LGs is context-bound if political decisions depend on specific historical, socioeconomic, and institutional contexts. Rationality is, therefore, not absolute but determined by certain local circumstances in which political choices are made (Kay, 2005). Path dependency highlights different institutions; this thesis focuses on formal political institutions relevant to Estonia, namely the European Union and small peripheral LGs.

Policy change is viewed mainly through the economic policy of formal institutions. Hall (1993) distinguishes three types of policy change at the level of political instruments, change in the usage of specific instruments and the change

in the whole paradigm of political institutions. First-order change involves adjustments to the settings or calibration of existing policy instruments while keeping both the instruments themselves and the overall goals unchanged. For example, small peripheral LGs adjusting the budget allocation for rural road maintenance from 50,000 euros to 75,000 euros annually without changing the maintenance approach. This represents routine policy adjustments based on past experience and new information. Second-order change involves altering the instruments or techniques of policy while maintaining the same hierarchy of goals and overall paradigm. For example, switching from individual farm visits by agricultural advisors to group training sessions while keeping the same advisory objectives. This goes beyond routine adjustments to develop new policy tools. Third-order change represents the most fundamental transformation – a complete “paradigm shift”. It involves simultaneous changes in the instrument settings, and also the instruments themselves, and the hierarchy of goals behind policy. This is accompanied by changes in the overarching terms of policy discourse and represents a radical shift in how policymakers understand both problems and appropriate solutions. For example, transforming from “agricultural productivity focus” to “sustainable rural ecosystem” paradigm, incorporating environmental protection, tourism, and rural heritage preservation alongside agriculture, requiring entirely new policies, departments, and partnerships.

Path dependency suggests that the policy choices of small peripheral LGs are narrowed to specific paths – due to sunk costs and increasing returns of specific business sectors (Thelen, 1999). Small peripheral LGs become locked into supporting particular economic sectors because they have already invested significant financial and time resources (sunk costs) in infrastructure, expertise, and relationships that favour those sectors, making it costly to switch to alternatives. Once these investments are made, supporting the same sectors becomes increasingly efficient and beneficial (increasing returns). Therefore, small peripheral LGs continue choosing policies that strengthen existing economic paths rather than exploring new development directions. This might be due to local economic and institutional factors. This thesis analyses local factors to show how path renewal – new possibilities to increase local farms’ productivity and innovation – can be executed.

Path dependency points out that changes in institutional or political settings are incremental, based on previous decisions, and new ones are made. Using this principle to provide interventions for specific regions, these specific localities’ current economic, political, and institutional factors must be noted. By translating the strategies of Silicon Valley in the context of small peripheral LGs in Central and Eastern Europe, necessary preconditions for such strategies and developments do not exist in CEE countries. Silicon Valley’s innovation depends on world-class research universities like Stanford and Berkeley with extensive R&D capabilities and an entrepreneurial culture, while peripheral CEE localities typically lack major research institutions, have limited university-industry collaboration traditions, and insufficient research infrastructure to support high-tech spin-offs. In agriculture, innovation requires specialized agricultural research

institutions and extension services that are often underdeveloped in peripheral regions, making technology transfer to small farms particularly challenging. Interventions happen incrementally, in small changes, to be relevant (Lindblom, 1959). The decision-making comes from previous knowledge because of the incremental changes, which are more predictable, also for competing political parties or jurisdictions (and LGs). Still, it is a good option for leaders of small peripheral LGs to avoid policy failure because political decisions based on incrementalism models give better options for step-by-step development of intervention, which provides room for policy testing and improvement, learning from the consequences of previous intervention measures.

To understand the path dependency of regional development in a microregion (EU) or a specific country, three types of regional innovation systems are used, as proposed by Isaksen (2001): old industrial, fragmented, and peripheral areas. Each type represents factors that hamper the productivity and innovation activity of local farms. In old industrial regions, regional innovation exists, but there are “lock-in” situations due to closed networks between different RIS actors like universities, big local firms, and other knowledge providers. These “lock-in” situations arose thanks to cumulative learning and path-dependent processes. Already established RIS actors could specialise in one specific sector, which may be declining and has a knowledge base that is too narrow.

Technological trajectories refer to the established patterns of technological development and innovation that regions become locked into over time (Isaksen, 2001). These are specific directions of technological advancement that build upon previous investments, knowledge, and capabilities within a particular sector or industry. For example, a technological trajectory might be a region’s specialization in conventional grain production technology and related agricultural machinery, or focus on intensive livestock farming systems and associated veterinary solutions. Once established, these trajectories become self-reinforcing because farms, agricultural research institutions, and equipment suppliers continue to invest in improving and advancing the same types of technologies, creating cumulative learning and expertise in that specific direction. The problem arises when these technological trajectories become too narrow or focused on declining agricultural practices. In such cases, the region becomes trapped in outdated or less competitive farming methods, making it difficult to adapt to new market demands like organic farming, precision agriculture, or sustainable food production systems, hence the need to “break” these trajectories by introducing new knowledge sources and diversifying into different technological directions.

Fragmented RIS describes a region where necessary knowledge providers exist, but they do not trust each other and do not cooperate (Isaksen, 2001) and, therefore, do not complement each other’s knowledge. This leads to underutilization of resources, low productivity, and low innovation activity in these regions. Networks of social interaction among local firms and other knowledge providers help to develop bonding social capital (Westlund and Kobayashi, 2013). This, in turn, increases the probability of local firms with complementary knowledge to find and cooperate with knowledge sources within and outside of the region

(Laursen et al. 2012) if the bridging of social capital occurs (Westlund and Kobayashi, 2013). Studies focused on fragmented RIS can focus on whether and how small peripheral LGs can bridge (Westlund and Kobayashi, 2013) social capital to change historically developed informal institutions (Isaksen, Karlson 2016) to increase path renewal of local regions.

The peripheral type of region is common in CEE countries. In peripheral areas, relatively few knowledge providers or sources are available, and social interactions occur between a limited number of actors. Therefore, small peripheral LGs form the cornerstone of the innovation-supporting infrastructure (Doloreux and Dionne, 2008; Andersson and Karlsson, 2004). Firms in peripheral areas have lower productivity and innovation activity due to territorial and functional perspectives (Isaksen, 2001). Territorial and functional perspectives lead to inefficiency in different ways. The productivity and innovation activity of local farms are hindered if small peripheral LGs cannot fulfil their functions properly, such as providing infrastructure, land planning, or social services. Without infrastructure, like local roads, the local firms cannot access or use specific resources like water to build hydroelectric stations. Land planning of small peripheral LGs must support the efficient land use of local firms. The knowledge production of local firms is insufficient if a tacit knowledge exchange does not occur between local firms and mainly external knowledge providers, such as suppliers of technology, consultants, universities, funding, and training organisations (Tödtling and Kaufmann, 1999).

By using the path dependency concept, it may be concluded that in unequal regional development is that history matters. A question arises: is it possible to change the developmental path of small peripheral LGs? By analysing historical processes and sources of regional path dependence, it is possible to form interventions. The evolution⁵ of the concept itself shows the increasing role of political institutions in local practical interventions. The author analysed regional development theories, particularly RIS approaches, to reveal how historical technological choices, institutional frameworks, and geographical factors create unique path dependencies that shape current economic structures at the local level. Based on the methodology provided in the author's conference paper (see Looga 2016 pages 233–234, summary of the results 240–246, and also the results in Annex 4,5 and Annex 6), the following section shows how the role of small and peripheral LGs in the innovation processes of firms is derived from historical processes and sources of regional path dependence.

The spatial pattern of firms was explained by static theories – location theory and growth pole theory – the regional dependence on natural resources, raw materials, market location (Weber, 1909), and transport costs (Isard, 1949). The economic convergence/divergence theories (Tiebout, 1956; Williamson, 1965) explained the structural changes in the industry and political systems and their impact on the regional distribution of growth. These theories highlight the notion of cumulative causation, the self-reinforcing process in the region that gives

⁵ Viewed through static theories to systemic institutional approaches (see Annex 4).

impulse to a systematic change in the future. For example, industrial (compared to only agricultural) regions have more opportunities to develop because firms have a higher demand for industrial products, and the population increases more quickly in higher per capita income regions. Industrialization causes high sunk costs (regarding local assets like infrastructure, equipment, etc.) and impacts the regional economy's direction.

Theories of structuralism added other factors, processes, and sources of regional path dependence. Much of the literature concentrates on the linkages between agglomerations and periphery, which is the effect of dominant firms or industries and their interlinkages with dependent firms or industries (Perroux, 1950). The outcome of these interlinkages occurs in "trickling-down" (Hirschman, 1958) and "spread effect" (Myrdal, 1957) or "backwash" (Hirschman, 1958) and polarisation effect" (Myrdal, 1957). Dominant firms lead to the concentration of capital, labour, central government investments, R&D, and infrastructure and could, but may not influence the peripheral locations. These centripetal and centrifugal effects are the interest of analysis in new economic geography, where path dependence in time and place takes place as a result of the changes in local technology and institutions (Fujita, 1999; Krugman, 1991, 1999).

One opposite approach to industrialisation and mass production is the introduction of flexibility. The region grows if the institutions create conditions – for example, internet accessibility, regulations for an equal wage, working conditions, and diverse, skilled labour – for a competitive environment (Piore and Sabel, 1984; Porter, 1990; Cooke and Morgan, 1993; Saxenian, 1994), which leads to higher productivity, technological innovations, and dynamism. At the same time, efficiency is institutionally supported by joint trade, input orders, joint purchasing of materials, joint marketing and credits, and provision of industrial infrastructure. This cooperative environment is held together by social, political, ethnic, and even religious community ties (Piore and Sabel, 1984), the benefits of which – namely, diffusion of innovation and tacit knowledge created by clusters, ability to adapt to change, and buyer-supplier partnership) outweigh the opportunistic behaviour of some firms.

The role of small peripheral LGs in innovation processes of local firms is derived from systemic institutional (Cooke et al. 1997; Asheim and Isaksen, 2002; Malmberg and Maskell, 2002) and evolutionary-structuralist approaches (Nelson and Winter 1977, 1982). The systemic institutional approach leads to the public intervention rationale of market and systemic failure (Bleda and Del Rio; 2013). In this approach, tacit knowledge, created and diffused through interpersonal relations, trust, and regular contact, is essential (Uyarra, 2007; Laranja et al. 2008; Manjón and Merino; 2012). Emphasis is on the institution's role in organizing knowledge and technology flows between and with the help of different actors within and outside the region (Manjón and Merino; 2012). There is a discussion about whether the decision-makers should concentrate on local buzz or organize global pipelines (Lawson and Lorenz, 1999, Bathelt et al. 2004). However, it may be assumed that both are equally important. Public intervention is possible on different levels: the EU initiatives for financing regional innovation

systems, national innovation policies for R&D subsidies, and the critical role of small peripheral LGs because tacit knowledge and its diffusion are geographically immobile and place-specific, unlike codified knowledge. Therefore, the small peripheral LGs and other institutions in the region (Keeble et al. 1999) have to be “collective agents” who create local synergy effects, including collective learning, networks, and information flows (Camagni, 1991). The evolutionary-structuralist approach emphasizes the institutional ability to change and adapt to the developments in the private sector. The institutions have to coevolve with the business sector and available technologies, thereby adjusting the supporting services and finding ways to improve the diffusion of knowledge. The systemic institutional approach did not give insights into how firms use the existing knowledge of the innovation system (IS) and how the IS adapts to changing needs over time (Uyarra, 2010).

As businesses search for new information and knowledge from geographically close areas, it leads to incremental innovations, which are locally cumulative (Boschma, 2004). So there is a specific path dependency of technological and institutional change, which could lead to lock-in situations (Laranja et al. 2008). Of course, the institutions are not able to change infinitely, and over time the advantage of a specialized and unique local innovation system would be lost for firms who belong there and for the newcomers, the tacitness of information and access to local intangible factors makes the approach very difficult (Boschma, 2004). This, therefore, leads to the question: How much public intervention is necessary for the evolutionary approach? The idea of an open innovation system (Chesbrough, 2003), global pipelines and local buzz (Bathelt et al. 2004) are proposed. There is also a need for a new redefinition of RIS for lock-in/small/peripheral regions because the policies drawn from successful (Silicon Valley) RIS do not work in peripheral locations. From the evolutionary approach, the need for related variety in local economics and openness to extra local related links (Uyarra, 2010)⁶ is proposed.

In summary, the role of small and peripheral LGs in the innovation processes of firms from historical processes and sources of regional path dependence is related to the following factors (see Looga 2016 page 241–247):

1. Knowledge, absorptive capacity, and human capital:

- Demand for innovative products. The volume of demand for products;
- Tacit and codified knowledge sources and networks. Firms’ cooperation with knowledge sources, like universities and business knowledge providers. Firms geographical proximity with knowledge sources;
- Absorptive capacity of firms and market information;
- Human capital. Education of firms’ employees.

⁶ Empirical results of Frenken et al. (2007) show that there is positive effect between employment development and related variety, while unrelated variety helps to overcome external shocks to the local labour market.

2. Cooperation and linkages:

- Cooperation networks of firms;
- Cooperative environment and community ties;

3. Competition and economic structure:

- Strategy and rivalry preconditions;
- Business structure and (un)related variety;
- External factors;

4. Natural resources and infrastructure:

- Natural resources and land planning. Access to and processing of raw materials, strategic planning, public demand and land use regulations of innovative resource use;
- Infrastructure and transaction costs: The mobility of production inputs, residents, and information and the reduction of transaction costs.

These four factors represent the “Regional Development Factors of Small Peripheral LGs” in the conceptual framework (Figure 1, page 13) diagram. The following section demonstrates how these theoretical factors manifest in the context of Estonian policy, showing which interventions are feasible given path-dependent constraints.

2.3.2 Path-dependent constraints on small peripheral LG capacity in Estonia

The following discussion illustrates how historical processes and sources of regional path dependence are in mutual interaction with policies (local, national, etc) affecting farm productivity and innovation in small peripheral LGs.

The author collected and analysed regional development theories (see the list of theories and authors in Annex 4) which answer the question: which development factors are relevant for small peripheral LGs? This discussion draws on the classical works and authors who introduced the theory and the main discussions, which are related to the fundamental development of the theory, not the modifications introduced in recent years. The foundational theories remain most relevant for peripheral agricultural contexts where basic structural factors (infrastructure, land planning, knowledge networks) rather than advanced innovation system dynamics constitute the primary development challenges.

The conceptualization of space in regional development theories has evolved from physical-metric space in location theories emphasizing transportation costs to uniform-abstract space in neoclassical regional growth and export base theories, and further to diversified-relational space in growth pole theories and diversified-stylized space in new economic geography (Capello and Nijkamp, 2009). Although regional economics has moved beyond treating regions merely as administrative units (Capello, 2016), such as municipalities and LGs, these evolving theoretical perspectives nonetheless provide diverse frameworks for understanding development factors relevant to small peripheral LGs.

First, criteria are established to determine whether Estonian small peripheral LGs can intervene directly, indirectly, or not at all. These criteria are based on Estonia's legal framework, small peripheral LGs' economic investments (and their dependence on EU funding), budgets, budget strategies, development plans, and policy reports. Second, based on how each LG meets these criteria, their intervention possibilities are marked with different colours (see Annex 5).

Estonian small peripheral LGs can intervene directly when they have autonomy (in decision-making and fiscal resources) and when the specific intervention relates to functions legally assigned to them. Small peripheral LGs can intervene indirectly (compared to "green" areas) when they can create only some preconditions because they meet only some criteria. Small peripheral LGs cannot intervene when the action relates to central government functions or when they have no ability to control the process. In some cases, small peripheral LG intervention possibilities cannot be determined based on existing theories. Annex 6 illustrates Estonian small peripheral LGs' practical interventions for enabling firm innovation activities. This analysis summarizes the intervention capabilities available to Estonian small peripheral LGs.

Here are some examples of how historical processes and sources of regional path dependence (see below 1, 2, 3, and 4) interact with policies (local, national, etc.) affecting productivity and innovation in small peripheral LGs based on the analysis (summary based on Annexes 4, 5 and 6).

Knowledge, absorptive capacity, and human capital (1) (for practical interventions for small peripheral LGs, see Annex 6 (page 65–67): Human capital is important for local farms' productivity and innovation. The level of education of farm owners and workers plays a significant role both for productivity and innovation. Farms with owners who have received full agricultural training are more productive than those with owners who have merely practical experience. This outcome is consistent with previous research. Educated workers are more efficient and adopt innovations (like new machinery or production processes) more quickly than uneducated workers; they "use a different mix of inputs compared to a relatively low-skilled peasant" (Reimers and Klasen, 2013). As a result, education should have a positive impact on productivity. Due to technical advancements and increasingly complicated production processes that require greater absorptive capacity, education primarily has a favourable effect on productivity in middle- or high-income nations (Reimers and Klasen, 2013).

Available skilled personnel depend on the provision and location of education and R&D facilities. Small peripheral LGs can use associations of LGs, political parties, and members of parliament in their election districts to lobby for the location of universities and R&D facilities. Small peripheral LGs in Estonia have the right to lobby for the location of universities. Estonia has no legal regulations on organizing the lobby (Jemmer, 2014). Small peripheral LGs can pay membership fees and have more substantial lobbying power via the Estonian-wide Association of LGs, which also has its office in Brussels (Association of Estonian Cities and Rural LGs, 2018a). Municipality-specific interests may be represented through the Estonian MP or the election programme of political parties who can

make decisions that favour LGs that belong to their election district. Regarding agricultural support measures for productivity and innovation, the main provider of structural funds in Estonia is the Agricultural Registers and Information Board (ARIB), and its service bureaus are located⁷ in every county centre. This means that all agricultural producers have good access to advisory services and financial support measures. The vocational and higher education providers are also located in different Estonian locations⁸.

Most of the R&D policy in Estonia – management, development, innovation policy, and establishing R&D institutions – is according to the Organization of Research and Development Act (2016, § 10), under the responsibility of central government. Still, small peripheral LGs can establish research and development institutions (Ibid 2016, § 5–1).

Cooperation and linkages (2) (for practical interventions for small peripheral LGs, see Annex 6 (page 68)): One of the reasons why differences between peripheral farms and agglomerations exist is the number of cooperation partners and existing linkages developed over time. It is usually easier to export products from capital cities. Capitals and bigger cities have locational advantages (harbours, airports), which is why these cities have developed into economic centres. There are specific export barriers (Leonidou, 2004) where small peripheral LGs can intervene to mitigate the barriers. The cooperation of small peripheral LGs with twin towns can facilitate market access for local farms – either through direct sales arrangements with processors in those regions or by enabling short supply chains for speciality products. While most farms sell to processors or intermediaries rather than export directly, consolidated farm structures enable participation in value chains requiring guaranteed volumes and quality standards that fragmented holdings cannot meet. Farms usually analyse whether the search for export channels is profitable due to sunk costs and hesitate to export if they see no potential. If small peripheral LGs already have contacts with foreign cities, finding the necessary distribution and information channels is more accessible – it does not lead to additional search costs for small peripheral LGs or farms. In this case, big LGs have a competitive advantage because they have many firms and other institutions like universities that already belong to different networks or have valuable contacts and cooperation partners. Bigger LGs have more possibilities to expand local firms knowledge breadth (Laursen and Salter, 2006).

Estonian agricultural products are produced by bigger farms and a high number of small farms. The differences between small and big farms with regard to productivity, innovation, and export indicators are increasing (Põllumajanduse ja ... 2023). To decrease these differences, it is important to implement strategic land planning instruments (land consolidation projects initiated by small peri-

⁷ See the locations of ARIB bureaus: <https://www.pria.ee/teenindusburood>

⁸ See the locations Vocation Center in Järvamaa (<https://www.jkhk.ee/en>), Olustvere School of Service and Rural Economics (<https://www.olustvere.edu.ee/en>), Räpina School of Horticulture (<https://www.aianduskool.ee/>), Luua Forestry School (<https://www.luua.ee/en/about-us/>), Estonian University of Life Sciences (<https://www.emu.ee/>), Tallinn University of Technology (<https://taltech.ee/en/>)

peripheral LGs), which help to increase peripheral farms productivity and innovation so they are capable of exporting their products. It is important not to focus on exporting raw materials but rather value added products. The demand is high for good quality and organic food (Põllumajanduse ja ... 2023), and Estonian small farms can specialize in such products if they have optimal land for such production.

