Exploring the role of cross-border regional factors in innovation in the agri-food sector

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Sabine Neuberger

Propositions

- Innovation brokers facilitate agri-food innovation in cross-border regions. (this thesis)
- Entrepreneurs' uncertainty originates from cross-border differences in culture, university structure, institutional set-up and governance structures. (this thesis)
- 3. Interdisciplinary studies require the ability of scientists to transcend beyond their own scientific paradigms.
- 4. Due to the picture superiority effect, policy makers are more sensitive to evidence presented in charts and bars in setting the policy agenda.
- 5. Besides conducting research within a PhD project, a by-catch for PhD students is the management of different visions of supervisors.
- 6. Growing up in a region with different cultural backgrounds promotes the appreciation of other cultures.

Propositions belonging to the thesis, entitled

Exploring the role of cross-border regional factors in innovation in the agri-food sector

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Exploring the role of cross-border regional factors in innovation in the agri-food sector

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Exploring the role of cross-border regional factors in innovation in the agri-food sector

Sabine Neuberger

Thesis

submitted in fulfilment of the requirements for the degree of doctor at Wageningen University by the authority of the Rector Magnificus, Prof. Dr A.P.J. Mol, in the presence of the Thesis Committee appointed by the Academic Board to be defended in public on Wednesday 16 March 2022 at 1.30 p.m. in the Aula.

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Chapter 1: Introduction

1.1 Background

Innovation is a means to improve the economy and prosperity especially in rural regions (Damanpour and Schneider 2006; Vermeulen and Paier 2017). The process to innovate is "an evolutionary and social process of collective learning" (Edquist 2006), facilitated by a network of actors (Tranos 2014; Carvalho and Gomes 2017). In rural areas, particularly small- and medium-sized enterprises (SMEs) are driving forces of innovation (Noronha Vaz, Viaene, and Wigier 2004) and their networks with other firms, research organizations or intermediary institutions positively influence their innovation processes (Zeng, Xie, and Tam 2010). The literature on national systems of innovation (Edquist 2006; Lundvall 2010; Nelson 2010) highlights that not only enterprises but also other stakeholders of the system (i.e. nation) are necessary for innovation success. Hence, innovation system literature acknowledges an important role to cooperation among multiple organizations because it can facilitate or impede enterprises' innovation process (Lundvall 2010; Klerkx, Aarts, and Leeuwis 2010b). However, in rural regions, less cooperation in innovation processes occurs compared to urban regions (Hjaltadóttir, Makkonen, and Mitze 2020).

Strong networks are particularly important in the agri-food sector because external sources of knowledge are vital for agri-food innovation (Lefebvre, Steur, and Gellynck 2015). The agri-food sector is among the biggest economic sectors in the European Union (EU) (European Commission 2018); hence, such knowledge networks are necessary to develop innovation for increased sustainability and resource efficiency and to achieve the objectives of the EU Green Deal to become climate neutral by 2050 (European Commission 2019a). The occurrence of agri-food innovation is related to the region and its innovation environment (Läpple et al. 2016).

Enterprises are embedded in a specific regional setting which affects their success in business operations and innovation (Trippl 2010; Galanakis 2006). The regional setting provides enterprises with access to a local knowledge network and regional support in the innovation processes (Vermeulen and Paier 2017). The region determines the so-called innovation environment¹ which is beyond enterprises direct control and usually defined by national borders (Niebuhr, Peters, and Schmidke 2020). The **innovation environment** comprises access to finance, university knowledge and customers (Galanakis 2006) and, hence, affects the innovation processes (Klerkx, Aarts, and Leeuwis 2010b) and subsequent market success of innovations (Dziallas and Blind 2019).

SMEs often lack resources and capacities to innovate independently and need support to work within the innovation environment (Nooteboom 1994; Narula 2004). **Innovation support services** offer such support functions to enterprises, e.g. brokering,

¹ Innovation system literature implemented the term national innovation environment to account for influences from the system (Edquist 2006; Lundvall 2010; Nelson 2010).

network building, or demand articulation (Kilelu et al. 2011; Faure et al. 2019; Mathé et al. 2016)². Using innovation support services can increase enterprises' performance because it facilitates co-innovation (Klerkx et al. 2017b) and positively impacts innovation adoption (Rosa et al. 2020). However, research showed that the provision of such services is often fragmented within a country and some support services work well in one country but not in another (Klerkx and Guimón 2017; Klerkx et al. 2017b; Peiker et al. 2012; Berdegué Sacristán 2001). Enterprises which develop innovation are confronted with an even more complex innovation environment in a setting beyond the national, i.e. a cross-border region.

Cross-border regions are regions fragmented by the jurisdiction of two or more different authorities (Guo 2012a). The EU defines cross-border regions as the 25 km zone falling on either side of the border (European Commission 2017b). Currently, the EU has 40 internal land borders (European Commission 2017b) resulting in 40 % of EU territory being declared as border regions (European Commission 2017a). A benefit of cross-border regions is that additional market knowledge, sources of knowhow and business contacts in the neighboring market are available at short distance (Makkonen and Leick 2019; Smallbone and Welter 2012). A cross-border setting affects how efficient local actors can utilize resources and, hence, influences enterprises' operations (Capello, Caragliu, and Fratesi 2018c). The location of an enterprise in a cross-border region can positively affect innovation because it offers opportunities for business development (Weidenfeld, Björk, and Williams 2016).

However, enterprises in cross-border regions are also confronted with economic imbalances because border regions have a disadvantaged position compared to the core of a country (Camagni, Capello, and Caragliu 2019; Camagni et al. 2017). Border regions are inefficient in exploiting local resources (Capello, Caragliu, and Fratesi 2018c; Camagni, Capello, and Caragliu 2019) because borders hamper trade flows between areas, increase firms production costs (Capello, Caragliu, and Fratesi 2018b) and hence have negative effects on production, employment levels and economic growth (Camagni, Capello, and Caragliu 2019). Enterprises already struggle to develop strong networks in national contexts (Tödtling and Kaufmann 2002). In a cross-border region, establishing networks is even more difficult (González-Gómez and Gualda 2016; Leick 2011). Cross-border cooperation and network development depend on the level of cross-border integration (Lundquist and Trippl 2013; Makkonen et al. 2018), and can be problematic due to differences in the culture of business interactions (Balogh and Pete 2017), the distance to networking activities (Leick 2012), changes in policy debates and the economy (Peck and Mulvey 2017; Makkonen and Williams 2018). Consequently, differences in integration influence innovation in cross-border regions

² Innovation support services are originally part of the extension and advisory system in Agricultural innovation and knowledge systems and as such often focusing on matching farmers demands (Kilelu, Klerkx, and Leeuwis 2014; Klerkx and Leeuwis 2008). However, the same functions also assist enterprises' innovation processes.

(Lundquist and Trippl 2013; Trippl 2010). Until now, the full potential of the location in a cross-border region is not used by enterprises and a loss of potential GDP exists due to lack of cross-border integration and administrative and legal barriers across borders (Camagni, Capello, and Caragliu 2019).

Three literature reviews identified significant gaps in cross-border research which can help explain why cross-border regions hold untapped economic potential. One literature review on cross-border cluster development revealed that research on establishing cross-border linkages is limited (Rohde 2016). Another literature review on the distribution of disciplines identified that only 5% of the studies focused on business management and only 1% on the agricultural sector (Makkonen and Williams 2016). A third one concluded that cross-border studies rarely focus on SMEs (Makkonen and Leick 2019). Hence, little is known about how the cross-border setting influences the approach of enterprises to innovation in the agri-food sector and how innovation can be stimulated and improved in cross-border regions (Makkonen and Leick 2019; Makkonen and Williams 2016).

1.2 Problem statement

European Cohesion Policy promotes cross-border regional integration (European Commission 2020) but lacks insight and understanding of enterprises' situation and the role of different stakeholders within cross-border regions. Compared to national operating enterprises, cross-border operating enterprises have different needs to develop their business in cross-border regions and to establish cross-border networks (Knockaert, Vandenbroucke, and Huyghe 2013; van den Broek, Benneworth, and Rutten 2019). The cross-border regional innovation system framework (Trippl 2010; Lundquist and Trippl 2013) provides a macro level perspective of cross-border integration but lacks on showing immediate consequences at enterprise level. The original framework of the innovation environment (Galanakis 2006) focuses on influences at enterprise level but does not consider a cross-border context nor does it sufficiently acknowledge the role of different stakeholders. Hence, information on how enterprises cooperate with its innovation environment particularly in cross-border regions are needed to make informed decisions on supporting enterprises working on agri-food innovation.

This thesis goes beyond previous literature on cross-border regional innovation systems (Lundquist and Trippl 2013; Trippl 2010) and the innovation environment (Galanakis 2006) by exploring cross-border factors at enterprise level and attributing an important role on enterprises' cooperation with other regional stakeholders for innovation development in the agri-food sector. Other regional stakeholders include members of universities, governmental institutions, and industry representatives. In this way, this thesis contributes to a better understanding of innovation in cross-border regions and informed decision making of European Cohesion Policies.

1.3 Research objectives

The overall research objective was to explore how cross-border regional factors determine innovation in the agri-food sector. Four sub-research objectives were derived, namely:

- (1) to investigate the relation between factors that define cross-border business interaction and innovativeness in cross-border regions.
- (2) to investigate how the innovation environment affects product innovation processes of agri-food enterprises located in a cross-border region.
- (3) to investigate how innovation support services (ISSs) are provided and used in a cross-border region and to explore regional stakeholders' perceptions on their limitations and opportunities.
- (4) to identify and analyze regional stakeholders' viewpoints about the aspects that could facilitate cross-border cooperation.

1.4 Thesis outline

This thesis consists of six chapters including four research chapters (Chapter 2, 3, 4 and 5) which address the four research objectives. Figure 1-1 presents the outline of this thesis and the arrows indicate the linkages between the chapters.



Figure 1-1 Outline of this thesis

Chapter 2 addresses the first research objective and focuses on cross-border regions in Europe. While in regions within a country the level of innovativeness is mostly coherent, it diverges greatly between regions of neighboring countries, i.e. in cross-border regions. Factors hampering cross-border business interaction were investigated in a survey to explain these different levels of innovativeness in cross-border regions. Chapter 2 investigates the relation between cross-border factors and innovativeness and provides the base for further exploration of this relation in Chapter 3, 4 and 5. Chapter 3 and 4 followed a case study approach and specifically focus on the Dutch-German cross-border region. They are interrelated because they present different perspectives of the innovation environment: the enterprises' perspective and the regional stakeholder perspective.

Chapter 3 addresses the second research objective and offers insight into the innovation environment from an enterprises' perspective. Based on interview data, nine innovation processes were reconstructed to explore at which stages of the innovation process the cross-border innovation environment (positively or negatively) influenced enterprises' business operations in the Dutch-German cross-border region.

Chapter 4 addresses the third research objective and offers insight into the innovation environment from a regional stakeholder perspective. Interviews with stakeholders from university, regional authorities, and enterprises focuses on the provision and use of innovation support services in the Dutch-German cross-border region.

Chapter 5 addresses the fourth research objective and applies Q methodology, a method combining quantitative and qualitative research data/techniques. This chapter identified stakeholders' viewpoints on factors that can facilitate cross-border cooperation.

Chapter 6 synthesizes the findings of the four research chapters, discusses the methods and provides policy and business recommendations.



Chapter 2:

Can differences in innovativeness between European crossborder regions be explained by factors impeding crossborder business interaction?

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Abstract: Business interaction is important for innovation performance but may be challenging in cross-border regions. The objective of this research was to investigate the relation between factors that define cross-border business interaction and innovativeness. From the cross-border regional innovation systems literature, we operationalized thirty-five factors which potentially influence cross-border business interaction; these factors concern availability of science and knowledge bases, socio-cultural proximity, accessibility, institutional set-up, and governance. We conducted a survey focusing on these factors and analyzed the data using Cronbach's alpha and linear regression. The cross-border interaction factors identified in the survey results served as independent variables and the differences in innovativeness levels in different European cross-border regions served as our dependent variable. This study confirmed that differences in innovativeness levels between countries can be related to factors hindering cross-border business interaction.

Keywords: Business interaction, cross-border region, regional innovation, sectoral innovation system, cross-border regional innovation system

2.1 Introduction

Despite a common market and the free movement of goods in the European Union (EU), national borders continue to be in place politically and administratively. Forty percent of the EU territory is classified as cross-border regions (the area which touches a 25 km zone to the border), falling on either side of the 40 internal land borders within the EU (European Commission 2017a, 2017b). As cross-border regions are fragmented by the jurisdiction of two or more different authorities (Guo 2012b), legal and administrative barriers related to European borders reduce the potential economic performance in the border regions by 8.7%, which equals about 3% of the EU's GDP (Camagni, Capello, and Caragliu 2019). Explanations for the lower economic performance of border regions are differences in culture, administrative structures, and infrastructure, which affect business interactions, networking activities, and transportation cost (Leick 2012). Such a fragmentation caused by national borders not only has an impact on GDP but also directly affects enterprises' operations and the efficiency of actors in utilizing local resources (Capello, Caragliu, and Fratesi 2018c). Hence fragmentation through national borders may have more indirect negative effects which are more difficult to measure (e.g. innovation) (Trippl, Asheim, and Miörner 2016).

The role of innovation as a driver for regional development was already stressed by Lundquist and Trippl (2013). While the level of innovativeness within a country is mostly coherent, the innovativeness levels of neighboring countries are often not on the same level in border regions (European Commission 2017c). van den Broek (2018) found that institutional failures in regions with weaker innovation systems are one possible explanation for different levels of innovativeness.

Small- and medium-sized enterprises are driving forces for economic growth, employment creation and innovation development (Noronha Vaz, Viaene, and Wigier 2004). Enterprises interact with other stakeholders, and establish networks which are context specific and driven by the same goals to effectively utilize resources through, for example, exchange of knowledge (McAdam et al. 2016; Drejer and Østergaard 2017). However, networks in cross-border regions are influenced by the national political-administrative structure, the socioeconomic context, geography, and spatial conditions of each country (González-Gómez and Gualda 2017). Hence, cross-border business interactions which we define as interaction (a) between stakeholders (b) from different sides of the border may be hindered by cross-border differences in economic structures, institutional set-ups, and accessibility (Lundquist and Trippl 2013).

Only a few empirical studies have explored the role that a national border plays in business interactions and how innovation can be stimulated and improved in cross-border regions (Makkonen and Williams 2016). Makkonen and Williams (2018) provided survey metrics and applied them at enterprise level in two Nordic cross-border regions. Peck and Mulvey (2017) used a qualitative case study approach to investigate the effect of national borders on the development of an enterprise's collaboration activities. Both cross-border

studies found that changes in the policy debates and economy influence the motivation for business interactions between cross-border countries. The existing literature related to innovation focused on a selection of cross-border regions (Koschatzky 2000; Läpple et al. 2016; Klerkx, Aarts, and Leeuwis 2010a) and often used a macro-level perspective (Lundquist and Trippl 2013; Topaloglou et al. 2005). Very little is currently known about the relation of cross-border business interaction and innovation in cross-border regions at a European level.

Hence, the objective of this research is to investigate the relation between factors that define cross-border business interaction and innovativeness in cross-border regions. The cross-border regional innovation system approach served as our conceptual framework to describe and analyze the relationship between level of innovativeness and the factors influencing cross-border business interaction (Trippl 2010; Lundquist and Trippl 2013). To advance current knowledge, we conducted a survey and quantitatively analyzed factors for cross-border business interaction in European cross-border regions. This study is the first to use a quantitative survey approach to investigate the relation between regional innovativeness to study cross-border regions at a European level. Furthermore, it provides suggestions for policy makers aimed at facilitating cohesion and economic development across the EU.

2.2 Conceptual framework

Innovation system approaches assume that enterprises can equally benefit and make use of the resources and linkages present within the system (Lundvall 2010). However, particularly in cross-border regions this assumption does not necessarily hold which was the reason for developing a cross-border regional innovation system approach (Trippl 2010). The cross-border regional innovation system incorporates literature on agglomeration economics (Baldwin and Martin 2004) and cluster development (Kurowska-Pysz 2016). Comparable to the differences in proximity (Boschma 2005; Boschma, Marrocu, and Paci 2016), the cross-border regional innovation system approach identifies three levels of integration and each level is described by the dimensions, namely nature of linkages, science and knowledge bases, socio-cultural proximity, accessibility (physical proximity), institutional set-up, and governance (economic and policy structure) (Lundquist and Trippl 2013; Trippl 2010).

2.2.1 Dimensions of cross-border regional innovation systems and their operationalization in factors

The presence of linkages was emphasized numerous times in innovation literature (Lundvall 2010; Nelson 2010), and therefore we built this research on the premise that cross-border business interaction is a prerequisite for innovativeness in cross-border regions. Linkages are defined as the mere availability of interactions, connections, networks and relationships among stakeholders. Linkages between stakeholders improve the mobilization of resources and the development of knowledge (Hekkert et al. 2007; Klein Woolthuis, Lankhuizen, and

Gilsing 2005). They are also considered to counteract resistance to change and thereby take an important role for the adoption of innovation and consequently for the economic performance of enterprises (Hekkert et al. 2007). The kind of exchange or flow within a cross-border region can be described as: interactive, symmetrical or asymmetrical, knowledge- or cost-driven (Lundquist and Trippl 2013). Hence, the interaction between stakeholders at different levels needs continuous reflection on the position in the network and their goals (Klerkx, Aarts, and Leeuwis 2010a).

We derive that linkages, i.e. cross-border business interaction, is the base dimension of the framework and can be hampered by weak science and knowledge bases, a lack of socio-cultural proximity or physical accessibility (infrastructure), unfavorable institutional set-ups, economic structure and policy structures that constrain innovativeness (see e.g. Makkonen and Williams 2018,van den Broek and Smulders 2015,Weidenfeld, Björk, and Williams 2016). These other dimensions are described in detail below and Table 2-1 presents an overview of the dimensions and their operationalization using 35 factors influencing crossborder business interaction.

Theory-based dimension	No. of factors	Factors			
	1401013	Educational institutions (Hekkert et al. 2007: Klein Woolthuis			
		Lankhuizen and Gilsing 2005: Trinnl 2010)			
		Research institutions (Trippl 2010)			
Science and knowledge	5	Projects (Hermans, Klerky, and Roen 2015)			
bases	5	Networking events (Hekkert et al. 2007: Hermans, Klerkx, and Roep			
		2015)			
		R&D funds (Hermans, Klerkx, and Roep 2015)			
		Language (Tonaloglou et al. 2005)			
		Addressing neonle (Hekkert et al. 2007: Johannessen 2009)			
		Hierarchal structures (Hekkert et al. 2007: Johannessen 2009)			
		Attitudes in doing business: reliability mistrust (Hermans Klerky			
Socio-cultural proximity	7	and Roen 2015)			
Socio cuna ai proximity	,	Prejudice and mistrust (Hermans Klerky and Roen 2015)			
		Working schedules (Johannessen 2009) (company internal factors)			
		Communication tools (Johannessen 2009: Caravannis and			
		Grigoroudis 2014)			
		Presence of natural barriers (Klein Woolthuis Lankhuizen and			
		Gilsing 2005)			
		Travel distance (Klein Woolthuis, Lankhuizen, and Gilsing 2005)			
		Transport infrastructure (highway, train, ships)(Klein Woolthuis			
		Lankhuizen and Gilsing 2005)			
		1 presence			
		2 usage			
Accessibility (physical	11	 auality: efficiency highway infrastructure 			
proximity)	11	4 quality: efficiency train infrastructure			
		5 quality: efficiency shinning infrastructure			
		6 quality: physical condition			
		7 density (traffic jams)			
		Internet connection (Klein Woolthuis Lankhuizen and Gilsing			
		2005: Caravannis and Grigoroudis 2014)			
		Communication costs (Caravannis and Grigoroudis 2014)			
		Legal system and requirements (Hermans Klerkx and Roen 2015)			
		Interaction and cooperation facilitating organization (Hermans			
		Klerky and Roen 2015)			
Institutional set-up	4	Communication among institutions (Hekkert et al. 2007: Klein			
		Woolthuis Lankhuizen and Gilsing 2005: Trinnl 2010)			
		"Help desk" abroad (Hekkert et al. 2007)			
		Economic situation (Hekkert et al. 2007; Caravannis and			
		Grigoroudis 2014)			
		Living standard and purchasing power (Topaloglou et al. 2005)			
		Industrial specialization (Hekkert et al. 2007: Trippl 2010)			
Governance leconomic and		Enterprise specific foci (Hekkert et al. 2007)			
nolicy structure)	8	Enterprise demands (Hekkert et al. 2007)			
r - mey strated of	0	Oualified employees (Hermans, Klerky, and Roen 2015; Caravannis			
		and Grigoroudis 2014)			
		Government agenda (Trippl 2010: Hermans, Klerkx, and Roep			
		Government agenda (Trippl 2010; Hermans, Klerkx, and Koep 2015)			

Table 2-1 Operationalization of dimensions in factors influencing cross-border business interaction

These factors were derived from the literature and only contains factors which already provided positive results. We excluded those factors that did not prove influential in previous research.

Science and knowledge bases encompass the presence of educational and research facilities, research funds, research projects, and workshops and conferences (Lundquist and Trippl 2013; Trippl 2010). Attending workshops and conferences offers interesting possibilities for enterprises to develop and apply knowledge and to establish a network (Hekkert et al. 2007; Klein Woolthuis, Lankhuizen, and Gilsing 2005; Hermans, Klerkx, and Roep 2015). Hence, education and research facilities with their related activities can be considered as facilitators of not only innovation development but also cross-border linkages between enterprises (or industry) and research.

Socio-cultural proximity captures norms, values, and cultures (Hermans, Klerkx, and Roep 2015) and can be observed in differing hierarchal structures, habits of addressing each other, or attitudes in doing business. Prejudice, general mistrust or both among citizens of cross-border regions influences the willingness and quality of cross-border business interaction.

Accessibility (or physical proximity) of cross-border regions is defined as the presence of natural barriers and the condition of infrastructure (Klein Woolthuis, Lankhuizen, and Gilsing 2005; Lundquist and Trippl 2013). Natural barriers include mountains, rivers, or sea, and can present limitations to direct cross-border business interaction. This limitation is especially severe if transport and communication infrastructure is not sufficiently available in border regions.

Institutional set-up is defined as the degree of similarity in laws and regulations as well as the degree of accordance in plans and goals for future economic progress (Lundquist and Trippl 2013; Trippl 2010). Because of country specific differences in the institutional set-up, it is important that organizational infrastructure (such as network organizations, information brokers, other information channels) is present in cross-border regions to provide information on matters in the other countries for e.g. enterprises, but also to link national tasks with tasks of the neighboring regions and countries.

Governance concentrates on the economic and policy structure of cross-border regions. Economic structure refers to the industry specialization and strategies for coherent industry development (Lundquist and Trippl 2013; Trippl 2010) and can be described for example through the presence of regional competences (Trippl 2010) or unit labor cost (Carayannis and Grigoroudis 2014). Policy structure of cross-border regions is defined by the political system (centralist versus federalist), modes of operation and governance structures. These can differ among countries in terms of ruling and agenda setting by the nation, or a regional authority such as a province or a city. The availability of instruments of cross-border policy and innovation policy affect enterprises' innovation activities (Lundquist and Trippl 2013; Trippl 2010; Hermans, Klerkx, and Roep 2015). Differences, synergies and complementarities of the countries in a cross-border region affect an enterprise's willingness to cooperate (Peck and Mulvey 2017).

The underlying assumption is that factors hindering cross-border business interaction might explain differences in innovativeness levels. Hence, we expect that regional innovativeness levels differ in cross-border regions compared to central regions, if obstacles for cross-border business interaction exist. Such obstacles may occur with regard to availability of science and knowledge bases, socio-cultural proximity, accessibility, institutional set-up, and governance (economic and policy structure). The operationalized factors serve as the basis to study cross-border business interaction.

2.3 Material and methods

Two different data sources were used for this research. We collected primary data on crossborder business interaction through an online survey, and secondary data on differences in innovativeness was derived from an indexed measure provided by the European Commission. Below, we first describe the design and implementation of the online survey and second explain the extraction of secondary data

2.3.1 Primary data

We used a survey approach because secondary data proxies are barely available at a crossborder level. The questionnaire was based on the conceptual framework and focused on how the dimension *linkages*, i.e. cross-border business interaction, is influenced by the other five dimensions: (a) *science and knowledge bases*, (b) *socio-cultural proximity*, (c) *accessibility*, (d) *institutional set-up*, and (e) *governance*. These five dimensions were addressed in five blocks of questions, each consisting of a closed and an open question and arranged similarly. The closed questions asked whether "Cross-border business interaction is hampered by" any of the 35 factors operationalized in Table 2-1. The responses were ranked on a 5-point Likert scale ("Not at all", "Slightly", "Moderately", "Very", and "Extremely"). The open questions provided the option of naming positive or negative examples.

Respondents: In EU regions, regional institutions play an important role in shaping economic growth (Ketterer and Rodríguez-Pose 2018) and cross-border institutions are important for facilitating cross-border cooperation (Molema 2018). Therefore, representatives of European cross-border institutions such as Euregio offices were considered as the target group of the survey. We aimed to overcome potential limitations of the study, such as the selection of factors and the total number of questions, by pre-testing with three professionals of the Euregio office Rhine-Waal. The final draft of the questionnaire was finalized with minor adjustments.

The Social Sciences Ethics Committee of Wageningen University & Research retrospectively approved this study. When the study began in 2018, Wageningen University rules did not require to obtain explicit consent for surveys and therefore, we did not include a separate section in the survey. However, we had fully informed participants about the aim of the study, use of results, and that all data was processed anonymously. Therefore, we conclude that everything was done to fulfill the anonymity and information requirements to the participants.

The survey was available online from September 18 through October 31, 2018. For reasons of user-friendliness, the survey was conducted online using the provider "Sosci-Survey" (<u>www.soscisurvey.de</u>) because of the provider's location in Germany and its liability to the German law of data security. Access was provided by a link sent by email to cross-border region institutions. In total, 96 institutions were contacted. Two reminders were sent after 10 and 18 days while the survey was available online. The overall response to the survey was 26%. Due to the low response rate and the design of the survey, our research was limited to exploring whether a relationship of the factors influencing cross-border business interaction and differences in levels of innovativeness exists, but it was not possible to investigate the causality of the relationships between the factors and innovativeness.

2.3.2 Use of secondary data

We collected secondary data on regional innovativeness from the "Regional Innovation Scoreboard" (RIS) (European Commission 2017c). The RIS is established by the European Commission as a tool to assess and to compare the innovation performance of innovation systems in European regions and is measured at two different NUTS levels, i.e. the 'Nomenclature of territorial units for statistics'. The EU introduced NUTS to divide the economic territory of the EU for conducting regional statistical and socio-economic analysis of the regions, and framing of EU regional policies. It consists of 4 levels, whereas NUTS 0 is country level (e.g. Germany) and NUTS 3 is the smallest diversification for specific diagnoses of regions (Eurostat 2018). The RIS is available at NUTS 1 and NUTS 2 level. It is an indexed measure based on 16 indicators, such as population with tertiary education, scientific co-publication, and R&D expenditure in the public sector and the business sector (European Commission 2017c). We consider different RIS levels on either side of the border as underutilized innovation potential.

One limitation of RIS is that data relating to each of the 16 indicators used for RIS index calculation in each region is not always available, resulting in differences in inputs for RIS index calculation between countries. Furthermore, RIS measures tend to measure research driven innovations, and they do not include regional specialization (Trippl, Asheim, and Miörner 2016). Despite these shortcomings of RIS, we decided to use this score because (1) it was emphasized in the literature that not one single measure can account for the level of innovativeness, (2) individual countries measure innovativeness differently, and there is no other database available to compare regions on a European level, and (3) RIS is used by the EU to develop policy action plans (see also Trippl, Asheim, and Miörner 2016).

