Smart Specialization in Europe: Agrotech Cluster Development in Sweden and Poland

David Bartlett
Kogod School of Business
American University
Washington, DC

Tomasz Mroczkowski
Kogod School of Business
American University
Washington, DC

Elżbieta Zysk
Department of Real Estate
University of Warmia and Mazury
Olsztyn, Poland

Abstract

As the most ambitious regional development in the history of the European Union, RIS3 (Research and Innovation Strategies for Smart Specialization) has stimulated a large body of theoretical and empirical research. This article advances the scholarly literature through a comparative analysis of RIS3 programs in two EU regions: Sydsvierge in southern Sweden and Warmińsko-Mazurskie in northeastern Poland. The former is one of Europe's most innovative regions, while the latter ranks as a laggard in regional development. We focus on innovation in food and agriculture, an industry prioritized in the RIS3 programs of both of the target regions. Using a three-pronged cluster mapping model (industry specialization, size of cluster, knowledge complexity) and data extracted from the European Observatory for Clusters and Industrial Change, we examine smart specialization paths across five segments of the ag/ food industries of Sydsvierge and Warmińsko-Mazurskie (core, upstream, downstream, related, unrelated). By comparing and contrasting the results of RIS3 programs of two regions occupying polar positions in European development, we explore the factors promoting and hindering smart specialization in food and agriculture. The article provides important insights on key questions in the smart specialization literature: the risks/benefits of related versus unrelated diversification; the role of technological complexity in regional development; and the challenges of innovation and competitiveness in developed and underdeveloped regions.

I. Introduction

In June 2011, the European Commission created a Smart Specialization Platform to promote growth, innovation, and competitiveness in regions of European Union countries and non-EU states. By 2020, 210 regions had registered in the program under the auspices of RIS3 (Research and Innovation Strategies for Smart Specialization). Departing from the industry-specific approach to specialization associated with Michael Porter, RIS3 aims to expand the capacity of regions for technology-driven innovation within and across industries. In that context, "diversified specialization" prioritizes the augmentation of existing regional assets and 1 development of new capabilities to enable movement into both related and unrelated industries (Foray, Goddard, Beldarrain, Landabaso, McCann, Morgan, Nauwelaers, and Ortega-Argilés 2012; Foray, Morgan, and Radosevic 2017). The EU's RIS3 campaign has spurred a growing body of theoretical work on smart specialization and empirical research on program outcomes in participating regions. This article augments the extant literature with a detailed investigation of smart specialization in two participants in the RIS3 program: Sydsvierge in southern Sweden and Warmińsko-Mazurskie in northeastern Poland. The former is one of Europe's strongest performing regions measured by innovation, specialization, technology adoption, and diversification in value-added industries. The latter is one of the least developed regions in the European Union that ranks near the bottom of EU assessments of innovation and competitiveness. Our comparative analysis of RIS3 programs in the two regions charts potential paths for smart specialization in underdeveloped EU regions based on best practices in strong regions.

We focus on smart specialization in food and agriculture. The food/agriculture industry well illustrates the opportunities and challenges of smart specialization in Europe.

Global competitive forces are exerting mounting pressure on European farms to diversify out of low-margin commodity markets and to adopt advanced technologies across the ag/food value chain. To guide our empirical analysis of smart specialization in the ag/food industries of Sydsvierge and Warmińsko-Mazurskie, we devise a cluster mapping model that applies three measures: degree of industry specialization, size of industry cluster, and level of knowledge complexity in the industry. Using this model, we analyze cluster development across five segments of the agro-industrial value chains of the target regions: core ag/food industries, upstream industries, downstream industries, related industries, and unrelated industries.

2. Smart Specialization in Europe

The novel research design of the article–combining a three-pronged cluster mapping model and empirical data on two regions of Europe occupying polar positions in agrotech development–generates important contributions to scholarly research on smart specialization in Europe. We address the threads of the smart specialization literature:

2.1 Diversification Strategies

Scholars of smart specialization have identified two paths of regional diversification: Related diversification (development of industrial capabilities closely related to existing regional assets) and unrelated diversification (movement into industries remote from established regional capabilities). Studies of regional development in Europe indicate that related diversification is more common than unrelated diversification (Xiao, Boschma, and Andersson 2018). Diversification based on existing local capabilities (e.g., movement from motor cycles to trucks) is less risky and difficult than diversification requiring capabilities not present in the region (e.g., migration from bananas to computers). (Boschma, Coenen, Frenken, and Truffer 2017). Unrelated diversification is most likely to occur in regions exhibiting strong entrepreneurship (new facilities created by local startups rather than plants created by established incumbents) and robust ties to innovative companies and multinational enterprises based outside the region (whose local subsidiaries bring new capabilities to the host region). (Boschma 2017) Our empirical investigation augments the smart specialization literature by analyzing patterns of related and unrelated diversification in the ag/food sectors of Sydsvierge and Warmińsko-Mazurskie. Echoing the results of other studies, we find that related diversification is more common than unrelated diversification in those sectors. But our analysis also reveals examples of unrelated diversification in both target regions, demonstrating the potential for diversification out of specialized ag/food sectors in Europe.

2.2 Technology Adoption

Scholarly works on smart specialization examine the challenges facing RIS3 regions undergoing technological modernization. Using EU patent data, Balland, Boschma, Crespo, and Rigby (2019) develop a framework to map smart specialization strategies along the metrics of technological relatedness and technological complexity. The combination of high relatedness/high complexity designates an optimal strategy offering strong benefits and low risks ("high road"). Low relatedness/low complexity describes a sub-optimal strategy that provides weak benefits with high risks ("dead end"). The combination of high relatedness/low complexity entails low risks but limited benefits ("slow road"). Smart specialization strategies combining low relatedness and high complexity offer strong potential benefits, but also significant risks for regions diversifying into complex technologies unrooted in existing capabilities ("casino"). Asheim (2019) argues that such high reward/high risk diversification strategies are increasingly plausible owing to the dispersion of key enabling technologies (KET) such as biotechnology, digital technology, nanotechnology, photonics, and advanced materials.

He cites the examples of developed regions in the EU (East Central Sweden, Upper Austria, and Emilia-Romano in Italy) that have leveraged KETs to accelerate diversification into complex, unrelated technologies. KET-based strategies have also proven effective in some regions in Central and Eastern Europe (e.g., Mazovia in Poland) that possess strong institutional and technological assets and factor cost advantages. However, most peripheral regions in the CEE countries lack the resources (absorptive capacity, institutional governance, academia-industry links) to parlay KETs for diversification into complex/unrelated technologies. Adoption of new and emerging technologies presents opportunities for competitive differentiation in regions with large ag/food sectors. Deployment of "precision agriculture" technologies (automated equipment, soil sensors, unmanned aerial vehicles, etc.) facilitates migration from commodity to value-added products. However, adoption of advanced farm technologies that are misaligned with regional absorptive capacity raises serious risks. Conversely, reliance on outdated technologies presents comparatively low risks but may lock ag/farm industries into cycles of eroding competitiveness and declining margins. This article illuminates the risk/reward tradeoffs of technology modernization in the ag/food sectors of regional participants in the EU's RIS3 program.

Our research design (which disaggregates the ag/food sectors of Sydsvierge and Warmińsko-Mazurskie into core, upstream, downstream, related, and unrelated segments) allows us to track the diversification of regional farms into components of the ag/food value chain exhibiting varying levels of knowledge complexity.

Scholarly research shows wide regional disparities in the RIS3 program. Highly developed regions in Northern and Western Europe report the most favorable outcomes, reflecting strong institutional environments that facilitate refinement of existing practices. Some Southern European regions with weak governance systems have managed to surmount institutional barriers to smart specialization. RIS3 implementation has proven challenging in participating regions of Central and Eastern Europe, where post-communist institutional and governance structures remain weak (McCann and Ortega-Argilés 2016; Grillitsch and Asheim 2018). Asheim, Grillitsch, and Trippl (2016) explore the factors underpinning the relative success of the Scandinavian countries in smart specialization: effective governance, high institutional capacity, strong knowledge-based industries, robust entrepreneurial sectors, talent pools with large shares of tertiary education, high levels of social capital that promote inter-organizational collaboration. Southern Sweden stands as an archetype of diversified specialization based on that region's concentration of knowledge-creating institutions ("organizational thickness") and heterogenous industrial structure enabling new path development.

While the countries of Central and Eastern Europe have significantly narrowed the productivity gap with Western Europe, they still lack the regional assets requisite to Scandinavian-type smart specialization. Gianelle, Guzzo, and Mieszkowski (2019) and Muscio, Reid, and Leon (2015) examine the "regional innovation paradox" of the CEE area: The contradiction between the demand for increased EU spending on innovation in the CEE countries and the region's lower capacity to absorb public funds. Benner (2019) shows how the legacies of top-down decision making in the former socialist countries clash with the bottom-up orientation of the RIS3 program, which relies on discoveries of innovation opportunities by local entrepreneurs (EDP). Anić, Corrocher, Morrison, and Aralica (2019) note the low level of trust between local agents in CEE economies that frustrates inter-firm alliances and knowledge sharing. Against these region-wide liabilities, the CEE countries display important variations in RIS3 programs. Smart specialization is least advanced in less developed CEE countries such as Romania (Healy 2018; Ranga 2018). The development paths of advanced CEE economies like Slovenia and Czech Republic align more closely with EU norms. The Baltic Republics (whose small domestic markets hinder formation of horizontal local linkages) have pursued technology enclave strategies aimed at integration in international value chains (Karo and Kattel 2015). For transitional economies dependent on European Union funding, ex ante conditionality (which obliges member states to enact RIS3 programs to access European Structural and Investment Funds) serves an impetus for smart specialization in the CEE region (Reimeris 2016). Our comparative analysis (focusing on the agtech components of the RIS3 programs of a two regions occupying polar positions in European development) highlights possibilities of narrowing the regional performance gap. The experiences of Sydsvierge (a highly developed region of southern Sweden with world-class assets) indicate paths for smart specialization in Warmińsko-Mazurskie (an underdeveloped region of northeastern Poland with significant untapped potential in ag/food and related industries).