The circulation of knowledge within farm-related innovation systems includes cooperation between agricultural producers and across the value chain. Farms and farm clusters benefit from knowledge circulation and cooperation in regard to joint ventures, licensing agreements, and technical assistance partnerships. It is necessary that innovators like equipment manufacturers, custom service operators, and adopters like farms and farm clusters work effectively (OECD, 2013).

A country's foreign direct investment (FDI) policy also impacts the productivity and innovation of local firms. Although the evidence is sparse in high tech, there is some indication that FDI can further boost productivity complemented with sufficient local investment or a strong enough export orientation. However, it is more prevalent in industries that require a lot of labour and resources (Fillat and Woerz, 2011). In Estonia, foreign venture capital firms are important employers in peripheral locations, but more interventions are necessary to attract more such investments to peripheries (Varblane et al., 2020). The innovativeness and productivity of farms are smaller in peripheral locations of Estonia because there are fewer export-oriented and venture capital firms. These firms can increase their productivity by gaining access to new markets, technologies, and skills through FDI. Knowledge spillovers from FDI can benefit local firms by allowing them to adopt the technologies and business methods of their overseas counterparts, making it possible to increase domestic innovation. In the Estonian agricultural sector, the increase of FDI (mainly from Finland) was 25 times greater in 2019 compared to 1998, and the FDI in dairy farming constitutes 15% of all investments (Varblane et al., 2020). Foreign investors seek to gain profit, so for them it is important that available land is in right shape and existing infrastructure supports the production processes since such factors help to gain higher profits as they contribute to the productivity and innovation.

Competition and economic structure (3) (for practical interventions for small peripheral LGs, see Annex 6 (page 69)). Small peripheral LGs themselves have to understand the local business environment, its actors, the obstacles to innovation (Segarra-Blasco et al. 2008), and also the external environment (Hadjimanolis, 1999; Frenken, 2001). This capacity helps small peripheral LGs to target policies to decrease the obstacles that block farms' innovation, such as the competition for price, quality, and marketing, and the competition for innovations, market share, and demand, among other other obstacles (Piatier, 1984; Breschi and Malerba, 1997; Freel, 2003). It is necessary to consider the sectoral patterns and effects (Pavitt, 1984; Castellacci, 2008) of innovation and innovation obstacles, which may be complementary or can be substituted for each other (Segarra-Blasco et al. 2008). The innovation barriers vary between farms with different characteristics like size, age, innovativeness and it is necessary to ensure

fair competition between local farms to increase their willingness to develop. The aim of the small peripheral LGs may be to pave the way for a diversified local economy to enhance intense competition between the local farms (Jacobs externalities) or improve the specialization of farms to increase the interindustry knowledge spillovers (Marshall externalities), with both actions potentially enhancing innovativeness (Panne, 2004). Available land on small peripheral LG territory is one factor that firms compete for (as shown in Study 3), as highlighted by the land take indicator⁹ that every year agricultural, forest, and other semi-natural land is redirected to transport, housing, and industrial purposes. Regarding the support for the local socioeconomic environment – local farm productivity, innovation, and environmental and sustainability goals – the small peripheral LGs in EU do not see spatial planning as an instrument that they can use to set future goals (Nadin et al., 2018) on how their territory will be formed. CEE countries, including Estonia, can use the practice of Western Europe where multi-purpose land consolidation is used (Veršinskas et al., 2020) to achieve goals related to agricultural development, climate change adoption, biodiversity, and so forth.

The competition is not only among firms but also between LGs. Municipal competition is usually in favour of bigger LGs than smaller peripheral ones that lack the effects of agglomerations – the availability of education and R&D institutions, a different type of innovative high-tech industries with spillover effects (Isaksen and Onsager, 2010). Estonian small peripheral LGs compete with bigger LGs on the factors and resources they can influence. For example, land zoning is better for big companies who cannot move to urban areas without available land (the land is too small or expensive). It is vital to minimize production costs, so the small peripheral LGs compete for land taxes, restrictions, regulations, skilled labour, and high-quality infrastructure based on other competitive advantages and resources.

Natural resources and infrastructure (4) (for practical interventions for small peripheral LGs, see Annex 6 (page 70–71)): Small peripheral LGs are responsible for local road development, public water, sewerage systems (Local Government Organisation Act, 2023) and land consolidation projects (Land Consolidation Act, 2024). Estonian small peripheral LGs exercise these spatial planning competencies within the framework established in Section 2.3: land-use planning authority determines which agricultural activities are spatially feasible; environmental integration requirements shape parcel configurations enabling eco-innovations; and property rights clarification through cadastral coordination reduces transaction costs preventing farm restructuring.

In Estonia and other Baltic states, land reform after the socialist era caused extreme fragmentation through plot-by-plot restitution (Hartvigsen, 2014; Jürgenson 2017). This fragmentation – characterized by irregular shapes, swamp conditions, and variable soil quality – requires higher production costs (Gonzalez

⁹ This indicator reflects the change in the forest, agricultural, and semi-natural land area to urban and other artificial land (see European Environment Agency 2021).

et al. 2007) and leads to limited technical efficiency (Rahman and Rahman, 2008), causing lower labour productivity and constraining innovation activities. The land reform process remains unfinished in most CEE countries including Estonia (Hartvigsen 2014; Jürgenson et al., 2025), with acquisition of neighbouring plots remaining unfavourable due to poor site conditions, perpetuating the fragmentation that prevents farmers from adopting labour-saving technologies regardless of available capital or knowledge.

Current spatial planning practices in Estonia, like in most CEE countries, rely predominantly on regulatory instruments (76% at the local level) rather than visionary or strategic approaches (Nadin et al., 2018; Jürgenson et al., 2025), limiting small peripheral LG capacity to pursue transformative spatial reorganization despite formal land consolidation authority. This regulatory dominance, combined with insufficient data support and technical competence at the local level (Jürgenson et al., 2025), creates the implementation gap between formal competence and practical capacity examined in Studies 2 and 3.

The examples of historical processes and sources of regional path dependence show that local and central government policies have significantly affected productivity and innovation in peripheries. Central government policies have significantly impacted the production possibility curve in agglomeration and periphery (OECD, 2024). In Estonia, these interventions did not help reduce disparities between urban and rural areas; more balanced distribution of resources and opportunities is still needed (OECD, 2024). Regarding innovation activity and productivity in different Estonian regions, path dependency has led to differences in economic outcomes due to unique historical factors and political decisions influencing development of innovation ecosystems.

In Estonia, bigger LGs have a long history of investing in R&D, promoting collaboration between academia and industry, and supporting productivity and entrepreneurship, therefore having a more robust innovation infrastructure compared to small peripheral LGs lacking the same infrastructure, knowledge providers, advanced technologies access, human and financial resources, cooperation partners, and FDI investments. Locational factors, historical events, central government decisions, and investments created advantages and disadvantages persisting over time, influencing farms' innovation and productivity levels in small peripheral LGs. Path-dependent processes shaped RIS (Isaksen, 2001; Tödtling, Trippel 2005), considered the driver of economic growth within endogenous growth or place-based development models.

By understanding the path dependency of different peripheral and small peripheral LGs, local policymakers and stakeholders can identify opportunities to leverage historical strengths and address weaknesses promoting innovation and productivity growth. It is essential to consider each region's unique context and tailor strategies based on historical factors shaping its current economic landscape.

This analysis reveals the complete causal chain from the conceptual framework diagram: path dependency → peripheral RIS → small peripheral LG constraints → focus on four regional development factors → interventions through land consolidation. The Estonian examples demonstrate that while path

dependency severely constrains traditional innovation policies, small peripheral LGs retain capacity to intervene in natural resources and infrastructure (land consolidation, local roads, water/sewerage), indirectly influence cooperation and linkages (twin town partnerships, knowledge circulation), and create framework conditions affecting competition and economic structure and knowledge and human capital. These intervention possibilities, operating through Hall's (1993) policy change orders, form the empirical foundation for testing whether land consolidation enables innovation activities despite organizational thinness.

3. DATA AND METHODS

3.1 Case selection: Estonia as a critical case

The Estonian case represents a theoretically instructive example for examining land consolidation as a spatial planning instrument enabling farm innovation activities in small peripheral local governments due to the convergence of extreme contextual conditions. Estonia exhibits organizationally “thin” regional innovation systems (Tödting and Kaufmann, 1999), with small peripheral LGs disadvantaged compared to agglomerations like Tallinn and Tartu where RIS prerequisites exist. The role of the central government is to equalize municipal revenues¹⁰ and fiscal autonomy according to the European Charter of Local Self-Government (Council of Europe, 1985), yet Estonian LGs have the lowest tax autonomy compared to EU member states (OECD 2018, see Figure 2) and cannot fulfil their functions (National Audit Office, 2012). The various indicators – for example, fiscal and borrowing autonomy, among others (see Figure 2) – of municipality autonomy highlight the constraints on how small peripheral LGs can introduce policy instruments to increase local farms’ productivity and innovation.

Despite these constraints, Estonia’s agricultural innovation ecosystem includes county development centres, AKIS (Agricultural Knowledge and Innovation Systems), universities, research institutes, and professional organizations (OECD, 2013). Within this ecosystem, small peripheral LGs occupy a distinct niche role: spatial planning and coordination of local infrastructure enabling farm-level innovation adoption. While AKIS provides advisory services, it cannot restructure fragmented parcels preventing farmers from deploying this knowledge. While national and EU institutions design agricultural innovation policies, small peripheral LGs control spatial prerequisites through land consolidation authority (Land Consolidation Act, 2024) alongside responsibility for local roads, public water, and sewerage systems (Local Government Organisation Act, 2023). This complementary role recognizes that innovation diffusion – not innovation creation – represents the primary bottleneck in peripheral regions (OECD, 2013). However, insufficient data support and competence at the local level prevents effective implementation (Jürgenson et al., 2025), creating critical capacity gaps between formal responsibilities and practical capabilities.

Estonia’s 1990s transition from Soviet central planning to a market economy represents a critical external shock fundamentally reshaping regional preconditions (Grillitsch et al., 2022). This transition created the dual legacy of extreme land fragmentation through plot-by-plot restitution and weakened spatial planning systems when services were closed under the “breaking with centrally planned economy” banner (Jürgenson et al., 2025). This established the founda-

¹⁰ The role of central government in equalizing LG revenues and ensuring fiscal autonomy derives from the European Charter of Local Self-Government (Article 9, paragraph 5), which Estonia has ratified and incorporated into its legal framework, rather than being explicitly stated in Estonian domestic law.

tion for Estonia’s current challenges where Soviet-era structures intersect with market economy requirements while lacking institutional capacity to mediate between them.

Estonia’s 2017 administrative reform decreased the number of LG from 213 to 79 and increased average inhabitants from 6,349 to 17,118, yet two-thirds of LGs remain small (<10,000 inhabitants) by definition (Tödtling and Tripl, 2005). Importantly, no changes occurred in local autonomy indicators comparing the years before (2015) and after (2020) the reform, suggesting structural reforms alone cannot overcome fiscal and institutional constraints (National Audit Office, 2022). The reform did nothing to address underlying technical capacity deficits: small peripheral LGs continue lacking the Geographic Information System (GIS) expertise, spatial analysis capabilities, and stakeholder coordination skills necessary for effective land consolidation implementation (Jürgenson et al., 2025).

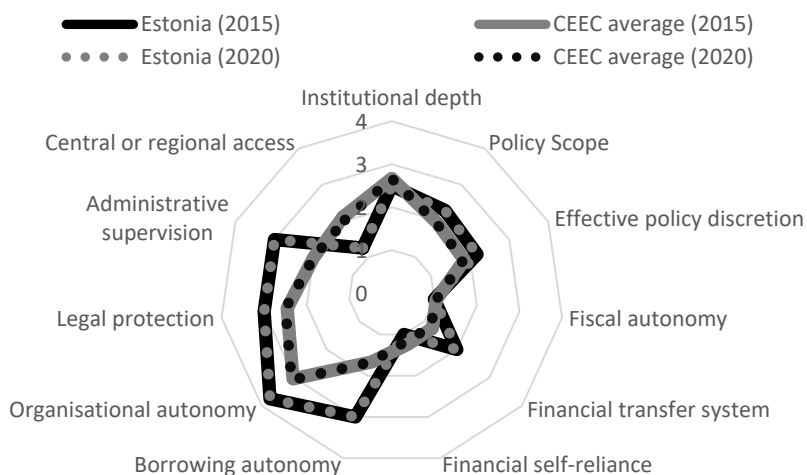


Figure 2. Local government autonomy in Estonia and CEEC average in 2015 and 2020. Source: author’s calculation based on Ladner et al. (2022).

When examining LG autonomy in Estonia and other CEE countries, similar challenges emerge from shared historical experiences and institutional frameworks developed since the post-Soviet period. Limited fiscal autonomy forces small peripheral LGs to find creative resource allocation strategies and build partnerships with national governments and international organizations. The predominance of regulatory instruments (76% at local level) over visionary or strategic planning instruments constrains small peripheral LG capacity to pursue transformative policies (Jürgenson et al., 2025; Nadin et al., 2018). While land consolidation projects fall formally within small peripheral LG competence, effective implementation requires systematic monitoring frameworks, clear

methodological guidance, and multilayer integrated data structures that are largely absent (Jürgenson et al., 2025).

Estonia, like most CEE countries, relies predominantly on regulatory instruments rather than visionary or strategic planning tools (Jürgenson et al., 2025). The COMPASS report (Nadin et al. 2018) reveals varying sophistication across CEE planning systems (see Figure 3), though CEE countries' planning systems remain constrained by their weakening in the 1990s, which fundamentally limited visionary capacity development.

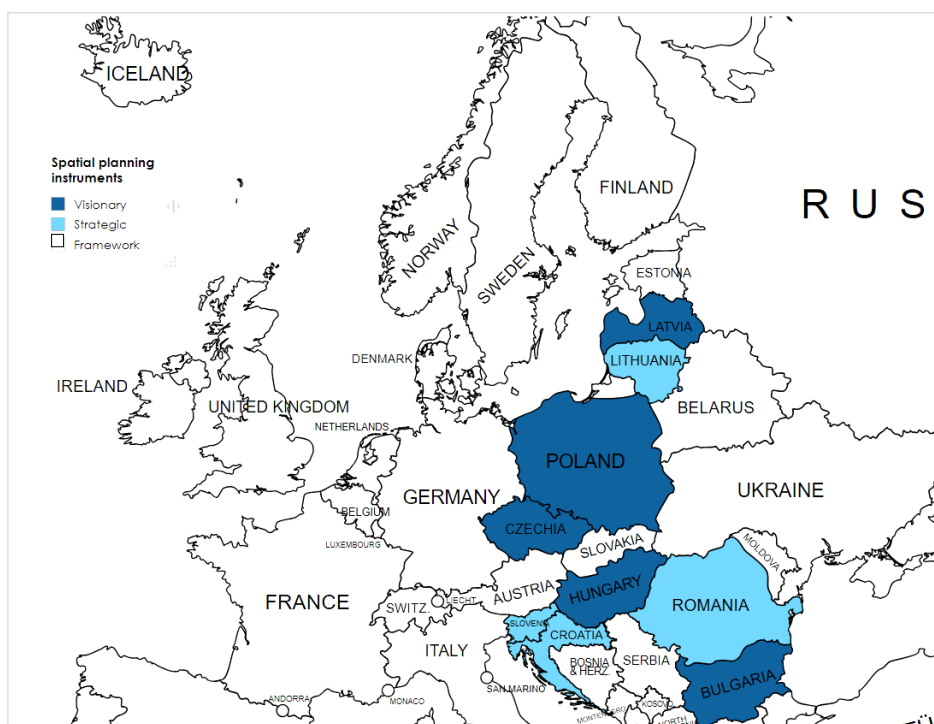


Figure 3. Strategic planning instruments in Central Eastern European countries. Composed based on data from Nadin et al. (2018).

Within this constrained planning landscape, small peripheral LGs in Estonia retain one significant advantage: 57% of agricultural land remains in small peripheral LG territories even after territorial reform. By implementing land consolidation projects, it becomes possible to decrease inefficient land use and increase production possibilities. The necessity for land consolidation in Estonia arises specifically from land reforms implemented since independence, as extensively discussed in Section 2.5.2, which created severe and persistent fragmentation fundamentally constraining farm-level innovation capacity (Hartvigsen 2014; Jürgenson et al., 2025).

Furthermore, Estonian innovation policy is highly centralized with little regional or local focus. LGs are not involved in industrial or R&D planning processes (Karo and Kattel, 2015), leaving them with primarily regulatory and spatial planning instruments. This centralization means that while national and EU institutions control substantive agricultural innovation policy through CAP and R&D programmes, small peripheral LGs must focus on spatial and infrastructural prerequisites enabling farmers to adopt externally-developed innovations. However, the rural development component of the EU's Common Agricultural Policy (CAP Pillar II) explicitly delegates rural development implementation to local authorities requiring GIS analysis, multi-stakeholder consultation, environmental impact assessments, and outcome monitoring (European Commission, 2021). Without small peripheral LG technical capacity for these functions, CAP rural development funds cannot be effectively deployed regardless of national agricultural innovation policy quality (Dax et al., 2016; Sutherland et al., 2022). This technical capacity requirement intersects with Estonia's weak capacity building investments (2% of CP allocation, as shown in Study 1) and insufficient data support at the local level (Jürgenson et al., 2025), creating situations where funding exists but local implementation capacity lags behind.

Estonia represents a critical case for examining how small peripheral LGs can enable agricultural innovation despite severe and compounding constraints operating at multiple governance levels.

- At the EU/national policy level – lowest tax autonomy among EU member states, centralized national innovation policy limiting local discretion, weak equalization systems constraining fiscal capacity, and CAP Pillar II delegation requiring technical skills that small peripheral LGs lack.
- At the structural agricultural level – extreme fragmentation from the 1990s land reform (detailed in Section 3.1), ongoing structural changes with 66% rental rates in 2024 (Vill-Sulp et al. 2025), creating tenure uncertainty, and 57% of agricultural land in small peripheral territories distant from urban innovation infrastructure.
- At the local institutional level – organizational thinness (absent universities, missing science parks, and limited knowledge providers, as established in Section 1.1), planning systems weakened by the 1990s reforms constraining visionary capacity, predominance of regulatory over strategic planning instruments, insufficient data support and competence preventing effective land management (Jürgenson et al., 2025), and lack of systematic monitoring frameworks hindering evidence-based policy development.

Within this context, land consolidation falls formally within small peripheral LG competence under the Land Consolidation Act 2024, yet implementation capacity remains critically constrained – creating the precise conditions this thesis examines: whether spatial planning interventions can enable farm innovation activities despite severe institutional, fiscal, and technical limitations. The following chapters empirically test this proposition through three complementary studies examining EU fund allocation patterns across CEE regions (Study 1), farm

structure-productivity relationships at the micro-level (Study 2), and direct effects of land consolidation on innovation activities (Study 3), using Estonia as the empirical context where theoretical mechanisms face their most stringent test precisely because implementation capacity constraints are so severe.

3.2 Data sources and analytical methods

This chapter provides an overview of the data sources and analytical methods used in Studies 1–3 (see Table 2). All three studies are based on secondary data sources and employ quantitative analytical techniques.

Table 2. Data and methods used in Studies 1–3

Study	Data source	Year	Region	Method
Study 1. Duba, W., Loewen, B., Looga, J., Zdražil, P. (2018). Regional development in Central-Eastern European countries at the beginning of the 21st century: path dependence and effects of EU Cohesion Policy	Eurostat, European Commission, DG REGIO	2004–2015	CEE countries, NUTS II level data	Descriptive statistics Beta-convergence Correlation analysis Cluster analysis
Study 2. Looga, J., Jürgenson, E., Sikk, K., Matveev, E., Maasikamäe, S. (2018). Land fragmentation and other determinants of agricultural farm productivity: The case of Estonia.	Farm Accounting Data Network (FADN), Agricultural Registers and Information Bureau (ARIB)	2015	Estonia, farm level data	Descriptive statistics Correlation analysis Regression analysis
Study 3. Looga, J., Maasikamäe, S., Rasva, M., Matveev, E., & Jürgenson, E. (2023). Land consolidation as one of the innovation policy instrument for small LGs: The case of Estonian agricultural farms.	Farm Accounting Data Network (FADN), Agricultural Registers and Information Bureau (ARIB)	2014–2019	Estonia, farm level data	Descriptive statistics Correlation analysis Logistic regression analysis

Source: based on Studies 1–3.