A second limitation of the RIS is that it provides information at **national level of NUTS regions** and therefore never addresses a cross-border region. Cross-border regions are defined as the area of all NUTS 3 regions within 25 km from the border, also if the NUTS 3 region is only partially located in that zone (European Commission 2017b). The RIS data is only available at the NUTS 2 and sometimes even only at the NUTS 1 region level. Thereby, it does not coincide with the EU definition of cross-border regions based on NUTS 3 level. Because our survey addressed the level of **cross-border regions**, we calculated the difference in innovativeness levels between the countries of a cross-border region (RIS_{diff}) and thereby addressed the problem of different national levels of observation. Occasionally, a cross-border region also covered an area of several NUTS regions within one country. In such cases, the in-country mean among the according regions was calculated first before calculating the difference in RIS. An illustration of RIS_{diff} calculation can also be found in the Appendix ("Calculation of differences in levels of innovativeness").

2.3.3 Internal consistency of questionnaire design

We tested the factors that were derived from the conceptual framework (Table 2-1) on their ability to coherently describe one dimension, i.e. internal consistency. Standardized Cronbach's alpha (α_{st}) was used to calculate internal consistency of the factors within each dimension:

$$\alpha_{st} = \frac{n\bar{r}}{1+(n-1)\bar{r}}$$
 (Equation 1),

where *n* is the number of factors and \bar{r} the average correlation between the factors using Kendall's tau correlation coefficient. Instead of the Pearson correlation coefficient, it was considered appropriate to calculate the correlation coefficient based on Kendall's tau because our dataset contained non-parametric data with ordinal scale measures. Kendall's tau measures the degree of association between two variables, i.e. factors, without carrying any assumption about the distribution of data. Compared to Spearman's rho, Kendall's tau has usually smaller values, is insensitive to error, and is more accurate with smaller sample sizes (Salkind 2007).

Internal consistency is indicated by Cronbach's Alpha being above 0.7 (Field, Miles, and Field 2013; Trobia 2008). Table 2-2 presents the exact values for Standardized Cronbach's Alpha and 95% confidence interval. Results show that internal consistency was provided in all dimensions which means that the operationalized factors of the five dimensions were coherently addressed through the variables that were measured in the questionnaire.

Dimension	No. of factors	Standardized	Lower CI	Upper CI
		Cronbach's Alpha		
Science and knowledge bases	5	0.827	0.72	0.94
Socio-cultural proximity	7	0.718	0.55	0.88
Accessibility	11	0.867	0.79	0.94
Institutional set-up	4	0.785	0.65	0.92
Governance	8	0.774	0.64	0.91

Table 2-2 Standardized Cronbach's Alpha for each dimension

2.3.4 Exploring relationships

The analysis included two steps. First, we conducted a linear regression analysis: our dependent variable is the difference of RIS in a cross-border region (RIS_{diff}), while the factors addressed in the survey serve as our independent variables. Four observations were excluded from the analysis due to missing data about regional innovativeness in Russian regions, resulting in n=23. Second, we investigated whether region specific differences exist between the factors and levels of innovativeness. Compared to the first analysis step, where each factor was considered individually in the regression analysis, we used the dimension's mean (across all factors of one dimension) in the second analysis step to identify region specific differences. In that sense, we followed Makkonen and William's (2018) suggestion to use the mean if the internal consistency shown in Cronbach's alpha was high.

To identify region specific differences, we decided on three subsets of regions and sequentially excluded them from the analysis. The first subset consisted of Slovakia, Czech Republic, Hungary, Poland, and Lithuania, i.e. the EU member states that entered the EU with the 2004 enlargement because results could be biased due to their late entry to the EU that limited their time to catch up or adjust to other EU countries. The second subset consists of non-EU countries, i.e. Russia, Switzerland, Liechtenstein, and Norway because of a lack in strong EU policies and support instruments. The third subset includes only Germany because it is overrepresented in the results with 50% of the survey responses in cross-border regions encompassing Germany.

2.4 Results

2.4.1 Cross-border regions covered

Survey responses were obtained for 17 different European cross-border regions and corresponded to 20 different countries. Figure 2-1 shows the regions from which data were obtained.



Figure 2-1 Map of cross-border regions included in the study, presented at NUTS 1 and 2 level (Source: modified after Eurostat 2021; © EuroGeographics for the administrative boundaries)

The 17 EU countries included Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Liechtenstein, Lithuania, the Netherlands, Poland, Portugal, Slovakia, Spain, and Sweden (alphabetical order). Three of the countries were non-EU countries, namely Russia, Switzerland, and Norway.

Survey respondents stem from cross-border regions with different levels of innovativeness, covering a mean RIS between 61 and 140, where 100 indicates the European mean (European Commission 2017c). The difference of innovativeness levels (RIS_{diff}), i.e. the difference among different countries of a cross-border region, ranged between 6 and 111 (see Table 2-A1 in the Appendix).

2.4.2 Exploring the relationship between factors defining cross-border business interaction and innovativeness

Regarding the first analysis step which included all regions, we observed that factors hindering cross-border business interaction are stronger in cross-border regions with a large RIS_{diff} than in border regions with a small RIS_{diff} . Such a positive relationship was found in 33 out of 35 factors (94%) on RIS based on our linear regression model which is in line with our expectation. However, three factors showed a negative relationship and are not in line with our assumption. The respective factors were: different habits of addressing people (e.g. greeting, first or last name), differing hierarchal structures in businesses, and differing approaches and attitudes in doing business (see Figure 2-A1 in the Appendix).

In the second analysis, we excluded subsets to investigate whether specific differences in the regions exist between the relationship of factors and innovativeness levels. Similar to the first analysis, we found positive relationships, i.e. ascending slopes of the

dimension's mean: solid line) in four of the five dimensions. In the dimension *socio-cultural proximity*, the subset "excluding non-EU countries" acted against our expectations by showing a descending slope. Hence, we also observed varying subset-specific differences.

The results are illustrated in five graphs, one for each dimension (Figure 2-2). In all graphs, the y-axis refers to the difference of regional innovativeness levels measured from 1 to 120: "1" indicating a low and "120" indicating a high level of inequality on the level of innovativeness. The x-axis represents the mean of each dimension, and the boundaries are defined by the 5-point Likert scale used in the survey, where the lowest score, i.e. "not at all hampered" can be found on the left side, and the highest, i.e. "extremely hampered" on the right side of the x-axis. The black dots refer to the results of all observations (n=23) and the fitted lines illustrate the relationship between each dimension and the level of innovativeness. The solid line refers to all observations, while the three additional lines in the scatterplots present the three subsets (i.e. newer EU countries, non-EU countries, and Germany) and show the results excluding the selected cases.



Figure 2-2 Region specific differences in innovativeness Source: Own elaboration based on survey data and RIS (European Commission 2017c)

2.5 Discussion

In this study, we focused on the question whether differences in innovativeness levels within European cross-border regions can be explained by factors that influence cross-border business interaction. To answer this question, a conceptual framework was developed based on the cross-border regional innovation system approach. The framework emphasizes the importance of linkages or interactions among enterprises and external stakeholders such as governmental institutions or education and research facilities. We operationalized factors defining cross-border business interaction from the cross-border regional innovation system dimensions and considered linkages, i.e. cross-border business interaction, as the base dimension assembling the other dimensions, i.e. science and knowledge bases, socio-cultural proximity, accessibility, institutional set-up, and governance. The factors were investigated through a survey since empirical studies specifically devoted to these cross-border regions are scarce.

In the remainder of this section, first, we discuss each dimension and use open question responses from our survey to provide specific examples of topics which influenced cross-border business interaction (these will be highlighted in *italics*). Second, we present implications for future research and policymaking.

2.5.1 The relationship between the dimensions and difference in innovativeness

Each cross-border region has its own local peculiarities (Decoville and Durand 2019), hence the balance of the five dimensions is different in every cross-border region. Our study showed a mainly **positive** relationship between the dimensions and regional innovativeness levels and also identified subset-specific differences: the more factors hindering cross-border business interaction, the greater the difference of the regional innovativeness level between countries. These results indicate that our findings are generally in line with previous research which will be discussed in detail below.

Our study showed that if cross-border business interaction is impeded by the dimension **access to science and knowledge bases**, it leads to increasing difference in the level of innovativeness. This finding confirms the insights of Schäffler *et al.* (2016) who revealed that a well-educated labor supply was important for cooperation in the German-Czech border region – even more important than lower wages. One explanation of this positive relationship could be the multi-presence and intermediary role of specific universities in cross-border network structures (González-Gómez and Gualda 2017) because collaboration with public research organizations encourages innovation behaviors among employees and the emergence of new ideas that challenge the organizational situation of enterprises (Olmos-Peñuela et al. 2017). In our survey, one response indicated *a striking balance in science and knowledge bases between regions*, but yet others pointed out that *specialized Federal Research Institutions are partly less accessible for businesses in neighboring countries* and that there is *a lack of public funding*. We derive that less accessible

or lacking public research funds results in forming poor conditions for collaboration and learning (see also Hermans, Klerkx, and Roep 2015).

Our observation of the positive relationship between **socio-cultural proximity** and difference in the level of innovativeness confirms the results of a qualitative study conducted with Czech-German enterprises in border regions (Leick 2012). Leick (2012) identified three reasons responsible for different developments of border regions (especially eastern European border regions), among which cross-cultural differences in cross-border business interactions were identified. Balogh and Pete (2017) found that a local cross-border culture including language and ethnicity was a significant element for cross-border integration. A real-life situation showing the importance of socio-cultural proximity was provided by one respondent who described a problem of differing business attitudes: *A German director had no trust in an easygoing Dutch director who talked about personal issues, such as bringing his child to childcare*.

Our results showed a positive relationship of **institutional set-up** and innovativeness levels. This finding reflects those of van den Broek and Smulders (2015) who found that the institutional embeddedness of actors influence cross-border regional innovation systems. Respondents considered *Interreg projects* (3 respondents) and *a connection among governmental institutions* (2 respondents) as a facilitator for the establishment of cross-border partnerships, while, on the other hand, *a lack of a common strategy of economic institutions, a lack of responsible persons, and unclear procedures* constrained cross-border business interaction.

Our study showed a positive relationship between **accessibility** and the difference in levels of innovativeness; responses indicated that the transportation infrastructure in crossborder regions should be improved. Schäffler *et al.* (2016) found that regional connectedness is important in cross-border regions, and an improved infrastructure can increase foreign direct investment in cross-border regions. Respondents asked for *establishing a rail connection* (10 respondents) and *public transportation* (4 respondents), and were concerned with the *quality of (highway) roads* (4 respondents) and the *(re-) construction of bridges* (3 respondents). To give an example of the importance of a well-established infrastructure: the mutual willingness to reconstruct bridges along the Slovak-Hungarian border turned out to be a crucial step for cross-border flows (Balogh and Pete 2017). Concerning communication infrastructure, the *establishment of high-speed internet* in rural areas is a problem specifically affecting cross-border regions (3 respondents). *Roaming costs* were abolished in the EU but still represent a financial burden for non-EU countries (2 respondents). Research on this topic is currently missing, but given the increasing importance of communication infrastructure, it should also be considered in future cross-border studies.

We also found a positive relationship between **governance** (economic and policy structure) and difference in the innovativeness level. According to our respondents, the *mutual acceptance of business qualification* (1 respondent) and *the lack of skilled employees* (2 respondents) increased cross-border business interaction, while *legal obstacles* (1 respondent) or *different technical standards* (1 respondent) made cross-border business

interaction difficult. Leick (2011) also identified employee recruitment as a motivation for cross-border business interaction. However, motivations can shift in response to changed economic conditions and policy priorities (Peck and Mulvey 2017), and cross-border business interaction of enterprises also depends on the size and industrial focus of the neighboring market which is also an indication of the importance of the economic environment (Dimitrov et al. 2003). Some Euregios have succeeded to act as a policy advisor in cross-border regions, while other multinational organizations still suffer from increased coordination costs (Noferini et al. 2020).

2.5.2 Subset-specific differences

From our study, we cannot say that one dimension is superior or more important than another for innovativeness because each of the dimensions can explain different levels of innovativeness. Our observation showed positive relationships between factors hampering cross-border business interaction (x-axis) and differences in innovativeness levels (y-axis) no matter which subset (i.e. new EU members, non- EU countries, and Germany) had been left out. This indicates that our results are not biased through over- or underrepresentation of specific regions. It is reasonable to assume that substitution mechanisms and overlap mechanisms in geographical and non-spatial proximity measures play a role in cross-border regions, indicating that shortcomings in one measure can be supplemented by others (Hansen 2015). For example, Ferrara et al. (2016) came to a similar result when they investigated the impacts of two cohesion policy interventions, i.e. in transport infrastructure and in research, technological development and innovation, in two programming periods. They concluded that both policy interventions led to the desired results, although they observed different performance outcomes (Ferrara et al. 2016).

We want to highlight that regional conditions promoting innovation development are not static, and it is important to ensure that framework conditions for innovativeness are constantly adapted by e.g. institutional and policy changes (see also Capello, Caragliu, and Fratesi 2018c, Hall). While cross-border business interaction fluctuated over time, Euregional institutions seem to have a positive impact on the level of cross-border business interaction (Peck and Mulvey 2017). An interplay of various stakeholders, such as enterprises, research organizations, and policy makers is important to facilitate knowledge flows across industries and hence to support innovation, i.e. a horizontal approach (Tödtling and Trippl 2018). Additionally, bottom-up approaches should be favored over top-down approaches to foster stakeholder integration (González-Gómez and Gualda 2016). Local, Euregional authorities play an important role in fostering both approaches. Although Euregio or Euregional institutions do not explain the successful integration of border regions, they play an important role in translating ideas for economic growth (Molema 2018). Many Euregio institutions are important as a policy advisor by establishing a common forum and providing financial resources (Noferini et al. 2020). Our results can be interpreted that every region must find its own solutions (see also Capello 2017, Hjaltadóttir, Makkonen, and Mitze 2020).

While cooperation may be challenging in cross-border regions, these regions are also provided with opportunities which are not available for regions located further inland. Close geographical cooperation can compensate for most negative border effects, and there is still potential for increasing knowledge flows within the EU (Hjaltadóttir, Makkonen, and Mitze 2020). Yet, research showed that high levels of cross-border proximity did not lead to stronger cross-border economic integration (e.g. Cappellano and Makkonen 2020). It was suggested that cross-border funding schemes such as the Interreg program offer a potential utility to support inter-regional innovation cooperation and knowledge sharing (Hjaltadóttir, Makkonen, and Mitze 2020). However, it is still unknown whether there is an optimal level of proximity in the dimensions of the cross-border regional innovation system providing better conditions for various stakeholders involved in cross-border cooperation which ultimately leads to an alignment of innovativeness levels in cross-border regions. Further research must be conducted to test the feasibility of fostering cross-border business interaction without decreasing differences that make collaboration interesting.

2.6 Conclusions, implications and future outlook

Our research shows that differences in innovativeness levels within European cross-border regions can partially be explained by hampered cross-border business interaction between the countries. Our exploration of factors that define cross-border business interaction showed that obstacles in the five dimensions science and knowledge bases, socio-cultural proximity, accessibility, institutional set-up, and governance can be related to differences in innovativeness levels. European cross-border regions are diverse and the survey results were not fully representative for all European cross-border regions. Also based on our study, it was not possible to determine the relative importance of different factors in defining the level of innovativeness. However, we derive some cautious conclusions: the dimensions we investigated are interrelated, and therefore policy makers should collectively analyze them for strategic decision making. It is essential to know about specific characteristics of each region to facilitate cohesion in the EU and consequently the economy.

In practice, we suggest that a first step to increase levels of innovativeness through improvement of cross-border business interaction could be the mutual acceptance of business qualification and mutual accessibility of federal research institutions. In the short term, improving the condition of one dimension e.g. through establishing education and research facilities can increase the level of innovativeness. In the long term, all dimensions should be considered by policy makers while developing future strategies of regional development to make use of the full potential of enterprises in cross-border regions. Therefore, experts with insights into the objectives of all cross-border parties are needed in the relevant regions.

Future research should focus on two directions. First, it should concentrate on establishing coherent measures applicable at a wider level on which basic decisions can be

made. Compared to non-cross-border regions, the lack of cross-border data remains a main problem of cross-border region research leading to difficulties for scientists and policy makers to estimate what effect which policy might have. A majority of websites of e.g. crossborder projects or cross-border institutions are only available in local languages, making EU wide comparisons of current policy objectives and research very difficult. A second direction for future research is the investigation of causal relations between factors hampering crossborder business interaction and levels of innovativeness. An investigation of the direct influence of dimensions on enterprises' innovation processes is suggested to be the next research challenge for further understanding and improving the level of innovativeness in cross-border regions. From such research, we could derive suggestions about how obstacles can be overcome and even how cross-border differences can provide positive spin-offs.

Appendix A.1

Table 2-A1 RIS scores of respondents' cross-border regions. Overview of the regional innovativeness in European cross-border regions participating in the survey; calculated from the indexed Regional Innovation Scoreboard (European Commission 2017c)

Countries in cross-border region	Difference RIS (between countries)	Mean RIS (whole region)	"New" EU members	Non-EU countries	Germany
Norway - Sweden	6	120		х	
Finland- Sweden	7	122			
Germany - France	8	130			Х
Spain – Portugal (i)	8	78			
Spain – Portugal (ii)	12	61			
Belgium- Germany -Netherlands	15	126			х
Hungary – Slovakia	16	72	х		
Germany – Netherlands (i)	18	112			Х
Germany – Netherlands (ii)	19	120			х
Czech Republic – Poland	21	62	х		
Spain – Portugal (iii)	22	68			
Switzerland - France	26	139		Х	
Austria - Switzerland - Germany - Liechtenstein	35	134		x	x
Czech Republic - Germany	44	81	х		Х
Switzerland - Germany – France	60	140		х	х
Austria - Hungary	63	91	x		
Austria - Switzerland - Italy	82	114		х	
Germany – Denmark – Poland - Sweden-Lithuania	111	104	x		v

We received responses from different cross-border regions in Spain-Portugal and Germany-Netherlands. Hence, we calculated the mean for the region different regions separately and indicated this with Roman numbers (i, ii, and iii).
Appendix A.2 Calculation of differences in levels of innovativeness

This file explains the two-step calculation of innovativeness based on the RIS of different regions. First step: A cross-border region covers an area of five NUTS regions in three countries (A, B, C), and we identified the RIS of each region (Table 2-A2).

T S utjj		
NUTS region	Country	RIS
1	А	80
2	А	90
3	В	100
4	С	100
5	С	110

Table 2-A2 Input for **RIS_{diff}** calculation

We are interested in the innovativeness scores of the *countries* (not NUTS regions) in the cross-border region; therefore, we calculated the in-country-mean:

$$\bar{x}A = \frac{1}{2}(80 + 90) = 85$$
$$\bar{x}B = \frac{1}{1}(100) = 100$$
$$\bar{x}C = \frac{1}{2}(100 + 110) = 105$$

Second step: Among the three countries A, B, and C, we calculated the difference in innovation level (RIS_{diff}) in our example cross-border region via subtracting the highest and lowest score. Country C presented the highest score ($\bar{x}C = 105$), and country A the lowest ($\bar{x}A = 85$):

$$RIS_{diff} = \bar{x}C - \bar{x}A = 105 - 85 = 20$$

In our example, the RIS_{diff} of the cross-border region is 20 and serves as the indicator for the difference in innovativeness in the cross-border region.

Appendix B



Figure 2-A1 Regression results socio-cultural proximity. Specific differences of socio-cultural proximity factors: bold line = mean, continuous line = factors showing positive relationships, long dashed line = differing hierarchal structures in businesses, dashed line = different habits of addressing people, dotted line = differing approaches and attitudes in doing business (Source: own elaboration based on survey data and RIS (European Commission 2017c))



Chapter 3:

The influence of the cross-border innovation environment on product innovation processes in agri-food enterprises – A case study from the Dutch-German Rhine-Waal region

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Abstract: Enterprises of the agri-food and other sectors develop innovations that can serve the EU's Green Deal objective to become climate neutral by 2050. Innovation processes face specific innovation environment conditions which are beyond the enterprise's control. Our research aims to investigate how the innovation environment affects product innovation processes of agri-food enterprises located in a cross-border region. We developed our conceptual framework of the "cross-border innovation environment" based on innovation system and innovation management literature. We conducted semi-structured interviews in selected agri-food enterprises in the Dutch-German region Rhine-Waal. Results indicate that agri-food enterprises' innovation environments concentrated on national-level factors, and that cross-border factors and relationships were rare. Moreover, different factors influenced different stages of innovation processes that were primarily driven by markets compared to research. We conclude that integrating customers and business partners during research and technological development is important to address current challenges of the Green Deal. Understanding how the innovation environment influences innovation processes in agri-food enterprises can help to develop appropriate policies.

Keywords: innovation process, innovation environment, cross-border region, innovation history

3.1 Introduction

The agricultural sector in the European Union (EU) faces tremendous challenges to address greenhouse gas emissions, loss of biodiversity, soil degradation, and groundwater pollution. The EU launched the Green Deal action plan to foster the development of a circular economy through financial and technical support (European Commission 2019a). Meeting the goals set by the EU Green Deal will require farmers and agri-food enterprises to adapt current practices, increase their resource use efficiency and reduce the environmental impact. Innovation is one pathway towards achieving the goals set by the EU Green Deal and the EU and national governments support this pathway through funding programs and research projects.

Enterprises – in rural areas specifically small- and medium-sized enterprises (SMEs) - are driving innovation (Noronha Vaz, Viaene, and Wigier 2004), but not all innovations make it to the market, let alone become successful (Ahmed and Shepherd 2010). We define innovation as 'an evolutionary and social process of collective learning' (Edguist 2006), which is facilitated by networks of actors (Tranos 2014). This definition covers the dynamic process of product innovations of the agri-food sector. Hence, innovation processes and their outcomes are not only influenced by internal factors (e.g. creativity, technological capability, or organizational structure) but also by external factors, i.e. the national innovation environment (e.g. the financial system, existing infrastructure, and demand conditions) (Galanakis 2006). While enterprise performance depends mainly on internal factors which the enterprise can largely control, the national innovation environment also has an effect on enterprises but is beyond their direct control and determined by the location of the enterprise in a specific region (Niebuhr, Peters, and Schmidke 2020). In the EU, local, regional, national but also supranational governments shape the innovation environment of agri-food enterprises. Consequently, innovation environments are more complex in particular for enterprises located in a cross-border region, as the jurisdiction in such regions is typically fragmented between two or more different authorities (Guo 2012b).

A cross-border location can affect the innovation processes both positively and negatively: cross-border regions offer enterprises opportunities for business development, because of their proximity to a potential new market, additional market knowledge, sources of knowhow, and business contacts (Smallbone and Welter 2012; Makkonen and Leick 2019). However, different institutional set-ups, political, economic, and socio-cultural structures, may hamper innovation. It may also be more difficult to access universities or to develop interfirm relationships across the border (Lundquist and Trippl 2013).

The innovation environment affects the innovation processes and subsequent market success (Dziallas and Blind 2019). A case study showed that enterprises experienced different needs and problems in each stage of the innovation process (Davids and Frenken 2018). Yet, only a limited number of studies has focused on the innovation environment factors that affect specific stages of the product innovation process, especially in the early stages (Dziallas and Blind 2019), or alternatively are limited in scope (Karlsson et al. 2018).

Galanakis (2006) is an exception, and his so-called "**creative factory concept**" offers valuable insights on factors in specific stages of the innovation process. However, an important aspect less emphasized in this concept is the role of different external actors in innovation processes.

Innovation system literature stresses the importance of cooperation for innovation success (Lundvall 2010; Nelson 2010; Edquist 2006). Innovation processes benefit if enterprises are embedded within a strong network and can cooperate along and across the supply chain (Carvalho and Gomes 2017), but this can be problematic in cross-border regions (González-Gómez and Gualda 2016). This is particularly true for agri-food product innovations (Lefebvre, Steur, and Gellynck 2015).

To address this issue, our research aims to investigate how the innovation environment affects product innovation processes of agri-food enterprises located in a crossborder region. Product innovations in the agri-food sector are needed to accomplish the objectives of the Green Deal, hence, we also focus on product innovations in our research. In our case study, we conducted interviews with a selection of nine agri-food enterprises about external factors affecting the development of product innovations in the Dutch-German cross-border region to gather new insights that could guide enterprises and policy makers on how to improve the innovation environment.

3.2 Conceptual framework: cross-border innovation environment

Innovation is commonly defined as an iterative and non-linear process that runs through several stages and is subject to continuous evaluation. However, there is less agreement regarding the definition of concrete innovation process stages (Carbonell-Foulquié, Munuera-Alemán, and Rodríguez-Escudero 2004; Uecke 2012). The literature on innovation processes usually describes four to eight different stages which vary by the type of innovation, i.e. product, service, process, etc. (see e.g. Salerno et al. 2015). For example, Tzokas, Hultink, and Hart (2004) surveyed managers of manufactural industrial and consumer goods and identified five stages in new product development: idea generation, concept development, business analysis (economic evaluation), product development, and market testing and launch (Tzokas, Hultink, and Hart 2004). In the "creative factory concept", Galanakis (2006) provided a framework and model which emphasizes the enterprise as the main unit of analysis and divides the innovation process into three stages: idea generation, product design and development, and market entrance.

Innovation processes are influenced by internal and external factors. Galanakis' (2006) "creative factory concept" considers both factor types and hence provides a tool to managers to better understand the consequences of their decisions related to the innovation process. **Internal factors** include creativity, corporate strategy, risk taking policy, technological capability, organization structure, and organizational climate. **External factors** comprise the regulations, financial system, infrastructure, demand conditions, critical mass

and physical resources, and knowledge and human resources which Galanakis (2006) called national innovation environment.

In addition to the national innovation environment, innovation processes can be facilitated or impeded by the innovation environment and actors of neighboring countries. The term national innovation environment is deduced from the theory of national systems of innovation (Lundvall 2010; Nelson 2010; Edguist 2006), which discusses the nation's influence on innovation. Enhancements of this theory zoom in on a smaller unit of analysis and focus on a specific sector (Klerkx, Aarts, and Leeuwis 2010b) or region (Cooke, Gomez Uranga, and Etxebarria 1997). All innovation system theories acknowledge the important role of cooperation. This can occur among multiple organizations at several spatial scales (Lundvall 2010) and affects the innovation environment and therefore the enterprises' innovation process (Klerkx, Aarts, and Leeuwis 2010b). Lundquist and Trippl (2013) developed a concept for a cross-border regional innovation system focusing on the level of integration of innovation environments in bordering countries. This cross-border regional innovation system approach is an adaptation of the regional innovation system approach and all influences on enterprises are also applicable at a national level. Hence, for enterprises located in border regions, the cross-border innovation environment shapes their innovation processes. To investigate how the cross-border innovation environment affects the innovation process, the conceptual framework in our paper combines Galanakis' (2006) "creative factory concept" and Lundquist and Trippl's (2013) cross-border regional innovation system approach. The conceptual framework is presented in Figure 3-1 and covers three layers, i.e. the stages of the innovation process, the cross-border innovation environment, and the relevant actors.



Figure 3-1 Conceptual framework to investigate the influence of the cross-border innovation environment on specific stages of the innovation process (adopted from Tzokas, Hultink, and Hart 2004; Galanakis 2006; Lundquist and Trippl 2013; Hekkert et al. 2007; Trippl 2010; Spendrup and Fernqvist 2019; Bansal and Grewatsch 2020; Neuberger et al. 2021)

In the first layer, we distinguish four stages of the innovation process as a funnel, i.e. idea generation, concept development, product development, and market entrance (i.e. testing and launch) based on Galanakis (2006) and Tzokas, Hultink, and Hart (2004). The second layer represents the cross-border innovation environment derived from different levels of integration in cross-border regional innovation systems (Lundquist and Trippl 2013). The third layer contains important actor categories (Spendrup and Fernqvist 2019; Bansal and Grewatsch 2020).