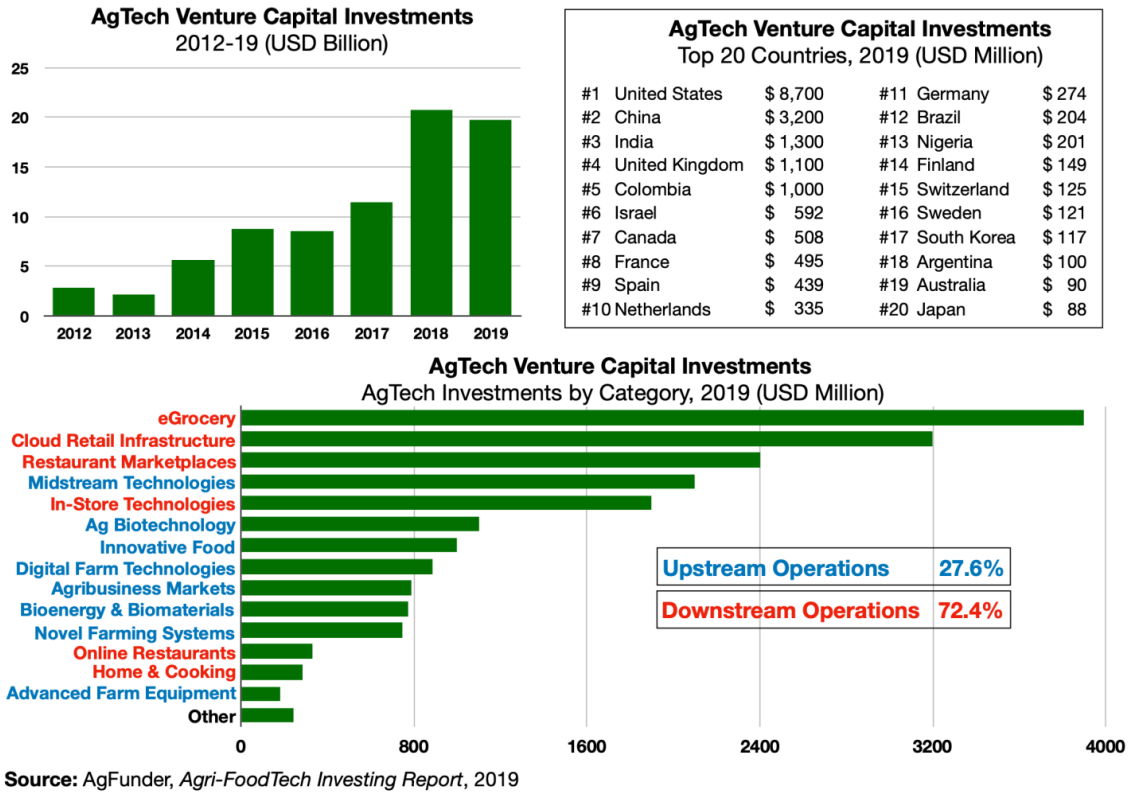
3. Research Questions

The article addresses following research questions: • To what degree and in what ways are Sydsvierge and Warmińsko-Mazurskie pursuing related versus unrelated diversification strategies? • How are the target RIS3 regions managing the risk/reward tradeoffs of technological complexity? • What lessons from the experiences of strong performing RIS3 regions such as Sydsvierge apply to weaker performing regions like Warmińsko-Mazurskie?

We focus on regional development strategies in food and agriculture, a sector prioritized in the RIS3 programs of both Sydsvierge and Warmińsko-Mazurskie. The problems addressed in the smart specialization literature–the benefits and risks of related versus unrelated diversification; the role of technological complexity in regional specialization strategies; the factors driving RIS3 outcomes in Western Europe and Central and Eastern Europe– clearly resonate in the food and agriculture sector. Smart specialization offers significant opportunities for agricultural producers. Amid mounting competition and declining margins, smart specialization provides a path for commodity farms to diversify into value-added products and escape the trap of low investment and weak market orientation. Regional specialization programs have bolstered the competitiveness of agro-based clusters in Africa (e.g., cut flowers, fish processing), Asia (grapes, livestock), and Latin America (coffee, wine, fruit). Applications of new and emerging technologies in these regions boost agricultural productivity, raise farm income, and facilitate integration of smallholder farms into global value chains (Gálvez-Nogales 2010). Advances in bioconversion systems enable the transformation of "flex crops" (maize, palm oil, soy, sugarcane) into biofuels, bioplastics, and other non-food byproducts that generate supplementary revenue streams and buffer farms against external shocks and market fluctuations (Bastos 2018).

The food/agriculture sector figures prominently in the EU's smart specialization program. Three-quarters of participating RIS3 regions have selected agro-food as a sectoral priority. Agro-based specialization programs underway in Europe cover applications of advanced technologies (biotechnology, biofuels, biopharmaceuticals, chemistry, digital technologies, sensors), food production and distribution, food safety and security, food traceability, organic foods, transport and logistics, health and nutrition, maritime and fisheries, aquaculture, and agro-tourism (Cavicchi and Stancova 2016; Cavicchi and Stancova 2017). Recent trends in venture capital investment signal the investor community's growing confidence in the commercial potential of agricultural technologies. Globally, VC funding of agtech reached $20 billion in 2019, over three times the level of 2012. Over 70 percent of agtech VC investments in 2019 went to downstream technology applications (eGrocery, cloud retail infrastructure, restaurant market places, et al); the remainder went to upstream operations (biotechnology, digital farm technologies, innovative food, et al). The United States, China, and India accounted for two-thirds of global agtech VC funding that year. (See **Figure 1** below).

Global Trends in Agricultural Technology **Figure 1**

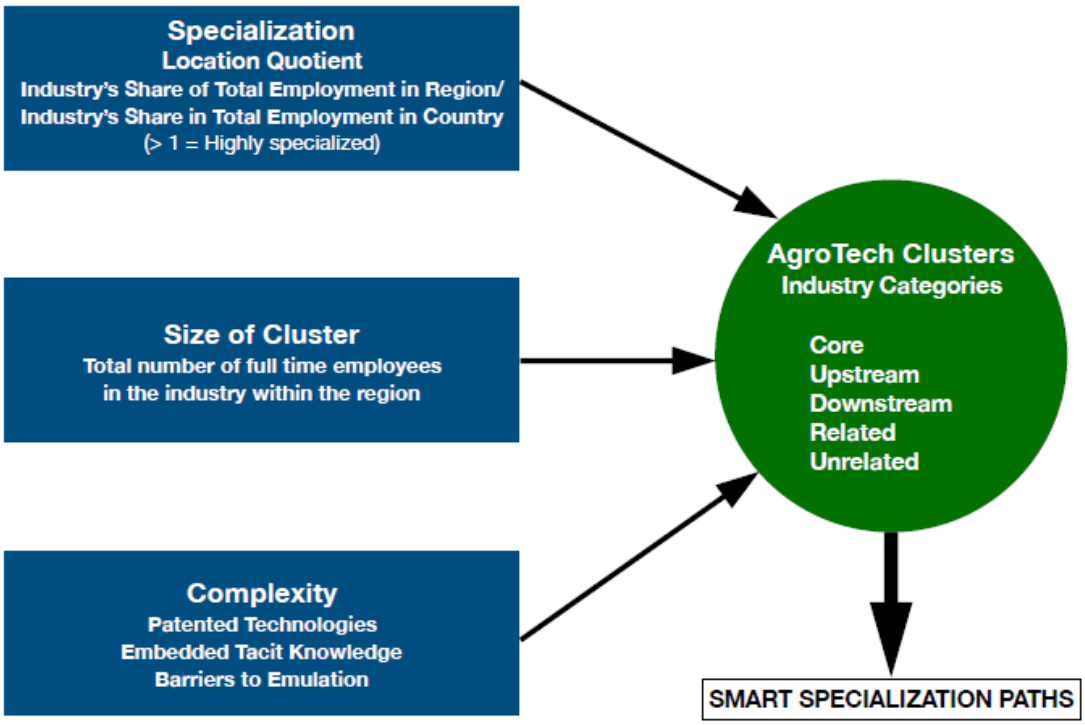


Source: AgFunder, *Agri-FoodTech Investing Report*, 2019

Investments in online supermarkets, cloud retail infrastructure, and related downstream operations are not region-specific. The primary aim of such agtech investments is to exploit commercial opportunities in food-related e-commerce markets at the national and international levels. By contrast, deployment of advanced agricultural technologies in upstream operations at the farm level (robotic farm equipment, wifi-enabled sensors, spectral food sensing, alternative proteins, GMO-based seeds, precision irrigation, integrated pest management) hinges on the availability of regional capabilities. Accordingly, the risk/benefit calculus of agtech applications for smart specialization is most salient in the sphere of upstream operations. The low risk/high benefits model is most likely to succeed in regions possessing indigenous capabilities closely related to the complex technologies under adoption. Regions attempting to diversify into advanced upstream technologies unrelated to local capabilities face a less favorable risk/benefit scenario. Our empirical investigation of agro-based smart specialization in Sweden and Poland illuminates these tradeoffs, examining the experiences of Sydsvierge (a capabilities-rich region) and Warmińsko-Mazurskie (a region with comparatively weak indigenous capabilities) in related/unrelated technology diversification.