For Study 1, the main data source was Eurostat (covering years 2004–2015), covering the data of EU28 (in total 272 regions¹¹) and Central and Eastern European Countries (10 countries) – Albania, Bulgaria, Croatia, Czechia, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, and Lithuania – and their

¹¹ Without the outliers of Inner London – West and Luxembourg.

NUTS II regions (53 regions¹²). Study 1 also uses CEEC data from the European Commission (CP budget for 2007–2013 and plans for 2014–2020), Eurostat (2017) and DG REGIO (2017). The variables used in Study 1 are presented in Table 3. Study 1 directly addresses the first research sub-question of the thesis by examining whether EU Cohesion Policy enables Central and Eastern European countries, including Estonia, to overcome historical development patterns and promote innovation-driven regional development.

To provide the answer for the first research question of Study 1, a conventional approach of measurement – Beta-convergence of EU regions – was used¹³. This allows us to evaluate the GDP growth patterns of EU regions simultaneously. The NUTSII level of regions is used because EU Cohesion Policy is focused on these type of regions. Beta-convergence could also be used not only for the long term but also for EU Cohesion Policy periods (Pike et al. 2016).

To provide the answer for the second research question of Study 1 the k-means clustering and correlation analyses was performed. Following the theories of the new economic geography and endogenous growth, indicators related to capital and labour and development indicators like human capital, innovation potential, and knowledge were examined. The changes in these indicators (measured by expenditures of EU Cohesion Policy) were also examined. K-means clustering resulted in three groups of CEE regions, which had similar changes in development indicators. Finally, the correlation between the EU Cohesion Policy funding and development indicators in the three groups of CEE regions was performed to see whether the policy's developmental effects varied across different CEE regions. This analysis provides crucial context for understanding the policy environment within which Estonian small peripheral LGs operate, establishing whether external funding mechanisms can effectively support RIS and break path-dependent development trajectories.

¹² For the calculation of beta-convergence there were 51 regions, without the outliers of Bratislava and Bucuresti – Ilfov. Outliers are excluded because of extremely high changes in development indicators. For the calculations of cluster analysis there were 48 regions, without the outliers of Bratislava, Bucuresti – Ilfov, Prague, Slovenia and Southeast (in Czechia).

¹³ See Study 1 page 83.

Table 3. Variables used in Study 1

Variable	Description	Source	Role in analysis
GDP per capita	GDP per capita in purchasing power standard, in euros	Eurostat	Dependent variables
	GDP per capita in PPS as percentage of the EU average		
The structure of cohesion policy budget by thematic objectives	% from budget of Member States allocated to selected aims, based on annual implementation report	European Commission	Variables of interest (hypothesis testing)
GDP growth	Annual growth rate of GDP, %	Eurostat	Dependent variables
GFCF	Gross fixed capital formation	All the indicators were weighted by the size of population; all monetary terms were expressed in EUR. Data from DG REGIO and Eurostat	Control variables
EMP	Employment		Control variables
PET	Participation in education and training		Relevant covariates
GERB	Gross expenditure on research and development of the business enterprise sector		Relevant covariates
GERN	Gross expenditure on research and development of the non-business enterprise sector		Relevant covariates
EEUCP	Expenditures of EU Cohesion Policy per capita, in euros	DG REGIO and Eurostat	Variables of interest (hypothesis testing)

Source: based on Study 1.

The case in land consolidation (LC) of Estonia was chosen based on the methodology described in Section 3.1. Annex 6 illustrates Estonian the practical interventions of small peripheral LGs for enabling firms' innovation activities. This analysis summarizes the intervention capabilities available to Estonian small peripheral LGs, based on framework conditions like legal decision autonomy, resource intensity, competition among LGs, and political criteria.

Examining land consolidation (Study 2 and Study 3) as a practical intervention for Estonian small peripheral LGs is justified because this intervention fulfills the framework conditions developed in the thesis. The first framework condition is decision autonomy, where small peripheral LGs possess the legal authority to manage their own land consolidation processes. Small peripheral LGs can implement land consolidation through various approaches, including the German system where land rearrangement occurs without requiring LG financial investment (Hartmann and Spit, 2015). This approach particularly benefits Estonia's small peripheral LGs, thus satisfying the second framework condition: resource intensiveness.

The third framework condition is horizontal LG competition. When land consolidation enhances the innovation capacity of existing local farms through strategic land rearrangement, horizontal competition among LGs (competition for resources and preconditions like available land necessary for practical interventions) becomes essentially non-existent. This policy instrument offers unique value to small peripheral LGs by leveraging one of their few competitive advantages over larger LGs: the availability of specific local resources. Small peripheral LGs can effectively implement land consolidation policies thanks to their accessible land, favourable land pricing, proximity to agricultural production centres, and local leadership's agricultural expertise.

The fourth framework condition is political considerations. Land rearrangement occasionally produces negative outcomes for certain landowners – for instance, when a newly reconfigured land parcel improves field shape but features lower soil fertility than the original plot. Such scenarios may discourage some small peripheral LG politicians from pursuing LC initiatives for fear of losing voter support. Political challenges often stem from insufficient knowledge and experience in executing land consolidation policies. Western European countries have already accumulated substantial positive experience and knowledge regarding successful land consolidation and its beneficial effects on farm labour productivity. Learning from these established practices makes addressing knowledge gaps considerably easier. Additionally, Estonia's 2017 territorial reform created larger LG territories with potentially greater resources for staff education and development. These factors suggest that land consolidation projects now have higher implementation success potential and greater impact on local farm innovation activities than was previously possible.

Land consolidation could serve as a key driver for regional development in Estonia when supported by complementary practical interventions of small peripheral LGs. These include development plans and policies that simultaneously address land consolidation, land use, local infrastructure, community needs, housing, environmental protection, and effective natural resource utilization. These aspects carry significant weight in EU strategies, while global trends in food demand, environmental protection, and especially issues related to national security present major opportunities and challenges for both European and Estonian rural areas.

For Studies 2 and 3, the main data sources were the databases of the Agricultural Registers and Information Bureau (ARIB) and the Farm Accounting Data Network (FADN). For Study 2, data from 2015 was used, while Study 3 utilized data from 2014–2019. A total of 7,610 agricultural holdings are above the economic size of €4,000, and these form the field of survey of the FADN. The regression model in Study 2 includes 435 farms located in Estonia, while Study 3 includes 392 farms located in Estonia with altogether 2,352 observations (years 2014 to 2019). The variables used in Studies 2 and 3 are presented in Table 4. These studies directly examine the mechanisms through which small peripheral local governments can influence farm innovation activities and labour producti-

vity, providing empirical evidence for the main research question of the thesis by analysing farm-level data within the Estonian context.

To answer the research questions of Studies 2 and 3, regression analyses were performed. The two data sources ARIB and FADN were used, the former providing the data for measuring land fragmentation (LF) of land parcels belonging to a farm, and the latter providing data about the economic activity of Estonian farms. The relationship between LF and labour productivity remains understudied due to measurement challenges (Demetriou et al., 2013). Current measures focus on parcel numbers and sizes, using indices such as the Januszewski index (Januszewski, 1968) and the Schmook index (Schmook, 1976), as noted by Latruffe and Piet (2014). However, existing research rarely examines whether the impact of land fragmentation on labour productivity persists when controlling for non-fragmentation variables. By analysing land fragmentation patterns, these studies address the second research sub-question of the thesis regarding how farm structure impacts farm labour productivity and innovation activities, which is essential for understanding the potential effectiveness of local government interventions.

Study 2 analyses the influence of land fragmentation on farm labour productivity in Estonia's agricultural sector, using regression analysis with control variables (based on various studies), including farmer education, production type, and Herfindahl diversification index. The results of the study show what factors impact farm labour productivity and, based on that, practical interventions for small local governments and central government were offered. Study 2 establishes the baseline relationship between land structure and labour productivity, providing the foundation for understanding how local government interventions in land consolidation might enhance farm performance.

Study 3 analyses whether land consolidation projects initiated by small local governments increase the probability of local farms' innovation activity using panel data model. This model includes economic, land- and location-related, and other explanatory variables. The primary data comes from the FADN, which provides information on farms' economic activities, financial performance, and also operational characteristics. This is merged with spatial data from the ARIB digital parcel maps, which enables the calculation of various land fragmentation indicators by analysing the spatial distribution and characteristics of farm land holdings. The integration of these two datasets allows for a thorough examination of whether changes in land structure influence farms' probability to perform innovation activity during the studied period. Study 3 directly tests the central hypothesis of the thesis by examining whether small local government initiatives in land consolidation can effectively stimulate farm innovation activities, thus demonstrating their concrete role within regional innovation systems.

Table 4. Variables used in Study 2 and Study 3.

Study No.	Variable	Description	Source	Role in analysis
2	Productivity	Logarithm of production per working hour, continuous variable	FADN	Dependent variable
2, 3	Area-weighted mean size of the parcels	Logarithm of area-weighted mean size of the parcels, continuous variable	ARIB	Variable of Interest (Hypothesis Testing)
2	HHI	Logarithm of Herfindahl diversification index, continuous variable	FADN	Control variable
2	Education	Categorical variable: Only practical agricultural experience; Basic agricultural training; Full agricultural training	FADN	Relevant covariate
2	Farming system	Categorical variable: Conventional production; Only organic; Organic and conventional; Conversion to organic	FADN	Relevant covariate
2, 3	Farm size group	Categorical variable: 0–40 hectare; 41–100 hectare; 101–400 hectare; >400 hectare	FADN	Relevant covariate
2, 3	Farm production type	Categorical variable: Field crops; Horticulture; Other permanent crops; Milk; Other grazing livestock; Granivores; Mixed production	FADN	Relevant covariate
3	Whether the farm invests in buildings, machinery, equipment, and inventory	Dummy variable (binary): 0 = “Did not invest”; 1 = “Invests”	FADN	Dependent variable
3	Capital stock (buildings, machinery, equipment, or inventory)	Log transformed continuous variable, euro	FADN	Control variable
3	Number of employees	Log transformed continuous variable, count of employees	FADN	Control variable
3	Productivity per working hour	Log transformed continuous variable, euro	FADN	Relevant covariate

Table 4 (continued) Variables used in Study 2 and Study 3.

3	Januszewski index	Continuous variable, ranged from 0 to 1	ARIB	Relevant covariate
3	Schmook index	Continuous variable, the reciprocal of index, ranged from 0 to 1	ARIB	Relevant covariate
3	Share of leased land	Categorical variable: no leased land; some of the land is leased; all land plots are leased	FADN	Control variable
3	Average distance of land plots from: capital; county centre; state road	distance from Tallinn, km; distance from county centre, km; distance from state road (main, basic, and secondary roads), km	ARIB	Control variable
3	Year	Year dummy (reference = 2014): 2015, 2016, 2017, 2018	FADN, ARIB	Control variable

Source: based on Studies 2 and 3.

4. EMPIRICAL STUDIES

5. DISCUSSION AND CONCLUSION

5.1 Summary of the studies

This thesis examines whether and how small peripheral local governments in Estonia can enable farm innovation activities through spatial planning interventions, specifically land consolidation, despite operating in organizationally thin regional innovation systems. The research contributes to the regional innovation systems (RIS) literature, agricultural economics, and spatial planning scholarship by demonstrating empirically how peripheral actors can influence innovation outcomes through strategic spatial interventions across multiple regional development factors despite severe institutional and fiscal constraints. Three complementary studies establish the complete empirical chain: Study 1 examines the macro-level policy environments shaping small peripheral LG capacity; Study 2 validates the farm structure-productivity mechanism; and Study 3 demonstrates that spatial planning interventions translate into measurable innovation activities outcomes.

Study 1: Regional development in Central-Eastern European countries at the beginning of the 21st century: path dependence and effects of EU Cohesion Policy

Study 1 analyses 53 NUTS II regions across Central and Eastern European countries during 2007–2013, examining whether EU Cohesion Policy offers mechanisms to overcome path-dependent development patterns identified in the RIS literature (Martin and Sunley, 2006; Isaksen, 2001). The study identifies systematic convergence through beta-convergence analysis showing that GDP per capita increases across CEE regions, while k-means clustering reveals three distinct regional types exhibiting differential responsiveness to cohesion policy funding. Estonia allocated 19% of cohesion policy resources to Innovation and R&D (highest among the CEE countries analysed) but only 2% to capacity building (lowest among the CEE countries analysed) and 0% to Urban and Territorial Dimension, creating a structural imbalance between national innovation supply and local implementation capacity.

These findings contribute to ongoing debates in spatial economics regarding convergence mechanisms in transition economies (Bachtler and Gorzelak, 2014) by providing empirical evidence that EU Cohesion Policy facilitates beta-convergence in CEE contexts. The identification of three distinct regional types with varying CP responsiveness challenges uniform “one-size-fits-all” approaches criticized in place-based development literature (Barca et al. 2012; Crescenzi et al. 2020), supporting arguments by Tödtling and Trippel (2005) for differentiated regional innovation policies adapted to specific RIS configurations. Recent evidence demonstrates that regional divides persist and can even widen during crisis periods despite convergence policies (Crescenzi et al. 2020), validating this thesis’s finding that structural imbalances in policy design create path-dependent constraints even when aggregate funding levels appear adequate.

The finding that Estonia's 19% R&D allocation creates innovation supply while 2% capacity building allocation constrains local implementation addresses a critical gap in the RIS literature, which predominantly focuses on knowledge production infrastructure (universities, research institutes) rather than the local institutional capacity to operationalize innovations (Doloreux and Dionne 2008; Tödtling and Kaufmann 1999). This empirical evidence extends Isaksen's (2001) peripheral RIS typology by demonstrating that organizational thinness manifests not merely through absent knowledge providers but critically through under-resourced local government capacity to create spatial prerequisites enabling innovation adoption. The structural imbalance identified here – abundant innovation supply (national R&D investment) constrained by limited local implementation capacity (municipal institutional capability) – represents a novel contribution positioning small peripheral LGs as critical yet under-examined bottlenecks in peripheral innovation systems, with recent evidence showing that institutional quality varies dramatically even within countries (Charron et al. 2022), validating the importance of capacity building investments for effective policy implementation.

By analysing how national CP allocation decisions (Study 1's thematic priorities) affect small peripheral LG capacity to implement spatial planning interventions, this study contributes to multi-level governance scholarship (Marks, 1993; Hooghe and Marks, 2003) by demonstrating how resource allocation patterns at supranational (EU) and national levels create enabling or constraining conditions for local-level innovation policy implementation. The finding that Estonia's allocation pattern creates systemic disconnection – 19% funding innovations that require spatial prerequisites but only 2% building capacity to create those prerequisites – extends the CAP implementation literature (Dax et al. 2016; Sutherland et al. 2022) by revealing how delegating the implementation of rural development to local authorities without commensurate capacity building creates implementation gaps regardless of the quality of agricultural innovation policy. Recent research demonstrates that the quality of government varies substantially across European regions, even within the same country (Charron et al. 2022), supporting this thesis's argument that national-level policy design must account for the heterogeneity of sub-national institutional capacity when delegating implementation responsibilities to local authorities.

Study 2: Land fragmentation and other determinants of agricultural farm productivity: The case of Estonia

Study 2 examines 435 Estonian farms from FADN 2015 cross-sectional data, demonstrating that farm spatial structure significantly affects labour productivity (output per working hour) independent of farm size, challenging the conventional agricultural economics literature that conflates fragmentation effects with scale disadvantages. The study develops area-weighted mean parcel size as a novel fragmentation metric, demonstrating superior correlation with labour productivity ($r=0.45$) compared to traditional Januszewski ($r=-0.94$ with parcel count)

and Schmook ($r=-0.60$ with parcel count) indices that primarily capture parcel numbers rather than spatial configuration.

These findings address a critical methodological gap in the land fragmentation measurement literature, where traditional indices (Januszewski, 1968; Schmook, 1962) developed for Western European contexts fail to capture fragmentation effects in CEE post-socialist contexts characterized by extreme parcel numbers (Estonian farms average 30 parcels). By demonstrating that traditional indices correlate primarily with parcel quantity rather than spatial organization efficiency, this study validates critiques by Demetriou et al. (2012) regarding fragmentation measurement limitations and extends Van Dijk's (2003) theoretical argument about spatial configuration mattering independently of farm size. The area-weighted mean size of parcels metric represents a methodological contribution enabling more accurate assessment of land consolidation project effectiveness in post-socialist context (Estonia).

The empirical validation that spatial structure affects labour productivity independent of farm size contributes to the agricultural economics literature on productivity determinants (Latruffe and Piet 2014; Rahman and Rahman 2008; Gonzalez et al. 2007) by specifying the dual-pathway mechanism through which fragmentation constrains productivity: direct effects through transaction costs (time wasted moving equipment between scattered parcels) and indirect effects through innovation adoption constraints (inability to deploy scale-dependent technologies on irregular geometries).

By establishing that spatial configuration affects labour productivity which subsequently determines investment capacity for innovation activities (Reimers and Klasen 2013; Rizov et al. 2013), Study 2 provides an empirical foundation for understanding the poverty trap mechanism in fragmented agricultural systems identified theoretically by Alvarez and Arias (2004). The finding that education significantly affects productivity across production types contributes to the human capital literature in agriculture (Reimers and Klasen 2013) while providing policy-relevant evidence that small peripheral LG spatial planning interventions must coordinate with educational initiatives to maximize productivity effects – addressing the knowledge and human capital regional development factor identified in the thesis framework.

The demonstration that spatial reorganization affects labour productivity independent of farm enlargement contributes to land consolidation scholarship (Van Dijk, 2003; Crecente et al. 2002; Thomas, 2006) by providing empirical evidence that consolidation benefits operate through spatial configuration improvements rather than requiring scale increases. This finding has critical policy implications for rental-dominated contexts like Estonia (66% leased land in 2024) where farm enlargement through land purchases remains structurally constrained by incomplete land markets and user-owner separation, but spatial reorganization through consolidation remains feasible by coordinating parcels across tenure boundaries – extending German multi-purpose land consolidation models (Thomas, 2023) to post-socialist institutional contexts.

Study 3: Land consolidation as one of the innovation policy instrument for small LGs: The case of Estonian agricultural farms

Study 3 employs panel data (392 Estonian farms, 2014–2019) with farm-level fixed effects to examine whether changes in farm structure affect the probability of innovation activities, operationalized as investment in buildings, machinery, equipment, and inventory following Oslo Manual (OECD/Eurostat, 2018) innovation activity definitions. Results demonstrate that area-weighted mean parcel size significantly increases the probability of innovation activities (odds ratio 2.01, $p < 0.10$), while labour productivity per working hour exhibits a strong positive relationship with the likelihood of innovation (odds ratio 1.44, $p < 0.01$). Farms operating entirely on leased land show an 80.5% lower probability of innovation (odds ratio 0.20, $p < 0.10$) compared to owner-operated farms, though spatial structure effects persist across tenure categories. Previous capital investments and employment levels also predict innovation activities, validating the cumulative nature of innovation capacity building.

These findings contribute to the innovation measurement literature (OECD/Eurostat, 2018; Eurostat, 2019) by operationalizing the outcomes-activities distinction in agricultural contexts, demonstrating that spatial prerequisites affect innovation activities independent of outcomes. By showing that area-weighted mean parcel size affects the probability of innovation controlling for farm size, this study extends the Oslo Manual's sector-specific guidance that innovation activities in traditional industries emphasize equipment acquisition over formal R&D, providing agricultural validation for frameworks developed in manufacturing contexts. The finding contributes to the agricultural innovation systems literature (OECD, 2013; Klerkx et al. 2012) by demonstrating how infrastructural system failures (fragmentation) create binding constraints on innovation activity independent of knowledge or financial resources. Recent evidence shows spatial prerequisites remain critical even for digital agricultural innovations requiring broadband connectivity, regular field geometries for GPS equipment, and consolidated parcels for sensor deployment (Fielke et al. 2020), validating that the spatial prerequisite mechanism extends beyond traditional mechanization to contemporary precision agriculture technologies promoted through EU agricultural innovation policies.