In the cross-border innovation environment, cross-border integration depends on socio-cultural proximity (SCP), accessibility (ACC), science and knowledge bases (SKB), institutional set-up (ISU), economic structure (EST), policy structure (PST), interfirm relationships (IFR), and nature of linkages (NOL) (Trippl 2010; Lundquist and Trippl 2013; Hekkert et al. 2007). *Socio-cultural proximity* refers to the relation between the norms, values, and cultures (Hermans, Klerkx, and Roep 2015). Business culture may vary across regions and countries, and if unfamiliar with the local customs, the communication with actors from across the border can become difficult and consequently influence the quality of and interest for cooperation. *Accessibility* (or physical proximity) considers any infrastructural barriers (Klein Woolthuis, Lankhuizen, and Gilsing 2005; Lundquist and Trippl 2013), as the distance to potential partners and between markets determine how and with whom enterprises operate. *Science and knowledge bases* are important as facilitators of common development and diffusion of knowledge (Hermans, Klerkx, and Roep 2015). As

such, education and research institutes can help enterprises in overcoming barriers or obstacles during the innovation process. *Institutional set-up* refers to alignment of laws and regulations in cross-border regions (Lundquist and Trippl 2013; Trippl 2010). During an innovation process, enterprises have to consider regulatory requirements of the potential future market. The *economic structure* addresses the influence of available market structures: competition, information services (Hermans, Klerkx, and Roep 2015), the structure of the supply chain (Trippl 2010), and the presence of niche markets (Hekkert et al. 2007). *Policy structure* denotes how the political system, governance structures, and modes of operation (causal cooperation vs. coherent strategy) might influence an enterprise's innovation process (Lundquist and Trippl 2013; Trippl 2010; Hermans, Klerkx, and Roep 2015).

Interfirm relationships refer to the interaction between actors at different levels, both within and outside of the enterprise. Innovation can be best stimulated if innovation teams work together with external actors (Bansal and Grewatsch 2020). External actors can include customers (including farmers, private persons, or other agri-food enterprises), business partners (including suppliers), education and research institutes and other regional actors, e.g. local or national governments, the chamber of industry and trade or the agricultural chamber (Hermans, Klerkx, and Roep 2015; Klein Woolthuis, Lankhuizen, and Gilsing 2005; Fort et al. 2004). Important actors in cross-border regions can be Euregio or Interreg offices, which try to facilitate cross-border relationships. The collaboration between different actors can encourage knowledge development, mobilize resources, and counteract resistance to change, thereby catalyzing innovation adoption (Hekkert et al. 2007; Klein Woolthuis, Lankhuizen, and Gilsing 2005). The *nature of linkages* further describes established relationships. Linkages can be driven by costs or knowledge exchange, and be mutual or one-sided (Trippl 2010; Lundquist and Trippl 2013; Hekkert et al. 2007).

The conceptual framework presented in Figure 3-1 allows identifying both positive and negative factors at the national and cross-border level that have an impact on each stage of the innovation process. According to the "creative factory concept", for idea generation and concept development, an enterprise's success and corporate strategy depend (amongst others) on financial systems (i.e. funding), on knowledge and on human resources. During product development, the influence of the innovation environment may lead to adaptations in the innovation process. Hence, it is common to switch back and forth between the concept development and product development stages to adjust the product before entering the market (Galanakis 2006; Tzokas, Hultink, and Hart 2004). For market entrance, infrastructure, demand conditions and critical mass (i.e. customers) affect the success of a new product on the market (Galanakis 2006). Different actors can further facilitate and imped the factors of the cross-border innovation environment. In our research, we apply the conceptual framework of the "cross-border innovation environment" to investigate agri-food innovation processes in the Dutch-German cross-border region Rhine-Waal.

3.3 Material and methods

We conducted a case study with interviews (Yin 2009) to ex-post evaluate innovation processes (Wittmayer et al. 2015). The Social Sciences Ethics Committee of Wageningen University reviewed and approved this research before data collection started (No. 09215846).

3.3.1 Case study region

Our research was carried out in the Dutch-German cross-border region Euregio Rhine-Waal. The region covers an area of 8,663 km² and extends over the Dutch areas of Achterhoek, Gelderland, the north east of Noord-Brabant, and Noord-Limburg and the German areas of Kleve, Wesel, Duisburg and Dusseldorf. With 4.2 million inhabitants and 22 universities and universities of applied sciences (eight in Germany and 14 in the Netherlands) (Euregio Rhine-Waal 2020), the Euregio Rhine-Waal is one of the most innovative regions in Europe (European Commission 2019b).

Nevertheless, Camagni, Capello, and Caragliu (2019) uncovered unused economic potential in this cross-border region. Furthermore, there is an urgent need for agricultural innovation, as intensive agricultural production systems and the unsustainable use of resources lead to environmental problems, such as high ammonia concentrations in ground water and surface water bodies (Landwirtschaftskammer Nordrhein-Westfalen 2021; Smit et al. 2015). Farmers in the Dutch and German parts of the Euregio Rhine-Waal need to adapt their farming practices to address these environmental challenges. The need for improved production techniques in the agri-food sector also opens business opportunities for enterprises in the region. These circumstances make the Euregio Rhine-Waal an interesting case to study.

3.3.2 Selection criteria of enterprises and innovation processes

We selected nine enterprises which (1) were located in the Euregio Rhine-Waal, (2) had experience in cross-border cooperation, and (3) were working on an innovation process (4) in the agri-food sector. While all selected enterprises were working on product innovations, their location varied (Germany vs. the Netherlands) providing a variety of contexts in line with our conceptual framework.

We contacted enterprises using a stepwise approach. First, we identified potential interviewees through a research project followed by snowballing and contacted the enterprises by mail followed by a short telephone survey. The short survey template covered twelve questions to identify whether the enterprise met the requirements and to enable the later comparison between the cases (see Table 3-A1 in Appendix A). Second, upon meeting our requirements, we scheduled face-to-face appointments and conducted semi-structured interviews. In total, nine interviews were conducted: five with interviewees from Dutch

enterprises and four with interviewees from German enterprises. Table 3-1 presents an overview of these enterprises.

Enterprise Case No.	Name of innovation	Aim of innovation	Potential final customers	Current stage of innovation process	Size of enterprise	Country	No of people working on innovation process	Founding year of enterprise	Starting year of the innovation process
Market-driv	en innovation processe	s (MAR)					1		
MAR 1	Asparagus harvester	Increasing resource efficiency and improving the quality of harvested asparagus through sub-surface detection of a construct. Independent of the detection	Farmers	Product development / Market	Small	NL	19	2014	2013
MAR 2	Barn climate control sensors	Improving animal welfare (and the quality of meat) through access to information on the barn climate and hence improved herd management	Farmers	Market entrance	Medium	NL	υ	2007	2016
MAR 3	Reptile feed	Increasing resource efficiency by processing insects for non-refrigerated reptile pet feed	Pet shops, reptile owners	Market entrance	Small	NL	10	2012	2017
MAR 4	Struvite fertilizer	Increasing resource efficiency through upcycling of industrial waste streams for fertilizer production	Farmers	Product development / Market entrance	Medium	GER**	دى ب	1954 (NL), 2004 (DE)	2014
Research-dr	iven innovation process	ses (RES)							
RES 1	Plasma technology for odour control	Decreasing odour emissions from livestock stables (to meet regulatory standards) by adapting plasma technology for odour control	Farmers	Product development / Market entrance	Small	NL	ເມ	2014	2018
RES 2	Surface texture technology (meat) - Sensors	Improving food safety by analysing the surface texture of meat and meat products to detect microorganisms	Meat industry	Concept development	Small	GER**	دى	,	2017
RES 3	Surface texture technology (meat) - Laboratory tests	Improving food safety by analysing the surface texture of meat and meat products to detect microorganisms	Meat industry	Concept development	Medium	GER	4	1996	2017
RES 4	Hydrothermal carbonization	Increasing resource efficiency in waste recovery systems through hydrothermal carbonization	Farmers, larger communities	Market entrance	Micro	GER	2	2009	2006
RES 5 * <i>Micro</i> (<	Surface texture technology (meat) – Industrial use <10 employees), small (1)	Improving food safety by analysing the surface texture of meat and meat products to detect microorganisms (improved surface of machine equipment) 0-49), medium (50-249) and large firms (>25)	Meat industry 0) (OECD 2021).	Concept development	Medium (NL), Large (world)	NL	S	1967 (2007 trans- formation)	2012
* Micro (<	<10 employees), small (1)	0–49), medium (50–249) and large firms (>25	0) (OECD 2021).						

Table 3-1 Overview of selected enterprises: Innovation processes driven by customers or business partners (MAR); Innovation processes driven by university and research (RES)

** Enterprise is located in Germany and the Netherlands, and the country is the main location for conducting the innovation process (in line with the interviewee's main locatio

3.3.3 Innovation histories

Innovation histories consist of an innovation timeline and an actor-network map and offer an inductive and heuristic approach to understand the innovation process (Wittmayer et al. 2015). Following the method of an event history analysis, researchers try to make sense out of past events which occurred during the innovation process (e.g. Hermans et al. 2019). In the context of our research, events are defined as events with any influence on the innovation process, e.g. participation in staff and project meetings, access to funding, access to education and research facilities, or relationships to customers and suppliers.

Whereas data collection for the innovation histories is usually done through group interviews, in our research we conducted individual interviews as only a few people were responsible for the innovation processes in the selected enterprises. Following Creswell (2014), we developed a codebook based on the conceptual framework (Figure 3-1) prior to conducting the interviews. The qualitative codebook consisted of three themes: stages of the innovation process, the cross-border innovation environment, and evaluative nodes (Table 3-2). The codebook helped to develop the semi-structured interview questions (Creswell 2014) and to structure these questions on a template. The interview template was designed in the style of a timeline and covered the stages of an innovation process, and (b) the actors involved. A pre-test was conducted in July 2019 whereupon minor adjustments of the interview questions were made.

	Theme	Code
1	Stages of the innovation process	Idea generation
		Concept development
		Product development
		Market entrance
2	Cross-border innovation environment ⁱ	SCP: socio-cultural proximity
		ACC: accessibility
		ISU: institutional set-up
		SKB: science and knowledge bases
		EST: economic structure
		PST: policy structure
		IFR: interfirm relationships
		NOL: nature of linkages
		EXF: external funding ⁱⁱ
3	Evaluative nodes	(+) Positive ⁱⁱⁱ
		(-) Negative ^{iv}

ⁱ For the sake of completeness, data on the firm-internal factors (e.g. firm management, firm capabilities) was collected but initial analysis found low variance between the enterprises, hence they were excluded from further analysis.

ⁱⁱ Galanakis (2006) stated that financial systems, next to knowledge and human resources, are part of a firm's success and corporate strategy and hence are internal factors. However, access to external funding turned out to be an important topic for firms in our sample. We therefore decided to add the code 'External funding (EXF)' to identify its influence in the cross-border innovation environment as presented in the conceptual framework above. ⁱⁱⁱ A factor was coded as positive, if the respondent made clear that the event had a facilitating role in the innovation process.

^w A factor was coded as negative, if the respondent made clear that the event was hampering or inhibited the innovation process.

Prior to starting the interview, we described the purpose and the objectives of our research. We showed the drafts of the research protocol, explained the research process, the consent form and data treatment, and that the respondents were free to quit the interview anytime. We asked interviewees to recall what affected the innovation processes and noted keywords on the template visible for the interviewee. The interview finished with developing the actor-network map as part of an iterative process to recall relationships and hence to reduce the potential drawback of using a linear innovation process timeline. Written informed consent was collected from all respondents at the end of their interviews.

The interviews lasted between 25 to 75 minutes. Interviews were recorded, transcribed and summarized. Recording was not possible or not permitted during three interviews. In these cases, notes were summarized in an extended form sent to the interviewee for validation and clarification. The summary of the recorded interview was also sent to the interviewees for approval.

Interview analysis was based on the codebook (Table 3-2) using the qualitative data analysis software NVivo 12. Every event (i.e. factor) was coded along the three themes of the codebook.

3.4 Results

Our study on the Dutch-German cross-border region Euregio Rhine-Waal demonstrates that external factors can occur in every stage of the innovation process. During the analysis of results, we found marked differences between innovation processes that were primarily driven by customers or business partners (i.e. the market) and innovation processes driven by universities (i.e. research). Therefore we first present the results for market-driven innovation processes (MAR1, MAR2, MAR3, MAR4) in a combined innovation history (Figure 3-2), followed by the combined innovation history of research-driven innovation processes (RES1, RES2, RES3, RES4, RES5, Figure 3-3). In both figures, we highlight the cross-border influence by an asterisk. The full description of the innovation histories is available in Appendix B.

3.4.1 Market-driven innovation processes

Four innovation processes were driven either by customers, such as farmers (MAR1, MAR2), and business partners along the supply chain (MAR3, MAR4). The combined innovation history is presented in Figure 3-2. The innovation processes concentrated on solving concrete problems of the agricultural sector: improving the quality of harvested asparagus, improving animal welfare (and the quality of meat), and increasing the efficiency of resources by processing insects for non-refrigerated reptile pet feed or by upcycling industrial waste streams for fertilizer production (see Table 3-1).



MAR2, MAR3, MAR4 Figure 3-2 Combined innovation history of innovation processes driven by customers (farmers) or business partners (own elaboration based on interviews with MARI

* highlights the cross-border influence

³¹ Others include local institutions such as the Agricultural Chamber of North-Rhine Westphalia (LWK NRW) and the Interest Group Cross-Border Integrated Quality Assurance (GIQS)

The main influence of the innovation environment stemmed from interfirm relationships with customers, business partners and later also universities. During the Idea Generation stage, all four enterprises concentrated on involving their potential future customers and established test groups - upon the enterprises' final decision to continue working on the idea (IFR) (see Table 3-1 for an overview of potential customers). One enterprise immediately initiated customer test groups in both countries (MAR1). All four enterprises maintained the relationships to their test groups during the whole innovation process. including market entrance, and considered them as very important. Three out of the four enterprises were already established businesses and could progress from idea generation to concept development without any external financial assistance (MAR2, MAR3, MAR4). However, in one case, idea generation occurred prior to the enterprise started up and hence financial resources had to mobilized before moving on to concept development (MAR1). An early relationship to a university helped to acquire financial resources through research projects (MAR1) (SKB, IFR). Enterprises valued universities as important partners but not as the initial drivers. However, the filing of patents was an important step before engaging with any partner or the public e.g. to raise funding (MAR1) (SKB).

During **Concept Development**, the other three enterprises (MAR2, MAR3, MAR4) also developed relationships with universities to assist in research activities ^(SKB, IFR). These relationships were essential to gain access to laboratories and students (MAR1, MAR3, MAR4) ^(SKB), but sometimes perceived as challenging because establishing mutual trust was time-consuming (MAR1) ^(SCP). All four enterprises initiated regular customer group meetings and maintained a close interfirm relationship to customers during the product development stage ^(IFR). At this point of the innovation process, enterprises' continuous search for funding started and continued to have an important role throughout the whole innovation process (MAR1, MAR2, MAR3, MAR4) ^(EXF). Access to external funding facilitated development and market launch (MAR3) ^(EXF).

During the concept development stage, the enterprises had to invest in the relationships with its test groups. Although resources were scarce, one enterprise had to adjust its communication to farmers by constructing an actual machine prototype (MAR1) (^{SCP)}. The development of such a tangible prototype increased the engagement of the test group to provide feedback on the ongoing machine development (^{IFR}), however, farmers also wanted to receive something in return for their engagement, resulting in continuous relationship investments by the enterprise (MAR1).

During **Product Development**, test group relationships helped enterprises to continuously adjust the product to market needs. Enterprises finally benefitted from the gained trust of the test groups and the long-term effect of the established relationships finally showed results (MAR1) ^(SCP, IFR). One enterprise valued the mutual engagement of partners (MAR2) ^(NOL) and the product development stage was positively affected through regular meetings with and training of test groups – in both countries (MAR1) ^(IFR). The network was further extended because experts were consulted e.g. to interpret the collected data (MAR2) ^(IFR).

Enterprises faced obstacles regarding funding, infrastructure, institutional set-up and economic structure during the product development stage. The importance of financial support grew in this stage, because enterprises had to develop, test, and further adjust the prototype (MAR1, MAR2) and access to funding provided a big push because e.g. new staff could be hired (MAR3, MAR4) ^(EXF). However, winning private investors also meant handing over power in decision making to the investor (MAR1) ^(EXF) and the regulations to access public funding were considered rather complex (MAR1) ^(ISU, EXF). Other obstacles experienced at this stage were of bureaucratic nature, i.e. the certification as a pet feed producer (MAR3) ^(ISU), and of economic nature, i.e. delivery problems along the supply chain (MAR3) ^(EST). Solving these issues was time consuming. At an early stage of product development, the customer test group of the foreign country drew the enterprise's attention to the existing infrastructural differences (i.e. different connection of the sensors with the internet) and hence these differences could be considered during product development (MAR2) ^(ACC, IFR).

During the Market Entrance stage, innovation processes were heavily influenced by the relationships to the test groups and other experts. The test groups provided feedback to adapt the product (MAR3), and also helped to raise attention and to diffuse information about the innovation among other potential future customers (MAR1) (IFR). The experts' networks also helped to promote the product and the press was identified as yet another important actor to draw the customers' attention to the innovation (MAR2) (IFR). The attention was also brought forth by the relationship to local institutions such as the Agricultural Chamber of North-Rhine Westphalia (LWK NRW) and the Interest Group Cross-Border Integrated Quality Assurance (GIOS) (MAR2). However, a relationship to the market across the border was partly missing because enterprises lacked the right network (governments and actors along the supply chain) (MAR3) (EST, IFR). Enterprises shared the opinion that crossborder relationships were difficult to initialize and that they needed a native employee to develop such relationships and to promote the innovation in the other country because of language issues (MAR1, MAR2, MAR3, MAR4) (IFR, SCP). Two enterprises (MAR1, MAR2) could establish a good network in both countries and could benefit from mutual exchange of knowledge and experience (IFR, NOL).

Enterprises experienced obstacles regarding the institutional set-up during the market entrance stage. Launching a new product on the market forced enterprises to deal with the existing regulations on privacy and data security (MAR2), or with a complete lack of a regulatory framework (i.e. for the production of insects) (MAR3). In this specific case (MAR3), the absence of laws provided the enterprise with the opportunity to define new standards (i.e. for insect production) ^(ISU). Because of the established relationships, enterprises seemed more aware of potential obstacles concerning different or absent regulations in the two countries and could consider them before the expected market entrance.

3.4.2 Research-driven innovation processes

Three innovation processes were driven by research of which two innovation processes involved one enterprise each (RES1, RES4) and the third one involved three enterprises (RES2/RES3/RES5). The combined innovation history is presented in Figure 3-3. The three innovation processes concentrated on the practical implementation of specific scientific achievements: decreasing odour emissions from livestock stables (to meet regulatory standards), increasing the efficiency of resources in waste recovery systems through hydrothermal carbonization, and improving food safety by analysing the surface texture of meat and meat products (see Table 3-1).

Actors	Cross-border	innovation ei	nvironmen	t	Innovation process
					Resea
University and Unive Applied Sciences	-) Negative influence	+) Positive influence		(+) IFR, SKB: connecti	rch-driven innov
sity of Business partners, test groups *			 +) IFR: connecting with business partners +) SKB: filing of patents +) SKB, IFR: recruiting students 	ng with university	Concept Development
۰	 (-) IFR: awaiting partner's progress and input (dependence) (-)* ISU: expecting more complex regulations in one country than in the other 	 (+) SCP, IFR: accessing the network of universities (+) ISU: paying attention to comply with regulations 	 +) IFR: connecting with business partners +) SKB, IFR: establishing small research teams 	+) IFR, SKB: connecting with university	Product Development
Experts	 (-) ISU: complying with country specific regulations (-) ISU: lacking power for system change (-) EXF: lacking access to funding (-) SCP: facing critical personal attitudes towards something new in power 		partners (+) SKB, IFR : interpreting customer data through experts	(+) IFR: connecting with business	Market Entrance

Figure 3-3 Combined innovation history of innovation processes driven by university and research (based on interviews with RES1, RES2, RES3, RES4, RES5)

Our results showed that in research-driven innovation processes, the relationships with universities were stronger than the ones with customers. Enterprises accessed sciencebased ideas for their innovation processes through existing relationships with universities (SKB, IFR). During the stages **Idea Generation** and **Concept Development**, the enterprises focused on research and development in collaboration with universities to test the applicability of their idea in practice and to recruit students to work on the innovation process (RES1) (SKB, IFR). One enterprise initiated a customer test group during the concept development stage and developed relationships to business partners in both countries (RES1) (IFR). Unfortunately, this enterprise could not offer further insight into the duration and influence of these relationships because the innovation process did not proceed beyond the concept development stage yet. However, the enterprise indicated to maintain these relationships during product development (as shown by the dotted line in "Actors" in Figure 3-3). The relationships with universities also affected product development but did not affect the market entrance stage.

During the **Product Development** stage, the innovation processes were almost exclusively determined by national-level factors. For example, existing relationships to universities provided access to their (mainly national) network and thereby facilitated the progress of the innovation process (RES2/RES3/RES5) ^(SKB, IFR). At this stage, enterprises paid attention to meeting the regulations required for later market entry (RES2/RES3/RES5) ^(ISU). In this specific case, enterprises planned to introduce the product first in one market (i.e. the Netherlands) as they were more familiar with the regulations and also expected more complex regulations in the other country (i.e. Germany) ^(ISU).

Enterprises considered research projects such as Interreg as a helpful source of funding, to mobilize resources and to easily connect with actors in the same business sector (RES1, RES4, RES2/RES3/RES5). The Interreg projects allowed enterprises to easily develop a network with business partners in the cross-border region. All enterprises with research-driven innovation processes participated in a publicly funded Interreg research project which might explain why enterprises did not mention access to external funding being a limiting factor in the innovation processes. However, with an increasing number of universities and business partners involved in the innovation process, the mutual dependence to complete tasks increased as well, causing progress delays ^(IFR).

Innovation processes with a strong focus on university relationships seemed to result in a disadvantage during the **Market Entrance** stage because universities usually do not have detailed insights in the market of a respective industry. Hence, enterprises perceived the relationship to experts who have such insights in the respective countries as essential to connect with potential customers and to facilitate a later marker launch (RES2/RES3/RES5) (^{SKB, IFR)}. At the time our study was conducted, only one of the three investigated innovation processes had reached the market entrance stage (RES4). In this case, the enterprise experienced regulatory obstacles which could have been (partly) resolved if considered earlier ^(ISU). The enterprise also missed to clearly define their targeted customers and hence the enterprise did not invite customers to analyze their requirements for buying and using the innovation. Due to the complexity of this specific innovation, a wider system change might be necessary to support the market launch of the innovation but the enterprise lacked the power to initiate such change and hence to motivate customers to adopt the innovation (RES4) ^(ISU, SCP).

3.5 Discussion

Our research offers three essential insights into external facilitators and obstacles during innovation processes of agri-food enterprises. First, our research indicates that the influence of cross-border factors on agri-food enterprises' innovation processes were less important than national-level factors. Second, we observed that different factors affect different stages of market-driven compared to research-driven innovation processes. Third, enterprises experienced a lack of public support to launch the innovation on the market. These three main findings will be discussed and explained in detail in the remainder of this section.

First, in all investigated cases, the majority of external factors stemmed from the national and not the cross-border innovation environment. We observed that factors concerning the institutional set-up and economic structure often occurred in the country in which the enterprise was located. Although institutional factors are important for SMEs business operations (Di Cai, Shen, and Liu 2016), Fichet de Clairfontaine et al. (2015) showed that institutional barriers and geographic distance are less important if cross-border cooperation between university and industry generates scientific output (e.g. publications). However, we only observed few relationships of agri-food enterprises with actors across the border because they perceived the development of a strong network abroad as difficult (MAR4). Our observation is in line with Tödtling and Kaufmann (2002) who stressed that SMEs already struggle to develop strong networks in a national context. However, research also showed that start-ups can already benefit from cross-border relationships if these are well planned (Dashti and Schwartz 2018). Hence, cross-border relationships with business partners and actors other than universities are important for the innovation process, but a literature review on cross-border cluster development revealed that research on establishing cross-border linkages is still limited (Rohde 2016). We observed socio-cultural factors when initiating relationships with actors abroad but enterprises perceived different mind-sets as beneficial for the innovation process (RES1). Borges et al. (2021) identified language as a barrier for cross-border cooperation and similarly, we observed minor language problems. Enterprises unanimously agreed that a native speaker is essential when the enterprise enters a neighboring market and starts the diffusion of the innovation.

Second, all the investigated innovation processes were driven by external sources of information, but we observed that different factors affect different stages of innovation processes driven by customers and business partners (i.e. the market) and by university publications (i.e. research). External information can be provided by customers, suppliers, competitors and be derived from publications and patents (Gaubinger et al. 2015; Hippel 1995).

In the investigated market-driven innovation processes, enterprises engaged with customers from the beginning, and therefore customers could help to develop the product to match their needs. Through the early relationships with customers, enterprises were reminded to take care of specific questions important for the customer group. Hence, customer feedback helped them to adapt the innovation and benefit from the long-term effects of these relationships (MAR1, MAR2). Svare (2016) confirms our finding that interaction with customers and access to their practical knowledge facilitates innovation. However, previous research also suggests that increased coordination costs of different partners can outweigh potential benefits of cooperation (D'Ambrosio et al. 2017). In our study, the positive effects on the progress of innovation processes prevailed although developing interfirm relationships with customer groups was time-consuming and not easy to manage for our selected enterprises. Additionally, we observed that enterprises which addressed customer questions already during product development benefitted when entering the market because time delays due to unmet regulatory requirements did not occur (MAR2, MAR3). Our observation adds to Galanakis' (2006) creative factory concept in that factors of the national innovation environment may cause adaptions of product development.

In the research-driven innovation processes we investigated, enterprises started to engage with customers and to consider market needs only when the innovation process had already progressed. Such late engagement may cause enterprises to benefit less from these relationships. For example, MAR3 could adapt the innovation during the product development stage according to customer input compared to RES4 who experienced difficulties because the innovation was adapted only after market entrance. This observation is in line with D'Ambrosio et al. (2017) who found that the duration of a relationship has a higher influence on innovation than the sheer number of actors, and with Apa et al. (2020) and Jong and Slavova (2014) who identified a positive effect of enterprise-university cooperation on the innovation processes. Previous research further suggested that customerdriven innovation processes are predominant in agri-food SMEs while research-based actors do not appear relevant to drive innovation (Lefebvre, Steur, and Gellynck 2015). We found that university is also an important actor. However, Živojinović et al. (2017) showed that relationships and networks are not always established equally well and even though enterprises develop relationships with universities easily, linkages to governmental organizations for innovation support were more difficult to establish (Živojinović et al. 2017). For example, linkages to governmental organizations were only present in market-driven innovation processes (MAR2, MAR3), and enterprises developed relationships to universities easier in research-driven than market-driven innovation processes. A possible explanation for this difference is that enterprises with research-driven innovation processes had already established some kind of relationship with university researchers before starting to further develop the idea.

Third, the enterprises in our case study experienced a lack of support in launching the innovation. The three research-driven innovation processes were part of a publicly funded research project. In line with D'Ambrosio et al. (2017), these enterprises estimated the

participation in research projects as positive for the innovation because they could access a broader set of information. However, previous research also showed that if enterprises relied on these public funds, they were not among the most innovative ones (D'Ambrosio et al. 2017). D'Ambrosio et al. (2017) hypothesized that one reason could be that funding generally tries to support less innovative firms or that dependency on external funding can reduce the enterprises funds and long-term capacity to innovate. Samara et al. (2020) acknowledged public funding as a good instrument to initiate innovation processes, but also advised public funding. One enterprise considered a major drawback of EU funding that potential market applications of innovations are not thought through at an early stage (RES5). Salerno et al. (2015) suggests that innovation processes driven by public calls for technological development need support to link research developments with market needs and consequently reduce uncertainty early. This is in line with our observation that enterprises working on research-driven innovation processes experienced difficulties to access the market.

In our case study, those enterprises with research-driven innovation processes mainly focused on the practical implementation of research and did not consider market requirements during product development. Hermans et al. (2019) found that enterprises who cooperate with public organizations such as government agencies and universities (i.e. public-private partnerships) are less capable of stimulating functions necessary for the final market development and meeting consumer demands of innovation. Burgelman and Sayles (2009) and Gaubinger et al. (2015) observed that SMEs often lacked strategic management of innovation processes - especially repeated evaluation between the stages which would prevent working on ideas without a market. Such phenomena have extensively been discussed in the literature on push- and pull-innovation (Burgelman and Sayles 2009). Faced with unmet market requirements, an enterprise was confronted with additional financial and administrative problems while making the necessary adjustments or dealing with regulatory offices (RES4). Our research also found indications that the economic evaluation of an idea and the estimation of the potential market application of a technology are particularly difficult in the beginning of an innovation process (RES5). However, if innovation processes are not designed to market needs, they could fail regardless of being e.g. the more sustainable or resource-efficient option (e.g. Gaubinger et al. 2015). Enterprises might need other or additional criteria than evaluation according to the stage-gate model to develop and launch sustainable agri-food innovations successfully (Bansal and Grewatsch 2020). Our observation is in line with Caiazza (2016) who identified a lack on policies and support especially for innovation diffusion.