4. RESEARCH DESIGN To guide our comparative analysis of the RIS3 programs of Sydsvierge and Warmińsko-Mazurskie, we devise a model to analyze smart specialization paths in food and agriculture. The model maps regional agricultural technology clusters along three dimensions (degree of specialization, size of cluster, and level of technological complex) across five industry segments (core, upstream, downstream, related, unrelated). This model is shown in **Figure 2** below:

Smart Specialization Theoretical Model



4.1 Degree of Cluster Specialization

To measure the degree of specialization in agrotech clusters, we employ a Location Quotient. Following the methodology of Figiel, Kuberska, and Kufel (2014), this metric gauges the concentration of employment in the target industry within the region relative to the concentration of employment in that industry nation-wide. A regional/national concentration ratio exceeding 1.0 indicates a comparatively high degree of specialization; a ratio below 1.0 a low degree of specialization. The cluster specialization metric is formalized as follows: LQ = Where LQ = Location Quotient A = Employment in the industry cluster within the region B = Total employment in the region C = Total employment in the industry cluster in the country D = Total employment in the country High Specialization: LQ > 1.0 Medium-High Specialization: LQ 0.80 – 0.99 Medium-Low Specialization: LQ 0.60 – 0.79 Low Specialization: LQ < 0.60

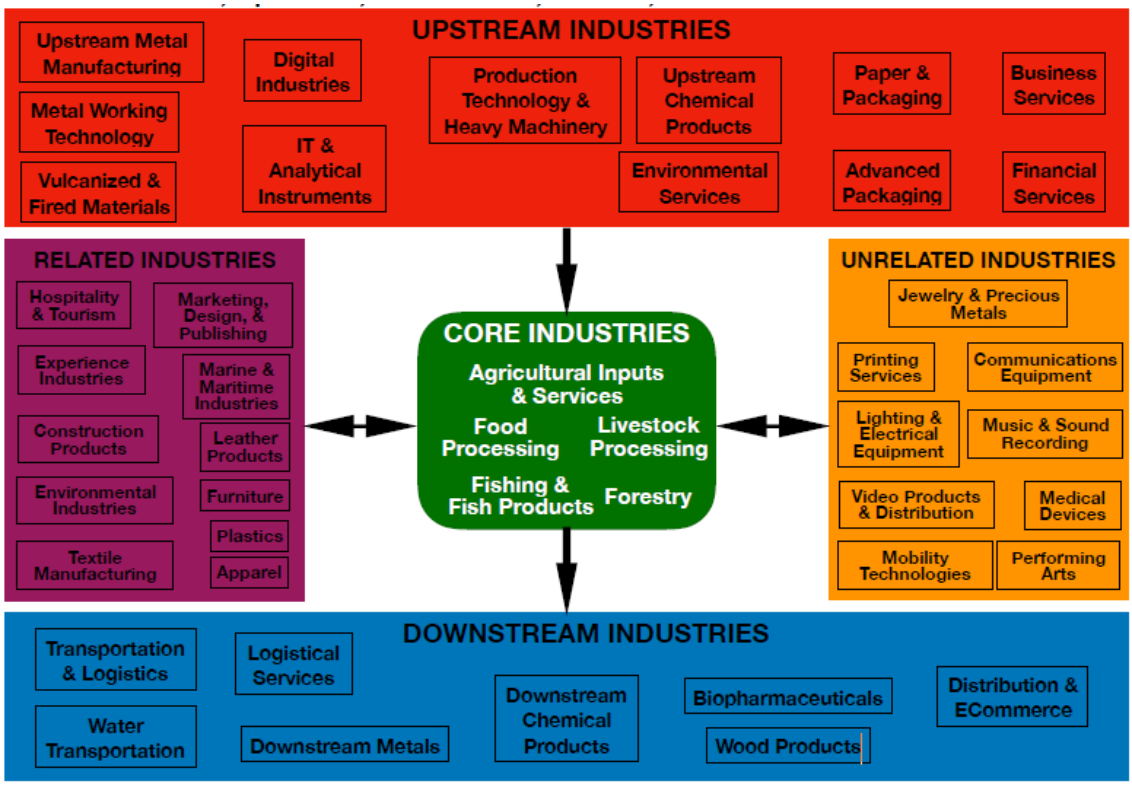
4.2 Size of Cluster

Our measure of the size of regional agrotech clusters is straightforward, based on the total number of full-time employees in the target industry within the region. **4.3 Level of Knowledge Complexity** This component of our cluster mapping model draws on the Knowledge Complexity index devised by Balland, Boschma, Crespo, and Rigby (2019) that uses patent data to measure the degree of complexity of selected industries. We supplement that patent-based index with qualitative assessments of the tacit knowledge and barriers to emulation present in the target industries.

4**.4 Agrotech Industry Categories**

We disaggregate the five agrotech industry categories (core, upstream, downstream, related, unrelated) into key industry segments

(Figure 3): 8 **Mapping of AgroTech Clusters Core, Upstream, Downstream, Related, and Unrelated Industries**



4.5 Complexity Groups We then sort these cluster industries by complexity groups: high complexity, medium/high complexity, medium/low complexity, low complexity (**Figure 4**):

Knowledge Complexity of AgroTech Clusters Core, Upstream, Downstream, Related, and Unrelated Industries

High Complexity	
Digital Industries	Upstream
IT/Analytical Instruments	Upstream
Biopharmaceuticals	Downstream
Medical Devices	Unrelated
Downstream Chemicals	Downstream
Upstream Chemicals	Upstream
Distribution/ECommerce	Downstream
Production Technology	Upstream
Environmental Services	Upstream
Environmental Industries	Related

Medium/High Complexity	
Agricultural Inputs & Services	Core
Food Processing	Core
Livestock Processing	Core
Business Services	Upstream
Financial Services	Upstream
Marketing/Design/Publishing	Related
Communications Equipment	Related
Lighting & Electrical Equipment	Unrelated
Mobility Technologies	Unrelated

Low Complexity	
Construction Products	Related
Wood Products	Related
Textile Manufacturing	Related
Apparel	Related
Leather Products	Related
Forestry	Core
Fishing & Fish Products	Core
Performing Arts	Unrelated

Medium/Low Complexity	
Transportation & Logistics	Downstream
Water Transportation	Downstream
Maritime/Marine Industries	Related
Logistical Services	Downstream
Plastics	Related
Furniture	Related
Music & Sound Recording	Unrelated
Video Products & Distribution	Unrelated
Experience Industries	Related
Metal Working Technology	Upstream
Upstream Metal Manufacturing	Upstream
Downstream Metals	Downstream
Jewelry & Precious Metals	Unrelated
Vulcanized & Fired Materials	Upstream
Advanced Packaging	Upstream
Paper & Packaging	Upstream
Printing Services	Unrelated
Hospitality & Tourism	Related

Source: Balland, P., Boschma, R., Crespo, J., & Rigby, D. (2019)

Using data extracted from the European Observatory for Clusters and Industrial Change (https:// interactivetool.eu/EASME/EOCIC/index.html), we apply this cluster mapping model to our agtech components of the RIS3 programs of Sydsvierge and Warmińsko-Mazurskie. This approach gives us analytical leverage on key questions regarding smart specialization in those regions: 1. The degree to which regional assets are dedicated to core, upstream, and downstream segments of the ag/food value chain 2. The extent to which the two regions are diversifying into industries related or unrelated to agriculture and food 3. The role of technological complexity in the diversification strategies of Sydsvierge and Warmińsko- Mazurskie

5. Profiles of Target Regions

Our selection of target regions follows the European Union's NUTS 2 protocol (Nomenclature of Territorial Units for Statistics, Level II). **Figure 5** reports the key socioeconomic indicators of Warmińsko-Mazurskie and Sydsvierge:

Profiles of Target Regions in Poland and Sweden Key Socioeconomic Indicators, Warmińsko-Mazurskie and Sydsvierge

INDICATORS		
Population	1,408,415	1,504,060
Per Capita GDP Share of EU Average	48.0 Percent	104.0 Percent
Life Expectancy	77.1 Years	82.4 Years
Labor Force Participation Age 20-64	65.6 Percent	78.8 Percent
Tertiary Educational Attainment Age 30-34	34.4 Percent	52.6 Percent
R & D Expenditures Share of GDP	0.32 Percent	3.21 Percent

Source: Eurostat

5.1 Sydsvierge

Sydsvierge subsumes the counties of Skåne and Blekinge in southern Sweden. The regional economy is well diversified, with established clusters in life sciences, food processing, and information and communications technology. The large Swedish multinational corporations are headquartered in other regions (e.g., Ericsson, H & M, and Skanska in Stockholm; Volvo in Gothenburg). However, Sydsvierge hosts a number of important mid-size companies such as Alfa Laval (machinery), Lindab International AB (fabricated metal), Peab AB (construction), Tetra Pak (packaging), and Trelleborg AB (plastic and rubber). Sydsvierge also hosts a number of internationally recognized universities and research institutions including Blekinge University of Technology, Kristianstad University, Lund University, Malmö University, and the Swedish University of Agricultural Sciences. These regional assets underpin Sydsvierge's standing as a national and EU leader in patent issues, R & D investments, and related metrics (European Commission 2020a).

5.2 Warmińsko-Mazurskie

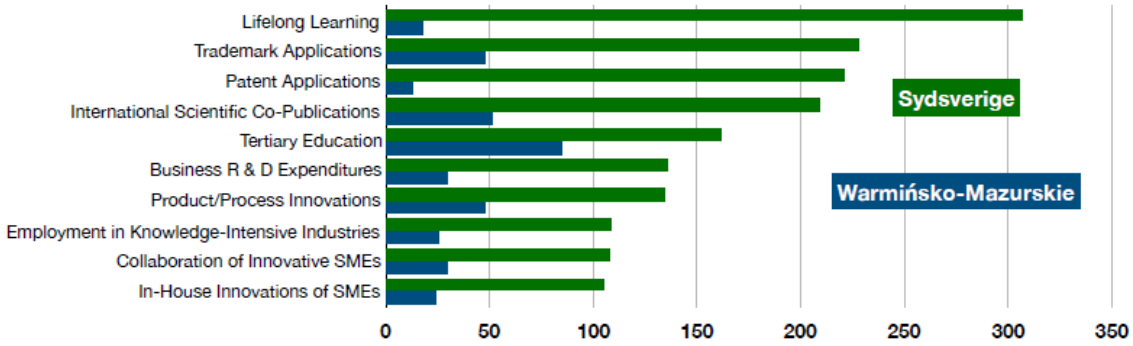
Warmińsko-Mazurskie is situated in northeastern Poland, bordering Lithuania and the Russian enclave of Kaliningrad. The region enjoys access to the Baltic Sea via the Bay of Gdańsk. With a per capita income of €15,000 (71 percent of the national average), Warmińsko-Mazurskie is one Poland's poorest provinces. Agriculture, fishing, food processing, construction, and metal forming represent the region's main industries. Warmińsko-Mazurskie is one of Poland's leading producers of beef, poultry, and pork. The region is naturally well endowed, with a high concentration of forests and lakes that creates significant potential in recreation, tourism, and wood/furniture manufacturing.