The panel fixed-effects methodology strengthens causal inference beyond cross-sectional land consolidation studies (Van Dijk, 2003; Latruffe and Piet, 2014), demonstrating that within-farm changes in spatial structure over time affect the probability of innovation activities. This methodological advance addresses critiques by Demetriou et al. (2012) regarding reverse causality concerns in fragmentation-innovation relationships, showing that improved spatial organization temporally precedes innovation investments.

The finding that fully-leased farms exhibit a significantly lower probability of innovation activity despite spatial structure improvements contributes to the agricultural tenure literature (Vranken and Swinnen, 2006) by demonstrating that user-owner separation creates investment barriers independent of spatial configuration. However, the persistence of positive spatial structure effects across tenure

categories represents a novel finding: even rental-dominated systems benefit from consolidation through reduced transaction costs and improved machinery deployment efficiency, suggesting that land consolidation remains a viable policy instrument in high-rental contexts (Estonia's 66% in 2024) where traditional consolidation models assuming ownership transfers (Thomas, 2023) prove structurally infeasible. This contributes to the emerging literature on adapting Western European land consolidation models to post-socialist contexts characterized by incomplete property rights transitions and rental-dominated tenure systems (Jürgenson et al. 2025).

By demonstrating that small peripheral LG spatial planning interventions (land consolidation) significantly affect farm the probability of innovation activities despite organizational thinness (absent universities, missing science parks), Study 3 contributes to the RIS literature on peripheral regions (Isaksen, 2001; Tödtling and Trippel, 2005; Doloreux and Dionne, 2008) by providing empirical evidence that alternative innovation infrastructure can partially compensate for the absence of knowledge production institutions. The finding that land consolidation enables innovation activities through creating spatial prerequisites extends Asheim et al.'s (2016) framework on endogenous path renewal by demonstrating how peripheral actors can influence innovation outcomes through strategic interventions targeting binding spatial constraints rather than attempting to replicate core region knowledge infrastructure. This represents a novel contribution positioning spatial planning as an underutilized practical intervention for organizationally thin peripheral regions where traditional innovation policies (university-industry linkages, R&D grants, science parks) remain structurally infeasible due to the fiscal and institutional constraints identified in Study 1.

The demonstration that spatial planning interventions affect innovation activities addresses implementation gaps in the CAP Pillar II rural development literature (European Commission 2021; Dax et al. 2016; Sutherland et al. 2022) by showing that while national and EU institutions design agricultural innovation policies (determining which innovations are available), small peripheral LG spatial planning capacity determines whether farms can physically adopt those innovations. This finding contributes to the multi-level governance literature by specifying the complementary division of labour: CAP designs innovation supply (precision agriculture technologies, organic certification schemes, sustainable practices promoted through eco-schemes), while small peripheral LGs create spatial demand conditions (consolidated parcels enabling technology deployment, infrastructure reducing transaction costs, spatial organization making scale-dependent innovations economically feasible). The identification of institutional capacity as a critical bottleneck – Study 1's 2% capacity building allocation constraining small peripheral LG technical expertise (GIS analysis, stakeholder coordination, environmental assessment) – extends CAP implementation scholarship by demonstrating how delegation without commensurate capacity building creates systemic disconnection between policy design and local implementation regardless of the quality of agricultural innovation policy.

Integrated Contributions: The Complete Empirical Chain

The three studies collectively contribute to a novel framework for understanding how peripheral innovation systems function when organizational thinness prevents traditional knowledge-based innovation policies. Study 1 establishes the macro-level policy environment demonstrating structural imbalance: abundant innovation supply (19% R&D allocation funding national research and agricultural innovation policy design) constrained by critically under-resourced local implementation capacity (2% capacity building allocation limiting small peripheral LG institutional capability). Study 2 validates the micro-level productivity mechanism demonstrating that spatial constraints create binding barriers independent of knowledge availability or financial resources. Study 3 completes the chain by demonstrating that spatial planning interventions addressing these constraints translate into measurable innovation activities outcomes. This integrated framework extends the RIS literature (Cooke et al. 1997; Asheim and Isakson, 2002) by demonstrating that innovation system effectiveness in peripheral regions depends not only on knowledge production capacity but critically on local institutional capacity to create spatial prerequisites enabling innovation adoption – a dimension largely overlooked in existing RIS frameworks focused predominantly on knowledge infrastructure rather than spatial enablement.

The thesis contributes to the path dependency literature (North, 1990; Martin and Sunley, 2006; Kay, 2005) by demonstrating how historical processes (1990s land reform creating extreme fragmentation, weakened planning systems from transition-era institutional disruption) create binding constraints on current innovation capacity, while incremental policy interventions (second-order instrument changes through land consolidation) can enable innovation activities despite these constraints. This finding challenges deterministic interpretations of path dependency criticized by Kay (2005) while supporting arguments about institutional evolution through strategic interventions within path-dependent constraints. Recent theoretical advances demonstrate how peripheral actors can exercise meaningful agency within path-dependent constraints through strategic exploitation of opportunity spaces – windows where resource recombination and institutional experimentation become possible despite structural limitations (Grillitsch and Sotarauta, 2020). This framework supports this thesis's finding that small peripheral LGs retain capacity for path renewal through spatial planning interventions despite organizational thinness, positioning land consolidation as such strategic opportunity where existing legal authority (Planning Act, Land Consolidation Act) enables meaningful intervention without requiring structural transformation. External shocks (EU accession, Cohesion Policy funding) can enable paradigm shifts otherwise impossible for resource-constrained small peripheral LGs (Grillitsch et al. 2022), showing that even severely constrained peripheral actors retain meaningful agency through the strategic deployment of available policy instruments.

The thesis contributes to ongoing debates regarding place-based versus space-neutral development policies (Barca et al. 2012) by demonstrating that uniform

policy approaches fail to address context-specific constraints in peripheral regions. The finding that Estonia's CP allocation pattern (19% R&D, 2% capacity building) creates systemic disconnection between innovation supply and local implementation capacity validates arguments for differentiated policy approaches tailored to specific regional contexts (Tödtling and Trippel 2005). Recent evidence shows that regional economic divides can persist and even widen during crisis periods despite convergence-oriented policies (Crescenzi et al. 2020), demonstrating that place-neutral approaches assuming automatic diffusion of innovation from core to peripheral regions fail to account for structural bottlenecks in implementation capacity identified in this thesis. The framework identifying four regional development factors (knowledge and human capital, cooperation and linkages, natural resources and infrastructure, institutional capacity) that small peripheral LGs can influence provides an analytical tool for designing place-based interventions addressing multiple constraints simultaneously rather than isolated single-factor approaches. This contributes methodologically to place-based policy evaluation by enabling systematic assessment of how policy interventions affect different dimensions of peripheral development systems.

Methodologically, the thesis demonstrates progression from cross-sectional correlational analysis (Study 2, establishing productivity-structure relationships) to panel fixed-effects causal inference (Study 3, demonstrating structure-innovation activities relationships), strengthening empirical rigour beyond the existing land consolidation literature predominantly relying on cross-sectional comparisons (Van Dijk, 2003; Latruffe and Piet, 2014). The development of area-weighted mean size of parcels metric represents a significant contribution to land fragmentation measurement, providing practitioners with improved tools for monitoring consolidation project effectiveness in post-socialist contexts, with recent validation through spatial panel applications in similar CEE contexts (Janus and Taszakowski, 2023). The integration of macro-level CP allocation analysis with micro-level farm productivity and innovation studies represents a novel multi-level analytical approach demonstrating how policy decisions at supranational and national levels create enabling or constraining conditions for local-level outcomes, contributing to multi-level governance research methodologies.

The thesis challenges prevailing assumptions in the RIS literature (Amin, 2017) suggesting that peripheral regions lacking knowledge infrastructure cannot meaningfully influence innovation outcomes. By demonstrating that small peripheral LGs can enable farm innovation activities through spatial planning interventions despite organizational thinness, this research extends Asheim et al.'s (2016) framework on endogenous actors in regional development, showing that even severely resource-constrained peripheral actors retain capacity for path renewal through strategic interventions targeting binding constraints within their legal authority and institutional capacity. Recent theoretical work on change agency in peripheral regions demonstrates that actors can create opportunity spaces for new path development through strategic resource combination and institutional experimentation even when formal power and resources remain

limited (Grillitsch and Sotarauta, 2020), supporting this thesis's empirical finding that small peripheral LG spatial planning authority – though narrow in scope – enables meaningful practical intervention when strategically deployed to address binding spatial constraints preventing innovation adoption.

5.2 Practical and policy implications for small peripheral LGs

Beyond theoretical contributions to the RIS literature and empirical advances in understanding land fragmentation effects, this thesis provides actionable insights for policy practitioners operating at multiple governance levels. The findings demonstrate that while peripheral regions face severe structural constraints – organizational thinness, fiscal limitations, weak institutional capacity – strategic deployment of available policy instruments can enable meaningful innovation outcomes. This section translates the theoretical framework and empirical findings into practical guidance for policy practitioners operating at multiple governance levels. The primary focus addresses small peripheral local government interventions, which is the central concern of this thesis's research questions. However, the empirical findings, particularly Study 1's identification of structural imbalances in cohesion policy allocation, reveal constraints at national and EU levels that affect small peripheral LG implementation capacity. Brief observations on these enabling conditions are included where they emerge naturally from the research, though comprehensive policy recommendations for higher governance levels extend beyond the scope of this investigation.

Land consolidation as a viable practical intervention: Small peripheral LGs in Estonia and similar CEE contexts should recognize land consolidation as a feasible spatial planning intervention for creating prerequisites enabling farm innovation activities despite limited resources. Unlike traditional innovation policies requiring universities, research institutes, or science parks that remain structurally unavailable in peripheral regions, land consolidation utilizes spatial planning powers that small peripheral LGs already possess under existing legal frameworks (Estonia's Planning Act, 2015 and Land Consolidation Act, 2024). The empirical evidence from Study 3 demonstrates that spatial reorganization significantly increases innovation activities probability, validating land consolidation effectiveness as practical intervention within small peripheral LG competencies.

Strategic prioritization of consolidation areas: Small peripheral LGs should systematically identify areas where land fragmentation creates the most severe constraints on farm innovation activities, using the area-weighted mean size of parcels metric developed in Study 2 as a diagnostic tool for measuring fragmentation severity and tracking improvement over time. Priority should be given to areas where: (1) fragmentation prevents deployment of scale-dependent technologies (precision agriculture, large-scale mechanization) despite farmer interest and available CAP subsidies; (2) multiple farms could benefit from coordinated infrastructure investments (roads, drainage, irrigation) requiring spatial coordina-

tion across property boundaries; (3) young farmers or new entrants face structural barriers preventing long-term investment due to tenure uncertainty created by fragmented spatial configurations. This strategic targeting maximizes the impact of limited small peripheral LG resources by focusing on areas where spatial constraints create binding bottlenecks preventing innovation adoption despite adequate knowledge and financial resources.

Multi-stakeholder platform creation: The consolidation planning process itself creates valuable social infrastructure for knowledge exchange beyond the technical infrastructure improvements. Small peripheral LGs should deliberately design consolidation projects to maximize these knowledge diffusion benefits by organizing commodity-specific stakeholder consultations where farmers producing similar products (dairy, crops, organic, mixed operations) interact with advisors, equipment suppliers, and successful early adopters during the planning process. Study 2's finding that productivity effects vary across production types suggests tailored approaches: dairy farm consolidation projects should involve dairy advisors and milk processors in planning discussions, while crop production consolidation should engage grain buyers and precision agriculture technology providers. These platforms strengthen the cooperation and linkages regional development factor (developed in Section 2.3) while simultaneously addressing natural resources and infrastructure through spatial reorganization.

Integration with educational and advisory initiatives: Study 2's finding that education significantly affects labour productivity across all production types demonstrates that spatial planning interventions must coordinate with human capital development to maximize effectiveness. Small peripheral LGs should use consolidation planning processes as opportunities to connect farmers with educational institutions, vocational training providers, and AKIS advisory services, thereby strengthening the knowledge and human capital regional development factor. Practical approaches include: organizing field demonstrations of precision agriculture equipment on newly consolidated parcels to show farmers how spatial reorganization enables technology adoption; partnering with agricultural schools to conduct training sessions during consolidation planning meetings; and coordinating with county development centres to provide business planning assistance, helping farmers translate productivity improvements into innovation investments.

Inter-municipal cooperation for capacity building: Study 1's finding that Estonia allocated only 2% of cohesion policy resources to capacity building – the lowest among CEE countries – reveals critical constraints on small peripheral LG technical expertise for implementing land consolidation effectively. Small peripheral LGs should form regional cooperation networks specifically focused on land consolidation, sharing costs for hiring GIS specialists, spatial planners, and environmental assessment experts who serve multiple municipalities simultaneously. The Estonian Local Government Organisation Act § 61 provides a legal framework for such cooperation through county-level joint planning bodies, enabling small peripheral LGs to pool resources for technical capacity that individual municipalities cannot afford independently. This approach mirrors the

German model where state-level Rural Development Agencies (Ämter für ländliche Entwicklung) provide professional support to multiple small local governments (Thomas, 2023), compensating for organizational thinness through coordinated multi-municipal service delivery rather than expecting each small peripheral LG to maintain in-house expertise.

Leveraging multiple funding sources beyond the LEADER¹⁴ approach: Estonian small peripheral LGs should expand beyond LEADER programme to actively pursue land consolidation projects using multiple funding mechanisms. During 2007–2013, Estonian LGs accessed only the LEADER measure under CAP, receiving merely 8.3% of LEADER budgets for 414 projects averaging €9,909 each, which is insufficient for meaningful consolidation interventions. Polish experience demonstrates alternative approaches: between 2007–2013, Poland allocated €160 million from the CAP Programme of Rural Area Development specifically to land consolidation projects, achieving significant scale through combining CAP Pillar II rural development funds with national co-financing and cohesion policy infrastructure measures (Janus and Markuszewska, 2017). Estonian small peripheral LGs should develop technical capacity to prepare competitive project proposals combining CAP Pillar II rural development funding for consolidation planning and implementation with cohesion policy infrastructure measures for roads, water systems, and drainage coordinated with consolidation and also national agricultural support for advisory services and farmer training accompanying spatial reorganization. This funding diversification addresses the institutional capacity factor that Study 1 identified as critically under-resourced.

Monitoring and adaptive management: Small peripheral LGs should establish systematic monitoring frameworks tracking consolidation project outcomes using the area-weighted mean size of parcels metric as key performance indicator. Pre-consolidation baseline measurements enable assessment of spatial reorganization effectiveness, while post-consolidation monitoring of farm innovation investments (machinery purchases, building construction, technology adoption) validates whether improved spatial structure translates into innovation activities, as demonstrated in Study 3. This evidence-based approach enables small peripheral LGs to refine implementation strategies based on empirical outcomes rather than assumptions, addressing the lack of systematic monitoring frameworks identified in the Estonian context analysis (Section 3.1). Monitoring data also strengthens the capacity of small peripheral LGs to demonstrate project effectiveness when applying for additional funding, building institutional credibility that partially compensates for organizational thinness.

Multi-stakeholder coordination and conflict resolution: Land consolidation inherently involves multiple stakeholders with potentially conflicting interests: farmers seeking consolidated parcels for operational efficiency; landowners

¹⁴ LEADER is an acronym derived from the French phrase “Liaison Entre Actions de Développement de l’Économie Rurale” which translated as “Links between activities (or actions) for the development of rural economy”.

(often non-farming) prioritizing land values and rental income; environmental organizations concerned about biodiversity and ecosystem services; local residents worried about landscape changes and infrastructure impacts; and national agricultural agencies promoting productivity improvements. Small peripheral LGs require the capacity for facilitating negotiations among these stakeholders, managing conflicts constructively, and designing consolidation schemes balancing competing objectives. Practical capacity building includes: training small peripheral LG staff in participatory planning methods, consensus-building techniques, and conflict mediation; developing standardized stakeholder consultation procedures providing clear information about consolidation benefits, costs, and timelines; establishing transparent decision-making processes where stakeholder concerns receive documented consideration even when not fully accommodated; and creating demonstration projects showing successful multi-purpose consolidation balancing agricultural productivity with environmental protection to build stakeholder trust. Polish experience demonstrates that effective stakeholder participation requires strong small peripheral LG leadership and landowner awareness of consolidation benefits – factors that capacity building can strengthen (Janus and Markuszewska, 2017).

Environmental integration and sustainability requirements: Recent EU policy developments – Nature Restoration Law, rewetting organic soils for GHG reduction, Biodiversity Strategy 2030, Farm to Fork Strategy – create additional complexity requiring small peripheral LGs to balance agricultural productivity improvements with environmental protection goals. Small peripheral LGs implementing land consolidation require the capacity to: conduct environmental impact assessments identifying restoration opportunities alongside agricultural consolidation areas; design multi-purpose consolidation creating consolidated parcels for intensive agriculture while establishing buffer zones, wetland restoration areas, and biodiversity corridors within project boundaries; integrate CAP eco-scheme requirements into spatial organization ensuring farmers can access environmental payments while maintaining consolidated operational structures; and coordinate with environmental agencies and NGOs identifying priority areas for nature restoration that can be incorporated into consolidation planning. Western European experience demonstrates that multi-purpose land consolidation successfully balances economic and environmental objectives (Hartvigsen, 2022), but this approach requires technical capacity beyond traditional agricultural consolidation expertise. Capacity building should include: training in ecosystem services assessment methods identifying environmental benefits from consolidation projects; access to environmental expertise through partnerships with universities, research institutes, or environmental agencies; and methodological guidance on integrating EU environmental directives into consolidation design without creating disproportionate burdens on small peripheral farms.

A comprehensive rural development approach: Traditional land consolidation focused narrowly on agricultural productivity improvement through creating larger, more regularly-shaped parcels. The thesis demonstrates that contemporary land consolidation must address multiple objectives simultaneously: economic

(enabling farm innovation activities and productivity improvements identified in Studies 2 and 3); environmental (integrating EU Green Deal objectives, nature restoration, climate adaptation); social (improving rural quality of life, maintaining agricultural employment, supporting young farmer entry); spatial planning (coordinating land use across agriculture, housing, infrastructure, environmental protection). Small peripheral LGs should adopt multi-purpose land consolidation approaches, balancing these objectives rather than pursuing single-purpose agricultural consolidation that may conflict with environmental requirements or fail to address broader rural development needs. Practical implementation measures include: environmental mapping in consolidation planning to identify areas suitable for different functions (intensive agriculture versus restoration); engaging diverse stakeholders beyond farmers (environmental organizations, tourism operators, local residents) in planning processes; designing spatial reorganization creating specialized zones rather than uniform consolidation across entire project areas; coordinating consolidation with other small peripheral LG planning processes (comprehensive planning, infrastructure development, environmental management) for integrated territorial development.

Differential spatial strategies for heterogeneous contexts: Study 2's finding that productivity effects vary across production types (crops, dairy, mixed operations) suggests that land consolidation strategies should adapt to local agricultural structures rather than applying uniform approaches. In crop-producing areas, consolidation should prioritize creating regular field geometries enabling precision agriculture and large-scale mechanization; in dairy regions, consolidation should focus on creating accessible parcels near farm buildings for rotational grazing systems; in mixed farming areas, consolidation should create flexible parcel configurations supporting diverse activities. Similarly, environmental requirements vary spatially: peatland regions require rewetting approaches potentially fragmenting parcels for environmental compliance, while non-sensitive areas can pursue agricultural consolidation without environmental trade-offs. Small peripheral LGs should develop location-specific consolidation strategies reflecting commodity specializations, environmental sensitivities, and infrastructure availability rather than pursuing standardized approaches. This differentiation maximizes consolidation benefits by aligning spatial reorganization with actual farming systems and environmental conditions.