3.5.1 Policy implications

First, our research showed that relationships to customers, business partners and research are important in every stage of the innovation process but influence it in different ways. Potential

customers provide valuable feedback during the concept and product development stage but also assist in the diffusion of the innovation. Hence, enterprises are advised to include them already during the early stages of innovation processes and maintain these relationships. If missing, enterprises can initiate to meet potential customers through already established relationships to universities and other business partners. Enterprises' relationships to universities are important at the beginning of innovation processes to foster research-related developments. If missing, enterprises could develop this relationship through an incubator space such as living labs or science and technology parks. Such incubator spaces do not only offer the needed linkages to research and universities, but also provide opportunities for interfirm relationships to evolve. Ubeda, Ortiz-de-Urbina-Criado and Mora-Valentín (2019) showed that the benefits of such a location depended very much on the stage of the SME and the mix of enterprises. Yet, enterprises can always benefit from events organized in such incubator spaces even if not directly located there, e.g. the Brightlands Campus Greenport Venlo offers regular events to engage with research and business partners of the respective field.

Second, our findings suggest that enterprises need more than just financial support for e.g. conducting research in their innovation processes. Capello (2017) questions the adequacy of current EU policies on facilitating innovation and suggests to develop thematically and regionally focused innovation policies. At the same time, policy concepts are becoming rather complex due to a broad conception of innovation (Meissner, Polt, and Vonortas 2017) and open calls for funding and financial support of innovation processes often concentrate on specific themes. Hence, the political agenda has a significant impact on the main areas of research and therefore determines which innovation processes will be developed further. However, this does not mean that innovation processes that are in line with the political agenda and meet societal needs such as sustainability or climate change are also successful on the market. Governments or local institutions should (1) provide enterprises with contact to actors of their respective industries (including customers), and (2) encourage enterprises to identify the potential market and to become familiar with market structures during product development to reduce later obstacles (see also Svare 2016; Tödtling and Kaufmann 2002; D'Ambrosio et al. 2017; Aldieri et al. 2019). In the agri-food sector, many enterprises face difficulties in achieving these quite intuitive requirements, because small enterprises lack managerial skills, have limited profitability, and are more dependent on public funding. Hence it appears more important for these enterprises to study customers rationale for innovation adoption, and governance structure can facilitate this process to reach the goals of the EU Green Deal (see also Vanclay, Russell, and Kimber 2013).

Especially in cross-border regions, enterprises might need additional assistance when entering non-native markets to facilitate the diffusion of promising innovations. For example, international patent cooperation was more likely to occur when market-based regulations were similar or when market-based strategies were jointly coordinated (e.g. through agreements on taxes and tariffs) (Milani 2020). Enterprises could reduce this type of obstacles by becoming involved in e.g. formulating standards for insect production (MAR3) (see also Borges et al. 2021).

3.6 Conclusions

We investigated the influence of the innovation environment on innovation processes in agrifood enterprises in a cross-border region. Our conclusions are summarized along three lines:

First, in a cross-border region, foreign enterprises indicate that cooperation with natives facilitated the innovation processes but that such cross-border cooperation was not easy to establish. Socio-cultural differences had an impact on cross-border cooperation in both market- and research-driven innovation processes. While this factor did not impede research-related activities during concept and product development, foreign enterprises had to make an effort to develop and manage relationships with potential customers and business partners in the other country.

Second, interfirm relationships affected all stages of both market- and researchdriven innovation processes. Enterprises' relationships with universities as well as relationships with customers or business partners facilitated the innovation process. While relationships between enterprises and universities seemed to be essential for fundamental research and development of prototypes during early stages of the innovation process, relationships between enterprise and customers or business partners had a major influence on innovation adaptation for meeting market requirements and market entrance.

We also conclude from our research that enterprises working on research-driven innovation processes should include customers or other business partners early in their innovation process to meet market requirements. Enterprises working on market-driven innovation processes should develop relationships with universities as well to facilitate their research process. In market-driven innovation processes, enterprises especially benefitted from business partners and customers because they also raised the enterprises' attention to additional factors of the innovation environment such as institutional set-up and economic structure. Hence, an early indicator for innovation processes which can successfully enter a future market could be the interfirm relationships to customers.

Regarding the other areas of the conceptual framework, we only found minor infrastructural problems in the investigated enterprises, and no factors of the policy structure influenced the innovation processes. However, a lack of factors directly influencing innovation processes does not imply that the policy structure is unimportant for innovation. Most likely, the influence of the policy structure was more noticeable at the level of the entire enterprise, and not specifically associated with the specific innovation process.

Lastly, we observed a lack of public support especially during later stages of the innovation processes. Hence, it is crucial for enterprises to know who should be approached for information on foreign institutional set ups and economic structures, especially when trying to enter a foreign market. We conclude that external actors are especially important

for enterprises working in a cross-border region and cross-border cooperation can facilitate innovation processes.

We conducted an explorative study based on qualitative interviews and hence future research should look for the applicability of the results in other geographical areas, in other industry sectors, with other types of innovation, or in larger enterprises. Other research methods than face-to-face interviews such as anonymous surveys might also increase the participants' willingness to share sensitive information. Future research should also focus on how the support for enterprises working on innovation processes can be more targeted to their continuously changing needs related to research, relationships or funding – irrespective of whether innovation processes are driven by consumers, business partners or research.

Appendix A.1

No.	Question	Operationalization
1	What type of innovation?	Product, service, marketing, organizational innovation
2	At what stage of the innovation process is the innovation currently in?	 (1) Idea generation (2) concept development (3) product development (4) market entrance (testing and launch)
3	Since when are you working on the innovation process?	Year
4	What is the core aim of the innovation?	e.g. for enterprise to become more sustainable; to provide a more sustainable product
5	Is the innovation potentially interesting for markets on both sides of the border?	Yes/No
6	Did you experience any "cross-border" related problems?	Yes/No (e.g. differing institutional set-ups, economic or policy structure; availability of science and knowledge bases; accessibility (infrastructure); socio-cultural issues)
7	Do you "cooperate" across the Dutch-German border?	Employees from other country Business partners Customers Education and research institutions
8	How many employees are working in the enterprise?	Number of staff total: <9; 10–49; 50–249; >250
9	How many employees are part of the innovating team?	Number of people involved in specific innovation process
10	Since when is the enterprise operating?	Year
11	In which range is your annual turnover?	Up to 2 Mill. EUR Up to 10 Mill. EUR Up to 50 Mill. EUR More than 50 Mill. EUR
12	What is your annual investment for R&D?	EUR internal and external sources
13	How much budget is available for the specific innovation?	% of annual investment in R&D

Table 3-A1 Telephone survey for interviewee selection

Appendix A.2 Innovation histories

In this section, we provide detailed insight in market- and research-driven innovation processes. Each innovation process is described in the manner of an innovation history (Wittmayer *et al.*, 2015) where events (i.e. any influence on the innovation process) were coded as factors and present a positive or negative influence on e.g. idea generation, concept development, product development, and market entrance. The factors are related to the national and the cross-border innovation environment.

Market-driven innovation processes

MAR1: Asparagus harvesting machine

Company MAR1 is a Dutch enterprise and was founded by two brothers (one machine inventor and one asparagus farmer) to revolutionize the asparagus world with an asparagus harvester. The idea evolved in 2000 and initial tests confirmed the applicability of their approach to use sensors to detect asparagus in the soil. After this confirmation, a first patent was filed, and funding was raised. The enterprise started their business operations in 2014. All employees—with only a few exceptions—are working in research and development. As part of the funding agreement, a yearly evaluation of the innovation process takes place and the enterprise is expected to meet predefined goals.

Idea generation: All enterprise operations are focused on the development of the asparagus harvester. The harvester aims to increase resource efficiency and improve the quality of harvested asparagus through sub-surface detection of asparagus (i.e. to detect the best harvest time and decrease damages). Additionally, a harvesting machine also means independence of farmers from seasonal co-workers. The idea was initiated by one of the founders (an asparagus farmer) who complained about the absence of an asparagus harvester on the market. The other founder (the machine inventor) started to brainstorm about possible technologies and developed and tested a first radar to detect asparagus in the soil with the help of a Russian university (IFR+, SKB+). When the functioning of the radar was confirmed, a patent was filed immediately to allow the enterprise to further engage in external cooperation and publicly ask for funding (ISU+). For example, the enterprise established a relationship with Wageningen University which helped to enable funding through research projects and hence to continue working on the innovation process (SKB+, IFR+, NOL+). Especially, this access to subsidies and funding facilitated the innovation process (EXF+).

Concept development: The enterprise particularly benefitted from the relationship with Wageningen University to develop and exchange knowledge ^(SKB+, IFR+). The enterprise also started to establish a relationship with farmers and invited them to participate in the innovation process as a test group. The enterprise established two test groups (one in the

Netherlands and one in Germany), organized common discussions and allowed farmers to contribute during the machine development stage ^(IFR+).

However, in the beginning, the enterprise struggled to motivate farmers to participate in a test group because they also wanted to receive something in return for their engagement (IFR-, NOL-). When farmers agreed to be involved in the machine development, the enterprise experienced the obstacle of abstract discussions. Hence, the enterprise was forced to spend time and money to actually develop a machine-like construction out of iron (SCP-).

Product development: The enterprise maintained the relationship with the university and benefitted from access to well-trained students who could work on the innovation processes during their internships ^(IFR+). During this stage, the relationship to the press also became important to raise attention among farmers, motivate employees, and attract private investors ^(IFR+, NOL+). As the machine development progressed, the number of test group participants grew until it reached a serious representation of the market (i.e. farmers holding 5,000 hectares of white asparagus). Hence, the enterprise finally benefitted from past year's efforts spent to develop relationships with farmers ^(IFR+). Farmer test groups from both countries were regularly invited to meetings in which they received updates on the progress of the machine development and were asked for their opinion on adjustments or additional things to consider ^(IFR+, NOL+). Farmers were positively surprised by the great attention the enterprise gave to their advice and by the influence they could have on the innovation process. During these regular meetings, the enterprise already started to teach farmers how to handle the machine ^(NOL+).

During these meetings, the enterprise also experienced language problems with the test groups from abroad (GER) ^(SCP–). Although the establishment of trust in the relationships with farmer test groups and with universities was time consuming ^(SCP–, SKB–, IFR–), one of the biggest challenges was still fundraising ^(EXF–). The enterprise encountered obstacles with private investors and public funding applications. Regarding private investors, the enterprise struggled to find private investors who were seriously interested. Upon finding investors, the enterprise had to resign power and influence to the private investor ^(EXF–). Regarding the latter, the enterprise claimed that the administrative procedures were a burden because applications for funded projects were complex ^(ISU–). The enterprise claimed that only external, commercial partners could handle the bureaucracy of project applications and considered it as unacceptable that externals hired only to handle bureaucracy received 10–15% of the funding—if successfully raised ^(ISU–). Project funding was successfully raised but the enterprise from the project partners to complete project-related tasks ^(IFR–, NOL–).

Market entrance: The asparagus-harvesting machine was not launched on the market yet at the time of our study. However, the enterprise already paid attention to tasks important for and during market entrance. For example, the enterprise was aware that it was difficult to convince customers (i.e. farmers) to buy a machine because of their complex decision processes before buying a new piece of equipment. Hence, the enterprise used the ongoing exchange with their test groups to diffuse information about the machine, to increase

familiarity with the product and ultimately, to facilitate the buying decision of farmers ^(IFR+). At the same time, the enterprise was aware of the powerful positions of their customers (i.e. farmers), because farmers know each other and interact, and they know exactly what the competition is doing ^(EST-). Hence, the enterprise also expected that their powerful positions will have negative consequences on their first sales when entering the market. Through their relationships with the test groups abroad, the enterprise experienced that natives would have to learn and train people how to use the harvester and also assist in sales and maintenance of the machine ^(SCP-). However, the search for dealers willing to take such a mutual risk in sales and maintenance was difficult so far ^(IFL-, NOL-).

MAR2: Barn climate control sensors

Company MAR2 is a Dutch advising and consulting enterprise. The enterprise's core business is data analysis and development of new data management tools and not climate sensors. Consequently, the enterprise has no budget for research and development and no standard procedures to manage innovation processes.

Idea generation: Advisors observed that farmers faced fluctuating meat quality which could be traced back to the fluctuating air quality in the pig barns. Advisors wanted to address this problem and started developing sensors to measure temperature, relative humidity, CO_2 , and ammonia. The innovation aims to improve animal welfare through access to information on the barn climate and hence improve herd management (and subsequently, meat quality). Hence, the innovation process was indirectly initiated by farmers. Close cooperation with a software developer helped to progress with the idea ^(IFR+).

Concept development: The progress of the innovation process was characterized by switching "back and forth" between the stages concept development and product development. The enterprise continuously developed new measurement concepts, applied the according changes to the sensor and tested them in real life situations. The enterprise held sufficient internal scientific knowledge to develop the first sensors. Hence, the enterprise developed a relationship with farmers as a customer test group to observe the practical application of the sensors in the barn ^(IFR+). The enterprise also established a relationship with Wageningen University and could obtain well-trained students to collect measurement data of the sensors in the barns. Hence, this relationship also positively influenced the progress of the innovation process ^(SKB+, IFR+). Furthermore, the enterprise contacted climate experts to interpret these measurement results ^(IFR+).

Product development: The enterprise also integrated the test group to further develop the sensors ^(NOL+, IFR+). Besides testing the applicability of the sensors, round tables were organized to discuss which information was needed and consequently which parameters should be measured by the sensors. These round tables were first organized only among Dutch farmers and later among German farmers. Through the relationship to the test groups, the enterprise established contacts to additional farmers and to companies of the feed and meat processing industry. Those companies recognized the main advantage of the sensor

technology in its additional measuring possibilities and became a new target group. Hence, the incorporation and mutual engagement of customers (i.e. farmers and other companies) had a facilitating effect on improving the sensors and consequently becoming ready to enter the market (IFR+, NOL+).

The enterprise experienced no difference between the Dutch and the German test groups because similar questions were raised by farmers in both countries. However, the enterprise was confronted with an infrastructural difference of the countries to connect the sensors with the internet. Hence, the product had to be adapted for the German market and was therefore slightly more expensive ^(ACC-).

Market entrance: During the market entrance, the press and media helped to raise attention for the innovation ^(IFR+, NOL+). The enterprise valued the mutual exchange within their network which include German partners such as the agricultural chamber of North Rhine-Westphalia (LWK NRW) and Interest Group Cross-Border Integrated Quality Assurance (GIQS) ^(IFR+, NOL+). When the product was already on the market, the enterprise could rely on the same climate experts to engage with farmers directly and to exchange their knowledge about the implications of their barn climate results ^(IFR+, NOL+). The enterprise positively valued that the product entered the market quickly and thereafter was continuously adopted through customer feedback. However, the enterprise also noticed that the product was only valued if something did not go as it should and was aware that farmers might question the relevance of having the sensors in case everything goes well in their barns. Hence, the enterprise experienced that, instead of farmers, companies of feed and food-processing industries became their main target group. Slaughterhouses and similar companies along the supply chain could promote the sensors among farmers as a first meat quality control instrument and hence help in marketing and diffusion of the innovation ^(IFR+).

The enterprise faced several challenges during the market entrance. First, the enterprise was confronted with a small language obstacle which influenced the marketing of the product: The original product name in Dutch "slimme stal" (in English: smart barn) could be confused with the German "Schlimmer Stall" (in English: bad barn) ^(SCP-). Second, the price of sensors measuring air quality was rather high, but the enterprise expected the price of sensors to decrease in the next years. Third, the enterprise was confronted with questions concerning data security and privacy issues before entering the market ^(ISU-). Fourth, the enterprise knew that the German market was potentially interesting because it was not far away. However, the enterprise was also aware that in the German market the cooperation with German partners will be necessary to distribute the innovation ^(SCP-, IRF-), but the establishment of contacts to German partners remained difficult and time consuming ^(NOL-).

Although the enterprise introduced the innovation to the market, the enterprise's core business is data analysis and further market growth can only be achieved if technical aspects, e.g. maintenance, can be handed over to another party.

MAR3: Insect based reptile feed

Company MAR3 is a Dutch enterprise active in the insect sector. The enterprise's business activities include consultancy for farmers, organization of seminars for insect rearing and processing, and the development of insect products. About 80% of their annual turnover is spent on insect research and the development of insect products.

Idea generation: The enterprise observed the problem among reptile keepers to have living insects in the refrigerator as feed for their reptiles ^(IFR+). Hence, the enterprise started to develop a non-refrigerated alternative to current reptile feed. Before seriously perusing the idea, the enterprise consulted nutritionists and other experts.

Concept development: The enterprise completed tasks of the concept development parallel to and in interchange with product development and testing among reptile owners. The enterprise participated in a research project funded by Interreg and this external funding helped the enterprise to progress faster in this innovation process ^(EXF+). Through a past research project, the enterprise had already developed internal knowledge which was useful for the current innovation process. Through the same foregone project, the enterprise had already established a network comprising the HAS University of Applied Sciences, insect farmers and reptile owners which could be accessed and which proved helpful during the concept and product development ^(SKB+, IFR+, NOL+).

Product development: The enterprise benefitted from the physical proximity to the close-by HAS University of Applied Sciences ^(ACC+) and hence from the relationship to this university because well-trained students could work in the innovation process during their internships ^(SKB+, IFR+). Generally, the location of the enterprise seemed well chosen because the logistics to insect farmers were not a problem ^(ACC+). However, the enterprise experienced some obstacles during the innovation process because the supply chain could not deliver the requested quality of insects ^(EST-). The enterprise considered administrative procedures a burden in the progress of the innovation process, e.g. the time-consuming certification as a pet feed producer ^(ISU-).

Market entrance: The insect sector in the Netherlands is a rather new industry sector lacking rearing and transport regulation. Through prior established contacts, the enterprise could be involved in the drafting of new standards for the insect sector (e.g. live insect transports) in the Netherlands ^(ISU+, IFR+). This helped to overcome uncertainties faced by the enterprise during their prior business operations with insects ^(ISU+). Finally, the enterprise also accomplished all administrative procedures and received the accreditation as pet feed producer which allowed them to sell the test feeds on the market ^(ISU+). The product first entered the market online. The enterprise adapted the product according to customers' feedback ^(IFR+) and funding from the Interreg project helped the enterprise to quickly develop the improved version 2.0 ^(SKB+, EXF+). However, the enterprise had doubts whether the fast market entrance via online distribution channels was the right choice, but ultimately considered being on the market fast as beneficial and believed that visibility was more important than feasibility ^(EST+).

A lack of knowledge about the native and foreign market first impeded the launch of the innovation. Especially in foreign markets, the enterprise felt restricted to not even know who to approach to gain insights into customer's requests and buying behavior in this very special market niche, for example, on the package design ^(EST-). Hence, the enterprise decided that natives must undertake training of farmers and extension workers to develop an insect supply chain in Germany and the marketing of the final product ^(SCP-).

MAR4: Struvite Fertilizer

Company MAR4 is originally a Dutch family run enterprise with currently one location in the Netherlands and four locations in Germany. The enterprise is specialized in developing material and waste management concepts and is trading with products of the agricultural sector for many years. The enterprise does not hold a department with explicit focus on innovation, but has procedures established to handle customer requests. The enterprise takes approximately six months to decide whether to proceed with further development of an idea.

Idea generation: The idea was initiated by customers who forwarded requests to the sales department ("Vertrieb") ^(IFR+) to develop a fertilizer from by-products and residual waste streams. Hence, the innovation process focuses on the development of a specific fertilizer, i.e. Struvite, to increase resource efficiency through upcycling of waste for fertilizer production. Struvite is a phosphate mineral which can be extracted by recycling waste streams and can be used as a substitute for phosphate fertilizers in arable farming. A main challenge was the synthetic extraction of the mineral but also the specific texture required for soil application and finally to sell it as a fertilizer on the market.

Concept development: The enterprise held a small research and development department (two researchers), but still provided sufficient internal sources of scientific knowledge to start the development. The enterprise's sales department established contact to customers (i.e. farmers) to elaborate together on potential solutions for using residuals for fertilizer production ^(IFR+). Simultaneously, the enterprise created an internal team of purposefully selected two to three persons to evaluate the feasibility (economic, scientific and judicial) of the idea and to decide whether the idea should be further advanced ^(IFR+).

Product development: Upon a positive evaluation of the idea's feasibility, the internal researchers started with laboratory experiments and the enterprise hired one additional person (university student) ^(SKB+). Besides the available internal knowledge, universities became important partners and the innovation process was further facilitated through access to their laboratories ^(SKB+, IFR+). The enterprise assessed the marketability of the product while the innovation was continuously adapted through a constant exchange with customers through the sales department ^(IFR+).

Market entrance: A field trial was established in Germany but a lack of linkages to Dutch farmers inhibited product testing in the Netherlands ^(IFR-). The enterprise observed concerns among customers, regarding the effectiveness of the new "recycled" fertilizer compared to traditional water-soluble phosphorus. The enterprise could not address this
concern through solely providing information but still aimed to solve customers' concerns before launching the fertilizer on the market ^(IFR-). Hence, the enterprise planned to organize on-farm trials with a follow up survey to observe whether customer concerns decreased after testing.

Innovation processes initiated by research

RES1 Plasma technology for odour control

Company RES1 is a Dutch enterprise located in an innovation hub, the Brightlands Campus Greenport Venlo. The enterprise operates within a technology-oriented (High Tech, Water and Chemistry) and food-oriented industry (Agri & Food and Horticulture). The enterprise's core business is different applications of plasma technology, with several research teams working on different applications (two to three people work on the innovation process described below).

Idea generation: The idea was developed at the Technical University (TU) Eindhoven, The Netherlands. The innovation process concerns the application of cold plasma technology to decrease odor emissions from livestock stables (and to help farmers meet regulatory standards). The enterprise first started to test several different applications of plasma technology based on scientific presentations, among them odor control. The enterprise could access these presentations through their relationship with the TU Eindhoven (SKB+, IFR+).

Concept development: The enterprise held internal scientific knowledge to start the development but the mutual exchange of knowledge with external departments such as the TU Eindhoven positively contributed to the innovation process. For example, through the relationship with the TU Eindhoven, well-trained people were attracted to work in the enterprise and on the innovation process (SKB+, IFR+, NOL+). Besides the relationship with the university, the enterprise also initiated a cooperation with farmers and the pig industry in Germany and the Netherlands. This cooperation was established to test the principles of using plasma technology for odor control (IFR+, NOL+). The enterprise was also part of a research project funded by Interreg and experienced working within the project as positive because the project coordinators and other project partners were looking for opportunities to progress in the innovation processes and hence tried to eliminate eventual difficulties (SKB+, IFR+, NOL+). Through participating in this research project, the enterprise identified additional potential applications of the plasma technology which also provided more chances for the innovation to enter the market (SKB+). The enterprise also benefitted from the location in the innovation hub Greenport Venlo which served as an incubator especially in the concept development phase (ACC+). Greenport Venlo is located only a few kilometers from the German border. The enterprise recognized that there were certain things in which Dutch differed from German culture. But the enterprise shared the opinion that especially in research projects focusing on innovation the working culture of different countries was quite similar and working together

offered a huge value for them ^(SCP+, NOL+). The enterprise started to value cultural habits such as the German checklist before proceeding ^(SCP+) and the enterprise acknowledged that cultural differences between the Netherlands and Germany were not challenging in practice if being located as close to the border as they were in Venlo ^(SCP+). Hence, the enterprise only experienced a little language barrier ^(SCP-).

Product development: The enterprise established a relationship with business partners, also across the border, and started 'co-developing' different product applications ^(IFR+, NOL+). However, by the time the interview was conducted, the innovation process did not pass the concept development and basic product development stage. Nevertheless, the enterprise already thought of a marketing strategy at this stage and tended to enter the market in their native country first. The enterprise considered a market entrance in the neighboring country as not too difficult if the innovation was established and positively evaluated in the native country ^(SCP+). So far, the enterprise experienced good support of local authorities ^(ISU+). However, the enterprise expected to be confronted with problems regarding current regulations once the innovation will be fully developed and ready to enter the market ^(ISU-). The enterprise shared the opinion that regulations will move quicker and a solution will be found sooner in the Dutch part of the border region and that the same procedure might take longer in Germany ^(ISU-).

Market entrance: N/A (not reached yet)

RES2/RES3/RES5: Surface texture technology

Three enterprises were involved in this innovation process: company RES2, RES3, and RES5. Company RES2 is an enterprise with locations in Germany, the Netherlands, and France³. The enterprise operates within the IT sector and develops software platforms to secure and monitor supply chains. Company RES3 is located in Germany. The enterprise offers laboratory analyses, quality management consultancy, audits, and seminars and trainings. Company RES5 is an international enterprise with locations all over the world – among these The Netherlands. The enterprise provides supplies (software, machinery, systems and solutions) for meat processing industries.

Idea generation: The University of Bonn and the Bonn-Rhein-Sieg University of Applied Sciences initiated the idea ^(SKB+, IFR+). The innovation process aims to improve food safety by analyzing the surface texture of fresh meat (meat pieces; pork and poultry). The technology is interesting for industrial companies in the meat sector e.g. to detect microorganisms in incoming goods. The innovation process would not have been pursued without the collaboration between the two universities (RES2, RES3) ^(SKB+) and the access to subsidies and funding through a research project funded by Interreg (RES3) ^(EXF+). In the research project, the universities collaborated with all three enterprises. The development of

³ The interviewee was located in Germany.

the project application was challenging because the enterprises had different interests which made the conception of tasks difficult (RES3, RES5). However, the enterprises started to advance the idea to use spectroscopic measurements for developing surface texture technology together with the universities.

Concept development: Each of the three enterprises held internal scientific knowledge. After the challenging project application phase, sharing know-how between the partners was luckily no problem and new common knowledge was developed through mutual exchange with the universities (RES5) (NOL+, SKB+). One enterprise appreciated that some of the partners already knew each other before the research project started which resulted in a good working atmosphere and a good personal relationship (RES2) (IFR+). One enterprise was based in both countries (Germany and The Netherlands) and was familiar with both languages and cultures which facilitated the establishment of good quality relationships (SCP+). However, the enterprise experienced an obstacle concerning the management between the project partners because the research and development workflow depended on each partners' adherence to due dates (IFR-). Different tasks were interdependent and consequently additional management was required to coordinate the innovation process between partners (RES2) (SKB-, IFR-). Furthermore, one enterprise had concerns to generally trust in people's effort during any kind of project work, because people usually have different agendas besides their project related tasks and past experiences thought them that the larger the group, the slower the progress (RES5) (SCP-). These management related obstacles also persisted during the product development stage.

Product development: The enterprises benefitted from easier cross-border resource mobilization through the research project (RES2) ^(NOL+). For example, the network of partners also across the border (the connection of the University of Bonn (GER) with Wageningen University (NL)) facilitated the progress of the innovation process (RES2) ^(SKB+, IFR+). One enterprise shared the opinion that Dutch universities focused more on fundamental research and thereby lacked a connection with industry, while the valorization of research in German universities of both countries facilitated this innovation process. Besides the different agendas of project partners (RES2, RES5), one (Dutch) industry partner considered the German invention act as a limiting factor for enterprises to engage with university (RES5) ^(SKB-).

Market entrance: By the time this research was conducted, the innovation process did not enter the market yet and the concrete application was not foreseeable. However, a crucial step to assure market success for the enterprise was to conduct an initial economic evaluation of the innovation. Although considered crucial, the same enterprise considered it difficult to judge up front the technological and marketing perspectives of an idea (RES5). A connection with people who have insights into their respective industries of their respective countries was considered highly valuable to enter the market because development for the purpose of development is not working in a business world – regardless how much money is spent (RES5) (EST+, IFR+).

RES4: Hydrothermal carbonization

Company RES4 is a German micro-enterprise consisting of only two researchers. The enterprise operates in the field of waste management and decentralized energy supply. Their core business is engineering, commissioning and maintaining their innovative machine for hydrothermal carbonization but also the consultancy for customers during approval procedures for the machine.