The provincial capital of Olsztyn hosts the University of Warmia and Mazury, which offers academic programs in agriculture, biology, engineering, and veterinary medicine supported by a Center of Innovation and Technology Transfer. The cities of Olsztyn, Elbląg, and Ełk host science and technology parks. The region holds several research institutions including the Institute of Animal Reproduction and Food Research in Olsztyn and the Institute of Innovation of the Dairy Industry in Mragowo. Meanwhile, the Polish National Investment and Trade Agency has designated Warmińsko-Mazurskie as a Special Economic Zone to stimulate investment in the region. But the technological and human capital assets of Warmińsko-Mazurskie remain among the weakest in Europe. Levels of tertiary education, R & D expenditures, and employment in high-technology sectors fall below the averages of both Poland and the EU-27. The region accounts for just 0.6 percent of patents issued nationally, the lowest of Poland's seventeen voivodeships (European Commission 2020b).

5.3 Innovation in Sydsvierge and Warmińsko-Mazurskie

Region-specific data show a large gap in the innovation capabilities of Sydsvierge and Warmińsko- Mazurskie. The European Commission ranks Sydsvierge among Europe's ten most innovative regions, a group that includes Zürich, Helsinki, Stockholm, and Berlin. By contrast, Warmińsko-Mazurskie ranks among Europe's least innovative regions, occupying a cluster of under-performing regions in Bulgaria, Greece, Romania, and Spain (See **Figure 6** below).

Regional Innovation in Poland and Sweden Selected Indicators (2019 Scores Relative to EU Average in 2012)



Innovation Performance in Europe
Composite Index, Selected Regions

Zürich, Switzerland	167.6	Prague, Czech Republic	103.6	Canarias, Spain	48.2
Ticino, Switzerland	164.2	Lisbon, Portugal	99.1	Olposkie, Poland	43.2
Helsinki-Uusimaa, Finland	163.4	Emilia-Romagna, Italy	92.6	Jadranska Hrvatska, Croatia	47.1
Stockholm, Sweden	161.1	Bratislava, Slovakia	93.3	Castilla-la Mancha, Spain	46.8
Hovedstaden, Denmark	158.1	Zahodna, Slovenia	90.8	Zachodniopomorskie, Poland	45.1
Berlin, Germany	152.3	Sostinė Regionas, Lithuania	90.5	Lubuskie, Poland	42.9
Sydsverige, Sweden	**143.4**	Budapest, Hungary	84.4	**Warmińsko-Mazurskie, Poland**	**38.7**
Oslo, Norway	141.9	Warsaw, Poland	82.4	Notio Aigaio, Greece	40.3
Utrecht, Netherlands	141.2	Madrid, Spain	77.5	Yugoiztochen, Bulgaria	37.4
Southeast London, UK	136.0	Malopolskie, Poland	73.4	Severozapaden, Bulgaria	32.6
Westösterreich, Austria	125.5	Belgrade, Serbia	68.7	Nord-Vest, Romania	31.1
Vlaams Gewest, Belgium	125.1	Vojvodina, Serbia	65.2	Ciudad Autónoma de Ceuta, Spain	27.2
Gelderland, Netherlands	124.4	Kontinentaina Hrvatska, Croatia	61.2	Nord-Est, Romania	22.5
Île de France, France	122.0	Pomorskie, Poland	60.4	Sud-Muntenia, Romania	19.3
Eastern and Midland, Ireland	115.7	Észak-Alföld, Hungary	52.0	Sud-Vest Oltenia, Romania	15.0

Source: European Commission, *European Innovation Scorecard*, June 2019

Sydsvierge's advantages over Warmińsko-Mazurskie are most notable in the innovation indicators of lifelong learning (307 percent vs.18 percent of the EU average), trademark applications (228 percent vs. 48 percent), patent applications (221 percent vs. 13 percent), business R & D expenditures (135 percent vs. 29 percent), and in-house innovations of SMEs (105 percent vs. 24 percent). **5.4 RIS3 Programs in Sydsvierge and Warmińsko-Mazurskie** Following European Commission guidelines, participants in RIS3 programs declare regional priorities in smart specialization. RIS3 program managers in Sydsvierge and Warmińsko-Mazurskie announced the following priorities:

RIS3 Regional Priorities

Sydsvierge

FOOD INNOVATION
Circular and bio-based food production
Personalized nutrition
Food security
Packaging
Logistics
Precision farming
Digital technologies

LIFE SCIENCE & HEALTH
New life science products and services
E-health
Preventative health

SMART SUSTAINABLE CITIES
Energy
Water
Mobility
Information services

TECHNOLOGY
Artificial Intelligence
Internet of Things
5G broadband
Image recognition
Big data
Gaming
Creative media

ADVANCED MATERIALS & MANUFACTURING
Digitization
Automotion
Sustainable production
New materials
Traceability

Warmińsko-Mazurskie

HIGH QUALITY FOOD
Water and animal farming
Food processing
Manufacturing and services for livestock
Production of agro machineries
Processing and disposal of farm waste

WOOD & FURNITURE
Furniture production
Carpentry
Wood processing
Design services
Maintenance of wooden goods

WATER ECONOMY
Transport
Sports
Manufacturing
Tourism
Food
Machinery
Yachts
Environment

Source: European Commission, Smart Specialization Platform https://s3platform.jrc.ec.europa.eu/home

The breadth of Sydsvierge's RIS3 priorities underscores that region's heterogeneous industrial structure, heightening prospects for a diversified specialization path aligned with the European Commission's Smart Specialization Platform. Under the bottom-up Entrepreneurial Discovery Process, local stakeholders identify opportunities for diversifying into related and unrelated areas by deepening the region's existing assets and developing new competitive capabilities. Sydsvierge!s resources–high innovation capacity, strong institutions, effective governance, dense network of inter-company and inter-industry links, collaborative ties with other innovative regions–augur favorably for the region's smart specialization strategy. By contrast, Warmińsko-Mazurskie's more narrowly defined RIS3 priorities indicate limited scope for diversified specialization. A number of priority areas declared in the Sydsvierge plan–next generation life sciences, advanced digital technologies, digitized manufacturing–reside at a considerable distance from Warmińsko-Mazurskie!s capabilities base. However, both regions include food and agriculture among their RIS3 priorities, with complementarities between the sub-components of those ag/food strategies. This provides a foundation for our empirical investigation of agtech cluster development in Sydsvierge and Warmińsko-Mazurskie, the results of which are reported below.

6. Empirical Analysis

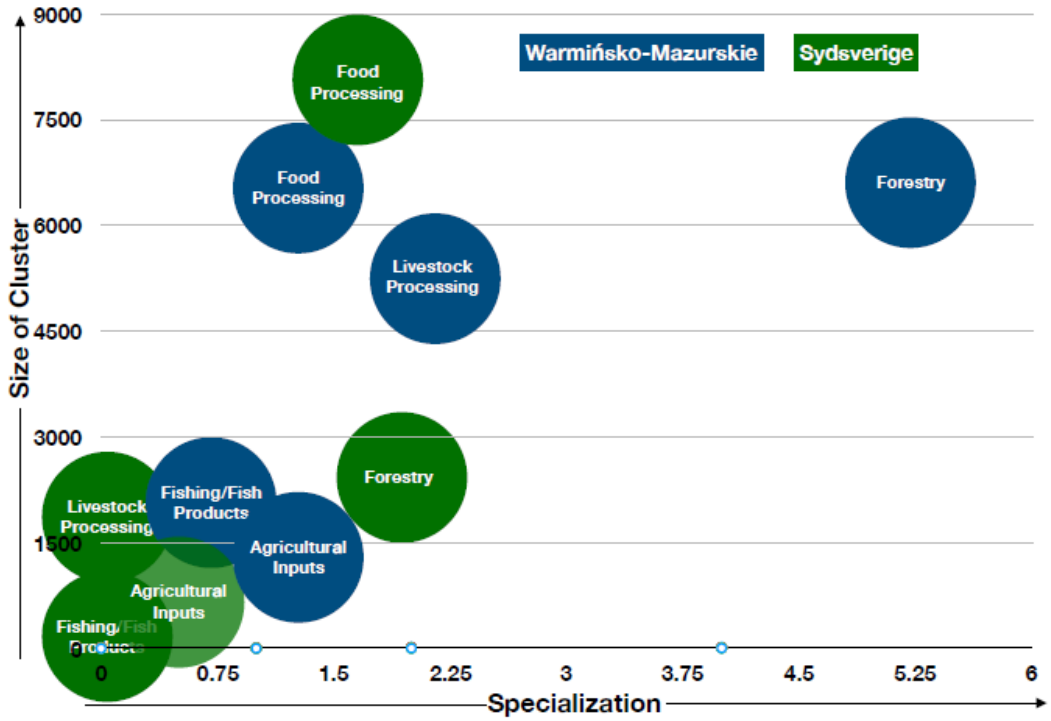
Our empirical analysis proceeds as follows. We begin by mapping agrotech clusters in the target regions, applying the specialization (location quotient) and size of cluster (employment) metrics across the five industry categories (core, upstream, downstream, related, unrelated). We classify those industry segments using the knowledge complexity framework (high complexity, medium/high complexity, medium/low complexity, low complexity).