Coordinating with CAP eco-schemes and environmental measures: The CAP 2023–2027 programming period emphasizes environmental performance through mandatory eco-schemes requiring farmers to adopt sustainable practices for receiving direct payments. Small peripheral LGs can coordinate land consolidation with eco-scheme implementation, creating spatial configurations facilitating farmer participation in environmental measures while maintaining consolidated operational structures. For example, consolidation projects organizing field boundaries to accommodate required buffer strips create regular geometries where precision application equipment becomes viable by reducing trade-offs between environmental compliance and operational efficiency; establishing wildlife corridors and biodiversity zones during consolidation enables landscape-

level eco-scheme participation where individual farms coordinate environmental actions; and creating consolidated access to water bodies facilitates riparian buffer implementation as collective action rather than fragmented individual farmer measures. This coordination strengthens the natural resources and infrastructure regional development factor while enabling cooperation and linkages through collective environmental action. Small peripheral LGs serve as essential coordinators ensuring CAP environmental requirements enhance rather than conflict with spatial consolidation objectives.

Long-term monitoring and adaptive management: Multi-purpose land consolidation addressing economic, environmental, and social objectives requires systematic monitoring assessing whether consolidation projects achieve their intended outcomes across multiple dimensions. Small peripheral LGs should establish monitoring frameworks tracking: agricultural outcomes (productivity improvements, innovation activities adoption, farm economic performance measured through the mechanisms validated in Studies 2 and 3); environmental outcomes (biodiversity indicators, water quality, soil health, carbon sequestration in restored areas); social outcomes (farmer satisfaction, young farmer retention, rural employment maintenance). Long-term monitoring spanning 5–10 years post-consolidation captures effects that emerge gradually as farmers adjust operations to consolidated structures and make investment decisions based on improved spatial configurations. Monitoring data enables adaptive management where small peripheral LGs refine consolidation approaches based on empirical evidence about what works in local contexts, building institutional learning that compensates partially for organizational thinness. This evidence-based approach also strengthens small peripheral LG credibility with stakeholders and funding agencies, demonstrating accountability for public investments in consolidation projects.

Scaling successful approaches through knowledge exchange: Small peripheral LGs successfully implementing multi-purpose land consolidation create valuable knowledge relevant to other peripheral municipalities facing similar challenges. However, organizational thinness limits opportunities for spontaneous knowledge exchange between geographically dispersed small peripheral LGs. Policy interventions should create deliberate knowledge exchange mechanisms: national-level consolidation networks organizing study visits where small peripheral LG staff visit successful projects to observe implementation approaches; documentation of case studies and best practices in formats accessible to non-expert small peripheral LG staff; peer-to-peer mentoring programmes pairing municipalities with consolidation experience with those initiating first projects; and regional consolidation conferences bringing together small peripheral LGs, technical experts, and farmers to share lessons learned. These knowledge exchange mechanisms strengthen the cooperation and regional development factors related to human capital (number 1 and number 2 in Section 2.3) by enabling small peripheral LGs to learn from peers rather than requiring each municipality to develop expertise independently through trial and error. The Polish and German experiences demonstrate that systematic knowledge exchange accele-

rates consolidation uptake and improves project quality (Janus and Markuszewska, 2017; Thomas, 2023).

Practical policy contributions: Beyond theoretical advances, this thesis provides actionable insights for policy practitioners. By identifying land consolidation as a feasible spatial planning intervention for small peripheral LGs with limited resources, the research translates the RIS theoretical approach into concrete policy instruments. The demonstration that strategically coordinated conventional instruments can achieve innovative outcomes challenges the assumption that peripheral regions require cutting-edge technologies or substantial financial resources to enable innovation activities. This practical orientation bridges the theory-practice gap often present in the RIS literature, offering small peripheral LG policymakers evidence-based guidance for interventions within their legal authority and resource constraints.

The thesis also contributes methodologically by developing the area-weighted mean size of parcels metric, providing practitioners with a more accurate tool for measuring land fragmentation and tracking the effectiveness of land consolidation projects than traditional Januszewski or Schmook indices. This metric enables small peripheral LGs to monitor spatial planning intervention outcomes and adjust strategies based on empirical evidence rather than assumptions about parcel numbers alone.

Most critically, this thesis positions small peripheral LGs as essential but under-resourced actors in peripheral innovation systems, demonstrating that their capacity to implement spatial planning interventions (particularly land consolidation) represents a critical bottleneck in translating national innovation investments (Study 1's 19% R&D allocation funding national research institutions and agricultural innovation policy design) into farm-level innovation activities outcomes (Study 3's findings on structure-innovation relationship). The thesis thereby contributes a novel perspective to the RIS literature: innovation system effectiveness in peripheral regions depends not only on innovation generation capacity (universities, research institutes designing agricultural technologies and policies) but crucially on the institutional capacity of small peripheral LGs (Study 1's critically under-resourced 2% capacity building allocation) to create spatial prerequisites enabling innovation adoption through land consolidation as a spatial planning instrument – a dimension largely overlooked in existing RIS frameworks focused on knowledge production rather than on the spatial enablement of innovation activities in organizationally thin peripheral regions.

5.3 Limitations

Every analysis has to consider certain limitations regarding the use of specific theoretical and empirical approaches and also context-specific factors which impact the specific field of study.

Local government reform in Estonia

The empirical analysis of this thesis covers the years 2014–2019, a period in which the LGs territorial reform was introduced (in 2017) in Estonia. According to the Estonian Ministry of Finances (2024), the merger of LGs offers several key advantages for local governance and development: first, they provide a formal administrative framework for existing cooperation between LGs, legitimizing and strengthening established partnerships. Merged LGs can coordinate development across the entire region and also implement more cohesive and strategic planning initiatives. The increased human and other resources of merged LGs increase their ability to receive EU funding for major development projects. This improved access to funding enables balanced investments across the region, not fragmented efforts by individual LGs. In addition, merged LGs can deliver higher quality services to residents, attract and retain more specialized staff with higher qualifications, and lead to improved service delivery and more professional administration.

The consolidation also strengthens administrative efficiency through the specialization of officials and streamlined operations, while improved organizational capacity leads to effective public services. Merged LGs can better improve regional infrastructure like public transportation, which leads to more integrated and efficient systems that serve the broader community (Ibid. 2024)

LG data, which is used for the empirical study of land consolidation, is based on the years 2014–2019. In 2017, there was an amalgamation of LGs in Estonia. For a number of reasons, it is assumed that the impact of this reform on the results of thesis is not significant. Firstly, most of the LGs in Estonia still have populations of less than 10,000 inhabitants, and 57%¹⁵ of agricultural land is still located in the territory of small peripheral LGs. Secondly, there were no major changes in LG functions, including business promotion (Tõemets, 2017). While other Central and Eastern European Countries (CEECs) experienced changes in local government autonomy between 2015 and 2020, Estonia maintained consistent levels across all measured aspects during this period (as illustrated in Figure 2 in Section 3.1). One change of functions is that the Estonian LGs are now responsible for regional planning and regional public transport, which were the previous task of county governments, which were abolished. The transfer of county development planning responsibilities to LGs enhances the potential for implementing LC projects in peripheral areas, as the Local Government Organisation Act § 6¹ (3¹) explicitly authorizes cooperation bodies to perform

¹⁵ Data according to the inquiry from the ARIB (Estonian Agricultural Registers and Information Board, 2018). The land which is added to the Field Register is considered.

administrative duties related to national support programmes for regional development, creating a direct mechanism for accessing state funding for LC initiatives. The requirement that planning decisions must involve at least two-thirds of local councils representing two-thirds of the county population, including the county centre (§ 61(3)), ensures that peripheral small local governments cannot be marginalized in planning decisions and must be included in land consolidation strategies that affect their territories. Additionally, the state budget support for these joint planning functions (§ 61(4)) and the flexibility to assign implementation through various cooperation bodies (§ 61(2)) provides small peripheral LGs with both financial resources and institutional options they previously lacked under county government administration, potentially making LC projects more feasible and locally responsive than before.

Common Agricultural Policy

The Common Agricultural Policy (CAP) has a major impact on agricultural development. This thesis did not include CAP measures in the analysis mainly due to the fact that the research question was directly related to small peripheral LGs and their ability to increase local farm labour productivity and innovation activities. According to the European Commission (2005) Council Regulation No 1698/2005, the three main objectives of the CAP are to enhance agriculture and forestry competitiveness through support for restructuring, development initiatives, and innovation activities; to support environmental protection and countryside preservation through targeted land management programs; and to enhance rural quality of life and promote economic diversification in rural areas. Most of the CAP budget is allocated to farmers, agricultural cooperatives, rural development projects, and environmental initiatives.

CAP measures are excluded from the analysis because they operate primarily at the farm level through direct payments and rural development subsidies to individual farmers, whereas this thesis specifically examines what small peripheral LGs can do through their spatial planning authority to enable farm innovation activities. While CAP funding significantly affects the economic viability and investment capacity of individual farms, it does not directly address the spatial prerequisites (land fragmentation, parcel consolidation, infrastructure coordination) that small peripheral LGs can influence through land consolidation as a spatial planning instrument. The thesis focuses on small peripheral LG-initiated interventions rather than farmer-accessed subsidies, placing CAP measures – despite their agricultural importance – outside the scope of analysing the capacity of small peripheral LGs to create spatial conditions enabling innovation through land consolidation projects.

In Estonia, LGs were eligible (in 2007–2013) for only one measure supported by the CAP. This was the LEADER measure (Leader-meetme raames..2010), where LGs could form a cooperation network of several LGs via nonprofit associations to implement local development strategies, execute small infrastructure projects, and develop community services. There is no evidence that any of

the LEADER groups in Estonia has prioritized land consolidation projects/initiatives. In the period 2007–2013, LGs received only 8.3% of the LEADER budget for 414 projects and the average budget of one project was 9,909 euros (Aro, 2013). Slightly over half of the projects accepted by ARIB (application from NGOs, businesses, and LGs) were related to village development and renewal, while support for the establishment and development of micro-enterprises constituted slightly over 10%, as did support for the promotion of tourism.

Practical Implementation Challenges

This thesis focuses on the theoretical mechanism and empirical evidence linking farm structure to labour productivity and innovation outcomes. However, the practical implementation of land consolidation in Estonia faces significant challenges not fully addressed in the empirical studies.

High land rental rates create tenure uncertainty that complicates multi-year consolidation projects, as traditional LC approaches assume ownership consolidation. Ongoing structural changes – with farm numbers declining while average size increases through market mechanisms – create “moving targets” for spatial planning. Limited local government capacity represents a critical constraint: small peripheral LGs lack technical expertise for GIS analysis, cadastral work, and multi-stakeholder coordination required for LC implementation. Coordination with CAP reforms introduces additional complexity, as new environmental requirements (nature restoration, rewetting organic soils) emerged during 2019–2024, after the empirical data collection period (2014–2019), potentially altering the LC implementation context.

These challenges are not unique to Estonia. Thomas (2023) demonstrates that Germany addressed similar capacity constraints through state-level Rural Development Agencies (Ämter für ländliche Entwicklung) providing professional technical support to multiple small municipalities simultaneously, rather than requiring each small peripheral LG to maintain in-house LC expertise. The German model – refined over 150 years of LC practice – shows that implementation success depends less on individual small peripheral LG capacity than on coordinated multi-level governance frameworks integrating regional technical support with local spatial planning authority (Thomas, 2023). Estonia’s 2017 LG mergers and county-level cooperation bodies (Local Government Organisation Act § 61) provide analogous institutional foundations for such support structures.

While the thesis validates LC as theoretically viable and empirically effective for improving farm outcomes, the pathway from theory to practice requires additional research on implementation mechanisms tailored to Estonia’s specific institutional and market conditions. Empirical validation of German-inspired implementation strategies in the Estonian rental-dominated context remains a priority for future research.

Environmental Considerations and New EU Requirements

This thesis does not systematically address the environmental impacts of land consolidation, focusing instead on labour productivity and innovation outcomes. However, environmental considerations are critical for practical LC implementation in contemporary EU policy contexts.

Recent EU policy developments present both challenges and opportunities for small peripheral LG-led land consolidation. The Nature Restoration Law (European Commission, 2022) requires member states to restore degraded ecosystems, potentially conflicting with agricultural consolidation objectives. However, multi-purpose LC can integrate restoration zones (wetland restoration, forest corridors, buffer strips) within project boundaries while consolidating productive agricultural areas. Rewetting organic soils to reduce GHG emissions may require smaller parcels in some areas (contrary to traditional LC goals), particularly in peatland regions, as outlined in the EU Soil Strategy (European Commission, 2021). Small peripheral LGs must balance consolidation for labour productivity with fragmentation for environmental compliance – suggesting differential spatial strategies rather than uniform consolidation.

Study 3 recognizes that the process and outcomes of land consolidation projects concern and impact many stakeholders and the social, economic, and ecological environment, noting that small peripheral LGs can use this intervention for various aims: to control land take, to assure sufficient income for agricultural producers, and to protect nature. In Western European countries, multi-purpose land consolidation has been developed to support agricultural development in one area and climate change adaptation initiated by small peripheral LGs (or other activities to fulfil environmental goals) in another area (Hartvigsen, 2022).

Role of small peripheral LGs in environmental transitions: Small peripheral LGs can coordinate land-use transitions by: (1) identifying suitable areas for different functions (intensive agriculture vs restoration); (2) facilitating land exchanges to separate production areas from restoration zones; (3) coordinating CAP eco-scheme participation at landscape scale; and (4) ensuring environmental requirements do not disproportionately burden small peripheral farms. This highlights that LC is not always about creating larger parcels; sometimes it involves creating right-sized parcels for specific purposes, including environmental functions.

Funding and strategic alignment: Achieving third-order policy changes (Hall, 1993) through environmental LC requires EU Cohesion Policy and CAP funding, necessitating alignment with EU strategies including the European Green Deal (European Commission, 2019), Biodiversity Strategy 2030 (European Commission, 2020), and Farm to Fork Strategy (European Commission, 2020). Small peripheral LGs cannot finance paradigmatic shifts independently; external funding enables environmental LC but constrains implementation choices to EU strategic priorities, potentially limiting locally-appropriate solutions in organizationally thin contexts.

Data and Methodological Limitations

The empirical analyses utilize FADN and ARIB secondary data, which present inherent limitations while remaining appropriate for addressing the research questions. The FADN sample (392 farms from 7,610 eligible holdings above €4,000 economic size) focuses on economically significant farms capable of innovation activities, which is appropriate given the research question's focus on enabling innovation rather than describing all agricultural holdings. However, voluntary FADN participation may introduce selection bias if participating farms differ systematically in management capacity or innovation orientation from non-participants.

Innovation measurement as a binary variable (whether farms invest in buildings, machinery, equipment, or inventory) captures innovation adoption decisions – the focus of research sub-question 3 – but cannot assess innovation intensity or quality. This aligns with the research objective of determining whether improved spatial structure increases innovation probability, though it limits conclusions about the magnitude or sophistication of innovation investments. The absence of certain variables (soil quality, detailed management practices, farmer succession planning) may omit factors affecting labour productivity and innovation, though the fixed-effects approach in Study 3 controls for time-invariant farm-specific characteristics.

Study 2's cross-sectional design establishes the labour productivity-land structure relationship required to answer research sub-question 2 but cannot definitively establish causal direction. Study 3's panel approach (2014–2019) strengthens causal inference through fixed-effects modelling, though the five-year observation period may not capture longer-term consolidation effects given that structural agricultural changes often unfold over decades. This temporal limitation is particularly relevant for assessing whether land consolidation interventions by small peripheral LGs produce sustained innovation outcomes beyond the immediate investment period.

5.4 Future research

Study 1 identified varying effects of the EU Cohesion Policy (CP) across different regional types. EU CP presents opportunities for CEECs to break historical development paths. At the same time, regional varieties in development indicators reveal that external support policies can create certain dependency traps – particularly through overinvestment in infrastructure and uniform “one-size-fits-all” approaches for diverse regions. This suggests that the effectiveness of CP depends heavily on how it is implemented and coordinated at different governance levels, with implications for how small peripheral LGs can access and deploy resources to create spatial prerequisites enabling farm innovation activities. The study emphasizes the importance of place-based, multi-level, and proactive policy design approaches. Recent EU policy developments regarding rural

areas highlight this coordination challenge, for example the Rural Pact and EU rural action plan (European Commission, 2021; Langlais, 2023). The Rural Pact aims to bring together governments and organizations at all levels – EU, national, and local – to work toward common rural development goals through coordinated multi-level governance ensuring that rural areas become stronger, connected, resilient, and prosperous by 2040.

However, critical bottlenecks remain in the implementation of multi-level rural governance, particularly for LC projects. Hartmann et al. (2025) emphasize that developing comprehensive multi-level governance frameworks integrating EU, national, regional, and local levels remains challenging. Importantly, their research demonstrates that LC success depends less on the ability of small peripheral LGs to deploy cutting-edge innovative instruments (such as pre-emption rights, advanced expropriation mechanisms, blockchain-based land registries, or AI-driven spatial planning tools) and more on the strategic coordination and sequencing of conventional instruments (including better coordination between existing tools, strategic timing, context-appropriate combinations, and improved implementation processes). This finding highlights that innovation in governance lies not necessarily in adopting new technologies but in creatively combining and coordinating existing policy tools more effectively – a crucial insight for small peripheral LGs operating with limited institutional capacity (Study 1’s 2% capacity building allocation discussed in Sections 5.1 and 5.2) in organizationally thin peripheral regions.

Therefore, a crucial future research question emerges: what combinations of spatial planning, LC, and funding mechanisms work best in small peripheral LGs, and how can conventional instruments (strategically coordinated) achieve innovative outcomes? Future research should examine how coordinated policy mixes affect farm innovation activities through the four regional development factors established in this thesis – particularly how multi-level governance strengthens institutional capacity (currently under-resourced at 2% capacity building allocation) and cooperation and linkages between small peripheral LGs, national authorities designing agricultural innovation policies, and EU institutions providing CP resources. Understanding which governance arrangements enable small peripheral LGs to implement land consolidation as a spatial planning instrument despite resource constraints remains critical for translating this thesis’s findings into actionable policy improvements.

Future research should build upon the foundations established in this thesis and analyse how farm structure affects farm profitability, market access, and economic sustainability. Examining the complete chain of mechanisms from land structure to innovation investment would strengthen our understanding of how small peripheral LG spatial planning interventions affect the natural resources and infrastructure factor within the regional development framework established in this thesis. This research direction would enhance the policy relevance of existing findings by bridging technical productivity insights with innovation activities outcomes and incorporating economic factors such as market access, price volatility, and cost-benefit ratios. A recent systematic review (Aslam et al.

2025) acknowledges that while the degree of land fragmentation impacts agricultural performance – productivity, efficiency and profitability – significant knowledge gaps remain in understanding these relationships comprehensively.

While this thesis made initial contributions by examining how infrastructural system failures (fragmented land) hinder local farms' labour productivity and innovation activities, it also revealed significant research gaps that require further investigation. The research demonstrated that regional development is strongly impacted by path dependency, yet limited research exists on how regional development patterns specifically influence LC outcomes. Most studies examine either regional developmental patterns or LC separately, creating a knowledge gap about which regional economic conditions and system-level interventions affect LC project success – particularly how small peripheral LGs operating in organizationally thin peripheral regions can most effectively implement land consolidation as a spatial planning instrument given their limited institutional capacity.

Building on these initial findings, several critical research areas require deeper investigation. It is necessary to understand how RIS specifically affect farm innovation activities in CEE countries, examining how CP can more effectively support LC initiatives implemented by small peripheral LGs, and to explore the complex triple relationship between governance structures, LC processes, and innovation activities outcomes. Future research should specifically examine how small peripheral LGs in organizationally thin regions can most effectively leverage their spatial planning authority within multi-level governance frameworks, given their limited institutional capacity demonstrated in this thesis (Study 1's 2% capacity building allocation). Both multi-level governance and innovation systems involve various stakeholders and policy interventions beyond small peripheral LGs (including the European Commission and national governments). Therefore, further research is essential to understand how coordinated policy mixes – addressing all four regional development factors (knowledge and human capital, cooperation and linkages, natural resources and infrastructure, institutional capacity) – can enhance local farms' innovation activities while avoiding the dependency traps identified in current CP implementation and strengthening small peripheral LG capacity to create spatial prerequisites enabling farm innovation activities in peripheral regions.