Idea generation: The idea was based on scientific knowledge of the Max Planck Institute Potsdam, Germany ^(SKB+). Hence, a group of university members and business people interested in the concept of hydrothermal carbonization met and started brainstorming together on possible applications. Among this group was the later founder of company RES4 ^(SKB+, IFR+) who saw a promising application of hydrothermal carbonization to increase resource efficiency in waste recovery systems. Through hydrothermal carbonization, storable energy sources and marketable fertilizers can be produced from biomass.

Concept development & Product development: The enterprise completed tasks of concept development parallel to product development because continuous adaptation was necessary. The concept and product development were conducted in small teams with researchers from universities without any obstacles ^(SKB+, IFR+).

Market entrance: Obstacles became obvious when the machine was ready to enter the market. First, the machine was (and still is) not self-explanatory and hence makes marketing difficult. Additionally, the high price was also a limiting factor for potential customers. The enterprise was confronted with obstacles regarding regulatory standards ^(ISU-). Based on their experience, the enterprise felt that the decision of an authority to grant a permit and hence to allow accessing a market also depended on the person in charge at the authority: Skepticism vs. Openness for new ideas ^(SCP-). For example, the enterprise faced the "hen-egg" problem in Germany: Because the machine did not exist before, the responsible authority could not approve it ^(ISU-). After all, the enterprise decided to relocate the first test machine from Germany to Switzerland where the regulations for processing of biomass were different and hence the market introduction possible ^(ISU-).

Another obstacle was (and still is) that Germany currently has a centralized energy supply system, while this innovation offered a decentralized solution. The enterprise experienced that local communities only invest in renewable energy technology if they were forced by regulations. For example, the subsidies for renewable energies in Germany were way less than in Switzerland, hence making the machine more attractive in Switzerland ^(ISU-, PST-). Hence, wider system changes and rethinking processes of the current system are necessary to allow the machine to exist on the market. So far, neither the enterprise nor the waste management lobby were successful in initiating the necessary rethinking processes on a local or regional level (the enterprise lacked in power compared to the "Braunkohleförderungslobby"). The enterprise expected that a wider system change is also unlikely to occur in the near future because there is no urgent need, such as lacking energy resources, to force technological change.



Chapter 4:

Do current innovation support services meet the needs of stakeholders in a cross-border region?

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Abstract: Agri-food innovations are necessary to increase resource efficiency and sustainability. An innovation support service (ISS) can benefit enterprises but the provision and access to it can be restricted across national borders, preventing such regions from reaching their economic potential. We aim to investigate how ISSs are provided and used in a cross-border region and to explore stakeholders' perceptions on their limitations and opportunities. We conducted a case study in the Dutch-German cross-border region Euregio Rhine-Waal; a content analysis of websites informed stakeholder interviews. Our results show that the provision of ISSs was limited by differing structures and national priorities. Stakeholders perceived restrictions due to unfamiliarity with responsible authorities, the large administrative effort, and uncertainty about pay-offs. This is the first study to explore the limitations and potentials of ISSs in a cross-border region. Our findings can inform policymaking for cross-border regional development and we provide recommendations on how to improve ISS systems in crossborder regions. Our research contributes to the literature of extension and advisory systems by investigating how advisory systems operate across borders.

Keywords: innovation support service, cross-border region, innovation process, enterprise, agri-food sector, internationalization

4.1 Introduction

The European Union (including Norway, Switzerland and Liechtenstein) has a total of forty internal borders (European Commission 2017a). Despite the implementation of European Cohesion Policies to strengthen cross-border regional integration since 1986/88 (European Commission 2008; Manzella and Mendez 2009), the economic potential in border regions remains underdeveloped (Camagni, Capello, and Caragliu 2019). Several factors influence cross-border regional integration, including differing national interests and strategies regarding economic and institutional structure, knowledge infrastructures, and socio-cultural factors (Lundquist and Trippl 2013).

Innovation is crucial for improving competitiveness and resource efficiency and decreasing negative environmental impacts (European Commission 2019a) in the agri-food system. Economic development in cross-border regions can be achieved through fostering innovation in small- and medium-sized enterprises (SMEs). Cross-border regions are often characterized as rural areas where agriculture is an important economic activity. Next to agricultural primary production where farms can also be considered a sort of SME (Klerkx and Leeuwis 2008; Phillipson et al. 2004), SMEs in these regions tend to also operate in the broader agri-food system, including food and feed processing, fertilizer production, waste management, or logistics. However, SMEs in particular often lack the resources and capacities to innovate (Nooteboom 1994; Narula 2004), and this has also been noted for agrifood (e.g. Klerkx and Leeuwis 2008). For example, cooperation is important for innovation development, but prior research showed that SMEs struggle to develop strong networks even in a national context (Tödtling and Kaufmann 2002), which implies additional barriers arise in a cross-border context (Neuberger et al. 2021). Based on earlier studies of Knockaert, Vandenbroucke, and Huvghe (2013), Faure et al. (2019), and van den Broek, Benneworth, and Rutten (2019), we argue that SMEs have different needs to develop their business in cross-border regions and to establish cross-border networks, compared to national operating SMEs. Hence, in cross-border regions, SMEs could benefit from the use of innovation support services (ISSs): national ISSs which operate across the border or dedicated crossborder ISSs.

ISSs constitute the extension or also called the advisory system within the Agricultural Knowledge and Innovation System (AKIS), and can be seen in different ways and fulfill different roles. They can provide subject matter expertise themselves (e.g. agronomists) but can also focus on matching information and resource supply with farmer demand (e.g. making sure the farmer finds the right agronomist) (Kilelu, Klerkx, and Leeuwis 2014; Klerkx and Leeuwis 2008), also referred to as 'intermediation' (Koutsouris 2014). ISS embed different functions: (1) knowledge brokering, (2) network building, (3) institutional support, (4) innovation process monitoring, (5) capacity building, (6) demand articulation,

and (7) access to resources⁴ (Kilelu et al. 2011; Faure et al. 2019; Mathé et al. 2016). ISSs can be funded privately or publicly, and provided by private advisors, public extension agents, companies, or researchers (Kilelu, Klerkx, and Leeuwis 2014; Birner et al. 2009; Christoplos 2010; Klerkx and Leeuwis 2008; Parkinson 2009; Swanson and Rajalahti 2010). In addition to farmers, enterprises within the agri-food sector also demand ISSs. Prior research shows that access to ISSs increases the likelihood of success for start-ups (Kee and Rahman 2017; Kee, Yusoff, and Khin 2019), helps enterprises to become market-oriented (Berdegué Sacristán 2001; Kaganzi et al. 2009), has a positive impact on innovation adoption (Rosa et al. 2020), and generally supports co-innovation (Klerkx et al. 2017b). Unlike most farmers who are connected to a particular territory, other agri-food enterprises also operate internationally. Agri-food enterprises can benefit from ISSs in multiple countries, for example at both sides of the border.

ISS systems exist in different forms in different countries (e.g. Knierim et al. 2017: Christoplos 2010; Rivera and Sulaiman 2009; Faure et al. 2019). Even within the same country, ISSs are fragmented as (sometimes competing) service providers can exist which can make it complicated for enterprises to access the right ISS providers and make optimal use of the diversity (Faure et al. 2019: Knierim et al. 2017: Prager, Creaney, and Lorenzo-Arribas 2017; Garforth et al. 2003). It is likely that this complexity increases in a cross-border setting due to difference between countries. In this regard, previous research showed that ISSs cannot be easily transferred from one country to another without adjustments (Klerkx and Guimón 2017; Klerkx et al. 2017b; Berdegué Sacristán 2001), due to differences in setup of national AKIS in terms of institutional frameworks, 'cultures' of innovating and collaborating, attitudes of ISS in terms of using linear or interactive approaches, and context specific knowledge. For example, Peiker et al. (2012) showed that regulations, cultures and institutional contexts of foreign countries impact service providers in the law sector differently compared to those in the engineering sector. The authors demonstrated that the normative knowledge of law service providers is closely linked to the national context of a country and difficult to transfer to other countries, while technical knowledge from engineering services can be transferred more easily. Hence, ISSs are context specific and some can only be partially adapted to the setting of another country, such as in cross-border regions. Nonetheless, ISS are not bound to national borders as advisors have started to operate internationally (Klerkx 2020). It is still unclear how ISS functions in cross-border settings

⁴ Knowledge brokering consists of dissemination and communication of knowledge and technology. Network building includes matchmaking and gate keeping. Institutional support comprises boundary work (linking science, policy, and practice) and facilitating institutional change (changes in rules/regulations, working on attitudes and practice). Innovation process monitoring involves mediating relationships, aligning agendas, building trust, and sharing complementary assets. Capacity building covers organizational development, training, and competence building. Demand articulation focuses on scanning and foresight diagnosis (Kilelu et al. 2011). Access to resources covers activities to ease and support the availability of resources (Faure et al. 2019).

are shaped, what affects their performance, and how their provision and use are matched, and calls have been made to unravel how international ISS systems operate across nations and what specific adaptations are required (Klerkx 2020; Klerkx et al. 2017a). To the best of our knowledge, insights are missing on how a (mis)match in the provision and the use of ISSs affects agri-food SMEs in cross-border regions. As Faure et al. (2019) indicate, studying the relationship between the provider (e.g. private advisors, public extension agents, companies, or researchers) and the user (e.g. enterprise, farmer) of ISS functions is central for a better understanding of how the system works, e.g. which activities take place.

This research aims to investigate how ISS are provided and used in a cross-border region and to explore stakeholders' perception on their limitations and opportunities. The results contribute to advisory systems literature by investigating the element of internationalization, i.e. how advisory service operate across borders (as suggested in Klerkx 2020) and contributes to the cross-border literature by adding empirical insights through exploring the factors that enable and limit ISS provision and use in the Dutch-German cross-border region Euregio Rhine-Waal. We first present the conceptual approach underlying this research, followed by the case study region and the two research phases.

4.2 Conceptual framework

The field distinguishes two ways of defining and studying ISS functions. One approach takes the perspective of the provider, namely organisations that either provide subject-matter oriented advisory services (e.g. knowledge, advice) or match the actors seeking advice or funding with those who can provide it (e.g. brokers) (Kilelu, Klerkx, and Leeuwis 2014; Klerkx and Leeuwis 2008). A second approach takes the perspective of the activity, where the relationship between provider (e.g. private advisors, public extension agents, companies, or researchers) and user (e.g. enterprise, farmer) is central (Faure et al. 2019). In this study, we explore **ISSs from an activity perspective** because we are interested in what influences the activities connected with the provision and use of ISS functions in a cross-border region, with the aim of unravelling limitations and opportunities of the cross-border ISS system.

Compared to a national context, different levels of cross-border regional integration cause specific challenges for ISS systems in a cross-border region, all of which influence the relationship between providers and users. Weakly integrated cross-border regions are characterized by major differences in science and knowledge infrastructure, economic structure, policy structure, institutional set-up, the nature of the linkages and accessibility (Lundquist and Trippl 2013). In strongly integrated regions, these aspects are more homogeneous. It is worth mentioning that neither too much nor too little integration is favorable for innovation (Boschma 2005). We argue that the functions of ISSs in a cross-border setting are similar to a national advisory system and should focus on possibilities for knowledge exchange and research, information regarding availability of financing, networking opportunities, legal advice (including patents), market structures, development of business strategies and advanced training (based on (Kilelu et al. 2011; Galanakis 2006;

Lundquist and Trippl 2013). However, the *activities* of providing and using these ISS functions which are designed for or have evolved from a national context might be less appropriate in a cross-border setting.

Based on the reviewed literature, we identified factors that potentially affect the provision and use of ISS functions in cross-border regions. Table 4-1 presents an overview of aspects defining the level of cross-border regional integration, an overview of the ISS functions and of the factors which can influence ISS activities in a cross-border setting.

Aspects defining the level of	pects defining the level of ISS functions ^{1,2,3} Factors that influence ISS activi		
cross-border regional		in a cross-border setting	
integration ¹			
- Nature of linkages	- Knowledge exchange and	- Differing opportunity to establish	
- Accessibility	research	networks ^{4,5}	
- Socio-cultural proximity	- Financing	- Differing opportunity to cooperate	
- Science & knowledge base	- Networking opportunities	with universities ⁶	
infrastructure	- Legal advice (including	- Differing opportunities to access	
- Institutional set-up	patents)	(project) funding ^{6,7}	
- Economic structure	- Market structures	- Legal tension ⁶	
- Policy structures	- Business strategy	- Long term planning of cross-border	
	development	region development ⁸	
	- Advanced training	- Coordination of business strategies9	
		- Coordination costs ⁷	
		- Openness and willingness to engage	
		in cross-border cooperation ⁶	

Table 4-1 Conceptual approach for investigating provision and use of ISS in cross-border regions

¹ Lundquist and Trippl 2013; ² Kilelu, Klerkx, and Leeuwis 2014; ³ Galanakis 2006; ⁴ Tödtling and Kaufmann 2002; ⁵ Dashti and Schwartz 2018; ⁶ van den Broek, Benneworth, and Rutten 2019 ⁷ D'Ambrosio et al. 2017; ⁸ Szmigiel-Rawska 2016; ⁹ Milani 2020

ISS regional integration is influenced by accessibility, the nature of linkages, and socio-cultural proximity. Activities concerning the ISS function networking opportunities are affected by the cross-border setting because there generally are fewer business relationships and networks with stakeholders from the bordering country (Tödtling and Kaufmann 2002). Jørgensen (2014) proposed that SMEs lack motivation for cross-border interaction, but Makkonen and Leick (2019) could not confirm this finding. SMEs are also confronted with increased costs for coordinating networks in cross-border settings (D'Ambrosio et al. 2017), although involving foreign stakeholders could help enterprises in boosting their innovation activities (Dashti and Schwartz 2018). Universities often act as bridge builders for enterprise interaction in cross-border region networks (van den Broek, Benneworth, and Rutten 2019).

The level of ISS integration in the aspects of knowledge infrastructure, institutional set up, economic and policy structure also affects the cost; i.e. the less integrated, the higher the costs. The design of ISS financing, and knowledge exchange and research can influence

how easily SMEs can participate in research projects and access funding across the border (van den Broek, Benneworth, and Rutten 2019). Information access, training, and education are typical costs for learning in national innovation systems (Lundvall 2010). Accessing information across the border could increase costs, similar to higher coordination costs in cross-border regions (D'Ambrosio et al. 2017). A cross-border context also affects the extent to which SMEs have to adapt their business strategies in cross-border regions compared to national contexts (Milani 2020). Kurowska-Pysz (2016) showed that most companies treat all foreign markets the same, whether just across the border or further away. Hence, SMEs in a cross-border region demand ISSs specifically designed for the context of the neighboring country.

Another factor influencing ISS activities in cross-border regions is the availability of long-term coordination (Szmigiel-Rawska 2016). The European Regional Development Fund (ERDF) finances long-term cross-border regional integration with its Interreg program. Interreg can offer several ISS functions: i.e. funding, networking opportunities, introduction of the cross-border market structure, and familiarization with different cultures. However, the impact of Interreg for firms is not always obvious. While clear positive effects of Interreg funds for cross-border cooperation were observed in culture, education, sports, and tourism, an economic positive effect was less clearly observed (Kurowska-Pysz 2016).

4.3 Methods: Case study

4.3.1 Region

We conducted a case study in the Dutch-German cross-border region Euregio Rhine-Waal. The region covers the German areas of Kleve, Wesel, Duisburg, and Dusseldorf and the Dutch areas of Achterhoek, Gelderland, the northeast of Noord-Brabant, and Noord-Limburg. It is a predominantly rural cross-border region with urban centres close by. The agri-food sector is economically important in this region, with intensive animal husbandry, horticulture, and food processing industry (Landwirtschaftskammer Nordrhein-Westfalen 2021). The history of cross-border interaction in the region officially dates back to 1963. In 1993, the first cross-border public-law special administrative unit in Europe (in German "grenzüberschreitende, öffentlich-rechtliche Zweckverband in Europa") was founded in the region. This administrative unit aims to improve and intensify economic and social cross-border cooperation (Euregio Rhine-Waal 2021). Currently, the Euregio Rhine-Waal is among the most innovative regions in Europe (European Commission 2019b).

4.3.2 Content analysis of websites providing ISSs

First, we conducted a content analysis of websites to become familiar with the ISS functions provided in the region. This first phase of the research helped to design the interview questions. We identified the websites for the content analysis through a Google search with

prior defined search strings (Table 4-A1 in the Appendix). After excluding doubles, newspaper articles, and outdated programs, we arrived at our sample of 14 Dutch and 20 German websites providing ISSs. The websites were analysed through a pre-defined coding tree focusing on the ISS functions (Kilelu et al. 2011; Faure et al. 2019).

Often one website provided information about several ISS functions (Table 4-2). We found that only the Euregio Rhine-Waal with its Interreg program explicitly offers ISS functions tailored to enterprises on both sides of the border. All other ISS providers appeared to target only national enterprises. An indication was that the websites were mainly provided in the country's native language and rarely in the language of the neighboring country or English (German websites: 4/20 in Dutch, Dutch websites: 0/14 in German; German websites: 7/20 in English, Dutch websites: 9/14 in English).

ISS functions	German websites (n=20)	Dutch websites (n=14)
Knowledge exchange & research	9	8
Financing	17	12
Networking opportunities	16	12
Legal advice (incl. patents)	9	6
Market structure	7	8
Business strategy development	16	7
Advanced training	11	7

Table 4-2 Number of websites offering specific ISS functions

4.3.3 Interviews

Next, we conducted 19 semi-structured interviews⁵ with stakeholders in the Euregio Rhine-Waal: ten interviewees located on the Dutch side of the border and nine in Germany⁶ (Table 4-A2 in the Appendix). We interviewed four stakeholders from academic institutions and nine local and regional experts (including government institutions) about their role in supporting innovation and experiences with the provision and use of ISSs across the border. Additionally, six agri-food entrepreneurs were asked about their experience with available ISSs and how they could be improved. The interviews were conducted in English or German – depending on the interviewes' preferences. We recorded the interviews, collected informed consent and transcribed all interviews. We followed Stebbins' (2001) approach for exploratory research techniques and combined deductive and inductive coding⁷ to explore how ISSs are provided and used and to identify limitations and opportunities in the cross-

⁵ The Social Sciences Ethics Committee of Wageningen University & Research approved the study (CoC Number 09215846).

⁶ Another study was carried out with the same stakeholders but with a different research focus: the role of innovation brokers and academic institutions in fostering hybridization in cross-border cooperation (Knickel et al. 2021).

⁷ Deductive coding was applied to identifying ISS functions; inductive coding was used to explore the crossborder-related factors.

border region.

We handled data validity by triangulating different data sources. Information from the websites of ISS providers was compared with the interview data of local and regional (government) experts. We conducted interviews with stakeholders of similar institutions in Germany and the Netherlands to increase external validity by comparing their perspectives on either side of the border. We elaborated case study protocols prior to starting the research, followed these during research and documented all interviews.

4.4 Results

In this section, we show how ISS functions are provided and used in a cross-border region and how stakeholders perceive limitations and opportunities of ISS activities. It is worth mentioning that the Interreg program appeared to be the only provider of ISS functions across the border. We refer to the respondents who provided the information in brackets (i.e. R1, R3). The results are structured according to provision or use and divided into factors limiting ISS activities and factors which offer opportunities for ISS activities across the border (see also Table 4-3).

	Limitations	Opportunities
Provision of ISS	Differing prioritization of governments	Promotion of established structures
	- National interests: provision for national	- Matchmaking: Euregio office, cross-
	enterprises	border business club, incubator spaces
		- Interreg program
	Differing structures of	
	- Legal systems	Differing opportunities to access
	- Institutional authorities	financing
	- Academic institutions	- Cross-border cooperation between
		banks
		Coordination of business strategies
		 Business evaluation tool *
Use of ISS	Differing prioritization in business operations	Promotion of
	- Lack of time and resources: lack or low	 Available expert knowledge
	awareness of available assistance in accessing appropriate ISS	- Cultural awareness
	Uncertainty about	
	- Cooperation outcome: lack of clear benefits	
	- Administrative effort: lack of immediate	
	clear results	

Table 4-3 Overview of perceived limitations and opportunities of ISS in the Dutch-German cross-border region

* https://internationalisierungsscan.eu/

4.4.1 Provision of ISS functions in a cross-border setting: Limitations and opportunities

A limitation of ISS **provision** concerns the **different prioritization patterns** of countries and regions, for instance national governments tend to focus on national interests and support national enterprises (R3, R15). Hence, differing national interests of bordering countries compete and make it difficult to agree on a cross-border focus (R15). As a result, ISS functions mainly target the national context, for example tax benefits for start-ups and SMEs on the Dutch side (R7). Another example of different national prioritization is the relative importance of the agricultural sector in Germany versus the Netherlands. While in the Netherlands, innovation hubs such as Food Valley and Greenports were founded, something comparable is missing in Germany.

Differing institutional structures is another limitation that influences several aspects of the ISS **provision side**. Respondents mentioned that differing legal systems (R3, R15), institutional authorities and connections to academic institutions influence the appropriate supply of ISS functions. In Germany and in the Netherlands, several institutions support SMEs with advanced training and developing business strategies. Over time, these institutions reorganize and change within the country, which might in turn result in difficulties for SMEs to access ISSs. For example, while in Germany SMEs can currently contact the "Industrie- und Handelskammer" (i.e. chamber of industry and commerce) for

training and business strategy development, its Dutch counterpart, the "Kamer van Koophandel" no longer covers this function (R17). Another limitation concerns differing structures of academic institutions which directly affect opportunities for knowledge exchange and research. For example, a greater division was observed between the three stakeholder groups academic institutions, businesses, and local/regional government institutions in Germany (R2). Some respondents believed this has led to academic research being detached from the market (R4). In contrast, in the Netherlands, the different stakeholder groups seemed to be more closely connected to research (R2), forming an innovation ecosystem (R3). Because of these differences, our sample of entrepreneurs in Germany approached universities only if they are "stuck" with a certain issue (R1) or have no resources available to develop a solution internally (R18). At the same time in the Netherlands, agrifood enterprises are used to working with universities and rent space (R10) or equipment (R8) from universities. These differing structures limit activities related to cross-border knowledge exchange because universities engage with enterprises in different ways.

An opportunity to access ISS functions in the whole cross-border region is the presence of established cross-border structures which can be promoted and extended by the **provider**. Respondents suggested drawing SMEs' attention to already available matchmaking organizations such as the Euregio office (R11), the cross-border business club (R2), or specialized innovation spaces, such as the Dutch incubator food valley (R2, R8, R10). The Interreg program also represents an established structure which provides not only funding to Interreg cross-border projects but also contacts (R6, R7, R10, R11). SMEs from both countries value the Interreg program because of low entry requirements, support from local administrations, and reasonable chances to receive funding (R8, R11, R18). Moreover, an already available two-step evaluation tool helps businesses to access the cross-border market (https://internationalisierungsscan.eu/). The tool was developed by the Fontys University of Applied Sciences, which first evaluates how much the firm already focuses on a bordering country, and second, helps SMEs to develop a targeted business strategy. This business strategy often includes matchmaking to compensate for missing market knowledge (R2). Another opportunity is a planned cooperation between a Dutch and a German bank, which should stimulate cross-border investment and access to financing (R2).

4.4.2 Use of ISS functions in a cross-border setting: Limitations and opportunities

A general problem for SMEs is the lack of time and resources to search for and request the appropriate ISS which embody certain ISS functions. From the SMEs' (**user**) viewpoint, **prioritization** is necessary to use ISS services in the most efficient way. However, they rarely have the resources to remain up-to-date on public funding options and face difficulties in selecting the most suitable and promising option (R2, R5). An entrepreneur expressed that their team is not aware of existing assistance (i.e. brokers) to select among ISSs (R18). SMEs are often not aware of ISS functions such as networking opportunities and possibilities for knowledge exchange and research on the other side of the border (R10), and do not know

ISS providers (R3). There are brokering organizations (e.g. Oost NL, Euregio office) assisting enterprises in the process of finding potential (cross-border) partners, but enterprises still need to articulate their needs and expectations (i.e. clear goals), something that is perceived as difficult (R9). A local/regional expert indicated that differing mentalities could be a reason why individual enterprises seldom look for collaborators abroad (R17). However, one of the interviewed entrepreneurs shared that they are open for cross-border cooperation but need access to innovation brokers to connect with suitable partners because they lack a good network (R14). In a cross-border setting, casual unplanned interaction between actors rarely happens and the process does not seem to be sufficiently facilitated (R13).

Uncertainty is another limitation primarily SMEs face when using ISS functions such as financing and networking opportunities. As already mentioned, enterprises' time constraints cause careful consideration of pay-offs for every decision. This includes deciding in favor of certain funding applications and networking events over other ones. In a cross-border setting, the level of uncertainty increases due to the unfamiliarity with the neighboring country, both in terms of administrative effort and cooperation outcome.

Uncertain administrative effort: The interaction between enterprises and ISS providers often requires an administrative effort. For example, asking for financing involves writing a proposal, a business plan, and sometimes interim reports. Within a country, offices offering advice on knowledge exchange, financing, and business development can assist, but cross-border cooperation between such organizations is limited. Brokering services can establish linkages with these knowledge and financial resources. But clearly defined goals and the division of tasks are not always available within a country and even less frequently across the border (R2) - an exception mentioned by many respondents is the Interreg $program^8$. It is the only provider of ISS functions dedicated to a cross-border setting that provides a range of functions including funding, networking opportunities, introduction to market structure, and business strategy development. Targeted offices support Interreg program funding applications and assist in further project coordination. This appeared to occur equally effectively on both sides of the border. However, a critique raised in our interviews was that SMEs are confronted with different administrative efforts for Interreg projects. For example, while the Interreg grant application itself was perceived to be less demanding than other EU or regional and national government funding, the administrative tasks to be performed throughout the project appeared to be more stringent and elaborate in Interreg (R8). Another interesting finding was that while Interreg was initially planned to be only for enterprises, high administrative costs led to the involvement of universities to take over the coordination function, as illustrated by the following quote of a university representative:

⁸ At the time of this research (i.e. data collection and analysis) the Interreg VA program was operating.

"It is simply not possible to find five Dutch companies to work with five German companies unless a university or other research institution takes over the coordination" (R7, German University).

The administrative efforts combined with the long timeframe between writing a proposal and actually implementing the project (given that it is funded) sometimes causes project partners to withdraw (R12). In conclusion, the uncertainty increases with the unfamiliarity with additional tasks that might come along with the ISS function, such as recording working hours and writing reports, because this additional effort might in the end not be justified.

Uncertain cooperation outcome: A local/regional expert highlighted that networking is very important but can only work if entrepreneurs have an immediate benefit from it (R17). This stakeholder also observed that enterprises prefer to attend network events in their own country. However, there is one exception: if an SME is already familiar with the organizers of an event and trust relationships are already established, SMEs already feel connected and hence more willing to receive networking support and attend an event across the border (R17). Consequently, language and culture present an aspect of uncertainty in connection with anticipated cooperation outcomes. If unfamiliar with both, the outcomes are difficult to estimate in advance (R2, R11, R19). Another example from the participation in an Interreg program: financing is often not the main reason to participate but seen as a chance to establish contacts (R17). However, during an Interreg project, SMEs often succeed only in initializing partnerships which will still need to evolve over time (R2). Occasionally, networks cannot be sustained and as soon as funding ends, so does networking. Thus, enterprises cannot fully benefit from such projects as initially expected (R9). Hence, the ISS function of networking opportunities has to be designed in a sustainable manner, e.g. by focusing on a specific aim or topic (R6, R16).