We then integrate the components of our model (industry category– specialization–size of cluster–knowledge complexity) to generate summary results of our analysis of agrotech development in Sydsvierge and Warmińsko-Mazurskie.

6.1 Agrotech Cluster Mapping: Core Industries

Our analysis of core ag/food industries in the two regions yields the following results. The largest core segment measured by employment is the Food Processing industry in Sydsvierge, which also displays a relatively high level of specialization. By far the most specialized core segment measured by location quotient is the Forestry industry in Warmińsko-Mazurskie, which also exhibits a large cluster size. Warmińsko-Mazurskie's Food Processing and Livestock Processing industries report comparatively high levels of cluster size and specialization. Sydsvierge's other core agtech segments (Agricultural Inputs, Fishing/Fish Products, Livestock Processing) rate low in cluster formation (**Figure 7**).

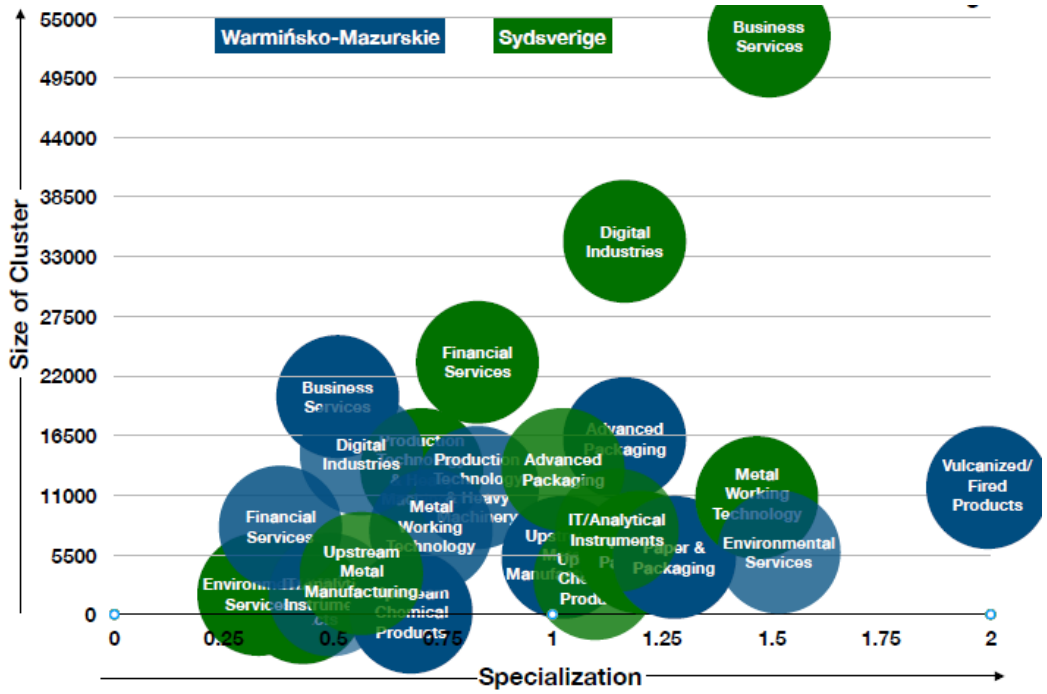
Mapping of AgroTech Clusters in Warmińsko-Mazurskie and Sydsvierge Core Industries (X = Location Quotient; Y = Employment)



6.2 Agrotech Cluster Mapping: Upstream Industries

Our cluster mapping analysis demonstrates the comparative strength of Sydsvierge in key upstream industries linked to agrotech development: Business Services, Digital Industries, IT/Analytical Instruments. Those industries display lower levels of specialization and cluster size in Warmińsko- Mazurskie. Advanced Packaging and Environmental Services in Warmińsko-Mazurskie!s report comparatively high specialization rates. Vulcanized/Fired Products in Warmińsko-Mazurskie emerges as an outlier in the upstream industry analysis, with a specialization level exceeding all other categories in the upstream group (**Figure 8**).

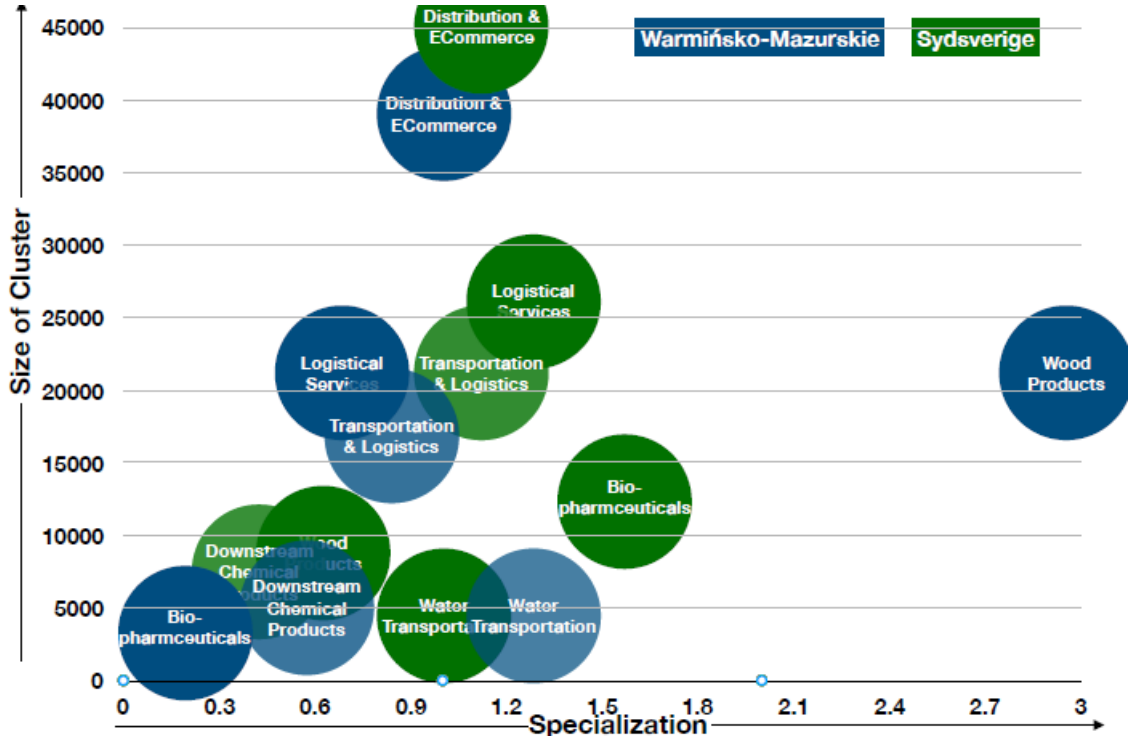
Mapping of AgroTech Clusters in Warmińsko-Mazurskie and Sydsvierge Upstream Industries (X = Location Quotient; Y = Employment)



6.3 Agrotech Cluster Mapping: Downstream Industries

Our mapping of downstream industries shows generally lower levels of cluster development, with most industry segments situated near the origin. Exceptions to this pattern include Distribution & ECommerce (large downstream clusters in both regions), Logistic Services, Transportation & Logistics, and Biopharmaceuticals in Sydsvierge (reflecting that region's diversified industrial structure), and Wood Products in Warmińsko-Mazurskie (illustrating that region's forestry resources). (**Figure 9**)

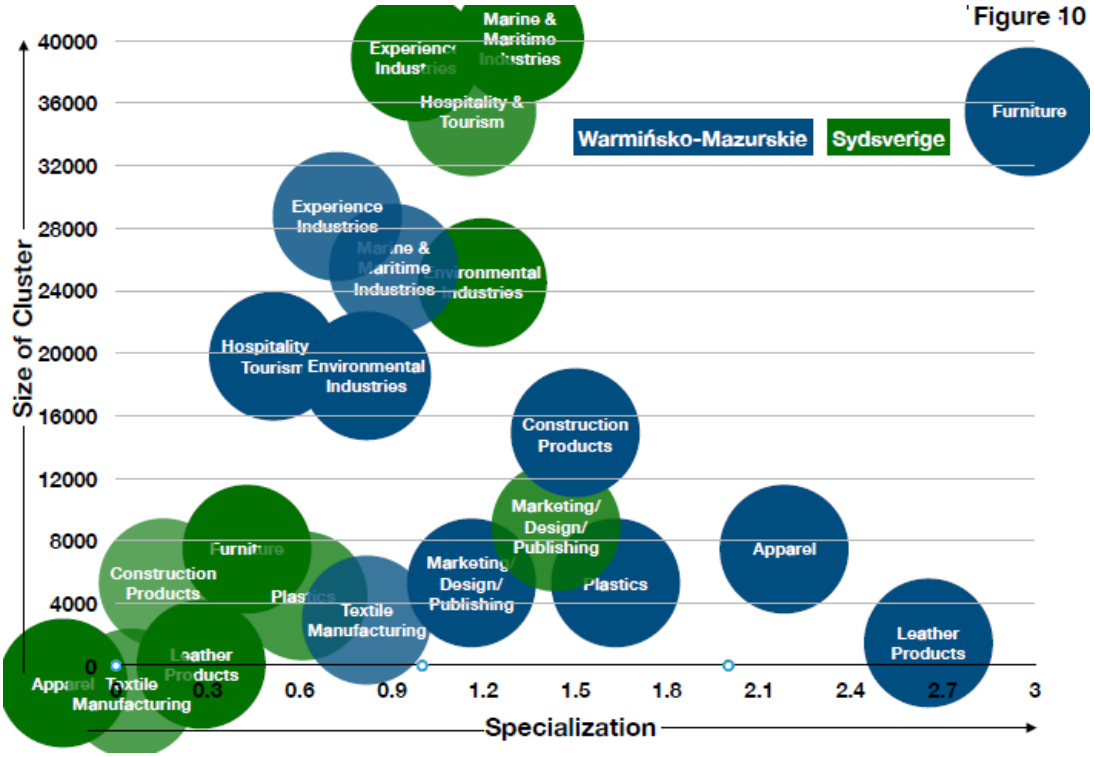
Mapping of AgroTech Clusters in Warmińsko-Mazurskie and Sydsvierge Downstream Industries (X = Location Quotient; Y = Employment)



6.4 Agrotech Cluster Mapping: Related Industries

Our mapping of related industries yields variegated results. The outlier in this dataset is Warmińsko- Mazurskie's Furniture industry, whose large size and high specialization provide further evidence of the region's forestry-related capabilities. Leather Products, Apparel, and Construction Products industries report comparatively high specialization rates in Warmińsko-Mazurskie and low specialization in Sydsvierge. Experience, Hospitality & Tourism, and Marine & Maritime rank as Sydsvierge's most developed related industry clusters (**Figure 10**).