5.5 Policy recommendations for small peripheral LGs in Estonia

Building on the general policy implications discussed in Section 5.2, this section translates those principles into specific actionable recommendations for Estonian small peripheral LGs. These recommendations address Estonia's unique institutional context, particularly the 2024 Land Consolidation Act framework and the specific challenges identified in Section 3.1 regarding organizational thinness,

fiscal constraints, and technical capacity limitations in Estonian peripheral municipalities.

Small peripheral LGs in Estonia should prioritize spatial planning interventions as their primary approach for creating prerequisites enabling farm innovation activities. Given their authority over land use planning codified in the Estonian Planning Act and Land Consolidation Act 2024, small peripheral LGs should systematically identify areas where land fragmentation hinders innovation activities and develop targeted land consolidation initiatives that create spatial prerequisites enabling technology adoption, reduce transaction costs, and facilitate deployment of scale-dependent innovations.

Leveraging Estonian institutional frameworks: Estonian small peripheral LGs should fully utilize the provisions of the Local Government Organisation Act § 61 for county-level cooperation bodies. These cooperation bodies are explicitly authorized to perform administrative duties related to national support programmes for regional development (§ 61(3)), creating direct mechanisms for accessing state funding for land consolidation initiatives. The requirement that planning decisions must involve at least two-thirds of local councils representing two-thirds of the county population, including the county center (§ 61(3)), ensures that peripheral municipalities cannot be marginalized in planning decisions and must be included in land consolidation strategies. Estonian small peripheral LGs should activate these cooperation bodies specifically for land consolidation purposes, pooling technical expertise and sharing GIS specialists, spatial planners, and environmental assessment capacity across multiple municipalities within each county.

Estonian-specific monitoring and metric application: Small peripheral LGs should use the area-weighted mean size of parcels metric developed in Study 2 as the primary indicator for measuring land fragmentation severity and tracking consolidation project effectiveness over time. Estonian ARIB (Agricultural Registers and Information Board) maintains comprehensive parcel-level data enabling baseline fragmentation measurement for all farms. Small peripheral LGs should coordinate with ARIB to establish pre-consolidation baselines using this metric, and then track post-consolidation changes to validate whether spatial reorganization translates into innovation activities adoption as demonstrated in Study 3. This evidence-based monitoring strengthens the capacity of small peripheral LGs to demonstrate project effectiveness when applying for additional funding from national and EU sources.

Coordination with the Estonian agricultural innovation ecosystem: Estonia's agricultural innovation ecosystem includes county development centres, AKIS advisory services, universities, and research institutes (OECD, 2013). Small peripheral LGs should create platforms connecting farmers with these existing resources through consolidation planning processes. Practical approaches specific to Estonia include: coordinating with county development centres to provide business planning assistance during consolidation planning meetings; partnering with the Estonian University of Life Sciences to conduct field demonstrations of precision agriculture equipment on newly consolidated parcels; and organizing

commodity-specific extension services through AKIS that align with Study 2's findings on production type variation (dairy, crops, organic, mixed operations). This coordination addresses the systemic disconnection identified in Study 1 between abundant innovation supply (19% R&D allocation creating available technologies) and local adoption capacity constrained by spatial prerequisites.

Addressing Estonian tenure challenges: Study 3's finding that fully-leased farms exhibit 80.5% lower innovation probability despite spatial structure improvements has particular relevance for Estonia where 66% (in 2024) of agricultural land is rented. Estonian small peripheral LGs implementing land consolidation must develop approaches appropriate for rental-dominated contexts: coordinate spatial reorganization across leased parcels involving multiple owners and tenants; design consolidation schemes ensuring tenant farmers can capture sufficient returns from productivity improvements despite tenure uncertainty; and work with landowner associations to demonstrate how consolidation increases land values through improved accessibility and parcel geometries. The Land Consolidation Act 2024 provides a legal framework enabling such coordination, but effective implementation requires the capacity of small peripheral LGs to facilitate negotiations among landowners and tenant farmers with potentially conflicting interests regarding consolidation participation.

Strategic prioritization for the Estonian context: Given limited resources, Estonian small peripheral LGs should prioritize consolidation areas where: (1) extreme fragmentation prevents deployment of precision agriculture technologies despite available CAP subsidies and AKIS advisory support; (2) young farmers or new entrants face structural barriers preventing long-term investment due to spatial configuration uncertainties; (3) coordinated infrastructure investments (roads, drainage) could benefit multiple farms simultaneously through spatial coordination across property boundaries. The finding that 57% of agricultural land remains in small peripheral LG territories even after the 2017 territorial reform indicates substantial consolidation potential, particularly in peripheral municipalities where fragmentation severity exceeds national averages.

Integration with Estonian spatial planning processes: Small peripheral LGs should integrate land consolidation with comprehensive planning and detailed planning processes required under the Estonian Planning Act 2015. This integration ensures that spatial planning decisions support rather than hinder farm modernization by creating prerequisites enabling innovation activities. Practical approaches include: developing fast-track procedures for land consolidation projects within county-level comprehensive planning frameworks; establishing preferential zoning for consolidated agricultural areas that facilitate deployment of scale-dependent technologies; and coordinating consolidation with rural road improvement programmes and public water/sewerage system development that small peripheral LGs are responsible for under the Local Government Organisation Act 2023.

Advocacy for capacity building support: Estonian small peripheral LGs should collectively advocate to central government for increased capacity building allocations addressing Study 1's finding of critically low 2% cohesion policy allocation

to institutional capacity development. This advocacy should emphasize that the implementation of effective land consolidation requires GIS expertise, environmental assessment capabilities, and multi-stakeholder coordination skills that individual small peripheral municipalities cannot maintain independently given fiscal constraints. The Estonian Association of Local Governments should coordinate this advocacy, leveraging its Brussels office and connections with MPs to influence national cohesion policy design for 2021–2027 programming period and beyond.

Pilot project approach: Rather than attempting system-wide land consolidation immediately, Estonian small peripheral LGs should initiate pilot projects in 2–3 counties demonstrating multi-purpose consolidation approaches that balance agricultural productivity improvements with environmental protection goals. These pilot projects should incorporate the Environmental Impact Assessments aligning with EU Green Deal objectives, creating demonstration cases showing successful integration of Nature Restoration Law requirements, CAP eco-scheme participation, and consolidated parcel configurations. Documentation of pilot outcomes using the area-weighted mean size of parcel metric enables knowledge transfer to other Estonian municipalities through peer-to-peer learning networks, building national-level consolidation capacity incrementally rather than requiring each small peripheral LG to develop expertise independently through trial and error.

6. ANNEXES

Annex 1. Small and peripheral local government role in the land consolidation process drawn from the German experience

The following discussion of land consolidation and small local government roles draws from the German experience as documented in Thomas (2023), selected because the existing land consolidation literature lacks a systematic theoretical treatment of LG institutional roles while Germany's 150-year statutory land readjustment history offers empirically-validated insights into capacity requirements and implementation pathways for small peripheral municipalities. Small local governments play a dual role in land consolidation procedures: as participants in formal decision-making through representation in bodies addressing public interests, and as beneficiaries of improved rural infrastructure resulting from consolidation projects. The German experience demonstrates that successful land consolidation requires the integration of agricultural sectoral planning with municipal territorial planning, necessitating coordination between specialized land consolidation authorities and municipal governments responsible for local roads, water infrastructure, and spatial planning. This coordination challenge is particularly acute for small peripheral municipalities that lack the technical capacity, fiscal resources, and administrative expertise to independently initiate or manage comprehensive land consolidation procedures, creating dependence on supra-local institutional support from state-level land development agencies.

The role of external funding – particularly the EU Cohesion Policy and the the European Agricultural Fund for Rural Development (EAFRD) – represents a critical enabler of third-order policy change in Hall's (1993) framework, as these funds permit small municipalities to shift from minimal first-order adjustments (reallocating modest local budgets) to paradigmatic transformations involving integrated rural development combining infrastructure provision, environmental protection, and agricultural restructuring within single coordinated interventions. However, EU funding alone cannot overcome fundamental capacity constraints: the German model reveals that effective land consolidation in small municipalities requires not only financial resources but also institutionalized technical expertise, established legal frameworks for property reorganization, functioning cadastral systems, and participatory mechanisms enabling farmer involvement through bodies of participants (*Teilnehmergemeinschaft*) that small peripheral LGs typically cannot create independently. The institutionalization of land consolidation as a state-level rather than purely municipal responsibility in Germany – where specialized Rural Development Agencies (*Dienstleistungszentrum Ländlicher Raum*) provide technical services to municipalities – illustrates how second-order policy changes (introducing new institutional instruments) can enable small peripheral LGs to access third-order transformative outcomes that would remain infeasible under purely municipal governance. Even without pursuing third-order paradigmatic change, small peripheral LGs retain the capacity for incremental improvements through first-order adjustments (reallocating existing budgets toward priority parcels, adjusting land tax rates to incentivize consolidation) and second-order instrument changes (initiating voluntary land exchanges under simplified procedures, establishing inter-municipal cooperation agreements for shared technical services), demonstrating that the land consolidation framework accommodates graduated intervention levels matched to available small peripheral LG capacity (Hall, 1993).

This supra-local institutional model addresses the organizational thinness characteristic of peripheral regions by creating external knowledge providers and technical

capacity that substitute for absent local universities, research institutions, and specialized planning expertise, thereby enabling small peripheral LGs to guide the implementation of comprehensive rural development measures despite limited internal capacity. Estonian small peripheral LGs face analogous constraints but lack equivalent supra-local institutional support: while the Land Consolidation Act (2024) provides the legal framework, actual implementation depends heavily on municipal initiative and capacity, creating systematic disadvantages for small peripheral LGs that cannot mobilize the technical expertise, stakeholder coordination, or co-funding required to access EU rural development programmes effectively.

The German experience thus validates the theoretical framework's emphasis on institutional capacity as the binding constraint: land consolidation can enable innovation activities and productivity improvements in peripheral regions, but only when small peripheral LGs either possess or can access through supra-local arrangements the technical, administrative, and coordinative capabilities the instrument requires – capabilities that path-dependent processes systematically denied to post-socialist peripheral municipalities.

Annex 2. The definition of land consolidation

Land consolidation represents a statutory spatial planning instrument for reorganizing fragmented rural land tenure through the voluntary or compulsory reallocation of parcels, exchange of land rights, and provision of infrastructure to improve agricultural productivity, environmental sustainability, and rural living conditions (Pasakarnis and Maliene, 2010; Veršinskas et al., 2020). In Central and Eastern European contexts, land consolidation addresses fragmentation resulting from post-socialist land reforms where plot-by-plot restitution created highly dispersed ownership patterns – Estonian farms averaging 8–12 parcels scattered across multiple locations – that constrain mechanization, increase transaction costs, and limit technology adoption (Hartvigsen, 2014; Van Dijk, 2003).

The procedure operates through integrated interventions combining physical plot consolidation (reducing parcel numbers, improving shapes and accessibility), infrastructure development (rural roads, drainage systems, field access), and landscape management measures (biodiversity corridors, erosion control) within a coordinated framework addressing agricultural, environmental, and territorial objectives simultaneously (Crecente et al., 2002; Hiironen and Riekkinen, 2016). Effective implementation requires balancing landowner property rights with public interest through participatory planning processes, systematic land valuation methodologies ensuring equitable exchanges, and technical capacity for cadastral surveying, spatial analysis, and stakeholder coordination – institutional requirements that pose significant challenges for small peripheral local governments (Demetriou et al., 2012; Veršinskas et al., 2020).

This comprehensive approach positions land consolidation as a multifunctional policy instrument capable of simultaneously addressing post-socialist structural legacies (extreme fragmentation), agricultural development needs (productivity improvement, innovation enablement), environmental protection goals (sustainable land use, biodiversity conservation), and rural development objectives (infrastructure provision, territorial cohesion) within a single coordinated administrative procedure (Pasakarnis and Maliene, 2010; Hartvigsen, 2014).

Annex 3. The theoretical mechanism linking farm structure to labour productivity

Before examining the theoretical mechanisms, it is essential to distinguish between productivity and efficiency – terms often used interchangeably but representing distinct concepts. Productivity measures the ratio of output to input (in this case, agricultural output per working hour), while efficiency refers to how effectively inputs are converted to outputs relative to a theoretical maximum. Specifically, technical efficiency indicates whether a farm achieves maximum output from its available inputs and technology, while allocative efficiency concerns whether inputs are combined in cost-minimizing proportions.

This study measures labour productivity (output per working hour) as the primary outcome variable because it reflects improvements from two interrelated mechanisms that land consolidation enables: (1) better utilization of existing technology – reduced transaction costs from consolidating scattered parcels allow farmers to deploy current machinery more effectively across their landholdings; and (2) adoption of productivity-enhancing technologies – consolidated spatial structure makes it economically feasible to invest in modern equipment (e.g. precision agriculture systems, large-scale mechanization) that would be unprofitable on fragmented farms (Alvarez and Arias, 2004; Demetriou et al., 2012).

This thesis focuses on the role of spatial organization in overcoming technical efficiency constraints rather than allocative efficiency concerns because land consolidation primarily affects production possibilities (which technologies can be used and how effectively) rather than input price ratios (which input combinations are cost-minimizing). Fragmentation creates a binding constraint on technical efficiency by preventing both optimal use of existing machinery and adoption of scale-dependent innovations, regardless of input prices (Latruffe and Piet, 2014).

The theoretical mechanism linking farm structure to labour productivity operates through multiple channels documented in the agricultural economics literature.

First, fragmented land parcels reduce the efficiency of existing operations by increasing transaction costs because farmers must move equipment and labour between scattered plots, reducing output per working hour even when using the same machinery (Wan and Cheng, 2001; Gonzalez et al., 2007). Irregular parcel shapes further constrain effective deployment of existing machinery designed for regular geometric fields, meaning farmers cannot achieve maximum output from equipment they already own (Latruffe and Piet, 2014).

Second, fragmented farm structures limit innovation activities by making the adoption of scale-dependent technologies economically unfeasible since precision agriculture systems, large-scale mechanization, and automated irrigation require consolidated landholdings to achieve positive returns on investment (Demetriou et al., 2012; Crecente et al., 2002). Even if farmers have financial resources to purchase modern equipment, fragmentation prevents profitable deployment of these technologies.

The dual-pathway causal mechanism operates as follows:

Pathway 1 (Existing technology): Land consolidation → reduced transaction costs and better spatial organization → more effective use of current machinery → increased labour productivity

Pathway 2 (Technology adoption): Land consolidation → economic feasibility of scale-dependent technologies → investment in productivity-enhancing innovations → increased labour productivity

Both pathways contribute to the observed relationship between farm structure and labour productivity, though empirically they cannot be fully disentangled because farmers simultaneously optimize existing operations and make technology adoption decisions.

This positions farm structure as a framework condition rather than a determinant: consolidated land does not cause productivity increases directly, but removes spatial constraints that both (1) prevent the efficient use of existing technology and (2) block the adoption of productivity-enhancing innovations (Van Dijk, 2003).

Study 2 tests whether this theorized farm structure → productivity relationship, well-established in Western European contexts, holds in Estonia's post-socialist peripheral regions where path-dependent land reforms created extreme fragmentation through plot-by-plot restitution (Hartvigsen, 2014). The labour productivity measure used – output per working hour – reflects improvements from both pathways: better deployment of existing resources and adoption of new technologies enabled by spatial reorganization (Rahman and Rahman, 2008).

Output per working hour represents the most theoretically appropriate productivity measure for assessing land consolidation impacts because it captures labour productivity improvements – the primary mechanism through which spatial reorganization affects farm performance in labour-constrained peripheral regions where farmers cannot easily expand their workforce but can reorganize how existing labour is deployed across space (Alvarez and Arias, 2004).

Alternative productivity measures such as total factor productivity or land productivity conflate multiple input adjustments (capital, fertilizer, seeds) with the specific technical efficiency from spatial reorganization gains attributable to consolidation, making it impossible to isolate whether productivity changes stem from reduced fragmentation or from unrelated input intensification (Manjunatha et al., 2013). The labour productivity measure aligns with Hall's (1993) policy change framework because land consolidation operates as a second-order instrument change: it modifies the spatial framework within which farmers make first-order input decisions (both using existing technology more effectively and investing in new technology), thus labour productivity isolates the framework effect from farmers' subsequent input choices (Ciaian et al., 2018).

Empirically, output per working hour demonstrates high sensitivity to farm structure variables in European studies: Latruffe and Piet (2014) found that a 10% reduction in fragmentation increased labour productivity by 3–5%. This empirical finding reflects improvements through both pathways: better use of existing equipment and higher rates of technology adoption on consolidated farms.

Finally, labour productivity carries direct policy relevance for small peripheral LGs because rising output per working hour enables farm household income growth without requiring additional labour supply, which is critical in ageing rural populations where labour availability constrains agricultural development more than land or capital availability (Rizov et al., 2013).

Annex 4. Regional development theories used in the thesis

	Theory	Authors
Static theories, which show the spatial pattern of firms	<i>growth pole theory</i>	Petty, W., Perroux, F., Boudeville, J.R, Hirschman, A.O., Friedmann, J.
	<i>land rent theory</i>	von Thünen, J.H., Alonso, W.
	<i>location theory</i>	Weber, A., Hotelling, H., Hoover, E., Lösch, A., Greenhut, M., Isard, W.
	<i>central place theory</i>	Christaller, W., Lösch, A.
Theories of regional economic convergence/divergence	<i>export base theory, convergence</i>	Tiebout, C., North, D.
	<i>neoclassical exogenous growth theory, convergence</i>	Harrod, R.F., Domar, E.D, (Borts, G. and Stein, J., Williamson, J.G, regional context)
	<i>modern growth theory, convergence</i>	Solow, R.M., Swan, T.
	<i>cumulative causation theory, divergence</i>	Myrdal, G., Kaldor, N., Dixon R.J., and Thirlwall, A.P.
Theories of structuralism	<i>stage/sector theories</i>	Hoover, E.M., Fisher, J.L, Thompson, W.R, Henderson J.V, Pred, A.
	<i>profit/product cycle theories</i>	Vernon, R., Markusen A.R, Weinstein, B.L.
	<i>industrial restructuring theories</i>	Empirical studies: Massey, M., Harrison, B., Bluestone, B., Noyelle T.J., Storper, M., Walker, R., Stanback, T.M. Jr., Sassen. S, Leigh, P.
	<i>flexible specialisation and network theory</i>	Piore, M.J., Sabel, C.F., Porter, M.E, Cooke, P., Morgan, K., Scott, A.J., Saxenian, A., Markusen, A.R.
	<i>Marxist theory</i>	Gordon, D., Castells, M., Martin, R., Holland, S., Harvey, B., Goodman, R., Perry, D.C., Smith, N., Markusen, A.R., Massey, D., Sunley, P.
Political Institutions and Regional Economic Development	<i>growth machine theory</i>	Molotoch, H., Wolman, H., Logan, J.R.
	<i>new institutional economics</i>	Coase, R.H., Williamson, O.E, North, D.
	<i>endogenous growth theory (role of space)</i>	Ramsey, F., Cass, D., Koopmans, T, Schumpeter, J. (Nijkamp, P., Poot, J., Barro, R.J., Aschauer, D.A., Button, K.)
	<i>the new economic geography</i>	Krugman, P., Fan, W.
Innovation system	<i>regional innovation system</i>	Cooke et al, Asheim, Isaksen, Malmberg, Maskell

Source: Dawkins 2003, author's addition

Annex 5. Estonian small local government intervention actions¹⁶ related to factors from regional development theories

	Growth Pole	Location	Export Base	Neoclassical Exogenous Growth	Cumulative Causation	Stage/Sector	Profit/Product Cycle	Flexible Specialization and Network
Agglomeration	Territorial reform	Market demand in AM	Market demand in AM	Market forces, CG sectoral strategies	Market demand in AM	Market forces, CG sectoral strategies	Business locate near AM	Business competition is higher in AM
Raw materials	Transport IS	Transport IS	Location factors differ in time	-	Transport IS	Regulations for innovative resource use	Location factors differ in time	Organize cooperation for input ordering
Infrastructure	Transport IS	Transport IS	Export IS	-	Transport IS	Transport IS	Communication IS	Transport IS
Investments in R&D	R&D subsidies	-	-	-	-	-	CG decides the R&D location	Organize contact meeting
Specialized, supporting services	Technological IS	Targeted S	Targeted S	-	-	-	-	Technological and social IS
LGs vs LGs competition	V (investments) H (Technological IS)	H (business subsidies, land)	V (social benefits) H (Export business subsidies)	V (for investments)	V (investments) H (Technological IS, business subsidies)	H (cooperation) and V (competitive advantage of bigger LGs)	H (business subsidies)	H (knowledge)
Human capital	Education S=CG	CG	-	-	-	CG	CG	Community (social, political or religious)

¹⁶ Estonian small peripheral LGs can intervene directly when they have autonomy (in decision-making and fiscal resources) and when the specific interventions relates to functions legally assigned to them. Small peripheral LGs can intervene indirectly (compared to “green” areas) when they can create only some preconditions because they meet only some criteria. Small peripheral LGs cannot intervene when the action relates to central government functions or when they have no ability to control the process. In some cases, small peripheral LG intervention possibilities cannot be determined based on existing theories.