An **opportunity** for increasing attention and use of ISS across the border is the promotion of experiences within the cross-border region. A stakeholder observed that (positive) experiences about cooperation and doing business across the border can change predefined opinions (R19). In our study, the demand for competences and expert knowledge appeared more important than the location (R17, R18), which indicates the value of ISSs that stimulate knowledge exchange and research. Becoming familiar with the working patterns and the culture can increase enterprises' willingness and openness to use ISSs across the border. One of the stakeholders highlighted that actual willingness to collaborate is helpful in overcoming cultural differences, because these differences can also exist within one country, i.e. southern and northern parts of Germany (R3). Respondents reported that a native speaker is not necessarily required to operate cross-border but a person familiar with the business culture of the neighboring country is recommended (R2). In Interreg, different cultures, communication patterns, and mentalities to handle projects and deliverables collide and this experience can help enterprises to develop an understanding and to some extent

harmonize working patterns (R15). If connections were initiated successfully within a project and SMEs experienced benefits, cross-border cooperation can outlive the duration of a project (R9). This observation indicates that the development of trust is important for cooperation and partnerships in the long term. As one of the respondents noted, established structures end at the border, only the reduction of these administrative borders might help to decrease borders in individuals' mind-sets (R17). Stakeholders acknowledged that Interreg projects represent a low threshold and high success rate for SMEs to "get in touch with a new country, a new way of working, new culture" (R2). Consequently, such new experiences might increase SMEs' cultural awareness and therefore promote further attempts to access ISSs across the border in the future.

4.5 Discussion

In this research we investigated how ISS comprise different combinations of ISS functions are provided and used in a cross-border region and we explored how stakeholders perceive limitations and opportunities of these services. Here, we will reflect these findings against the extant literature on the topic of internationalization of ISS. Our findings confirm previous studies which indicated that ISS systems are not transferrable and that the provision and use of ISS functions is closely linked to the national context (Klerkx and Guimón 2017; Berdegué Sacristán 2001; Klerkx et al. 2017b). We found that in our case study region, the Euregio Rhine-Waal, ISS functions primarily serve national interests and target almost exclusively national enterprises because governments prioritize the needs of their country. The content analysis of websites also indicated a national prioritization because information on the website was primarily presented in the national language. Cross-border organisations and the Interreg programs play a prominent role in sustaining cross-border relationships, as they are involved in key decisions and future development plans for the whole region (Szmigiel-Rawska 2016). As such, cross-border organizations can facilitate cross-border integration if they design and manage activities related to ISS functions flexibly (Ingram et al. 2020). The Interreg program was found to be the only one to offer ISS functions accessible on both sides of the border and, hence, links up two ISS systems existing in parallel in the two countries. The low level of institutional integration causes adaptation problems in the two systems present in the cross-border region and hence transferring ISSs from one country to another is not possible without adjustments (Klerkx and Guimón 2017; Berdegué Sacristán 2001; Klerkx et al. 2017b).

The level of integration of ISS systems influences how much assistance enterprises need to access ISS functions. Our findings confirm that innovation brokers are essential in connecting providers with users and that enterprises need support in demand articulation and partner identification (for e.g. knowledge, finance) (Klerkx and Guimón 2017; Klerkx and Leeuwis 2008; Knickel et al. 2021). SMEs need assistance to deal with ISS providers in a fragmented system (Christoplos 2010), comparable to a cross-border setting. An explanation could be that a similar effort is present for SMEs operating "just" across the border or further

away (R13). This phenomenon was also observed in the Czech-Polish border region (Kurowska-Pysz 2016). The business evaluation tool developed by the Fontys University of Applied Sciences could help SMEs to identify weaknesses and equip them with the necessary skills and knowledge (see also Vos 2005; Vos, Keizer, and Halman 1998). Interreg programs offer several ISS functions on both sides of the border which can decrease efforts for SMEs.

Another limitation for using ISSs was that enterprises were hampered in networking for knowledge exchange and research across the border. Learning is costly for SMEs: searching for and accessing information, training and education come at a cost, also in national innovation systems (Lundvall 2010). In a cross-border setting, the attempt to access knowledge networks across the border might increase the costs for learning even further. Prior research acknowledged that universities contribute to cross-border connections and can even educate people towards a more cross-border mind-set (van den Broek, Benneworth, and Rutten 2019). In the context of cross-border knowledge infrastructure, we observed that universities rarely fulfilled a brokering role in developing cross-border connections of ISS functions knowledge exchange and research in either country. We only found that the interaction of SMEs with universities differ in the cross-border region: problem-driven in the German region and co-development-oriented in the Dutch region. This finding is related to the prior evidence suggesting that different systems can also offer chances for mutual learning and can be beneficial for innovation development (Boschma 2005; Balland, Boschma, and Frenken 2015). However, we find that universities are important as central coordinators of Interreg projects and hereby confirm the findings of Tagliazucchi et al. (2021).

Potential benefits of integration were not immediately apparent at the enterprise level because enterprises usually operate within the national context and their expertise is less developed or completely absent for the neighboring country. This causes uncertainty for enterprises when considering the use of ISS functions in a cross-border setting. In this respect, we found that enterprises tend to be uncertain in the initial phase of finding partners and establishing contacts in cross-border networking because of the required time and resource investments. Nevertheless, enterprises demonstrated willingness and motivation to establish new contacts and partnerships while at the same time expressing their limited awareness of available networking opportunities across the border. This diverges from prior research with regard to enterprises motivation for border interaction: Jørgensen (2014) observed a lack of motivation, while Makkonen and Leick (2019) could not confirm such a lack of motivation. Another example of uncertainty reported in our study was that requesting the ISS function financing might lead to a dependence of the enterprise on this funding for their business, causing unwanted consequences in the long term. Within our study, cross-border accessibility of financing was limited to Interreg funding and applied to the context of Interreg financing. Prior research (Szmigiel-Rawska 2016; Samara et al. 2020) showed that not only enterprises can become dependent on Interreg financing: after the accession of eastern European countries to the EU, the formation of cross-border organizations often did not evolve naturally, which led to a continued dependence on funding for developing cross-border

relations (Szmigiel-Rawska 2016; Shepherd and Ioannides 2020). Hence, a lack of apparent short-term benefits may increase enterprise's uncertainty and reduce their willingness to look for ISSs across the border.

Our research confirmed earlier work of Lundquist and Trippl (2013) in the sense that the differences of the legal system, the institutional set-up, and the knowledge infrastructure limit the integration process of national ISS functions in a cross-border setting. However, these differences not only present a limitation in the *provision* of ISS functions for enterprises but also limits their *use* by enterprises. Extending and adopting ISS functions should follow a co-creation approach (as suggested by Lioutas et al. 2019). This is especially important in a cross-border setting because co-creation can foster the integration of a crossborder ISS system.

Due to the explorative character of our study, our findings must be interpreted with caution. A limitation of this study is that we focus on the Dutch-German cross-border region Rhine-Waal. Certain limitations and opportunities discussed in this study might pertain to other European cross-border regions with similar contexts, while others might not apply to the regions with a more recent history of cooperation. The respondents were recruited based on their insights and experiences with ISSs in the cross-border region. It was especially difficult to recruit enterprises to share their experiences. Future research is necessary to explore cross-border related factors influencing the provision and use of ISSs in other cross-border regions, in particular in regions without a long history and tradition of cross-border cooperation.

4.5.1 Implications for improving ISS

Frequent communication between enterprises, regional and national entities, and crossborder organizations responsible for regional development is essential to improve ISS provision and use in cross-border regions. The focus on national interests is the biggest limitation of ISSs in cross-border regions. Enterprises can benefit more from ISSs provided in both regions if already established structures in either country are integrated in a coherent cross-border regional setting. For example, a cross-border cooperation among banks is currently under development (R2) and is expected to facilitate cross-border business connections. Although the consequences of cross-border bank cooperation on network establishment and the whole cross-border regional economy are still unknown, similar attempts to integrate knowledge exchange and research, networking opportunities, or market structures are required.

Currently, agri-food SMEs in the two countries cooperate with universities under different circumstances in our case study. The Euregio office is operating in both countries and in exchange with national institutions and, more importantly, EU institutions. Hence, Euregio can facilitate university collaboration across the border through the initiation of a well-targeted Interreg program. The cross-border collaboration between universities could positively affect SMEs on both side of the border because they can access expert knowledge and benefit from the best of both sides.

Moreover, dedicated cross-border innovation brokers appear necessary to foster the use of ISS functions across the border because enterprises (a) often lack resources to familiarize themselves with available ISS options, and (b) are more uncertain about the payoffs of using ISSs across the border. The factor "uncertainty" was mentioned in the context of different cross-border aspects (i.e. institutional set-up, knowledge infrastructure, nature of linkages, accessibility) and influenced several ISS functions (i.e. possibilities for knowledge exchange and research, networking opportunities, market structures, business strategy development, and advanced training). To reduce the uncertainty for SMEs and encourage them to use ISSs functions, clearly defined actions, goals and expected outcomes of offered ISSs function should be communicated by innovation brokers.

4.6 Conclusions

Our research investigated how ISS functions are provided and used in a cross-border region and explored the limitations and opportunities perceived by different stakeholders. The results indicated that the provision and use of ISS functions is closely linked to the national context and that parallel systems exist in either country. The *provision* of ISSs across the border was limited by differences in structures and national priorities in the cross-border region. Furthermore, stakeholders perceived the *use* of ISSs in the other country as restricted by unfamiliarity with responsible authorities, the administrative effort required, and the uncertainty about pay-offs. The provision and use of ISS functions in cross-border regions can meet stakeholders needs only to a certain extent due to adaptation problems similar to transferring an ISS system to an international context without an immediate border. Our research adds to the literature on advisory systems by showing that ISS sub-systems in crossborder regions are bound to a national context and argue that cross-border linkages between national sub-systems are lacking.

Whereas our results pertain to the case study of the Dutch-German cross-border region Euregio Rhine-Wall, it should be noted that this region already has a long history of cross-border cooperation. Hence, cross-border regions with a more recent history of cooperation might face even more hurdles. As risk, uncertainty, and a lack of resources are common challenges in innovation development, we think that our conclusions can at least to some extent be generalized to other cross-border regions.

Appendix A

Country	Google search strings
Germany	 innovation* UND wissenstransfer UND unternehme* UND niederrhein
	 innovation* UND förder* OR berat* OR consult* OR unterstütz* UND
	unternehme* UND niederrhein
	 innovation* UND unternehme* UND niederrhein UND grenzregion
	 innovation* UND unternehme* UND niederrhein UND agrar
The Netherlands	 innovatie* AND kennisoverdracht* AND bedrijf* Gelderland OR Noord*brabant
	OR Limburg
	 innovatie* AND financiering* OR advies* OR raad* OR ondersteurning* AND
	bedrijf* AND Gelderland OR Noord*brabant OR Limburg
	 innovatie* AND bedrijf* AND grensgebied* AND Gelderland OR Noord*brabant
	OR Limburg
	 innovatie* AND bedrijf* AND landbouw AND Gelderland OR Noord*brabant OR
	Limburg
	 innovatie* AND bedrijf* AND agrar* AND Gelderland OR Noord*brabant OR
	Limburg

Table 4-A1 Search strings used for identifying Dutch and German websites providing ISS

Appendix **B**

R#	Stakeholder group	Germany	The Netherlands
1	Academic institution	х	
2	Academic institution		х
3	Local/regional expert		х
4	Local/regional expert	х	
5	Local/regional government institution	х	
6	Local/regional government institution		Х
7	Academic institution	х	
8	SME		Х
9	Local/regional government institution*	х	Х
10	SME		Х
11	SME		Х
12	Academic institution		Х
13	Local/regional government institution		х
14	SME		х
15	Local/regional government institution	х	
16	Local/regional government institution	х	
17	Local/regional expert	х	
18	SME	х	
19	SME	х	

Table 4-A2 Overview respondents

* This interview was conducted with a representative of the Euregio office, which operates in both countries.



Chapter 5: Stakeholder viewpoints on facilitation of cross-border cooperation

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Abstract: The European Union fosters cooperation in cross-border regions through the European Cohesion Policy (ECP). The implementation of ECP instruments requires a participatory approach, in which stakeholders' views are acknowledged. However, the multiple of views among and between stakeholders of cross-border initiatives complicate their involvement in a participatory approach. A prerequisite for a meaningful involvement of all stakeholders is an in-depth understanding of their viewpoints on what facilitates cross-border cooperation. However, to date, these viewpoints are poorly understood. This study aims to identify and analyze stakeholders' viewpoints on the facilitation of cross-border cooperation. The viewpoints of a sample of entrepreneurs, members of education institutes, and members from local institutions (policymakers and industry representatives) in the Dutch-German cross-border region Rhine-Waal were collected via Q methodology and complemented through interviews. Four viewpoints emerged: cooperation through pro-active engagement, cooperation through targeted policies, cooperation through an aligned institutional setup, and cooperation through socio-cultural proximity. Results can inform policy making aimed to increase stakeholder involvement in participatory approaches in cross-border regions.

Keywords: Q methodology; cooperation; cross-border region

5.1 Introduction

Despite decades of integration efforts in the European Union (EU), cross-border regions within Europe currently do not exploit their full potential in terms of economic and territorial integration. Administrative and legal barriers between countries lead to potential GDP losses (Camagni, Capello, and Caragliu 2019). One way to foster economic and territorial integration in these regions is through facilitating cross-border cooperation (Fritsch et al. 2015). In this regard, the EU has launched several policy instruments, including the Interreg programs (European Commission 2020) which are part of the European Cohesion Policy (ECP) and support cross-border cooperation via project funding.

ECP instruments require compliance with the principle of partnership, i.e. various entities (henceforth named stakeholders) collaborate in the planning and execution of funded projects (Dąbrowski, Bachtler, and Bafoil 2014). The principle of partnership is associated with multi-level governance, a policy-making system in which governments at the supranational, national, regional and local level, as well as local key-stakeholders from the civil society (e.g. entrepreneurs and NGOs) interact (Dąbrowski, Bachtler, and Bafoil 2014). The aim of this approach is to efficiently deliver tailored interventions (Commission of the European Communities 2001). The implementation of policy instruments that are supposed to comply with the principle of partnership and promote a multi-level governance system requires a participatory approach, in which stakeholders' views are acknowledged (Dąbrowski, Bachtler, and Bafoil 2014). However, to put into practice a participatory approach it is necessary to systematically assess and delineate the viewpoints of stakeholders toward aspects that influence cross-border cooperation.

Several aspects influence cross-border cooperation. For instance, cooperation between stakeholders is facilitated in cross-border regions that share a similar culture, offer access to university and research institutes, have a good infrastructure, and an aligned institutional setup, economic and policy structures (Boschma 2005; Lundquist and Trippl 2013; Trippl 2010). Although all these aspects are important for cross-border cooperation, it is reasonable to assume that stakeholders hold distinct interests, which are reflected in different views about how these aspects should be put into practice. For instance, local authorities might be interested in improving infrastructure, while entrepreneurs want an aligned institutional setup that reduces bureaucracy of doing business across the border. In fact, multiple views prevail among and between stakeholders of cross-border initiatives (Panten et al. 2018), complicating their involvement in a participatory approach. While we acknowledge that a competitive advantage of cross-border regions lies in their diversity and high levels homogeneity should not be a desirable outcome of participatory approaches (Boschma 2005), we argue that a prerequisite for a meaningful involvement of all stakeholders is an in-depth understanding of their viewpoints on what facilitates cross-border cooperation. However, to date, stakeholders' viewpoints on aspects that influence crossborder cooperation are poorly understood.

To fill this gap in the literature, we propose the use of Q methodology, which has been widely and successfully applied to identify and to analyze stakeholders' viewpoints on policy issues (for example Cuppen et al. 2010; Ellis, Barry, and Robinson 2007; Tuokuu et al. 2019), but not yet in the context of cross-border cooperation. More specifically, the objective of this study was to identify and analyze stakeholders' viewpoints about the aspects that could facilitate cross-border cooperation.

Our study goes beyond previous research by focusing on stakeholders' viewpoints. Previous literature focused on the identification of citizens' perceptions about the European Cohesion Policy (Capello and Perucca 2018), on the identification of obstacles that might hamper cross-border cooperation and how they can be compensated (Capello, Caragliu, and Fratesi 2018a), or on the identification of border related inefficiencies (Capello, Caragliu, and Fratesi 2018b). We argue that stakeholders can take active parts in forming cross-border cooperation, and therefore an in-depth understanding of their viewpoints on what facilitates cross-border cooperation is important. This should help to make stakeholders more aware of their own views and the views of others. For instance, by acknowledging that different viewpoints exist, stakeholders may be able to identify challenges to be addressed (Nhem and Lee 2020) and areas of consensus and divergences (Tuokuu et al. 2019). Such a research could provide insights to policy makers that can be used to stimulate stakeholder involvement in participatory approaches in cross-border regions and in a follow-up step to the formulation of better targeted policies.

5.2 Materials and methods

In this section, we first present the case study region. Second, we introduce the common terminology and the standard procedure of Q methodology. Furthermore, following the guidelines for application of Q methodology (Watts and Stenner 2012), information regarding our study design, statistical analysis and constructing the viewpoints are provided.

5.2.1 Case study region

This study was conducted in the Dutch-German cross-border region "Euregio Rhine-Waal", a region with a long history of cross-border cooperation. It covers an area of 9 831 km² and has 4.88 million inhabitants (Euregio Rhine-Waal 2019) (Figure 5-1). Through the INTERREG funding program, the European Fund of Regional Development (EFRD) supported different initiatives on health, security, education and industry to foster cooperation in the Dutch-German cross-border region. Between 2014 and 2020, approximately EUR 440 million were made available to increase innovation and decrease practical hurdles in the entire Dutch-German cross-border region, including the Ems Dollart Region, the Euregio (Gronau), the Euregio Rhine-Maas-Nord and the Euregio Rhine-Waal (Gemeinsames INTERREG-Sekretariat 2021).

Between 2008 and 2020, approximately 177 projects were initiated through INTERREG funding. The support of small and medium enterprises was and still is a special focus of INTERREG funding programs. Some recent projects are e.g., KISS ME, Digi Pro, Regional Skills lab, BRESE, EnerPRO and Food Pro-tec-ts. Stakeholders of the latter project were selected to participate in our study.



Figure 5-1 EUREGIO Rhine-Waal Region (Euregio Rhine-Waal 2019)

5.2.2 Q methodology – terminology/general overview

Q methodology⁹ explores the subjective dimension of any issue towards which different viewpoints can be expressed (Stenner and Stainton-Rogers 2004). In this study, the application of Q methodology allows us to identify stakeholders' viewpoints about the aspects that would facilitate cross-border cooperation¹⁰.

In Q methodology, participants express their own viewpoint in a structured way, sorting a set of statements of opinion according to a subjective scale (for example, a categorical scale) such as agreement/disagreement (Stenner et al. 2015; Stenner, Watts, and Worrell 2008). First, a set of statements of opinion, called a Q-set, is developed. Second, a sample of participants (P-set) are asked to sort the Q-set in a grid (see Figure 5-A1 in the Appendix for an example). The result of the sorting procedure is called a Q-sort and provides the researcher with a model of each participant's viewpoint (Stenner et al. 2015). Third,

⁹ Q methodology has a specific terminology (e.g., factors, P-set, Q-set, Q-sort). For the sake of consistency, we used the terminology based on Watts and Stenner (2012).

¹⁰ An alternative approach for eliciting stakeholder views would have been the Analytical Hierarchy Process, but this approach results in a preference ranking for different factors that contribute to cross border collaboration and not a deeper understanding of aspects that could facilitate cross-border collaboration.

participants are asked to elaborate on their personal reasoning for their specific Q-sort in the form of interview questions. Typically Q-sorts of all participants are then intercorrelated and factor-analyzed to identify any shared viewpoints among the participants (Watts and Stenner 2012). The results of this analysis are factors that identify a cluster of Q-sorts, which have been similarly sorted by participants (Stenner et al. 2015). The interpretation of each emergent factor is facilitated by the creation of its own factor array or 'exemplifying Q-sort' (Watts and Stenner 2012) (see Figure 5-2 for an example). A factor array resembles a Q-sort completed by a participant, but is in fact a 'best estimate' of the factor derived from all the Q-sorts that are significantly associated with the factor in question (Stenner et al. 2015; Watts and Stenner 2012). Finally, the exemplifying Q-sort is supplemented with input from qualitative interviews to describe of each emerging viewpoint emerged.



Figure 5-2 Example of the Q sort for factor 1.

5.2.3 Q methodology - study design application

In this study, we first developed the list of statements of opinion (Q-set) to be given to participants for Q sorting, following the guidelines for application of Q methodology (Watts and Stenner 2012). To define the Q-set, a literature review was conducted about the aspects that could facilitate cross-border cooperation and complemented with ten short interviews among Dutch and German stakeholders. Finally, a list of 25 statements was defined, which represent our Q-set (see Table 5-A1 in the Appendix for the list of statements). Before

collecting the data¹¹, we conducted a pre-test with five participants (who were not part of the sample) to validate the semantics of the statements. Next, the Q-set was applied to a sample of 17 participants (P-set).

All participants in our sample were stakeholders involved in the Interreg project 'Food Pro-tec-ts'. We focused on the stakeholder groups of entrepreneurs, members of education institutes (i.e., universities and universities of applied sciences), and local institutions (policymakers and industry representatives). A convenience sample of 17 participants (P-set) was recruited in the Dutch-German cross-border region (i.e., Euregio Rhine-Waal) through the personal network of the authors (n=10), complemented by snowball sampling (n=7). Ten participants from the Dutch (NL) side and seven from the German (GER) side were interviewed. Among the participants were six entrepreneurs (NL: 4, GER: 2), three members of education institutes (NL: 2, GER: 1) and eight actors from local institutions (NL: 4, GER: 3, NL/GER: 1). All participants had experience in cross-border cooperation.

For the interviews with the 17 participants, we created a grid starting with the following sentence: "Cross-border cooperation would be facilitated if..." (see Figure 5-A1 in the Appendix). The 25 statements of our Q-set were printed on individual laminated paper cards. Participants were given the option to be interviewed in German or English (statements were also presented in English or German, depending on their choices).

During data collection, researchers guided the participants to first read all statements and then sort them in two major groups: statements that they agreed to and those that they disagreed with. Second, each participant rated each of the 25 statements in relation to each other in the grid. The grid's scale ranged from -4 (strong disagreement) to +4 (strong agreement). Participants were encouraged to adjust their Q-sort until they felt it represented their viewpoint. This procedure resulted in 17 Q-sorts, with different sorting patterns (i.e., the 17 Q-sorts of 17 participants). Upon completion of this task, participants were interviewed to deepen the understanding of their Q-sorts. Finally, during the interviews, we collected information about educational background, current job position, and experience in job position. All tasks (i.e., statement sorting and interview) lasted on average 30 minutes.

5.2.4 Statistical analysis

The 17 Q-sorts were intercorrelated and factor-analyzed using the software PQ Method v. 2.35. (Schmolck 2002). This procedure generates factors, which represent clusters of Q-sorts similarly sorted by participants. For factor extraction, we used principal component analysis (PCA). To define the number of factors to retain for final analysis, we followed the guidelines suggested by Brown (1980), where each factor must have at least two significant loadings (± 0.51 at P<0.01), and eigenvalue should exceed 1. Of the initial eight factors, four were discarded because they had less than two significant loadings. Therefore,

¹¹ This project received ethics board approval from Wageningen University (N⁰ 09215846).

the other four factors were selected for factor rotation, which was performed using Varimax rotation. The four-factor solution represents four different viewpoints about the aspects that would facilitate cross-border cooperation and explains 66% of the total variance.

All 17 Q-sorts significantly loaded one of the four factors. Loadings of ± 0.51 or above were significant at P<0.01. Q-sorts that significantly load on a particular factor are called the defining Q-sorts; they exhibit a very similar sorting pattern (Watts and Stenner 2014). When a similar sorting pattern is found, this suggests that the participants' viewpoints (i.e., their Q-sorts) are similar and as a result we can assume that they share a distinct viewpoint of which aspects would facilitate cross-border cooperation. Q-sorts were either automatically flagged by PQ Method or manually added to one factor. Table 5-B1 in the Appendix shows the loadings of each Q-sorts.

The defining Q-sorts were subsequently merged to form a factor array. A factor array is a single ideal-typical Q-sort for each factor (Watts and Stenner 2014). It is calculated according to a procedure of weighted averaging, where higher loading defining Q-sorts are given more weight in the averaging process (Watts and Stenner 2014). The factors were interpreted via the holistic approach suggested by Watts and Stenner (2012), which considers the entire statement configuration captured in a factor array. Answers to the open-ended questions from interviews of participants whose Q-sorts were significantly (i.e., loadings of ± 0.51 or above at P<0.01) associated with the relevant factor were also used to complement the interpretation of the factors.

5.3 Results

Table 5-1 provides the list of statements and their respective scores on all factor arrays for the specific factors (i.e., viewpoints). Reading this table by column reveals the factor array for each of the factors. Factor F1, for example, has ranked statement 1 at 0, statement 2 at -4, and so on. Reading the table row-by-row reveals the cross-factor rankings of an individual statement. Statement 3, for example, has been ranked at 0 by Factor F1, at -2 by Factor F2, and so on. The four factors (i.e., viewpoints) were labeled as follows: cooperation through pro-active engagement (F1), cooperation through targeted policies (F2), cooperation through an aligned institutional setup (F3), and cooperation through socio-cultural proximity (F4).

Nb.	Statements	F1	F2	F3	F4
	"Cross-border cooperation would be facilitated if"				
1	People spoke the same language on both sides of the border.	0	0	4	4
2	Stakeholders in the cross-border region were more reliable.	-4	-4	-3	-1
3	Stakeholders adapted to the business customs (i.e. hierarchal structures) of the	0	-2	1	3
	other country.				
4	Universities cooperated more with industry on both sides of the border.	2	-1	-1	0
5	More cross-border R&D and innovation transfer projects were established.	3	1	-1	0
6	Enterprises had easier access to research institutions on the other side of the	0	-1	0	-1
	border.				
7	More networking events were organized on both sides of the border.	2	-1	-2	1
8	The cross-border region had better public transportation infrastructure.	-1	-2	2	-3
9	The cross-border region had better highway infrastructure.	-2	-3	-4	-3
10	The cross-border region had better internet connection.	-2	-2	-2	-2
11	The regulatory and bureaucratic burdens of doing business across the border were	1	2	3	2
	minimized.				
12	Intellectual property rights were regulated in a similar manner in both countries.	-1	0	-3	3
13	Bureaucratic formalities were reduced when applying for common projects on	0	3	3	2
	the other side of the border.				
14	Enterprises had access to services that address questions on entering the market	1	2	1	1
	on the other side of the border.				
15	Business sectors had similar priorities in both countries.	-1	0	0	1
16	Education and job qualification certificates were mutually accepted in both	1	1	2	1
	countries.				
17	Governmental strategies for industry development were similar in both countries.	0	2	0	2
18	Prices and costs of services and goods were similar in both countries.	-3	0	-1	-4
19	The political systems were similar in both countries (centralist in NL vs. federalist	-2	0	-2	-1
	in GER).				
20	Policy objectives of bordering regions were developed in cooperation with the	1	4	2	-2
	other country.				
21	Policy objectives in each country were more clear.	-3	3	-1	0
22	Cooperation was driven more by developing knowledge than reducing costs.	-1	1	0	-2
23	All stakeholders in the cross-border region were pro-actively engaged in	4	1	1	-1
	cooperation.				
24	All stakeholders mutually engaged in cooperation.	2	-3	1	0
25	Networks were better developed through cross-border research projects.	3	-1	0	0

In the interpretations presented below, the qualitative answers are indicated in italics. Where the ranking position of a statement is important to a section of interpretation, the relevant statement is noted in brackets; hence (1: +4) would indicate that statement 1 was ranked in the +4 position in the relevant factor array.

5.3.1 Factor 1 – Cooperation through pro-active engagement

The Q-sorts of eight participants significantly loaded (i.e., loadings of ± 0.51 or above at P<0.01) the first factor, which has an eigenvalue of 5.9 and accounts for 24% of the total variance (see column F1 in Table 5-B1 in the Appendix). Six of these eight participants were

Dutch: two entrepreneurs (R3, R12), two education institute members (R7, R14) and two actors from local institutions (R2, R16). Two participants were actors from local institutions in Germany (R5, R6).