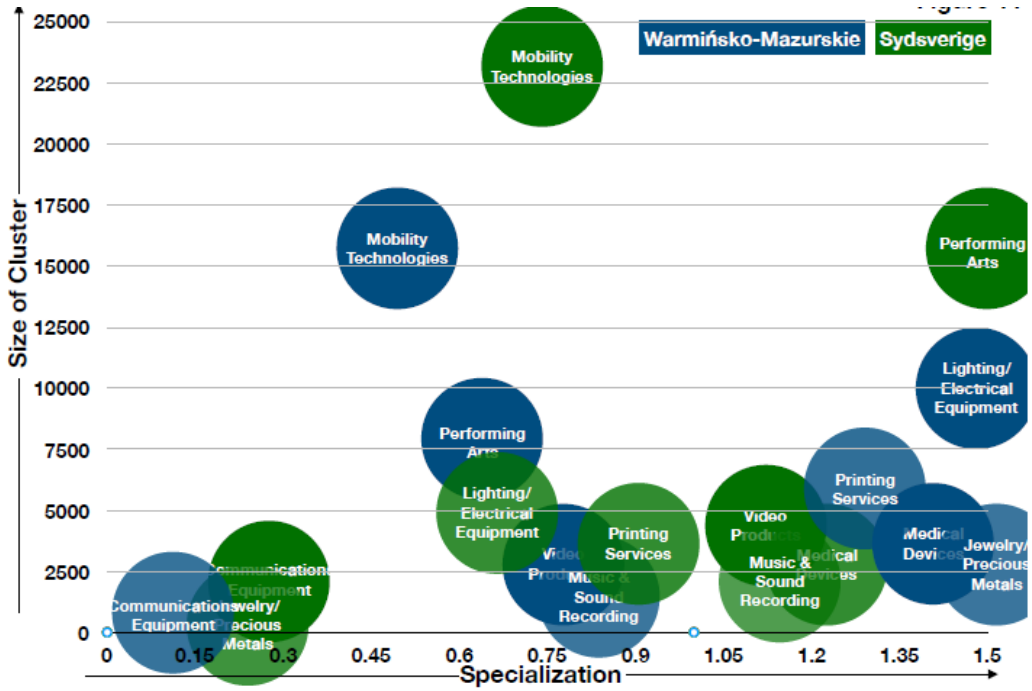
Mapping of AgroTech Clusters in Warmińsko-Mazurskie and Sydsvierge Related Industries (X = Location Quotient; Y = Employment)



6.5 Agrotech Cluster Mapping: Unrelated Industries

In both Sydsvierge and Warmińsko-Mazurskie, specialization levels in unrelated industries are generally lower than in the other industry categories. Exceptions to this pattern include Performing Arts, Video Production, Music & Sound Recording, and Medical Devices in Sydsvierge and Lighting/Electrical Equipment, Printing Services, Medical Devices, and Jewelry/Precious Metals) in Warmińsko-Mazurskie (**Figure 11**).

Mapping of AgroTech Clusters in Warmińsko-Mazurskie and Sydsvierge Unrelated Industries (X = Location Quotient; Y = Employment)



6.6 Smart Specialization: Summary of Results

The results of our analysis are summarized in **Figure 12** (Sydsvierge) and **Figure 13** (Warmińsko- Mazurskie), with the agrotech industry segments sorted by specialization levels, cluster size, industry category, and knowledge complexity.

Summary of Results Smart Specialization in Sydsvierge

High Specialization: LQ > 1.0

Industry	Location Quotient	Employment	Category	Complexity
Performing Arts	1.50	15,349	Unrelated	Low
Biopharmaceuticals	1.49	1,955	Downstream	High
Business Services	1.44	33,690	Upstream	High
Digital Industries	1.43	53,361	Upstream	Medium/High
Forestry	1.38	2,153	Core	Low
Marketing/Design/Publishing	1.32	8,398	Related	Medium/High
Paper & Packaging	1.20	2,618	Upstream	Medium/Low
Medical Devices	1.18	2,730	Unrelated	High
Food Processing	1.15	8,605	Core	Medium/High
Music/Sound Recording	1.12	433	Unrelated	Medium/Low
Video Products	1.09	1,282	Unrelated	Medium/Low
Hospitality & Tourism	1.09	38,583	Related	Medium/Low
IT/Analytical Instruments	1.06	5,316	Upstream	High
Marine/Maritime	1.06	41,371	Related	Medium/High
Advanced Packaging	1.06	15,390	Upstream	Medium/Low
Logistical Services	1.06	24,460	Downstream	Medium/Low
Upstream Chemicals	1.03	1,299	Upstream	High

Medium-High Specialization: LQ 0.80 – 0.99

Industry	Location Quotient	Employment	Category	Complexity
Environmental Industries	0.99	25,822	Related	High
Transportation & Logistics	0.94	21,062	Downstream	Medium/Low
Distribution/ECommerce	0.93	45,661	Downstream	High
Water Transportation	0.92	2,486	Downstream	Medium/Low
Financial Services	0.90	21,460	Upstream	Medium/High
Experience Industries	0.85	40,594	Related	Medium/Low

Medium-Low Specialization: LQ 0.60 – 0.79

Industry	Location Quotient	Employment	Category	Complexity
Production Technology	0.72	7,786	Upstream	High
Printing Services	0.73	2,808	Unrelated	Medium/Low
Mobility Technologies	0.71	22,695	Unrelated	Medium/High
Lighting/Electrical	0.69	4,252	Unrelated	Medium/High
Metal Working Technology	0.69	6,261	Upstream	Medium/Low
Plastics	0.67	3,950	Related	Medium/Low
Agricultural Inputs	0.64	921	Core	Medium/High
Downstream Metal	0.61	1,858	Downstream	Medium/Low

Low Specialization: LQ < 0.60

Industry	Location Quotient	Employment	Category	Complexity
Livestock Processing	0.57	1,558	Core	Medium/High
Furniture	0.56	6,265	Related	Medium/Low
Fishing/Fish Products	0.54	2,560	Core	Low
Upstream Metal	0.51	3,756	Upstream	Medium/Low
Wood Products	0.50	2,745	Downstream	Low
Vulcanized/Fired Materials	0.44	4,294	Upstream	Medium/Low
Construction Products	0.42	3,180	Related	Low
Downstream Chemicals	0.41	2,745	Downstream	High
Environmental Services	0.35	4,294	Upstream	High
Communications Equipment	0.28	719	Unrelated	Medium/High
Jewelry/Precious Metals	0.19	97	Unrelated	Medium/Low
Textile Manufacturing	0.15	521	Related	Low
Leather Products	0.14	53	Related	Low

Summary of Results Smart Specialization in Warmińsko-Mazurskie

High Specialization: LQ > 1.0

Industry	Location Quotient	Employment	Category	Complexity
Forestry	5.11	7,105	Core	Low
Furniture	3.57	35,770	Related	Medium/Low
Wood Products	2.87	19,332	Downstream	Low
Leather Products	2.68	879	Related	Low
Livestock Processing	2.14	5,839	Core	Medium/High
Vulcanized/Fired Materials	2.06	11,524	Upstream	Medium/Low
Jewelry/Precious Metals	1.54	721	Unrelated	Medium/Low
Lighting/Electrical	1.49	8,248	Unrelated	Medium/High
Construction Products	1.46	11,567	Related	Low
Metal Working Technology	1.42	13,416	Upstream	Medium/Low
Medical Devices	1.38	2,730	Unrelated	High
Environmental Services	1.33	4,988	Related	High
Printing Services	1.32	4,555	Unrelated	Medium/Low
Plastics	1.31	6,937	Related	Medium/Low
Paper & Packaging	1.22	3,472	Upstream	Medium/Low
Agricultural Inputs	1.21	1,549	Core	Medium/High
Downstream Metals	1.16	6,667	Downstream	Medium/Low
Advanced Packaging	1.05	13,506	Upstream	Medium/Low
Food Processing	1.03	6,841	Core	Medium/High
Upstream Metal	1.03	4,603	Upstream	Medium/Low
Water Transportation	1.02	2,465	Downstream	Medium/Low

Medium-High Specialization: LQ 0.80 – 0.99

Industry	Location Quotient	Employment	Category	Complexity
Marketing/Design/Publishing	0.98	5,535	Related	Medium/High
Textile Manufacturing	0.86	2,746	Related	Low
Production Technology	0.86	7,786	Upstream	High
Logistical Services	0.85	17,479	Downstream	Medium/Low
Distribution/ECommerce	0.85	37,310	Downstream	High
Fishing/Fish Products	0.83	1,032	Core	Low
Video Products	0.80	838	Unrelated	Medium/Low

Medium-Low Specialization: LQ 0.60 – 0.79

Industry	Location Quotient	Employment	Category	Complexity
Transportation/Logistics	0.79	15,933	Downstream	Medium/Low
Music/Sound Recording	0.78	269	Unrelated	Medium/Low
Marine/Maritime Industries	0.75	26,167	Related	Medium/Low
Environmental Industries	0.73	17,091	Related	High
Performing Arts	0.70	6,366	Unrelated	Low
Experience Industries	0.68	28,615	Related	Medium/Low
Upstream Chemicals	0.64	728	Upstream	High
IT/Analytical Instruments	0.62	2,768	Upstream	High
Hospitality/Tourism	0.61	19,364	Related	Medium/Low

Low Specialization: LQ < 0.60

Industry	Location Quotient	Employment	Category	Complexity
Mobility Technologies	0.53	15,287	Unrelated	Medium/High
Business Services	0.50	17,272	Upstream	Medium/High
Digital Industries	0.46	12,474	Upstream	High
Downstream Chemicals	0.43	2,939	Downstream	High
Financial Services	0.31	6,667	Upstream	Medium/High
Communications Equipment	0.23	519	Related	Medium/High
Biopharmaceuticals	0.21	61	Downstream	High

7. Discussion of Results

Our comparative analysis of the RIS3 programs of Sydsvierge and Warmińsko-Mazurskie reveals the following patterns.