	Growth Pole	Location	Export Base	Neoclassical Exogenous Growth	Cumulative Causation	Stage/Sector	Profit/Product Cycle	Flexible Specialization and Network
Variety creation	-	Market forces create variety	Market forces create export industries	-	-	CG strategies for different sectors innovation	-	CG regulates wages and labour conditions
LGs management role	Coordination, collaboration, knowledge procurer	Local business developer	Export developer, adoption to change	Cannot influence saving rates of businesses	Local business developer	Coordination, collaboration, knowledge procurer, in favour of bigger LGs	Coordination, promotion of the region	Cooperation and competitive environment facilitator

Notes: Infrastructure = I, services = S, vertical competition = V, horizontal competition = H, agglomeration = AM, central government = CG.
Source: Author's analysis.

Annex 5. Estonian small local government intervention actions related to factors from regional development theories (continued)

	Marxist perspective	Growth Machine Theory	New Institutional Economics	Endogenous Growth Theory	The New Economic Geography	Regional Innovation System	Evolutionary Economics
Agglomeration	-	-	-	AM and economy of scale	Market demand and variety	Small peripheral LG has few RIS institutions	AM adoption and preconditions for change
Raw materials	-	-	-	-	-	-	-
Infrastructure	-	-	Transaction costs	Transport, social IS	Transport IS	Transaction costs, I related to innovation system	R&D I
Investments in R&D	-	-	-	R&D subsidies	-	R&D subsidies	R&D subsidies
Specialized services	-	-	-	-	-	-	-
LGs vs LGs competition, vertical, horizontal	H (initiated by capitalist decision-making)	H (business subsidies) V (investments)	H (business subsidies)	V (investments), H (Technological IS, business subsidies)	H (land, labour and capital)	V (R&D I)	V (R&D I)
Human capital	-	-	-	-	-	-	-
Variety creation	-	-	-	-	Variety due to AM	Variety is the environment, where there is constant innovation and dynamism	Variety is environment, where there is constant innovation and dynamism
LGs management role	Main urban and economic planner, influenced by capitalists	Lobbyist for state aid	Main driver of economy by regulating informal and formal constraints	Active role as the facilitator of innovation, growth and trade	Market forces (centripetal and centrifugal forces)	Coordination, global knowledge procurer	Institutional ability to change and adopt to new emerging sectors

Notes: Infrastructure = I, services = S, vertical competition = V, horizontal competition = H, agglomeration = AM, central government = CG.
Source: Author's analysis.

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital.

Factors related to knowledge, absorptive capacity, and human capital	Possible instruments (numbered) and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Demand for innovative products	<p>Public procurement for innovation to increase public demand for innovation</p> <p>1. General and strategic procurements related to existing services of small peripheral LGs and organized without over specification of technical requirements, divided into smaller lots but targeted to promote competition and innovation diffusion. The pooling of resources by cooperation between LGs or by joining the similar services of local institutions to increase the buying power should be considered.</p> <p>Informative campaigns to increase residents' awareness of possible innovative solutions</p> <p>2. Training seminars and networking events to increase local knowledge of available innovations by inviting foreign specialists or LG representatives with best practices, and also to improve small peripheral LGs' understanding of local needs and residents' awareness of and involvement in possible innovations in local services.</p> <p>Social and business infrastructure to increase private demand for innovation</p> <p>3. The development of local infrastructure and services: roads and their maintenance, provide a good education, cultural and sport facilities, business infrastructure, or organize social events such as concerts and sport events to attract new residents.</p> <p>Housing infrastructure to improve the development of local firms and to increase population so private demand for innovation is higher.</p> <p>4. Increase the amount of available municipal housing to help to develop existing firms by providing the necessary housing for its new employees.</p>	YES	NO	YES/ NO
		YES	NO	NO
		YES	YES	YES
		YES	YES	YES

Source: compiled by the author based on Chapters 1–2

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital. (continued)

Factors related to knowledge, absorptive capacity, and human capital	Possible instruments (numbered) and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Demand for innovative products	<p>Tourist attraction services to increase private demand for innovative tourism services</p> <p>5. Tourist attraction services like developing tourism infrastructure: hiking trails, swimming places, tourism information centres. Also, it is possible to provide proactive tourism services, such as fairs and package tours or place marketing events in cooperation with other LGs.</p> <p>Territorial reform to increase the population and private demand for innovation</p> <p>6. Proposals to neighbouring LGs to merge to increase its population and central government investments.</p>	YES	YES/ NO	YES
Tacit and codified knowledge sources and networks	<p>Lobby for the location of institutions to increase the supply for innovation</p> <p>7. Small peripheral LGs can use LG associations, political parties and the MPs of its election district to lobby for the location of universities and R&D facilities.</p> <p>Increase the supply for small firms' innovation</p> <p>8. Small peripheral LGs can provide R&D subsidies for local firms.</p> <p>Network building that increases firms' knowledge about potential innovations in their business sector</p> <p>9. To organize small peripheral LG-university-industry cooperation meetings to increase the knowledge of local firms about university expertise and to increase the intensity of interactions between universities and industry. This cooperation should also aim to involve firms and universities in strategic planning.</p>	YES	NO	YES

Source: compiled by the author based on Chapter 1/2

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to knowledge, absorptive capacity, and human capital. (continued)

Factors related to knowledge, absorptive capacity, and human capital	Possible instruments (numbered) and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Absorptive capacity, access to market information	Fairs, conferences, seminars, and cooperation with external partners to broaden external networks to diffuse knowledge about innovations 10. Build international networks and diffuse innovations to local firms via international fairs, conferences, collaboration projects, and study visits. Recruiting and training to increase experienced specialists and more targeted innovation policies 11. Develop the analysis skills of the small peripheral LG specialists or buy the analysis of the local economy from some external institutions to make more targeted innovation policies. Specialized services to improve business knowledge and innovation 12. Provide the necessary financing of development centres to improve the consultation, training and joint projects of local firms.	YES	YES	NO
Human capital	Education services to increase entrepreneurship and innovation 13. Provide infrastructure of primary and preschool education 14. Organize entrepreneurship programmes for pupils at different school levels.	YES YES	YES/NO YES YES	YES/NO YES NO

Source: compiled by the author based on Chapter 1/2

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to cooperation and linkages. (continued)

Factors related to cooperation and linkages	Possible instruments and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Cooperation	Cluster development to increase various innovations 15. Initiate cluster development by organising roundtables for businesses and reinforce the cluster by providing supporting services via county development centres.	YES	YES/NO	NO
Foreign trade	Increase external knowledge sources to improve export activity and innovation 16. Small peripheral LGs can use their cooperation network, twin towns, and foreign project partners to provide market information and distribution contacts for local firms and thereby decrease firms export barriers. 17. Small peripheral LGs can organize place marketing events and foreign and local fairs to decrease the functional, marketing, and sociocultural barriers of firms.	YES YES	NO YES	YES YES
Community ties	The organization of services to build a cooperative environment and to improve the diffusion of tacit knowledge 18. Small peripheral LGs can increase community ties by organizing cultural, sports, charity, and other events that are related to their services.	YES	NO	YES

Source: compiled by the author based on Chapter 1/ Chapter 2.

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to competition and economic structure. (continued)

Factors related to competition and economic structure	Possible instruments and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Price competition	L and consolidation (LC) to improve land conditions and infrastructure developments to lower the cost of production to improve the preconditions for innovations 19. Small peripheral LGs can decrease local farmers' production expenditures and increase innovativeness by implementing land consolidation projects and supporting infrastructure developments and supporting Comprehensive and Detail plans. The role of small peripheral LGs is to encourage and intermediate the LC process to increase the amount of participants.	YES	YES/ NO	NO
Competition	Improve strategy and rivalry preconditions for local competition 20. Small peripheral LGs should implement and ensure supervision of their procurement procedures and the procedures related to conflict of interests according to the Estonian law of public procurement and anti-corruption.	YES	NO	NO
Business structure and (un)related variety creation	Increase the knowledge about local economy for more targeted innovation policies 21. Organize seminars and roundtables for local firm managers and order (or delegate to small peripheral LG specialists) the compilation of economic analyses by small peripheral LGs to understand the local business environment and innovation barriers. The diversification or specialization of business sectors to increase innovativeness 22. Small peripheral LGs can indirectly increase the diversified business structure through its membership in different agencies to influence national innovation policies. Small peripheral LGs can indirectly impact business structure by framing legal conditions via the county-wide spatial plan or directly through small peripheral LGs' Comprehensive and Development plans.	YES	NO	NO
External factors	Analysis of the external environment to improve the response to external shocks 23. Leaders of small peripheral LGs can increase their awareness of national and firms' strategic plans by participating in the information meetings of CG agencies and ministries, or seminars organized by business and LG associations.	YES	YES	YES

Source: compiled by the author based on Chapter 1/ Chapter 2.

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to natural resources and infrastructure. (continued)

Factors related to natural resources and infrastructure	Possible instruments and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Natural resources and land planning	Supporting infrastructure for different production inputs to increase product variety and innovation. 24. Small peripheral LGs can develop infrastructure like local roads, bridges, harbours and execute land planning through its Comprehensive plan to improve access to raw materials. Environment-friendly services, regulations and green procurement to improve environment protection and innovations. 25. Small peripheral LGs can enforce environmental policies by environmental friendly land planning, by setting restrictions or conditions related to buildings, construction works, and green areas (see further Planning Act 2016 § 75). Small peripheral LGs can set environment-friendly criteria in public procurement by demanding zero-emission public transport or buildings. 26. Small peripheral LGs can enforce environmental policies by introducing environmental taxes, subsidies or tradable permits. Establishing environmental goals for environmental technological change. 27. Small peripheral LGs can introduce environmental goals in their development plan, which are supported and complemented by other policies like environmental restrictions, land planning arrangements in Comprehensive and Detail plan or other Small peripheral LGs services. The actions to increase the local community willingness to accept new technologies. 28. Small peripheral LGs should negotiate with private companies and CG how their developments on small peripheral LGs territory can contribute to the local community. Small peripheral LGs can provide infrastructure like industrial districts for existing or new companies.	YES	YES/NO	YES
		YES	YES/NO	YES
		YES	NO	YES
		YES	YES/NO	YES

Source: compiled by the author based on Chapter 1/ Chapter 2.

Annex 6. Practical interventions for enabling firm innovation activities based on three framework conditions and regional development factors related to natural resources and infrastructure. (continued)

Factors related to natural resources and infrastructure	Possible instruments and their impact on the development factor	Decision autonomy	Resource intensity	Competition among LGs
Infrastructure and transaction costs	<p>Decrease bureaucracy in small peripheral LGs to lower transaction costs</p> <p>29. LGs should train their specialists to decrease business related bureaucracy.</p> <p>Internet access for innovation in accounting, network, and data storage</p> <p>30. Small peripheral LGs should initiate, in cooperation with local firms and telecommunication service providers, the construction of an access network to provide high speed internet for local firms.</p> <p>Develop infrastructure to improve the mobility of production inputs, residents, and information</p> <p>31. Small peripheral LGs can build and maintain local infrastructure and organize public transportation to improve local firms' production conditions and to attract labour from outside the small peripheral LG.</p>	YES	NO	YES
		YES	YES	YES
		YES	YES	YES

Source: compiled by the author based on Chapter 1/ Chapter 2.

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SUMMARY IN ESTONIAN

Väikeste perifeersete kohalike omavalitsuste roll põllumajandusettevõtete innovatsioonis: maade ümberkruntimine kui strateegiline ruumiline planeerimine Eestis

Motivatsioon

Piirkonna majanduslik heaolu sõltub osaliselt kohalike ettevõtete innovaatsilisusest (Etzkowitz and Ranga, 2015; Asheim and Gertler, 2005). Demokraatlikes detsentraliseeritud riikides sõltub piirkond osaliselt ühest või mitmest väikesest kohalikust omavalitsusest, kes vastutavad kohaliku arengu eest. Selliste valitsemisvormidega riigid – föderalsed või tugevalt detsentraliseeritud – on käesoleva väitekirja fookuses. Kui kohalikud ettevõtted innoveerivad, suureneb kohalike omavalitsuste eelarve ning on võimalik paremini jaotada ressursse kohalike majandus- ja sotsiaalingimuste parandamiseks. Samas, kasumit maksimeerivad ettevõtted otsustavad suurendada oma innovatiivsust ainult siis, kui innovatsiooni eeldatav tulu ületab kulusid (Nelson, 1959). Ettevõtete motivatsioon investeerida teadmusloomesse innovatiivsuse tõstmiseks on madal, sest uute teadmistega kaasnevat tulu ei saa ainult ettevõtte ise (Nelson, 1959; Arrow, 1962). Lisaks on leitud, et teadmusloome on seotud vaiketeadmusega (Polanyi, 2009). Seda tüüpi teadmisi võib vaadelda kui oskusteavet, mida on raske kodifitseerida ja mis levib tavaliselt võrgustiku või kogukonna sees. Seetõttu mängib võrgustiku või kogukonna sees leviv vaiketeadmus suurt rolli ettevõtete innovatsioonis. Eelpool nimetatud tegurite tõttu on teadmusloomel avaliku hüve omadused ja nii kesksel tasemel kui kohalike omavalitsuste sekkumine on vajalik, et teadmuse loomine oleks erinevates piirkondades tasakaalustatud.

Rajasõltuvus (path dependency) ja globaliseerumise protsessid on oluliselt mõjutanud kohalike majanduste kujunemist. Autor uuris regionaalarengu teooriaid, eriti regionaalse innovatsioonisüsteemi (RIS) lähenemisviise, illustreerimaks, kuidas ajaloolised tehnoloogilised valikud, institutsionaalsed raamistikud ja geograafilised tegurid loovad unikaalseid rajasõltuvusi, mis kujundavad kohalike majandusstruktuure. Need rajasõltuvuse protsessid määravad millised tööstusharud kohalikes majandustes õitsevad, kuidas levib teadmus ja milline on ettevõtete innovatsioonivõimekus.

Neoklassikalised teooriad (Solow, 1956; Swan, 1956) rõhutavad tavaliselt turupõhist tegurite jaotust ning pööravad piiratud tähelepanu kohapõhistele institutsionaalsetele teguritele või kohalike omavalitsuste rollile piirkondliku tootmisvõimekuse ja innovatsioonitegevuse tõstmisel. Need teooriad aga ei käsitle asjaolu, et igal piirkonnal on oma ajalooline trajektoor, institutsionaalne kontekst ja ressursside kättesaadavus, mis viib püsivate erinevuste ja rajasõltuvusteni. Viimased lähenemisviisid – regionaalne innovatsioonisüsteem, kohapõhine areng (Barca, 2009), evolutsiooniline-strukturealistlik lähenemine – väidavad, et sekkumised kohalike ettevõtete innovaatsilisuse tõstmiseks peavad olema kohandatud

konkreetsetele asukohtadele nende unikaalsete institutsionaalsete ja majanduslike omadustega.

Perifeersed piirkonnad võivad säilitada traditsioonilisi tehnilisi ja tootmisteadmisi ning muid ressursse, mis on linnastunud piirkondades kadunud. Need säilinud teadmised võivad pakkuda võimalusi unikaalsete ja spetsialiseeritud toodete arendamiseks, kui need integreeritakse kaasaegsete tehnoloogiate ja turustrateegiatega. Peamiseks väljakutseks on perifeersete ettevõtete geograafiline isolatsioon. Vaiketeadmuse ülekanne tugineb tugevalt sagedastele silmast-silma kohtumistele (Polanyi, 2009) ettevõtete, teadus- ja arendustegevuse asutuste või ülikoolide esindajate vahel. Perifeersetes piirkondades toimuvad sellised kohtumised sageli piiratud osalejate võrgustikus, kuna olulised teadmused pakuvad nagu ülikoolid, teadus- ja arendustegevuse asutused ja suuremad ettevõtted üldiselt puuduvad.

Innovatsiooni toetav infrastruktuur koosneb kolmest elemendist vastavalt RIS (regional innovation system) lähenemisele (Doloreux and Dionne, 2008; Anderson and Karlsson, 2002): teaduspargid uutele tööstusettevõtetele, kõrgharidussüsteemid, mis pakuvad teaduslikku ekspertiisi ja koolitust, ning kohalikud omavalitsused, kes edendavad kohalike ettevõtete innovatsiooni. Perifeersetes piirkondades puuduvad kaks esimest elementi ja seega on kohalikud omavalitsused ainuke ja kõige olulisem element, mis võiks innovatsiooni toetada.

See olukord viib väitekirja keskele uurimisküsimusele. Arvestades, et väikesed perifeersed kohalikud omavalitsused on sageli ainsaks innovatsiooni toetavaks elemendiks perifeersetes piirkondades – kus kaks muud võtmekomponenti (ülikoolid ja teaduspargid) on puudu – on oluline uurida, kuidas need väikesed perifeersed kohalikud omavalitsused saavad läbi ruumilise planeerimise tõsta kohalike põllumajandusettevõtete tööjõutootlikkust ning toetada nende innovatsioonitegevust.

Kohapõhise arengu lähenemine (Barca, 2009) väidab, et väikesed perifeersed kohalikud omavalitsused peaksid püüdma leevendada püsivaid ebaefektiivsusi – mis tulenevad ressursside alakasutamistest ja põhjustavad mitteoptimaalset sissetulekut – ning võidelda sotsiaalse tõrjutusega. Väikeste perifeersete kohalike omavalitsuste jaoks on innovatsioonitegevuste toetamiseks oluline mõista, millised kohalikud ressursid neil on ning leida viise nende efektiivsuseks kasutamiseks. Antud väitekirja teoreetiline raamistik määratleb maakorraldust kui ruumilise planeerimise instrumenti, mis võimaldab tõsta põllumajandusettevõtete innovatsioonitegevust. Teoreetiline argument kohaldub üldiselt kohalikele ettevõtetele erinevates sektorites, kuid see väitekirja keskendub empiirilisel põllumajandusettevõtetele, mis asuvad enamasti perifeersetes piirkondades.

Põllumajandus on domineerivaks majandustegevuseks perifeersetes kohalikes omavalitsustes Kesk- ja Ida-Euroopa (KIE) riikides (Copus and Noguera, 2010), kus muu innovatsiooni infrastruktuur toetavad elemendid nagu ülikoolid ja teaduspargid puuduvad – muutes põllumajandusettevõtte peamiseks erasektori esindajateks, keda väikesed perifeersed kohalikud omavalitsused saavad mõjutada. Teiseks, ruumiline planeerimine on hästi välja kujunenud poliitikainstrument selgete õigusraamistikega, muutes selle ideaalseks testjuhtumiks uurimaks,

kuidas väikesed perifeersed kohalikud omavalitsused saavad kohalike põllumajandusettevõtete innovatsioonitegevust toetada oma olemasolevate pädevuste piires. Kolmandaks, Eesti põllumajandus seisab silmitsi tõsise postsotsialistliku maa fragmenteeritusega (Hartvigsen, 2014), mis loob ruumilisi piiranguid, mis selgelt takistavad innovatsiooni omaksvõtmist – pakkudes konteksti, kus väikeste perifeersete kohalike omavalitsuste ruumiline planeerimine saab mõjutada kohalike ettevõtete innovatsioonitegevusi.