The main idea of this viewpoint is that cooperation would be mostly facilitated by pro-active engagement of stakeholders. It is grounded on participants' views that stakeholders need to be pro-actively and mutually engaged in cooperation (23: +4; 24: +2), because if they would cooperate more intensively on their own initiative, then there would also be more intensive cooperation and the bigger the circle, the more effective it would be (*R6*). It is not important that stakeholders are more reliable (2: -4), because *they already are* (R6) and it is not necessarily an aspect that will lead to more cooperation because if there is only one partner to work with, reliability becomes superfluous (R5). In cross-border regions, networks, events, and research and development projects should be strengthened (25: +3: 5:+3:7:+2) and universities should work in close collaboration with industry (4:+2) to improve knowledge exchange (R3, R5). The focus on specific innovation projects is not important, but focus should lie on the economic structures that are created, i.e., networks and clusters (R16). However, network events should really focus on the core business, activities and interests of the target group and not too widely (R3). The reduction of bureaucracy is not a high priority $(11; +1; 13; 0)^{12}$. Besides the general question whether it actually can be reduced (R14), bureaucratic hurdles are only considered to potentially slow procedures down, but they are not a clear limitation for business (R3). An alignment of political systems, and clearer and jointly developed policy objectives by countries located in cross-border regions are not important for cooperation (21: -3: 19: -2: 20: +1). Similar prices and costs for services and goods in cross-border regions were not considered important to facilitate cross-border cooperation (18: -3). On the contrary, differences were even seen as potentially profitable (R14), because they facilitate the need to go beyond the border (R12).

5.3.2 Factor 2 – Cooperation through targeted policies

The Q-sorts of three participants significantly loaded (i.e., loadings of \pm 0.51 or above at P<0.01) the second factor, which has an eigenvalue of 2.3 and accounts for 16% of the total variance (see column F2 in Table 5-B1 in the Appendix). The three participants were from Germany: two entrepreneurs (*R8, R10*) and one actor of a local institution (*R17*).

The main idea of this viewpoint is that cooperation would be mostly facilitated by targeted policies. Hence it is important for cooperation to formulate clearer policy objectives and that governmental strategies of bordering regions are developed in cooperation with the neighboring country (20: +4; 21: +3; 17: +2). *If similar policy goals are present, the*

¹² Although +1 and 0 are by no means low scores, these are the lowest scores given to these statements by any of the factors. Hence, the relative importance makes it worth mentioning.
implementation of projects would certainly be easier (R8). Bureaucracy should be reduced to do business on both sides of the border (13: +3; 12: +2), because *currently it seems difficult* to enter the foreign country without additional assistance, i.e., a coordinator (R10). In addition, an alignment of political systems in both countries seem worthwhile for cooperation (19: 0)¹³, but *if not present, it is not an obstacle (R10)*. To facilitate cross-border cooperation social proximity is not important (3: -2; 24: -3). Cross-border cooperation thrives on the fact that different structures come together and different impulses, different people with completely different approaches want to do things together (R17). Similar to Factor 1, it is not important that stakeholders are more reliable (2: -4), probably because they already are (R10, R17).

5.3.3 Factor 3 – Cooperation through an aligned institutional setup

The Q-sorts of four participants significantly loaded (i.e., loadings of \pm 0.51 or above at P<0.01) the third factor, which has an eigenvalue of 1.6 and accounts for 15% of the total variance (see column F3 in Table 5-B1 in the Appendix). One participant was a Dutch entrepreneur (*R13*), one a German education institute member (*R11*), and two were actors from local institutions – one from Germany (*R9*) and one from the Netherlands (*R15*).

The main idea of this viewpoint is that cooperation would be mostly facilitated by an aligned institutional setup. Hence bureaucratic barriers in doing business in cross-border regions should be reduced (11: +3; 13: +3). Regulatory and bureaucratic hurdles hinder especially smaller businesses in participating in funded projects (R9). In addition, people should speak the same language (1: +4), but like in Factor 1 and 2, it seems hardly important that stakeholders trust each other more (2: -3), possibly because *they already do (R9, R15)*. To facilitate cooperation, it is not important that more networking events and research and development projects are established in cross-border regions (5: -1; 7: -2). However, it was considered important that established networking events become sustainable and do not end as soon as funding ends (R11). Better public transportation in cross-border regions would also facilitate cooperation (8: +2), because trips across the border still take too much time which is a considerable problem for vounger people (R9 and R13). Increasing mobility also means increasing access to educational institutions and simultaneously facilitates exchange of people between e.g., educational institutions (R9). Common regulation for intellectual property rights between neighboring countries are not perceived to be important to facilitate cross-border cooperation (12: -3), because such issues arise among partners which are already in close cooperation (R13).

¹³ Although 0 is by no means a high score, this is the highest score given to this statement by any of the factors. Hence, the relative importance makes it worth mentioning.

5.3.4 Factor 4 – Cooperation through socio-cultural proximity

The Q-sorts of two participants significantly (i.e., loadings of ± 0.51 or above at P<0.01) loaded the fourth factor, which has an eigenvalue of 1.3 and accounts for 11% of the total variance (see column F4 in Table 5-B1 in the Appendix). Both participants were Dutch, one entrepreneur (*R1*) and one actor from a local institution (*R4*).

The main idea of this viewpoint is that cooperation would be mostly facilitated by socio-cultural proximity. Hence it is important for people in cross-border regions to speak a common language (1: +4), because *communication is essential for any form of collaboration* or cooperation (R1). However, to a large extent it is not only the language but also a bit of a culture as well. If you have similarities in culture, it is easier to work together than if you don't (R1). Stakeholders involved in business should be able to adapt to the customs of the neighboring country (3: +3) and trust each other (2: -1)¹⁴. Although one might expect a united European system, there are still hig differences (i.e., institutions) (R4) and the similarities in culture mentioned above also include mutual respect for traditions and customs (R1). In addition, cooperation would be facilitated by neighbor countries having a common regulation for intellectual property rights (12: +3) and a reduced bureaucracy to do business (11: +2; 13: +2), because a lack of similarities creates a gap between countries (R4). To facilitate cooperation on both side of the borders, similar prices and costs for services and goods (18: -4) are irrelevant, because one can easily do business in another country, and work closely together with a company in the other country that has a very different price structure (R1). It is also not important that the focus of cooperation is on knowledge creation (22; -2); while knowledge creation should be the aim in a scientific setting, in a business setting cooperation can be about and driven by costs (R1).

5.3.5 Consensus statements

Results suggested consensus of the four viewpoints regarding six statements (see Table 5-1). There were two statements for which the views were held strongly by stakeholders as indicated by high negative ratings. Specifically, there was a consensus against the notion that better highways (9), and better internet connection (10) would facilitate cooperation in cross-border regions. There were four statements for which the four viewpoints were neutral, "Cross-border cooperation would be facilitated if enterprises had easier access to research institutions on the other side of the border" (6); "if enterprises had access to services that address questions on entering the market on the other side of the border" (14); "if business sectors have similar priorities in both countries" (15); and "if education and job qualification certificates were mutually accepted in both countries" (16).

¹⁴ Although -1 is by no means a high score, this is the highest score given to this statement by any of the factors. Hence, the relative importance makes it worth mentioning.

5.4 Discussion and conclusions

In our study, stakeholder viewpoints on the facilitation of cross-border cooperation in the Dutch-German border region Rhine-Waal were identified using Q methodology. Compared to previous research which focused on "ordinary" citizens (Capello and Peruca, 2018, Capello, Caragliu, and Fratesi 2018a, Capello, Caragliu, and Fratesi 2018b), we focused on stakeholders because they can become actively involved in the process of forming cross-border cooperation. Our results centered around four viewpoints: 'cooperation through pro-active engagement', 'cooperation through targeted policies', 'cooperation through an aligned institutional setup', and 'cooperation through socio-cultural proximity'. These viewpoints vary not only across but also within stakeholder groups.

The viewpoint 'cooperation through pro-active engagement' prioritized aspects related to cooperative behavior and mutual engagement of all stakeholders. Hence, while this viewpoint considers cooperation as an individual 'responsibility', it also reflects the need of reciprocity in cooperation. Previous literature has emphasized the importance of reciprocity (and trust), particularly for long-term cooperation (Pesämaa et al. 2013), Given the explicit focus on pro-active behavior, the development of policies through a bottom-up approach would be favored over a top-down approach. In fact, this was the only viewpoint for which a reduction of bureaucratic formalities and a joint development of policy objectives were not considered a priority in cross-border cooperation. Instead, other aspects of this viewpoint are related to the importance of jointly establishing projects (e.g., innovation transfer projects). which suggest another route for enhancing cross-border cooperation. Indeed, previous studies have evaluated cross-border projects as positive for cross-border cooperation (González-Gómez and Gualda 2016). In addition, cooperation through pro-active engagement also entails the organization of targeted network events, which suggest a third route to enhance cooperation in cross-border regions. Indeed, previous studies have found that networking events are important for cultivating cooperation, particularly for business (Mitchell, Schlegelmilch, and Mone 2016; Kitchen 2017).

The viewpoint 'cooperation through targeted policies' emphasizes on policy structures. For this viewpoint, the formulation and development of clear policy objectives in cooperation with the neighboring country is particularly important. The emphasis on policy structure suggests that this viewpoint relies on policy-makers' initiatives to enhance cross-border cooperation, which might be explained by the argument that preconditions to allow full exploitation of assets should be set by appropriate policies (Cappellano and Rizzo 2019). Most cross-border regions have a core of four categories of policy areas, namely 'local economic development, transport and accessibility, environment, culture and education' (Noferini et al. 2020, 50) and a prioritization among those areas or a more detailed categorization should include the stakeholders' needs. This observation is in line with González-Gómez and Gualda (2016), who found a disconnection between EU-driven cross-border policies and the objectives of cross-border institutions and inhabitants in a specific location. Hence, this viewpoint might express the position that a pro-active engagement in

cooperation only seems necessary if targeted to formulate specific policy objectives, because similar objectives make the implementation of cross-border projects easier (Jacobs 2016). This result is in line with Szmigiel-Rawska (2016), who found that the ability of managing organizations to make key decisions and develop common policies concerning the whole cross-border region is essential for cross-border cooperation. Indeed, we also found that special services can assist enterprises to enter the foreign market. Not in alignment with latest findings (see e.g. Leick 2012), socio-cultural similarities were not considered to facilitate cooperation but were only seen as a bonus. Similar to a study conducted in the German-Polish-Czech cross-border region, cultural variations might be appreciated as an enrichment (Knippschild 2011). A possible explanation is that, in this specific case, socio-cultural differences are limited, and most people are aware of the specificities of the neighboring region.

The viewpoint 'cooperation through an aligned institutional setup' is mainly characterized by aspects related to the reduction of regulatory and bureaucratic barriers. In line with previous findings (Noferini et al. 2020), cross-border cooperation of this viewpoint is restricted by the asymmetries between administrative and legal systems causing increased coordination costs. As an example, this viewpoint emphasized the need for reducing bureaucratic formalities, particularly for small enterprises, when applying for common projects on the other side of the border. As institutional coherency serves as a prerequisite for long-lasting and self-employed cooperation. Furthermore, for this viewpoint, many networking events are not sustainable because when the funding ends, the initiatives stop so there is not long-term facilitation of cross-border cooperation. In fact, while external funding plays a role in cross-border cooperation (Szmigiel-Rawska 2016), previous findings also suggest that the preconditions to establish long-term cooperation have to remain stable over time and must not rely solely on financial incentives (Podadera Rivera and Calderón Vázquez 2018).

The viewpoint 'cooperation through socio-cultural proximity' is mainly characterized by aspects related to the importance of communication (verbal and non-verbal) and culture for cooperation. In particular, a common language, adaptation and respect to the customs and traditions of the neighbor country, are important for cooperation in this viewpoint. Previous research showed that socio-cultural proximity influences information and communication costs (Boschma 2005), and knowledge can only be effectively built and applied when this process is not impeded by cultural differences (Bardy 2010). For this viewpoint, there is no specific concern about the relationship between cooperation and knowledge creation, suggesting no major obstacles in the case study region. A case study in the Upper Adria cross-border region between Slovenia and Italy found that previous cross-border cooperation programs fostering cultural integration led to an increase of linkages and the formation of a new network among different nationalities, including minority groups of the neighboring region (Nadalutti 2014). Results also showed the formation of a 'new'

cultural identity which goes beyond nationality, i.e., cross-border community. The formation of a cross-border identity could be a long-term goal in other cross-border regions as well.

From our results, the following policy implications emerge. First, we argue that the identification of these four viewpoints reinforces the need of a participatory approach in developing future policy, in which stakeholders' views are acknowledged. This is particularly important for cross-border initiatives that are supposed to comply with the principle of partnership and promote a multi-level governance system. Given the four different viewpoints, it is possible that stakeholders will never be fully satisfied, but the acknowledgement of different viewpoints provides a starting point for cooperation. A crossborder open learning environment, such as a living lab, might facilitate the discussion of different views (Panten et al. 2018). Second, to implement a participatory approach, the stakeholder engagement is necessary. Previous research found that the attractiveness of the neighboring location, e.g. connection of different organizations through a common destiny. is essential for engagement in cooperation (Szmigiel-Rawska 2016) and that enthusiasm decreases if actors fail to see direct benefits (Pesämaa et al. 2013). Hence, we suggest that it is important to raise awareness among stakeholders of potential benefits of cooperation across the border. A joint managing organization could disseminate the benefits on both sides of the border and assist in establishing and enhancing cooperation (Perkmann 2003; Berzi 2017). Third, to put into practice a participatory approach it is necessary to identify the different stakeholders' viewpoints. In this regard, we argue that Q methodology is a useful tool, although its application might be seen as time and money consuming (Cuppen et al. 2010).

Our study has some limitations that should be considered in future research. First, we used a convenience sample complemented by snowballing to recruit participants. These sampling techniques are non-probabilistic and hence results have to be interpreted with care, but we argue that it is adequate for our study purposes. The application of Q methodology does not allow for generalizations; however, we argue that this approach offers a holistic view of aspects influencing cross-border cooperation. Second, the study was conducted only in a Dutch-German cross-border region, the Euregio Rhine-Waal, which might bias some of the results. For example, good communication and transport infrastructure was not seen as an important aspect in any viewpoint, but this is likely because the infrastructure is already well developed in the region. In the literature, the relationship between enterprises and education and research institutions, i.e. universities, is usually considered as beneficial for innovation development and economic growth (Barajas, Huergo, and Moreno 2012; Peer and Stoeglehner 2013). However, the role of education and research institutions for further facilitation of cross-border cooperation did not emerge in any viewpoint. For our study region, it might be the case that connections to universities and research institutes are already in place at national level. Thus, we suggest that future research should be conducted in other cross-border regions to verify whether the viewpoints align to those identified in our research. Furthermore, Q methodology could be applied in cross-border regions to investigate stakeholders' perceptions on specific policy instruments which are planned but before they are implemented.

Appendix A



Figure 5-A1 Grid to sort the Q set

Table 5-A1 Development of Q sample statements

Nb.	Statements				
	Cross-border cooperation would be facilitated if				
1	People spoke the same language on both sides of the border.	5) INT			
2	Stakeholders in the cross-border region were more reliable.	4) INT			
3	Stakeholders adapted to the business customs (i.e. hierarchal structures) of the other country.	1) 6)			
4	Universities cooperated more with industry on both sides of the border.	1) 2) 3) INT			
5	More cross-border R&D and innovation transfer projects were established.	4) INT			
6	Enterprises had easier access to research institutions on the other side of the border.				
7	More networking events were organized on both sides of the border.	1) 4)			
8	The cross-border region had better public transportation infrastructure.	2) 8)			
9	The cross-border region had better highway infrastructure.	2)			
10	The cross-border region had better internet connection.	2) 7)			
11	The regulatory and bureaucratic burdens of doing business across the border were minimized.	4)			
12	Intellectual property rights were regulated in a similar manner in both countries.	4) INT			
13	Bureaucratic formalities were reduced when applying for common projects on the other side of the border	INT			
14	Enterprises had access to services that address questions on entering the market on the other side of the border.	4) INT			
15	Business sectors had similar priorities in both countries.	1)			
16	Education and job qualification certificates were mutually accepted in both countries.	8)			
17	Governmental strategies for industry development were similar in both countries.	3)			
18	Prices and costs of services and goods were similar in both countries.	5)			
19	The political systems were similar in both countries (centralist in NL vs. federalist in GER).	3) 4)			
20	Policy objectives of bordering regions were developed in cooperation with the other country.	3) 4)			
21	Policy objectives in each country were more clear.	1)			
22	Cooperations were driven more by developing knowledge than reducing costs.	9)			
23	All stakeholders in the cross-border region were pro-actively engaged in cooperation.	9)			
24	All stakeholders mutually engaged in cooperation.	4)			
25	Networks were better developed through cross-border research projects.	4) INT			

Supporting literature: ¹⁾ Hekkert et al. (2007), ²⁾ Klein Woolthuis, Lankhuizen and Gilsing (2005), ³⁾ Trippl (2010), ⁴⁾ Hermans, Klerkx and Roep (2015), ⁵⁾ Topaloglou et al.(2005), ⁶⁾ Johannessen (2009), ⁷⁾ Carayannis and Grigoroudis (2014), ⁸⁾ Neuberger et al. (2020), ⁹⁾ Lundquist and Trippl (2013) ^{INT} Inputs from the interviews.

Appendix **B**

Q-sorts	F1	F2	F3	F4
Q1	0.18	0.03	0.12	0.85
Q2	0.76	0.04	-0.02	0.20
Q3	0.61	0.53	-0.20	0.09
Q4	0.07	0.46	0.28	0.64
Q5 ^a	0.71	-0.40	0.16	0.00
Q6	0.62	0.10	0.38	-0.04
Q7	0.68	0.22	0.14	0.21
Q8	0.05	0.84	0.03	-0.09
Q9 ^{ab}	0.48	0.22	0.57	0.31
Q10	0.13	0.73	0.30	0.29
Q11 ^b	0.47	0.44	0.55	0.02
Q12	0.62	0.06	0.23	-0.11
Q13	-0.12	0.08	0.69	0.04
Q14	0.56	0.06	0.23	-0.48
Q15	0.39	0.04	0.79	0.11
Q16 ^a	0.66	0.04	-0.19	0.28
Q17	0.07	0.58	0.42	0.28
Number of	0	2		
participants	ð	3	4	2
Eigenvalue	5.9	2.3	1.6	1.3
Explained	24	16	15	11
ariance (%)	24	10	15	11

Table 5-B1 Loadings of each participant and defining Q-sorts (in bold)

a Q-sorts completed by two respondents. b Q-sorts manually added to one factor



Chapter 6: General discussion

6.1 Introduction

European cross-border regions are areas with unused potential for economic development (Camagni, Capello, and Caragliu 2019). The cross-border setting influences enterprises ability for cooperation; and cooperation influences innovations, which are specifically needed in the agri-food sector (Galanakis 2006; Trippl 2010; Lefebvre, Steur, and Gellynck 2015). Promoting cross-border cooperation of enterprises involved in innovation in the agri-food sector can enable the utilization of previously untapped economic potential. This thesis goes beyond previous literature on cross-border regional innovation systems (Lundquist and Trippl 2013; Trippl 2010) and the innovation environment (Galanakis 2006) by exploring cross-border factors at enterprise level. In this way it attributes an important role to enterprises' cooperation with other regional stakeholders for innovation development in cross-border regions. Hence, it contributes to innovation system literature in cross-border regions and explores how cross-border factors determine innovation in the agri-food sector.

Chapter 2 indicated that differences in access to knowledge bases, accessibility, socio-cultural proximity, differences in institutional set-up and governance structure can explain differences in innovativeness in cross-border regions and hence confirmed earlier work of Lundquist and Trippl (2013). Chapter 3 and 4 further explored these factors and observed that they determine innovation in a cross-border setting. Chapter 2 concluded that these factors influencing cross-border cooperation are interrelated and should be analyzed collectively. Hence, Chapter 5 builds on this observation and identified four distinct viewpoints on how cross-border cooperation can be facilitated.

In the remainder of this chapter, the synthesis elaborates on the results of the four research chapters and compares the perspective of entrepreneurs to other regional stakeholders' perspective. It focuses on the limiting and utilizing cross-border factors that determine innovation and positions the findings in the literature. Other regional stakeholders include members of universities, governmental institutions, and industry representatives. Furthermore, this chapter discusses the methods and provides business and policy recommendations.

6.2 Synthesis on how cross-border regional factors determine innovation

The perspective of entrepreneurs and other regional stakeholders are compared along crossborder aspects identified in the four research chapters. In Chapter 2, 3, 4 and 5, the role of language and culture, university linkages, and institutional set-up and governance structures was investigated and in Chapter 3 and 4, the role of innovation brokers and cross-border institutions emerged as additional factor determining agri-food innovation. A first observation from looking at the results of Chapters 2, 3 and 4 is that other regional stakeholders and entrepreneurs address and identify similar cross-border factors which influence cooperation and hence innovation. However, after a comparison of perspectives from Chapter 3 and 4, it is apparent that innovation system dynamics are not really understood by other regional stakeholders because until today limitations of the border for enterprises are still present. The perspective of other regional stakeholders concentrates on aligning identified differences in culture, university structure, institutional set-up and governance structure in the cross-border region to support the entrepreneurs (Chapter 4). Chapter 3 and 4 show that these differences cause uncertainty for the entrepreneurs and, hence, make cross-border cooperation less appealing from an entrepreneurs' perspective. While innovation commonly is the outcome of a process in which the entrepreneurs are confronted with uncertainty, uncertainty seems to increase with factors related to the crossborder innovation environment. This vision is shared by the entrepreneurs in our sample. A detailed comparison of how these differences are perceived by the two stakeholder groups is presented in the remainder of this section.

6.2.1 Language and culture

The role of language and culture in cross-border cooperation and, consequently, for innovation was explored in Chapter 2, 3, 4 and 5. Chapter 3 and 4 showed that differing cultures (and not language) were a reason for less cross-border cooperation from the perspective of other regional stakeholders. The entrepreneurs also identified the same reason. In Chapter 3 and 4, the entrepreneurs indicated that these differences in culture caused uncertainty and limited their business operations across the border. This observation is in line with the outcomes of previous research showing that innovation in business networks in cross-border regions can benefit from differences in cultures (Leick 2012; Balogh and Pete 2017; Weidenfeld, Björk, and Williams 2016).

Chapter 4 also identified that the entrepreneurs were more willing to attend a networking event across the border if they were already familiar with the organizers. This observation suggested that trust was one prerequisite for cooperation to build and apply knowledge (Bardy 2010). Moreover, from an entrepreneurs' perspective, establishing contacts with a different culture and mind-set benefitted innovation, an outcome that was also observed in the German-Polish-Czech border region (Knippschild 2011). However, Chapter 5 revealed two opposite viewpoints: one which attributed a high facilitating role to socio-cultural proximity on cross-border cooperation, and the other where it was not considered important.

6.2.2 University linkages

The role of universities linkages for cross-border cooperation and, consequently, for innovation was investigated in Chapter 2, 3, 4 and 5. From the perspective of other regional stakeholders, limitations arose from different university structures in either country (Chapter 2, 4). In Chapter 4, the perspective of entrepreneurs indicated that these differing structures further caused a lack of awareness of possibilities for knowledge exchange and cooperation

with universities. The entrepreneurs indicated they lacked time and that they were left alone on how to establish cross-border university linkages while other regional stakeholders did not seem concerned about fostering university linkages in the future.

In Chapter 4, linkages of universities as part of the innovation support system were hardly present across the border. The entrepreneurs recognized that universities offered opportunities for accessing well-educated labor across the border and considered cross-border cooperation with universities as important. Literature on regional development (Grillitsch and Nilsson 2017; Peer and Stoeglehner 2013) also considered universities an important actor for knowledge transfer to enterprises in the region. Schäffler, Hecht, and Moritz (2016) confirmed the important role of university - SME cooperation in border regions; (van den Broek, Benneworth, and Rutten 2019) proposed that universities also play an important role in building cross-border networks and forming cross-border regional innovation systems. However, a special facilitating role of universities for cross-border cooperation was not found in the results of the analyzed cross-border region in this thesis. In Chapter 5, no viewpoint on the role of university for facilitating cross-border cooperation emerged. The absence of such a viewpoint suggested that university linkages did not take a special role in facilitating cross-border cooperation in the case study region.

6.2.3 Institutional set-up and governance structure

The role of the institutional set-up and the governance structure for cross-border cooperation and, consequently, for innovation was explored in Chapter 2, 3, 4 and 5. Other regional stakeholders acknowledged the differences in legislation and technical standards but did not consider them a major limitation for cross-border cooperation in Chapter 2 and 4. Other regional stakeholders' prime limiting factor was the focus of the national government on national demands because it inhibited the provision and use of innovation support services and the development of a common strategy for cross-border regional development. The importance of a common cross-border strategy for the governments was identified in case studies in the Anglo-Scottish border region (Peck and Mulvey 2017) and the Spanish-Portuguese border region (Podadera Rivera and Calderón Vázquez 2018) and also confirmed at EU level (Noferini et al. 2020).

In Chapter 4, from the entrepreneurs' perspective, the absence of a common strategy for cross-border development caused unclear procedures for cross-border cooperation and a lack of responsible persons assisting in cross-border problems. The absence of a cross-border focus of national governments ultimately led to uncertainty for the entrepreneurs and might explain why they also exhibited a national focus and why only few cross-border related influences were identified during agri-food innovation processes in Chapter 3. From the perspective of other regional stakeholders, the national focus of entrepreneurs and their absence of a cross-border focus can be interpreted as missed opportunities for early crossborder engagement in innovation development. The entrepreneurs indicated that they would appreciate inclusion in defining new standards and in complying with existing regulations (Chapter 3).

The observation of entrepreneurs and other regional stakeholders from Chapter 2, 3 and 4 indicated that aligning the institutional set-up and reducing barriers arising from different governance structures across the border was an essential complementary step. It is not a main factor for initial facilitation of cross-border cooperation but alignment of structures should be considered for further facilitation of cross-border cooperation. The identification of the viewpoint "cooperation through aligned institutional set up" supported the idea that alignment could be considered a follow-up step for successful cross-border cooperation (as also suggested by van den Broek, Rutten, and Benneworth 2020). van den Broek, Rutten, and Benneworth (2020) argued that cooperative linkages already need to be in place and only then reducing obstacles can help further cross-border integration.

6.2.4 Brokering and cross-border institutions

The role of innovation brokers for cross-border cooperation and, consequently, for innovation was observed in Chapter 3 and 4. In Chapter 4, the other regional stakeholders acknowledged that casual interaction between stakeholders across the border is not sufficiently facilitated. The entrepreneurs' perspective confirmed this observation by indicating that they lacked awareness for networking opportunities across the border (Chapter 4).

Furthermore, from the perspective of entrepreneurs, developing cross-border networks was time consuming and corresponded with an uncertain outcome (Chapter 4). This observation could be related to the fact that cooperation between brokering services across the border was limited. However, from Chapter 4 entrepreneurs did not indicate that brokers or cross-border institutions were specifically helpful in dealing with uncertainty. From the perspective of other regional stakeholders, the role of brokering services and cross-border institutions was considered important in facilitating and sustaining cross-border cooperation. Literature emphasizes the important role of brokers for cooperation in rural regions (Leick and Gretzinger 2020) and specifically in cross-border regions (Lepik and Krigul 2016) whereas the results of this thesis show that this is only perceived as an important factor by the other regional stakeholders. Historical analyses of cross-border cooperation in Europe (Molema 2018; Noferini et al. 2020) already indicated the positive impact of cross-border institutions on cross-border cooperation, however, the benefits may be more apparent for other regional stakeholders because they are more aware of the role and influence of those institutions in translating ideas into policy objectives than the entrepreneurs.

In Chapter 2, 3, 4 and 5, the Interreg program was a re-occurring topic because this program plays a major role in fostering integration and cooperation in cross-border region. Deriving from Chapter 2, 3 and 4, other regional stakeholders and entrepreneurs agreed about the facilitating role of Interreg projects for cross-border networking because this program usually has clearly defined common goals (which was considered important for territorial success across EU case studies in (Castanho et al. 2018). In Chapter 2, a lack of public

funding across the border was identified to limit cross-border cooperation and Chapter 4 revealed that only Interreg provided cross-border financing. However, access to financing was not the core motivation for participating in Interreg from the entrepreneurs' perspective; Chapter 3 concluded that the entrepreneurs needed more than just financial support for cross-border cooperation. Chapter 4 showed that, next to funding, entrepreneurs indicated that Interreg also provided networking opportunities, facilitated the introduction to a new market structure and eased the development of business strategies for the entrepreneurs. Case studies in the Spanish-Portuguese border region and the Southern Finish-Estonian border region confirmed the facilitating role of the Interreg program (González-Gómez and Gualda 2017, 2016). Nevertheless, Interreg programs have their limitations because research in Scandinavian cross-border regions and the German-Polish border region showed that the short-term focus of Interreg programs does not lead to sustainable cross-border cooperation (Shepherd and Ioannides 2020; Szmigiel-Rawska 2016).