7.1 High Specialization:

LQ > 1 In Sydsvierge, high specialization rates are most prevalent in upstream industries (Business Services, Digital Industries, IT/Analytical Instruments, Upstream Chemicals) with high levels of knowledge complexity. The region's diversification into highly specialized downstream industries is limited to Biopharmaceuticals and Logistical Services. Sydsvierge's Biopharmaceuticals cluster remains small (fewer than 2000 employees), indicating scope for expansion in that technology-intensive and highly complex industry. Two core agtech industries (Forestry and Food Processing) appear in the region's high specialization group. Sydsvierge has diversified into a number of unrelated industries with low or medium/low complexity (Performing Arts, Paper & Packaging, Music/Sound Recording, Video Products). The one unrelated/complex industry in Sydsvierge's portfolio is Medical Devices. Medical Devices also appears in Warmińsko-Mazurskie's high specialization group, reflecting the emergence of medical device manufacturing in the region (including a producer of ultrasound scanners in Olsztyn) and signaling potential industry spillover from more developed regions (Mazowiecki, Małopolskie, Pomorskie, Zachodniopomorskie, Dolnośląskie). Other industries in Warmińsko- Mazurskie!s high specialization/unrelated diversification group reside at lower levels of knowledge complexity (Jewelry/Precious Metals, Lighting/Electrical, Printing Services). Similarly, Warmińsko-Mazurskie!s highly specialized upstream industries (Vulcanized/Fired Materials, Metal Working Technology, Paper & Packaging), downstream industries (Wood Products, Downstream Metals, Water Transportation) exhibit medium or low complexity. The region's high specialization/related group comprises one high complexity industry (Environmental Services) and several low or medium/low complexity industries (Furniture, Leather Products, Construction Products, Plastics). Four core agtech industries (Forestry, Livestock Processing, Agricultural Inputs, Food Processing) appear in the region's high complexity group. Our analysis indicates that Warmińsko-Mazurskie!s greatest potential for regional specialization emanates from its Forestry, Furniture, and Wood Products industries, which display the highest location quotients in the entire dataset. While those industries exhibit relatively low levels of knowledge complexity, their developmental requirements align closely with the region's existing capabilities base.

7.2 Low Specialization:

LQ < 0.60 Sydsvierge and Warmińsko-Mazurskie display divergent patterns of cluster development in low specialization industries. The former region's low specialization group is populated with industries that appear in the latter's high specialization category:

Livestock Processing, Furniture, Wood Products, Vulcanized/Fired Materials, Construction Products, Jewelry/Precious Metals, Leather Products, Upstream Metal, Environmental Services). With the exception of Environmental Services, all of those low specialization Sydsvierge industries are low or medium/low complexity. By contrast, Warmińsko-Mazurskie's low specialization group includes high complexity industries that appear in Sydsvierge's high specialization cluster (Business Services, Digital Industries, Biopharmaceuticals). These results underscore the gap between Sydsvierge and Warmińsko-Mazurskie in the regional assets (R & D infrastructure, tertiary educational attainment, etc.) requisite to diversification in complex knowledge-intensive industries.

7.3 Medium Specialization:

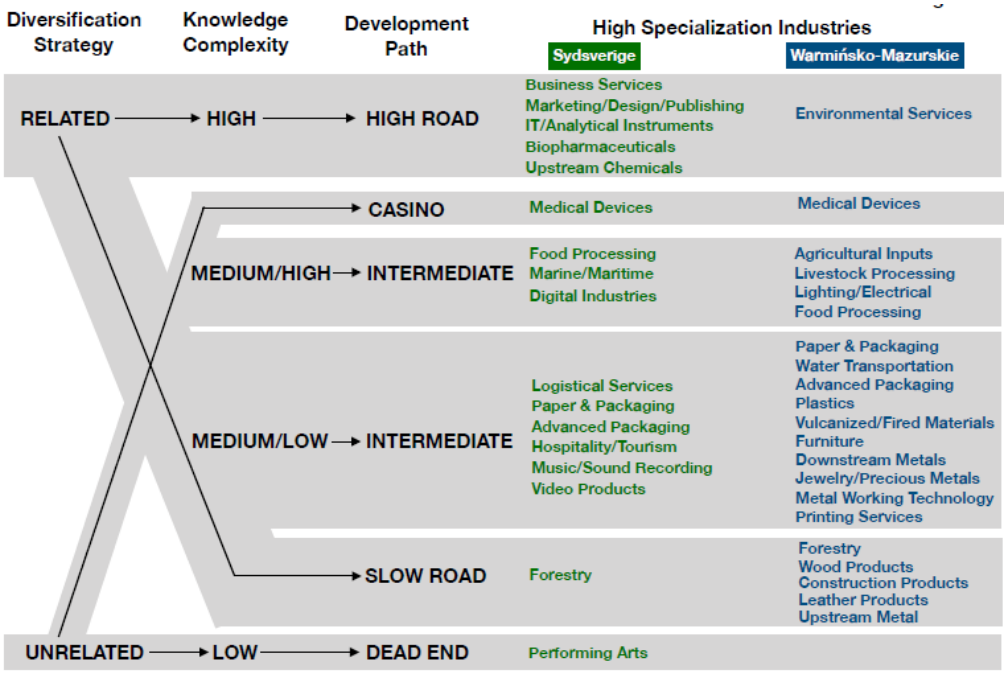
LQ 0.60–0.99

The intermediate categories (medium-high and medium-low specialization) show a wider range of results. At the upper end of that specialization range, Sydsvierge has diversified into related and downstream industries coded as highly complex (Environmental Industries, Distribution/ECommerce). In that medium-high group, Warmińsko-Mazurskie has diversified into two high complexity industries: Production Technologies and Distribution/ECommerce. On the lower end of the intermediate specialization range, Sydsvierge reports several medium/low complexity industries Printing Services, Lighting/Electrical, Plastics, Metal Working Technology, Downstream Metals) that exhibit significantly higher specialization levels in Warmińsko-Mazurskie. Warmińsko-Mazurskie's medium-low specialization group comprises three high complexity industries (Environmental Industries, Upstream Chemicals, IT/Analytical Instruments) that appear in Sydsvierge's high specialization cluster–echoing the previous observations concerning the latter region's advantages in technology-driven innovation. The results reported in the intermediate specialization categories also show variations in patterns of unrelated diversification in the two regions. Three unrelated industries in Warmińsko-Mazurskie's medium-high and medium-low groups (Video Products, Music/Sound Recording, and Performing Arts) are classified as highly specialized in Sydsvierge. Conversely, two unrelated industries in Sydsvierge's intermediate group (Printing Services and Lighting/Electrical) are rated as highly specialized in Warmińsko-Mazurskie.

8. Conclusions

Figure 14summarizes the smart specialization paths of Sydsvierge and Warmińsko-Mazurskie in food and agriculture. The ag/food industries of the two regions reporting high rates of specialization (LQ > 1) are situated in the categories identified by Balland, Boschma, Crespo, and Rigby (2019). Diversification into related industries with high knowledge complexity describes the "High Road" path. Diversification into unrelated industries with high knowledge complexity describes the "Casino" path. Diversification into related industries with low knowledge complexity designates a "Slow Road" path. Diversification into unrelated industries with low knowledge complexity describes a "Dead End" path.

Smart Specialization in Sydsverige and Warmińsko-Mazurskie



The broad trajectories of ag/food development in Sydsvierge and Warmińsko-Mazurskie reported in **Figure 14** augment the findings of prior research showing the obstacles to smart specialization in underdeveloped regions of Europe. Sydsvierge exhibits high rates of specialization in a cluster of industries combining high knowledge complexity and high relatedness to existing regional capabilities, a path that generates high value for the region (opportunities for competitive differentiation, migration into high-value products and services) at relatively low risk. By contrast, Warmińsko-Mazurskie hosts just one ag/food industry (environmental services) possessing that combination. The majority of Warmińsko-Mazurskie's high-specialization industries are clustered in the "Medium/Low Intermediate" and "Slow Road" categories describing diversification strategies anchored to current regional capabilities with comparatively low technology content.

These results lead us to the following conclusions regarding smart specialization in Sweden and Poland.