Eesmärk ja uurimisküsimused

Väitekirja eesmärk: uurida, kas ja kuidas väikesed perifeersed kohalikud omavalitsused Eestis saavad tõsta põllumajandusettevõtete innovatsioonitegevust ja tootlikkust maakorralduse kaudu tegutsedes organisatsiooniliselt õhukestes regionaalsetes innovatsioonisüsteemides, kus on piiratud institutsionaalne suutlikkus ja puudub traditsiooniline innovatsiooni infrastruktuur.

Peamine uurimisküsimus: kuidas saavad väikesed perifeersed kohalikud omavalitsused Eestis tõsta põllumajandusettevõtete innovatsioonitegevust ja tootlikkust maakorralduse kaudu organisatsiooniliselt õhukestes regionaalsetes innovatsioonisüsteemides?

Alaküsimused:

- Mil määral võimaldab EL Ühtekuuluvuspoliitika KIE riikidel (kaasa arvatud Eestil) ületada ajaloolisi arengumustreid ja edendada innovatsiooni, ning kuidas mõjutavad riiklikud ÜP eraldamise otsused väikeste perifeersete kohalike omavalitsuste suutlikkust rakendada maakorraldust?
- Milline on seos põllumajandusettevõtete ruumilise struktuuri ja põllumajandusettevõtete tööjõutootlikkuse vahel Eesti postsotsialistlikus fragmenteeritud maa kontekstis, ja kas väikesed perifeersed kohalikud omavalitsused saavad mõjutada seda seost maakorralduse kaudu?
- Kas Eesti põllumajandusettevõtte paranenud ruumiline struktuur suurendab selle ettevõtte innovatsioonitegevuse tõenäosust, ja kas väikese perifeerse kohaliku omavalitsuse algatatud maakorraldus saab luua ruumilised eeldused, mis võimaldavad innovatsiooni omaksvõtmist?

Empiiriliste uuringute lühikokkuvõte

Uuring 1. Analüüsi 53 NUTS II piirkonda kümnes KIE riigis perioodil 2007–2013. Beeta-konvergensti analüüs näitas SKP koondumist üle KIE piirkondade, kuigi ÜP mõjud erinesid märgatavalt eri tüüpi piirkondade lõikes. Eesti eraldas ÜP-st 19% innovatsioonile ja teadus-arendustegevusele (kõrgeim KIE riikide seas), kuid ainult 2% suutlikkuse ülesehitamisele (madalaim KIE-s) ja 0% linnalisele ja territoriaalsele mõõtmele, luues struktuurse tasakaalustamatuse riikliku innovatsiooni pakkumise ja kohaliku rakendamissuutlikkuse vahel.

Uuring 2. Analüüsi 435 Eesti põllumajandusettevõtet 2015. aasta ristandmetest. Tööjõutootlikkust mõõdeti kui toodangut töötunni kohta. Töötati välja uus maa fragmenteerituse mõõdik – pindalaga kaalutud keskmine maatükisuuruse

näitaja – ning leiti selle statistiliselt oluline seos tööjõutootlikkusega, pakkudes paremat tööjõutootlikkuse seletusvõimet kui traditsioonilised Januszewski (1968) ja Schmook (1962) indeksid.

Uuring 3. Paneelandmete analüüs 392 Eesti põllumajandusettevõtte kohta perioodil 2014–2019, kasutades ettevõtete fikseeritud efektidega logistilist regressiooni. Tulemused näitasid, et pindalaga kaalutud keskmine maatükisuuruse kasv suurendas statistiliselt oluliselt innovatsioonitegevuse läbiviimise tõenäosust. Tööjõutootlikkus töötunni kohta oli positiivselt seotud innovatsioonitegevuse läbiviimise tõenäosusega. Täielikult renditud maaga ettevõtted näitasid madalamat innovatsioonitegevuse tõenäosust võrreldes põllumajandusettevõtete, kellel rendimaad ei olnud.

Arutelu

Peamise uurimisküsimuse vastuseks: kolm uuringut koos näitavad, et väikesed perifeersed kohalikud omavalitsused saavad tõsta põllumajandusettevõtete innovatsioonitegevust maakorralduse kaudu hoolimata organisatsioonilisest õhukusest (Tödtling and Tripp, 2005). Uuring 1 näitas, et Eesti ÜP eraldamise muster (19% innovatsioonile ja T&A-le, 2% suutlikkuse ülesehitamisele) loob süsteemse lahknevuse riikliku innovatsiooni pakkumise ja kohaliku rakendamissuutlikkuse vahel. Uuring 2 valideeris mikrotasandil tootlikkuse mehhanismi, näidates, et ruumilised piirangud loovad siduvaid barjääre sõltumatult teadmiste kättesaadavusest või finantsressurssidest (Van Dijk, 2003; Hartvigsen, 2014). Uuring 3 lõpetas ahela, näidates et maakorraldus, mis käsitleb neid piiranguid, tõstab innovatsioonitegevuse tõenäosust.

Esimese alaküsimuse vastuseks: Uuring 1 näitas, et ÜP võimaldab KIE piirkondadel saavutada beeta-konvergensti SKP tasemetes (Bachtler and Gorzelak, 2014), kuid mõjud varieeruvad piirkondade tüüpide lõikes. Eesti ÜP eelarve eraldamise muster – kõrgeim protsent innovatsioonile ja T&A-le (19%), kuid madalaim suutlikkuse ülesehitamisele (2%) – loob struktuuralse tasakaalustamatuse, kus riiklikku innovatsiooni pakkumist piirab kohalike omavalitsuste institutsiooniline suutlikkus rakendada maakorraldust, mis võimaldaks ettevõtte tasandi innovatsiooni omaksvõtmist.

Teise alaküsimuse vastuseks: Uuring 2 näitas, et põllumajandusettevõtte ruumiline struktuur mõjutab oluliselt tööjõutootlikkust sõltumatult ettevõtte suuruselt. Pindalaga kaalutud keskmine maatükisuurus pakub paremat meetodilist lähenemist maa fragmenteerituse mõõtmiseks postsotsialistlikes kontekstides võrreldes traditsiooniliste Januszewski ja Schmook indeksitega.

Kolmanda alaküsimuse vastuseks: Uuring 3 näitas, et paranenud põllumajandusettevõtte ruumiline struktuur suurendab oluliselt innovatsioonitegevuse tõenäosust. Väikese perifeerse kohaliku omavalitsuse algatatud maakorraldus võib luua ruumilisi eeldusi, mis võimaldavad innovatsioonitegevuste elluviimist isegi organisatsiooniliselt õhukestes piirkondades. Mõju püsib üle rendivormide kategooriate, kuigi täielikult renditud ettevõtted näitavad oluliselt madalamat innovatsioonitegevuse tõenäosust. Tulemused valideerivad maakorraldust kui

teostatavat ruumilist planeerimist väikeste perifeersete kohalikele omavalitsuste poolt, kes saavad kasutada olemasolevaid ruumiplaneerimisega seotud õigusruumi poolt reguleeritud võimalusi.

Panus teoriasse

1. Regionaalse innovatsioonisüsteemi (RIS) teoreetilisele raamistikule: väitekiri näitab, kuidas perifeersed väikesed kohalikud omavalitsused saavad mõjutada innovatsioonitegevust maakorralduse kaudu hoolimata organisatsioonilisest õhukusest. Olemasolev RIS kirjandus (Cooke et al., 1997; Asheim and Gertler, 2005) keskendub peamiselt teadmuse loomise infrastruktuurile (ülikoolid, teadusasutused), kuid mitte kohaliku omavalitsuse võimalustele innovatsioonitegevuste toetamisel (Doloreux and Dionne, 2008; Tödtling and Kaufmann, 1999). See väitekiri näitab, et innovatsioonisüsteemi tõhusus perifeersetes piirkondades sõltub mitte ainult teadmuse loomise võimest, vaid ka kohaliku omavalitsuse institutsionaalsest suutlikkusest luua ruumilisi eeldusi, mis võimaldavad innovatsioonitegevuste elluviimist.

2. Rajasõltuvuse kirjandusele: väitekiri näitab, kuidas ajaloolised protsessid – 1990ndate maareform, mis lõi äärmusliku maa fragmenteerituse, nõrgenenud planeerimissüsteemid üleminekuperioodil – loovad siduvaid piiranguid praegusele innovatsioonitegevusele, samal ajal kui järkjärgulised poliitilised sekkumised (teise astme instrumendi muudatused maakorralduse kaudu) võivad võimaldada innovatsioonitegevust ellu viia hoolimata piirangutest. Väitekirja tulemused näitavad, et rajasõltuvust võivad kohalikud institutsioonid oma sekkumiste teel muuta. Kuigi ajaloost tingitud tegurid piiravad võimalike sekkumiste valikuid (Martin and Sunley, 2006; Kay, 2005; Hall, 1993), saavad kohalikud omavalitsused siiski kasutada maakorraldust, et võimaldada innovatsioonitegevuste elluviimist.

3. Metoodiline panus: pindalaga kaalutud keskmine maatükisuurus kui mõõdik võimaldab postsotsialistlike kontekstide jaoks praktikutele paremat tööriista maakorralduse projektide tõhususe jälgimiseks kui traditsioonilised maa fragmenteerituse indeksid.

Peamised piirangud ja edasised uuringud

1. Empiirilised analüüsid kasutavad FADN ja ARIB sekundaarseid andmeid. FADN valim (392 põllumajandusettevõtet 7,610 kõlblikust majapidamisest üle 4,000 € majandusliku suuruse) keskendub majanduslikult olulistele põllumajandusettevõtetele, kes on võimelised innovatsioonitegevuseks. Vabatahtlik FADN osalemine võib siiski tuua kaasa mõnevõrra kallutatud valimi, kui osalevad ettevõtted erinevad süstemaatiliselt juhtimissuutlikkuse või innovatsiooni orientatsiooni poolest mitteosalejatest.
2. Innovatsiooni mõõtmine binaarmuutujana (kas ettevõtted investeerivad hoonetesse, masinatesse ja seadmetesse) hõlmab innovatsiooni omaksvõtmise otsuseid kooskõlas OSLO käsiraamatuga (OECD/Eurostat, 2018), mis on 3

- uuringu fookus, kuid ei saa hinnata innovatsiooni intensiivsust või kvaliteeti. See sobib aga uurimiseesmärgiga, sest on võimalik määrata, kas paranenud ruumiline struktuur suurendab innovatsioonitegevuse tõenäosust.
3. Uuring 2 ristlõikeline disain kinnitab tööjõutootlikkuse-maastruktuuri seost, mis on vajalik alaküsimusele 2 vastamiseks, kuid ei saa lõplikult kinnitada põhjuslikku seost. Uuring 3 paneelained (2014–2019) tugevdavad põhjuslikku järeldust fikseeritud efektide modelleerimise kaudu.
 4. Praktiline rakendamine seisab silmitsi oluliste väljakutsetega Eestis: kõrged maarendihinnad loovad rendiõiguse ebakindlust, mis muudab mitmeaastased konsolideerimisprojektid keeruliseks, kuna traditsioonilised maakorralduse lähenemised eeldavad omandiõiguse konsolideerimist. Piiratud kohaliku omavalitsuse suutlikkus esindab kriitilist piirangut: väikesed perifeersed kohalikud omavalitsused vajavad tehnilist ekspertiisi GIS analüüsiks, katastrite ja mitme sidusrühma koordineerimiseks, mida maakorralduse rakendamine nõuab (Jürgenson et al., 2025).
 5. Tulevased uuringud peaksid ehitama sellele väitekirjale rajatud alustele ja analüüsima, kuidas põllumajandusettevõtte struktuur mõjutab kasumlikkust, turule pääsu ja majanduslikku jätkusuutlikkust. Viimane süstemaatiline ülevaade (Aslam et al., 2025) tunnistab, et kuigi maa fragmenteerituse aste mõjutab põllumajanduse tulemuslikkust – tootlikkust, efektiivsust ja kasumlikkust – jäävad alles olulised lüngad nende seoste põhjalikus mõistmises. Samuti on vajalik mõista, kuidas regionaalse arengu muustrid mõjutavad maakorralduse tulemusi ning kuidas erinevate poliitikate kombinatsioonid – käsitledes kõiki nelja piirkondliku arengu tegurit (teadmised ja inimkapital, koostöö ja sidemed, loodusvarad ja infrastruktuur, institutsiooniline suutlikkus) – saavad tugevdada kohalike põllumajandusettevõtete innovatsioonitegevust (Hartmann et al., 2025).

Kokkuvõtteks demonstreerib see väitekirj, et väikesed perifeersed kohalikud omavalitsused Eestis saavad tõsta põllumajandusettevõtete innovatsioonitegevust ja tööjõutootlikkust maakorralduse kaudu, mis tegeleb rajasõltuvuse loodud struktuursete piirangutega. Kuigi organisatsiooniline õhukus, fiskaalsed piirangud ja puuduv innovatsiooni infrastruktuur loovad tõsiseid väljakutseid, näitavad väitekirjas läbiviidavad uuringud, et strateegilise maakorralduse kasutamine võib luua eeldusi, mis võimaldavad põllumajandusettevõtetel omaks võtta innovatsioone, mida edendatakse EL ja riikliku põllumajanduspoliitika kaudu (European Commission, 2021). Need tulemused näitavad, et isegi tõsiste ressursside piirangutega regionaalsed innovatsioonisüsteemid omavad läbi kohalike omavalitsuste olemasolevate poliitikainstrumentide võimaluse tõsta kohalike põllumajandusettevõtete tööjõutootlikkust ja innovatsioonitegevusi.

CURRICULUM VITAE

Name: Jaan Looga
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Education:

2013–... PhD Student, (sup) Kadri Ukrainski, Peter Joachim Friedrich, The Role of Small Peripheral Local Governments in Farm Innovation: Land Consolidation as a Spatial Planning Instrument in Estonia, The university of Tartu, School of Economics and Business Administration

2009–2010 Master’s Degree, (sup) Janno Reiljan, Financing Estonian Local Governments to Promote Balanced Regional Development, The university of Tartu, School of Economics and Business Administration

2005–2009 Bachelor’s Degree, (sup) Toomas Raus, Local Governments Income Differences, The university of Tartu, School of Economics and Business Administration

Training:

November 2012 “The uniform basis for NGO financing buy public sector budgets” – Praxis, Saima Mänd, 8h

October 2011 “Central government and local governments cooperation” – Geomedia OÜ, Rivo Noorkõiv, 16h

October 2011 “The evaluation of health-promoting organisation’s capabilities” – Advisio OÜ, 8h

October 2011 “Public speaking” – Public Speaking Academy, Andero Uusberg, 8h

Employment history:

03.2025– Tartu Health Care College, Research manager (1.00)

11.2022– Tartu Health Care College, Research coordinator (1.00)

10.2019–10.2022 Tartu Health Care College, Development specialist (1.00)

09.2014–08.2019 University of Tartu, School of Economics and Business Administration, Institute of Economics, Chair of Public and International Economy, Junior Research Fellow in regional economics (0.50), from 2017 (0.75).

08.2011–12.2014 Association of Local Authorities in Viljandi County – managing director

- The Foundation Perekodu – board member
- Non-profit Association Viljandimaa Noortekeskus – board member

- Foundation South-Estonian Tourism – member of the supervisory board
- Mardi fair 2014 – the leading organiser
- 03.2011–12.2011 The Centre for Applied Social Sciences (CASS) at the University of Tartu – analyst
- Since 2017– Lectures for local government leaders and specialists about Estonian small LGs innovation policies. Presentations took place in Hiiumaa, Tallinn, Jõgeva.

Analyses/projects:

- 01.01.15–30.09.15 The economic impact of research in the sectoral innovation systems of the technologies, which are rewarded in Estonia
- 01.06.14–30.06.14 The analysis of economic competitiveness and growth areas of Ida-Virumaa
- 16.12.13–30.04.14 The development of smart specialisation strategy for Tartu and South-Estonia
- 30.09.13–04.11.13 The analysis of economic competitiveness and growth areas of Tartu and South-Estonia
- 01.03.12–30.11.12 The study of Viljandimaa tourism sector 2012
- 14.04.11–31.12.11 Mid-term evaluation of structural assistance for 2007–2013
- 30.08.10–31.07.11 Estonian Mechanical Engineering Industry Sector Study 2010

Languages:

- Estonian – very good
- Russian – very good
- English – very good
- German – good

Computer skills: MS Excel, MS PowerPoint, MS Word, STATA, SPSS

Interests: Books, movies, sports

Belonging to organisations and other activity:

- 2009–2010 Tartu University Students Marketing Club
- 1998–2005 Viljandi school of Sports, basketball speciality

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Hariduskäik:

2013–... Tartu Ülikooli majandusteaduskond – doktoriõpe
Doktoritöö teema “Väikeste perifeersete kohalike omavalitsuste roll põllumajandusettevõtete innovatsioonis: maade ümberkruntimine kui strateegiline ruumiline planeerimine Eestis“

2009–2010 Tartu Ülikooli majandusteaduskond – magistriõpe
Magistritöö teema: “Eesti kohalike omavalitsuste rahastamine regionaalarengu tasakaalustajana“

2005–2009 Tartu Ülikooli majandusteaduskond – bakalaureuseõpe
Bakalaureusetöö teema: “Kohaliku omavalitsuse tulude diferentseeruvus“

Täiendkoolitused:

november 2012 „Ühtsed alused kodanikuühenduste rahastamiseks avaliku sektori eelarvetest” – Praxis, Saima Mänd, 8h

oktoober 2011 „Riigi ja kohalike omavalitsuste koostöö” – Geomedia, Rivo Noorkõiv, 16h

oktoober 2011 „Tervist edendava projektorganisatsiooni (PO) suutlikkuse välishindamine” – Advisio OÜ, 8h

oktoober 2011 Avaliku esinemise koolitus – Avaliku Esinemise Akadeemia, Andero Uusberg, 8h

oktoober 2016 „Simulatsioon Euroopa Liidu eelarve läbirääkimistest” – Regioonide Komitee, Euroopa Poliitikauuringute Keskus, 4h

Töökogemus:

03.2025– Tartu Tervishoiu Kõrgkool, Teadustegevuse juht (1,00)

09.2014–08.2019 Tartu Tervishoiu Kõrgkool, Teadustegevuse koordinaator (1,00)

10.2019–10.2022 Tartu Tervishoiu Kõrgkool, arendusspetsialist (1,00)

09.2014–08.2019 Tartu Ülikool, Majandusteaduskond, Riigimajanduse ja majanduspoliitika õppetool; regionaalökonomika nooremteadur (0.50), alates 1.09.2017 (0.75)

08.2011–12.2014 MTÜ Viljandimaa Omavalitsuste Liit – tegevdirektor
– SA Perekodu – juhatuse liige
– MTÜ Viljandimaa Noortekeskus – juhatuse liige
– SA Lõuna-Eesti Turism – nõukogu liige
– Helsingi Mardilaat 2014 – põhikorraldaja Eestis

03.2011–12.2011 Tartu Ülikooli sotsiaalteaduslike rakendusuringute keskus – analüütik

Uuringud/analüüsid:

- 01.01.15–01.09.15 Teadustöö majanduslike mõjude avaldumine Eestis premeeritud tehnoloogiaid hõlmavates sektoraalsetes innovatsioonisüsteemides
- 01.06.14–30.06.14 Ida-Virumaa konkurentsivõime ja kasvualade analüüs
- 16.12.13–30.04.14 Tartu ja Lõuna-Eesti nutika spetsialiseerumise strateegia
- 30.09.13–04.11.13 Tartu ja Lõuna-Eesti konkurentsivõime ja kasvualade analüüs
- 01.03.12–30.11.12 Viljandimaa turismivaldkonna uuring 2012
- 14.04.11–31.12.11 Perioodi 2007–2013 struktuurivahendite vahehindamine
- 30.08.10–31.07.11 Eesti masinatööstuse sektoruuring 2010

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