6.2.5 Synthesized view on agri-food innovation in cross-border regions

This thesis provided different perspectives on cross-border influences in innovation processes of agri-food enterprise. A shortcoming of the cross-border regional innovation system approach (Lundquist and Trippl 2013; Trippl 2010) was the missing enterprise level perspective; a limitation of literature on innovation environment (Galanakis 2006) was the restriction on national and not cross-border factors. Only 1% of cross-border studies focused on the agricultural sector (Makkonen and Williams 2016) and hence still little was known about how the cross-border setting influences the way enterprises work on agri-food innovation.

This thesis highlighted the importance of three main findings especially relevant for agri-food innovation, namely culture, brokers and long-term goals in cross-border regions. Cooperation with other stakeholders was considered to be especially important in the agrifood sector (Lefebvre, Steur, and Gellynck 2015; Klerkx, Aarts, and Leeuwis 2010b) and this thesis showed that differences in culture influence enterprises' interaction with other stakeholder. Consequently, differences in culture influences the development of agri-food innovation in cross-border regions. As SMEs are driving forces of innovation in rural regions (Noronha Vaz, Viaene, and Wigier 2004), this thesis confirmed that innovation benefits from university linkages. However, on top of this enterprises need brokers to work across the border. Cross-border organizations and the Interreg program provide funding, initialize contacts and ease the first steps of cultural integration. However, especially in the agri-food sector, long-term planning for cross-border regional development is necessary because enterprises need long-term goals of cross-border regions for adequate planning of innovation development and testing. Long-term planning is especially important for agri-food enterprises because - contrary to most other sectors - agri-food innovation development can depend on specific production cycles within one or even several years. Hence, specific phases of the innovation process such as testing can be conducted only within specific periods. Longterm plans for cross-border regional development can help to decrease enterprises' uncertainty during innovation development in cross-border regions.

6.3 Reflection of material and methods

Conducting research in cross-border regions is challenging because data for such regions is hardly available. EU databases offer regional data at different regional levels according the 'Nomenclature of territorial units for statistics' (NUTS)¹⁵. The EU defines cross-border regions as NUTS 3 areas in a 25 km zone along the border. However, administrative institutions in cross-border regions (i.e. so-called "Euregions") evolved historically and they not always match the areas defined by the NUTS classification. Consequently, this leads to difficulties for scientists to estimate their outcomes and policy makers to make informed decisions on implementing policy instruments. Besides the explained mismatch, scientists and policy makers are also challenged by the fact that not all data is available at NUTS 3 level. In this thesis, these shortcomings of data availability were overcome by using a survey approach in Chapter 2 and conducting interviews in Chapter 3, 4 and 5.

The survey conducted in Chapter 2 had a relatively low response rate and ultimately covered a non-representative sample of European cross-border regions. Hence, it was difficult to imply causal relations or to determine the relative importance of cross-border factors for innovativeness. For the purpose of this thesis research chapter, namely to explore whether a relationship between cross-border factors and innovativeness at EU level exists, this approach was sufficient. However, increasing the response rate with a special focus that all cross-border regions are represented can improve the validity of the results. If data were consistently available on cross-border regions in the EU, only a longitudinal study can test the causality of the relation between measures to foster cross-border cooperation and innovation outcome.

In Chapter 3, 4 and 5, the focus was on a specific region, namely the Dutch-German cross-border region Euregio Rhine-Waal which makes it difficult to generalize the results to other cases for two reasons. First, the region has a long history of activities to foster cross-border cooperation compared to other European cross-border regions. Hence, results may look different in regions that do not have a long history of cross-border cooperation. Second, the agri-food sector is similarly important in the Dutch and German regions of the Euregio Rhine-Waal and cross-border regions with different industrial foci on either side of the border might face other cross-border factors influencing innovation.

¹⁵ The EU introduced NUTS levels to divide the economic territory of the EU for conducting regional statistical and socio-economic analysis of the regions, and framing of EU regional policies. It consists of four levels, whereas NUTS 0 is the largest unit at country level (e.g. Germany) and NUTS 3 is the smallest diversification for specific diagnoses of regions (Eurostat 2018).

Qualitative research methods like conducting interviews have their limitations regarding participant selection and researcher bias. In Chapter 3, 4 and 5, interview participants were recruited through the researchers' personal network, complemented by snowballing. The recruitment of entrepreneurs was especially difficult because entrepreneurs lack in time and tend not to see an immediate benefit from participating in research. Hence, the sample included primarily entrepreneurs who already realized the potential benefit of participating in cross-border cooperation. Entrepreneurs who had no experience (yet) with cross-border cooperation in innovation development were less represented in the sample of this thesis. Understanding their motivations for a national focus in their business operations would enrich the exploration of factors determining agri-food innovation in cross-border regions. Moreover, research protocols and coding schemes were developed to reduce the researcher bias while conducting and analysing the interviews. The researchers contributing to the various research chapters of this thesis helped to implement and refine the protocols.

6.4 Implications for businesses and policy

Implications of this thesis address entrepreneurs located in cross-border regions, cross-border region institutions and EU authorities responsible for developing the new round of European Cohesion Policy plans within ERDF (including the Interreg program). A core concern of entrepreneurs was: how to deal with uncertainty in different cross-border related factors. The results from Chapter 3 and 4 suggest that entrepreneurs can overcome cultural differences by involving people who are familiar with the culture of the neighbouring country. Entrepreneurs can benefit from insights generated in this thesis by including people familiar with the culture in their cross-border business operations. Moreover, innovation brokers can coordinate enterprises' demand for innovation support services and hence, the establishment of cross-border innovation brokers is crucial for enterprises' engagement across the border (Chapter 4).

Other regional stakeholders prioritize the alignment of structures across the border, while alignment is 'just' a complementary step (Chapter 2, 3 and 4). Chapter 2 highlights that every cross-border region has its particularities and facilitating cohesion and economic development can take several forms in different cross-border regions. The results from Chapter 2 and 5 are particularly important for EU authorities and cross-border region institutions because they suggest that general priorities are acceptable at EU level if individual cross-border regions still have decision freedom in the specification of interpreting and achieving EU goals. The cross-border specific interpretation of EU goals should be based on stakeholders' needs and different stakeholders should be involved in formulating specific tasks and policies. For example, policy makers should include entrepreneurs in defining new standards and in complying with existing regulations (Chapter 3).

6.5 Implications for future research

This thesis started to unravel cross-border regional factors determining innovation in the agri-food sector but considerably more work is necessary to understand the relation between cross-border regional factors and innovation success. Further research should concentrate on the following three priorities. First, the external validity of the results of this thesis have to be tested more extensively. Future research should be conducted in the agrifood sector in other cross-border regions and results should be compared with the case study results of this thesis. Furthermore, the applicability of the thesis results should be tested within other industry sectors, specific types of innovations and among larger enterprises.

Second, further insights at enterprise level are necessary. It is essential to know the costs and benefits for enterprises to access innovation support services across the border and to participate in Interreg programs. What are the reasons for enterprises to cancel or maintain cross-border linkages? A longitudinal study can help to understand the effect of cross-border influences experienced by entrepreneurs on innovation success and to evaluate cross-border facilitating measures such as the Interreg programs.

Third, further insights are necessary to evaluate policy instruments. This is especially difficult because until now, data for cross-border regions are not uniformly collected and data at NUTS3 level are not consistently available for all EU regions. An investigation of stakeholders' perspectives on specific policy instruments before they are implemented in cross-border regions could increase the chances that the policy instruments actually meet the needs of the targeted stakeholders. Q methodology can assist in such a preevaluation.

6.6 Main conclusions

- Cross-border factors are related to differences in innovativeness in European crossborder regions (Chapter 2).
- Uncertainty increases for enterprises operating and developing innovation across the border because different structures exist on the other side of the border (Chapter 3 and 4).
- Regional stakeholders share views on how cross-border cooperation can be facilitated, namely through proactive engagement, aligned institutional set-up, targeted policies and socio-cultural proximity (Chapter 5).
- Entrepreneurs consider cross-border factors such as different legislations and market requirements too late (if at all) in the innovation process (Chapter 3).
- Cross-border differences in culture, university structure, institutional set-up and governance structures cause uncertainty for entrepreneurs and make cross-border cooperation less appealing in the case study area (Chapter 3 and 4).
- Innovation brokers are a facilitating factor determining agri-food innovation in cross-border regions (Chapter 3 and 4).

- Every cross-border region has its own unique constellation of factors influencing cross-border cooperation (Chapter 2).
- In the Dutch-German cross-border region, universities do not have a particularly important role in facilitating cross-border cooperation (Chapter 3, 4 and 5).
- From the perspective of other regional stakeholders (members of universities, governmental institutions, and industry representatives), general priorities at EU level have to be considered but from the entrepreneurs' perspective decision freedom in the specification of interpreting and achieving EU goals in the Euregions is needed (Chapter 3, 4 and 5).



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English summary

Innovations in the agri-food sector are necessary to increase resource efficiency and sustainability and contribute to the EU's Green Deal objective to become climate neutral by 2050. Enterprises are a main initiator of innovations and innovation is facilitated by enterprises' cooperation with other stakeholders. In cross-border regions, cooperation is particularly challenging due to differences in language, network structures and the economy. This can explain the underutilization of border regions' economic potential. European Cohesion Policy promotes cross-border regional integration to ease cross-border cooperation but lacks insight and understanding of enterprises' situations and the role of different stakeholders within the cross-border setting. It is still unknown how the cross-border setting influences the way enterprises work on agri-food innovation. Hence, a better understanding of innovation in cross-border regions is required for informed decision making in European Cohesion Policies. This thesis explored how cross-border regional factors determine innovation in the agri-food sector.

Chapter 2 investigates the relation between factors defining cross-border business interaction and innovativeness in cross-border regions. These interactions can be influenced by factors concerning the availability of science and knowledge bases, socio-cultural proximity, accessibility, institutional set-up, and governance. Using secondary data and survey data, Chapter 2 confirmed that differences in innovativeness levels between countries are related to factors hindering cross-border business interaction. Chapter 2 concludes that the investigated factors are interrelated and should be collectively analyzed for strategic decision making in cross-border regions. The findings of Chapter 2 formed the base for further exploration of the relation of cross-border cooperation and agri-food innovation in Chapter 3 and 4, and for the identification of regional stakeholders' viewpoints on facilitating cross-border cooperation in Chapter 5.

Chapter 3 investigates how the innovation environment affects product innovation processes of agri-food enterprises located in a cross-border region. The innovation environment is beyond enterprises direct control and comprises access to finance, university knowledge and customers. The market success of innovations depends on the innovation environment. The results of the case study indicate that innovation processes were mainly influenced by factors regarding the innovation environment at a national level, and that cross-border factors and cooperation were rare in the Dutch-German cross-border region. Chapter 3 concludes that enterprises should integrate customers and business partners - especially across the border - during research and technological development to facilitate the innovation process and ease market entry – also across the border.

Chapter 4 studies the provision and use of innovation support services to explore their opportunities and limitations in a cross-border region. Innovation support services assist enterprises to work within the innovation environment and offer support in network building or demand articulation. The results show that the provision and use of innovation support services is nationally concentrated and only a single cross-border innovation support service provider was identified, i.e. the Interreg program. The Interreg program presents a linkage of two systems of innovation support services which exist parallel in each country (and are therefore hardly integrated). Chapter 4 concludes that the provision and use of innovation support services in cross-border regions face adaptation problems similar to transferring an innovation support service system to countries further away.

Chapter 5 focuses on understanding how cross-border cooperation can be facilitated. The European Union fosters cooperation in cross-border regions through the European Cohesion Policy, but the development of according policy instruments requires a participatory approach in which stakeholders' views are acknowledged. A prerequisite for a meaningful involvement of all stakeholders is an in-depth understanding of their viewpoints on what facilitates cross-border cooperation. Q methodology was used to identify and analyze stakeholders' viewpoints about aspects that could facilitate cross-border cooperation. Four distinct viewpoints emerged: cooperation through (i) pro-active engagement, (ii) targeted policies, (iii) an aligned institutional setup, and (iv) socio-cultural proximity. Chapter 5 concludes that it is crucial to learn more about stakeholders' experiences and viewpoints to increase their involvement in participatory approaches and thus reduce disparities and promote cohesion between the EU member states.

Chapter 6 synthesizes the findings of Chapters 2 through 5. It discusses the perspective of entrepreneurs and other regional stakeholders on the role of language and culture, university linkages, institutional set-up and governance structure, the brokering and cross-border institutions in determining innovation. Chapter 6 concludes that culture, availability of brokers and a cross-border strategy influence enterprises' business operations in cross-border regions but a facilitating role of university linkages does not seem to be immediately apparent at enterprise level. This thesis contributes to cross-border literature by (i) presenting opportunities and limitations of cross-border regional innovation systems at enterprise level, (ii) offering insight on cross-border influences in agri-food innovation processes, (iii) providing information to improve informed decision making in cross-border regions, and (iv) proposing ways to stimulate cross-border cooperation to facilitate agri-food innovation development.

The main conclusions of this thesis are:

- Cross-border factors are related to differences in innovativeness in European crossborder regions (Chapter 2).
- Uncertainty increases for enterprises operating and developing innovation across the border because different structures exist on the other side of the border (Chapter 3 and 4).
- Regional stakeholders share views on how cross-border cooperation can be facilitated, namely through proactive engagement, aligned institutional set-up, targeted policies and socio-cultural proximity (Chapter 5).
- Entrepreneurs consider cross-border factors such as different legislations and market requirements too late (if at all) in the innovation process (Chapter 3).

- Cross-border differences in culture, university structure, institutional set-up and governance structures cause uncertainty for entrepreneurs and make cross-border cooperation less appealing in the case study area (Chapter 3 and 4).
- Innovation brokers are a facilitating factor determining agri-food innovation in cross-border regions (Chapter 3 and 4).
- Every cross-border region has its own unique constellation of factors influencing cross-border cooperation (Chapter 2).
- In the Dutch-German cross-border region, universities do not have a particularly important role in facilitating cross-border cooperation (Chapter 3, 4 and 5).
- From the perspective of other regional stakeholders (members of universities, governmental institutions, and industry representatives), general priorities at EU level have to be considered but from the entrepreneurs' perspective decision freedom in the specification of interpreting and achieving EU goals in the Euregions is needed (Chapter 3, 4 and 5).



Deutsche Zusammenfassung

Untersuchung der Rolle grenzübergreifender regionaler Faktoren bei Innovationen im Agrar- und Ernährungssektor Innovationen im Agrar- und Ernährungssektor sind notwendig um die Ressourceneffizienz und Nachhaltigkeit zu steigern und dazu beizutragen die Ziele des Europäischen Green Deals zur Klimaneutralität bis 2050 zu erreichen. Unternehmen sind Hauptinitiatoren von Innovationen und Innovation wird durch die Kooperation von Unternehmen mit anderen gesellschaftlichen Akteuren (fortan "Stakeholder" genannt) gefördert. In Grenzregionen ist Kooperation durch Unterschiede in der Sprache, den Netzwerkstrukturen und der Wirtschaft besonders schwierig. Dies kann die fehlende Ausschöpfung des wirtschaftlichen Potentials von Grenzregionen erklären. Die europäische Kohäsionspolitik fördert die regionale Integration um grenzübergreifende Kooperation zu erleichtern. Dennoch ist über die Situation und die Rolle von Unternehmern sowie anderer Stakeholder in Grenzregionen wenig bekannt. Es ist noch nicht klar wie ein grenzübergreifendes Umfeld die Arbeitsweise von Unternehmen an Innovationen im Agrar- und Ernährungssektor beeinflusst. Daher ist ein besseres Verständnis von Innovation in diesen Regionen für fundierte Entscheidungen bei Maßnahmen im Rahmen der europäischen Kohäsionspolitik erforderlich. In dieser Dissertation wurde untersucht, wie grenzübergreifende regionale Faktoren Innovationen im Agrar- und Ernährungssektor bestimmen.

Kapitel 2 erforscht den Bezug zwischen Innovationskraft in Grenzregionen und Faktoren. die grenzübergreifende Geschäftsbeziehungen definieren können Geschäftsbeziehungen können beeinflusst werden durch Faktoren hinsichtlich der Verfügbarkeit von Wissenschafts- und Wissensbeständen, soziokultureller Nähe, Erreichbarkeit (Infrastruktur), institutionellem Aufbau und Steuerung der Politik und Wirtschaft, Anhand von Sekundärdaten und Daten aus einer Befragung wurde in Kapitel 2 bestätigt, dass Unterschiede in der Innovationskraft zwischen angrenzenden Ländern in Bezug zu Faktoren stehen, die grenzübergreifende Geschäftsbeziehungen behindern. Kapitel 2 schlussfolgert, dass die untersuchten Faktoren auch untereinander in Bezug stehen und deshalb gemeinsam analysiert werden sollten. Dies ist wichtig für strategische Entscheidungsprozesse in Grenzregionen. Diese Ergebnisse aus Kapitel 2 waren die Basis für weitere Untersuchungen zum Einfluss von grenzübergreifender Kooperation auf Innovationen im Agrar- und Ernährungssektor in Kapitel 3 und 4, und für die Identifikation von Meinungsbildern regionaler Stakeholder zur Förderung grenzübergreifender Kooperation in Kapitel 5.

Kapitel 3 erforscht wie das Innovationsumfeld Produktinnovationsprozesse in Unternehmen in Grenzregionen beeinflusst. Auf das Innovationsumfeld haben Unternehmen keinen direkten Einfluss. Es umfasst die Verfügbarkeit von finanziellen Mitteln, universitäres Wissen und auch die Endkunden. Der Markterfolg von Innovationen hängt vom Innovationsumfeld ab. Die Ergebnisse der Fallstudie deuten darauf hin, dass hauptsächlich von Innovationprozesse Faktoren beeinflusst werden. die das Innovationsumfeld auf nationaler Ebene betreffen, und dass grenzübergreifende Faktoren und Kooperation in der deutsch-niederländischen Grenzregion rar sind. Kapitel 3 schlussfolgert, dass Unternehmen potenzielle Kunden und Geschäftspartner - speziell auf der anderen Seite der Grenze - während der Forschung und der technologischen Entwicklung

miteinbeziehen sollten, damit der Innovationsprozess gefördert und der Markteintritt erleichtert wird – auch auf der anderen Seite der Grenze.

Kapitel 4 befasst sich mit der Bereitstellung und Nutzung von Dienstleistungen zur Innovationsförderung um Chancen und Hindernisse in Grenzregionen zu erforschen. Solche Dienstleistungen helfen Unternehmen innerhalb des Innovationsumfeldes zu arbeiten und bieten Unterstützung beim Netzwerken und der Identifikation von Bedürfnissen. Die Ergebnisse zeigen, dass sich die Bereitstellung und Nutzung von Dienstleistungen zur Innovationsförderung auf den nationalen Kontext konzentriert; nur eine einzige grenzübergreifende Dienstleistung wurde identifiziert, nämlich das Interreg-Programm. Das Interreg-Programm bietet eine Verbindung von zwei Systemen an Dienstleistungen zur Innovationsförderung, die parallel in jedem Land existieren (und deshalb kaum miteinander verknüpft sind). Kapitel 4 schlussfolgert, dass die Bereitstellung und Nutzung von Dienstleistungen zur Innovationsförderung in grenzübergreifenden Regionen mit Adaptionsproblemen zu kämpfen hat, die ähnlich sind wie Probleme, wenn solche Dienstleistungen in weiter voneinander entfernte Länder eingeführt werden.

Kapitel 5 beschäftigt sich damit zu verstehen wie grenzübergreifende Kooperation gefördert werden kann. Die Europäische Union fördert Kooperation in Grenzregionen durch die Europäische Kohäsionspolitik, aber die Entwicklung von entsprechenden politischen Maßnahmen bedarf einer Herangehensweise unter Einbindung lokaler und regionaler Akteursgruppen, in der die Bedürfnisse und Ziele von Stakeholdern berücksichtigt werden. Eine Voraussetzung für eine sinnvolle Beteiligung von allen Akteursgruppen ist ein grundlegendes Verständnis von Meinungsbildern darüber, was grenzübergreifende Kooperation fördert. Die O-Methode wurde angewendet um die Meinungsbilder von Stakeholdern zu Aspekten, die grenzübergreifende Kooperation fördern könnten, zu identifizieren und zu analysieren. Vier unterschiedliche Meinungsbilder waren erkennbar: Kooperation durch (i) proaktives Engagement, (ii) zielgerichtete politische Maßnahmen, (iii) ein angeglichener institutioneller Rahmen und (iv) soziokulturelle Nähe. Kapitel 5 schlussfolgert, dass es ausschlaggebend ist, mehr über die Erfahrungen und Meinungsbilder von Stakeholdern zu erfahren. Nur so kann deren Teilnahme an mitbestimmenden Maßnahmen erhöht. Missverständnisse reduziert und Kohäsion zwischen EU-Mitgliedsstaaten gefördert werden.

Kapitel 6 stellt die Verbindung zwischen den Ergebnissen aus den Kapiteln 2 bis 5 dar. Es erörtert die Perspektive von Unternehmern und anderen regionalen Stakeholdern bezogen auf die Rolle von Sprache und Kultur, Verbindungen im Hochschul- und Forschungssektor, institutionellem Aufbau und politische und wirtschaftliche Strukturen, und diskutiert die Rolle von grenzübergreifenden Institutionen als Informationsvermittler als entscheidende Faktoren für Innovation. Kapitel 6 schlussfolgert, dass Kultur, die Verfügbarkeit von Vermittlern und einer grenzübergreifenden Strategie unternehmerisches Handeln in Grenzregionen beeinflussen. Allerdings ist eine fördernde Rolle von Verbindungen mit Universitäten für Unternehmen nicht sofort erkennbar. Diese Dissertation trägt zur Literatur in Grenzregionen bei indem sie (i) Chancen und Einschränkungen von grenzübergreifenden regionalen Innovationssystemen auf Unternehmensebene präsentiert, (ii) Einblick in grenzübergreifende Einflüsse in Innovationsprozesse im Agrar- und Ernährungssektor bietet, (iii) Informationen zur verbesserten Entscheidungsfindung in Grenzregionen darlegt und (iv) Wege zur Stimulierung von grenzübergreifender Kooperation zur Förderung von Innovationsentwicklungen im Agrar- und Ernährungssektor vorschlägt.

Die Hauptschlussfolgerungen dieser Dissertation sind:

- Grenzübergreifende regionale Faktoren stehen im Zusammenhang mit Unterschieden in der Innovationskraft in europäischen Grenzregionen (Kapitel 2).
- Die Unsicherheit steigt für Unternehmen, die auf der anderen Seite der Grenze tätig sind und Innovationen entwickeln, weil unterschiedliche Strukturen auf der anderen Seite der Grenze existieren (Kapitel 3 und 4).
- Regionale Stakeholder teilen Meinungsbilder darüber, wie grenzübergreifende Kooperation gefördert werden kann, nämlich durch proaktives Engagement, angepasste institutionelle Strukturen, gezielte politische Maßnahmen und soziokulturelle Nähe (Kapitel 5).
- Unternehmer beachten grenzübergreifende regionale Faktoren wie verschiedene Gesetzgebungen und Voraussetzungen am Markt zu spät (wenn überhaupt) im Innovationsprozess (Kapitel 3).
- Grenzregionale Unterschiede in der Kultur, universitären Strukturen, institutionellen Strukturen und Steuerung von Politik und Wirtschaft bewirken Unsicherheit für Unternehmer und machen grenzübergreifenden Kooperation weniger attraktiv in der Fallstudienregion (Kapitel 3 und 4).
- Innovationsvermittler sind ein fördernder Faktor für Innovationen im Agrar- und Ernährungssektor in Grenzregionen (Kapitel 3 und 4).
- Jede Grenzregion hat eine einzigartige Konstellation an Faktoren, die grenzübergreifende Kooperationen beeinflussen (Kapitel 2).
- Universitäten spielen in der deutsch-niederländischen Grenzregion keine außerordentliche Rolle in der Förderung grenzübergreifender Kooperationen (Kapitle 3, 4 und 5).
- Aus der Perspektive von regionalen Stakeholdern (Mitglieder von Universitäten, Regierungsinstitutionen und Industrie) müssen allgemeine Prioritäten auf EU-Level beachtet werden, aber aus Perspektive der Unternehmer braucht es Entscheidungsfreiheit bei den Spezifikationen der Interpretation und dem Erreichen von EU-Zielen in den Euregionen (Kapitel 3, 4 und 5).



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About the author

Sabine Neuberger was born on March 27, 1992 in Eisenstadt, Austria, and grew up on a farm in the Eastern part of Austria, close to the Hungarian border. She obtained a Bachelor's degree in Agricultural Sciences at the University of Natural Resources and Life Sciences Vienna (BOKU) in 2014. During her Bachelor, she spent an ERASMUS semester in Aarhus, Denmark. In 2015, she obtained a Master's degree in Agriculture and Food Economies at the University of Natural Resources and Life Sciences Vienna (BOKU).

In 2016, she joined the scientific staff at the Rhine-Waal University of Applied Sciences in Kleve, Germany, and assisted in several courses in the Bachelor programs "Agribusiness" and "Sustainable Agriculture". One year later, she became involved with the Interreg-funded project "Food Pro-tec-ts" and was offered the opportunity to start a PhD in September 2017 at the Business Economics Group of Wageningen University. She was supervised by Prof. Dr A.G.J.M. Oude Lansink and Dr H.W. Saatkamp from Wageningen University and Prof. Dr D. Darr from the Rhine-Waal University of Applied Sciences. During her PhD, she studied how cross-border regional factors determine innovation in the agri-food sector.

In January 2022, she started to work as a Junior Scientist at the Center for Innovation Systems and Policy in the Austrian Institute of Technology (AIT) in Vienna, Austria.





Education certificate

Sabine Neuberger Wageningen School of Social Sciences (WASS) Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
A1 Managing a research project			
Introduction course	WASS	2017	1
Research Methodology: From Topic to Proposal	WASS	2017-2018	4
Writing PhD research proposal	BEC, WUR	2017-2018	2
Scientific Writing	Wageningen in'to Languages	2019	1.8
Intensive Writing Week	Radbound In'to Languages, Nijmegen	2021	1
"Business interaction and innovativeness in	Regional Studies Annual Conference,	2019	1
European cross-border regions"	Santiago de Compostela, Spain		
"Innovation processes in agri-food SMEs in cross-	International European Forum on	2020	1
border regions - A case study within Dutch and	System Dynamics and Innovation in		
German enterprises"	Food Networks, Garmisch-		
	Partenkirchen, Germany		
"Study of innovation support services for agri-	XVI EAAE Virtual Congress,	2021	1
food enterprises in the Dutch-German cross-	Prague/online		
border region"			
"Stakeholder viewpoints on facilitation of cross-	Q21 conference, Nantes/online	2021	1
border cooperation"			
A2 Integrating research in the corresponding discipline			
Theories for Business Decision, BEC54806	WUR	2017	6
Technology and Innovation in the Agricultural	Technical University Munich, Germany	2017	3
Sector - Theoretical and Empirical Approaches			
Advanced Qualitative Research Design and Data	WUR	2019	6
collection, GEO56806			
B) General research related competences			
B1 Placing research in a broader scientific context			
Innovation Systems in Bioeconomy	University of Helsinki, Finland	2017	5
Data Analysis in Social Scientists	Massachusetts Institute of Technology,	2019	5
	edx online learning		
NVIVO-based Qualitative Data Coding and	WASS	2019	1
Management Training for Social Scientist			
B2 Placing research in a societal context			
Workshop organization within Food Pro-tec-ts	Rhine-Waal University of Applied	2020	1
project: 'Nutzung von Biomasse, Restströme und	Sciences, Kleve, Germany		
Nährstoffen in Deutschland und den			
Niederlanden'			
C) Career related competences/personal development			
Teaching "Strategy and Management" and	Rhine-Waal University of Applied	2020	4
"Agricultural Extension"	Sciences, Kleve, Germany		
Total			44,8
		1	

*One credit according to ECTS is on average equivalent to 28 hours of study load

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