8.1 Diversification Strategies

The smart specialization literature addresses the tradeoffs of related versus unrelated diversification. The results of our empirical analysis illuminate the risks/rewards of alternative diversification strategies in food and agriculture in two European regions with sharply divergent capability bases. Echoing the findings of previous works on smart specialization, our study of RIS3 programs in Sweden and Poland indicates a low incidence of unrelated diversification. Diversification into unrelated industries with high levels of knowledge complexity ("casino") represents the riskiest–and potentially most rewarding–path of smart specialization. Our investigation indeed found just one industry–medical devices–displaying a combination of high specialization/unrelated/high complexity. Interestingly, that high risk/high reward scenario occurs in both Sydsvierge Warmińsko-Mazurskie, underscoring the possibilities of diversification into a technology-intensive industry far removed from food and agriculture. The least risky–and typically least rewarding–smart specialization path entails a diversification strategy emphasizing development of core, upstream, and downstream industries with low levels of complexity. That path generally aligns with the case of Warmińsko-Mazurskie, whose most highly specialized industries (Forestry, Wood Products, Vulcanized/Fired Products) are core/downstream/upstream industries with low/medium complexity. Sydsvierge's most highly specialized industries are also downstream/ upstream, albeit at higher levels of knowledge complexity (Biopharmaceuticals, Business Services, Digital Industries).

Related diversification occupies an intermediate position in the risk/reward spectrum of smart specialization. Such industries reside within the capabilities base of the core industry, and therefore present fewer challenges than diversification into unrelated activities. But unlike upstream and downstream operations, related industries are not formally integrated with the core industry. Our study located a number of related industries in the high specialization groups: Furniture, Leather Products, Construction Products, and Environmental Services (Warmińsko-Mazurskie); Marketing/Design/ Publishing, Hospitality & Tourism, Marine/MaritimePlastics (Sydsvierge). Consistent with the broader findings of the investigation, low complexity industries play a greater role in Warmińsko-Mazurskie's related diversification strategy than in Sydsvierge.

8.2 Technology Adoption in Food and Agriculture

As indicated previously in the article, over 70 percent of global venture capital investments in food and agriculture focus on downstream technologies (e.g., cloud retail infrastructure, e-commerce, restaurant market places) with a smaller share of agtech investments destined for upstream operations (alternative proteins, precision farming, integrated pest management, etc.) We noted that the application of advanced agricultural technologies in upstream operations raises different challenges for regional specialization than downstream operations, posing greater demands on region-specific capabilities for agtech deployment at the farm level. Our empirical investigation augments the extent literature on the role of advanced technologies in upstream and downstream components of the ag/food value chain. Both of our target regions host sizable clusters in Distribution & ECommerce, albeit with relatively low specialization levels. Transportation & Logistics and Logistical Services (both coded as downstream in our model) report roughly similar results in the two regions measured by cluster size and location quotient. The differing levels of technological complexity of the most highly specialized downstream industries in Sydsvierge and Warmińsko- Mazurskie (Biopharmaceuticals and Wood Products respectively) underscore the divergent capability bases of the target regions.

The pattern of technology adoption in upstream agricultural operations in the two regions reinforces that observation. In Sydsvierge, the upstream industries exhibiting the highest rates of specialization (Business Services, Digital Industries, IT/Analytical Instruments) are relatively technology-intensive. By contrast,

Warmińsko-Mazurskie's most specialized upstream industry is Vulcanized/Fire Products (hardened rubber), an important link in the ag/food value chain but an industry displaying comparatively low technology content.

Upstream industry segments emphasizing farm-level applications of digital technology are poorly developed in Warmińsko-Mazurskie. However, two of the region's upstream industries (Advanced Packaging and Environmental Services) report high specialization levels, indicating a potential for follow-on agtech investments that would hasten Warmińsko-Mazurskie's transition to value-added agricultural operations.

8.3 Smart Specialization in Central and Eastern Europe

Our study enriches scholarly research on the particular challenges of smart specialization in Central and Eastern Europe. The general trajectory of the RIS3 programs in Sydsvierge and Warmińsko-Mazurskie–showing higher levels of diversification in complex, technology-intensive industries in the former region than in the latter region–validates the findings of other studies of the regional outcomes of smart specialization programs in Europe. Our examination of agtech development in Warmińsko-Mazurskie highlights the institutional, social, and economic hurdles confronting CEE regions undertaking RIS3 programs: residues of top-down decision making under state socialism that clash with the bottom-up orientation of the Entrepreneurial Development Process; low levels of social capital that hinder inter-firm and intra-regional collaboration; paucity of high quality universities and research institutions needed to deepen workforce skills and enable adoption of new and emerging technologies. To address these challenges, the European Union has a launched a special facility (RIS3 in Lagging Regions) to support less developed regions undertaking smart specialization programs. Along with Warmińsko-Mazurskie, other underperforming provinces in Poland (Kujawsko-Pomorskie, Lubuskie, Podlaskie) and lagging regions of other CEE countries (Bulgaria, Croatia, Hungary, Romania) have joined that facility. Agtech innovation is a critical priority in Poland, a country heavily dependent on agricultural exports that possesses strong competitive assets in food production. For an underdeveloped province like Warmińsko-Mazurskie, exploitation of untapped regional potential in food and agriculture hinges on targeted investments in core industry segments that already display high levels of specialization (food processing, forestry) and related industries where the region's natural endowments confer a competitive advantage (furniture, wood products).

8.4 Directions for Future Research

Finally, our research points to directions for future research on smart specialization in Europe. The methodology employed in this article–a cluster mapping model drawing on the EU's EOCIC database on regional specialization–generates valuable findings on RIS3-related developments at the industry level. Meanwhile, the research design of the article–a comparative analysis of two regional participants in RIS3 programs occupying polar positions in European development–delivers important insights on the factors supporting and hindering smart specialization in food and agriculture.

The scholarly literature would profit from micro-level research focusing on the regional activities, processes, practices related to smart specialization in ag/food industries. Drawing on the quadruple helix model (academia–industry–government–citizenry), such a research program would employ interviews of RIS3 program officials, business managers, entrepreneurs, university faculty, and other local stakeholders combined with field work addressing farm-level operations, technology applications, and cultural practices.

References

AgFunder (2019). AgFunder agri-food tech investing report: 2019 year in review Anić, I., Corrocher, N., Morrison, A., and Aralica, Z. (2019). The development of competitiveness clusters in Croatia: a survey-based analysis., *European Planning Studies*, 27(11), 2227-2247.

Asheim, B. (2019). Smart specialisation, innovation policy and regional innovation systems: what about new path development in less innovative regions?, *Innovation: The European Journal of Social Science Research*, 32(1), 8-25. Asheim, B., Grillitsch, M., and Trippl, M. (2016). Smart specialization as an innovation-driven strategy for economic diversification: examples from Scandinavian regions. Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE) Lund University Papers in Innovation Studies Paper no. 2016/23.

Balland, P., Boschma, R., Crespo, J, and Rigby, D. (2019). Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional Studies*, 53(9), 1252-1268.

Bastos, M. (2018). Toward multipurpose agriculture: food, fuels, flex crops, and prospects for a bioeconomy. *Global Environmental Politics*, 18(2), 143-150. Benner, M. (2019). Smart specialization and institutional context: the role of institutional discovery, change and leapfrogging. *European Planning Studies*, 27(9), 1791-1810.

Boschma, R. (2017). Relatedness as driver of regional diversification: a research agenda. *Regional Studies*, 51(3), 351–364.

Boschma, R., Coenen, L., Frenken, K., and Truffer, B. (2017). Towards a theory of regional diversification: combining insights from evolutionary economic geography and transition studies. *Regional Studies*, 51(1), 31–45.

Cavicchi, A. and Stancova, K. (2016). Food and gastronomy as elements of regional innovation strategies. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain.

Cavicchi, A. and Stancova, K. (2017). Dynamics of smart specialisation: agri-food trans-regional cooperation. European Commission, *JRC Technical Reports*, S3 Policy Brief Series.

European Commission (2019. European Innovation Scorecard, June. European Commission (2020a). Regional Innovation Monitor Plus: South Sweden. https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/south-sweden European Commission (2020b). Regional Innovation Monitor Plus: Warmińsko-Mazurskie. https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/warmi%C5%84sko-mazurskie

Figiel, S., Kuberska, D., and Kufel (2014). Agri-food clusters in Poland. Warsaw: National Research Institute, Institute of Agricultural and Food Economics.

Foray, D., Goddard, J., Beldarrain, X., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C., and Ortega-Argilés, R. (2012). Guide to research and innovation strategies for smart specialization. European Commission, Regional Policy.

Foray, D., Morgan, K., and Radosevic, S. (2017). The role of smart specialization in the EU research and innovation policy landscape. European Commission, Regional and Urban Policy.

Gálvez-Nogales, E. (2010). Agro-based clusters in developing countries: staying competitive in a globalized economy. Food and Agriculture Organization of the United Nations, Agricultural Management, Marketing and Finance Occasional Paper 25.

Gianelle, C., Guzzo, F., and Mieszkowski, K. (2019). Smart specialisation: what gets lost in translation from concept to practice? *Regional Studies*, Open Access, 1-14.

Grillitsch, M. and Asheim, B. (2018). Place-based innovation policy for industrial diversification in regions. *European Planning Studies*, 26(8), 1638-1662.

Healy, A. (2016). "Smart specialization in a centralized state: regional contribution in North East Romania". *European Planning Studies*, 24(8), 1527-1543.

Karo, E. and Kattel, R. (2015). Economic development and evolving state capacities in Central and Eastern Europe: can "smart specialization" make a difference? *Journal of Economic Policy Reform*, 18(2), 172–187.

McCann, P. and Ortega-Argilés, R. (2016). The early experience of smart specialization implementation in EU cohesion policy. *European Planning Studies*, 24(8), 1407–1427.

Ranga, M. (2018). Smart specialization as a strategy to develop early- stage regional innovation systems. European Planning Studies, 26(11), 2125-2146.

Reimeris, R. (2016). New rules, same game: the case of smart specialization in Lithuania. *European Planning Studies*, 24(8), 1561–1583.

Xiao, J., Boschma, R., and Andersson, M. (2018). Industrial diversification in Europe: the differentiated role of relatedness. *Economic Geography*, 94(5), 514-549.