Enhancing Innovation Ecosystems: An Analysis of Cross-Border Collaboration in the North Netherlands region

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Abstract:

This study has the explorative aim of investigating cross-border innovation collaboration from the perspective of the North Netherlands. Contributing to knowledge on the innovation capabilities of the region and assuming socio-economic benefits of a more innovative region. The North Netherlands region actively employing strategies and policies to increase collaboration with neighboring countries in the North Sea area, intensifying in the year 2016. The changes in innovation capabilities since 2016 being captured by three main factors examined by this study, cross-border administrative policies, the influence of sharing a common language, and the role of geographical proximity. The study employs a gravity model to test which factors can explain changes in innovation collaboration before and after the introduction of policy measures. Where innovation collaboration is measured through the number of joint patents. The findings of the study suggest a positive effect of cross-border policies on the number of cross-border joint patents with neighboring regions.

Keywords: Innovation, North Netherlands, Gravity model, Policy, Cross-border collaboration

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Introduction

Contextual framework and problem definition

Policy makers are no strangers in introducing schemes to increase the economic activity in their respective constitutes to contribute to regional development. In their quest to facilitate regional development policy makers may opt for interregional collaboration, creating semi-cohesive regions in which resources are pooled towards common goals. One such region is the North Netherlands region, defined as the geographical area encompassing the three provinces Drenthe, Groningen, and Friesland in the kingdom of the Netherlands.

The collaboration on regional (economic) development in the North Netherlands is facilitated by the creation of semi-public organisations of which the 'Collaboration agency for the North Netherlands' (Samenwerkingsverband Noord Nederland, SNN) oversees the common policy goals. To this end the SNN has created the regional innovation strategy of smart specialization (RIS[1]), focusing on key themes believed to be suitable for the North Netherlands region. The RIS approach being a program of the European Commission to take advantage of places inherent strengths and unique opportunities (Foray et al., 2012). These key themes are meant to guide policymakers and regional development agencies in effective policy making and strategy development. The themes are based on regional strengths such as existing and historic industries or accessibility of certain resources and knowledge.

Innovation is a complex subject as it can take many forms. For this study innovation is defined as the creation of new systems and technologies that could be used for economic purposes. The number of these in a region indicating a high degree of inventive people and potential for economic growth. Furthermore, the assumption is made that the quality of innovation is enhanced by collaboration between inventors (Jandhyala & Phene, 2015). The diversity of different inventors next to collaboration itself is also assumed to enhance the quality. Therefore, the collaborative inventions across borders are assumed to have a higher potential of high-quality inventions (Jandhyala & Phene, 2015).

While the North Netherlands region has an internal strategy for boosting innovation, production and application, there is an understanding that broader collaboration is needed[2] (Balland & Boschma, 2021). Not only to share knowledge, but also because implementation of technologies might go beyond the geographical boundaries of the North Netherlands. Therefore

[1] https://www.snn.nl/strategie-programmas/ris3-strategie-voor-het-noorden (Accessed on 17-7-2023)
[2] https://www.nom.nl/media/actueel/top-dutch-noord-nederland-top-of-mind-bij-buitenlandse-bedrijven/ (Accessed on 17-7-2023

in recent years increased attention is given to cross-border administrative relations in the region. (CPMR, 2020; Gasunie, 2020; Provincie Drenthe, 2020; Provincie Groningen, 2016; SNN, 2022).

The year 2016, a year after the provincial elections in the Netherlands, marks a key point in time where strategies on cross-border administrative collaborations are further intensified in the North Netherlands region. The ambition to intensify relations being codified in the newly draft political coalition agreements and as extension into the semi-public regional organizations. 2016 furthermore, marks the year that the North-Sea commission revised its strategy for closer cooperation among nations bordering the North-Sea (CPMR, 2020). The North-Sea commission is a cooperation platform for regions around the North Sea. The objectives being to promote awareness around the globe of the economic potential of the North Sea region, a platform to fund joint projects and lobby for transitional projects to be developed in the region.

However, evidence for cross-border collaboration policy being a beneficial way of promoting regional economic development is lacking. Previous studies do exist but focus on national levels between countries, disregarding internal differences of geographical locations. As evidence for regional cross-border policy is limited the novelty of this study will be to investigate if effects of North Netherlands policy attempts can be found. Findings can be used by policy makers concerned with regional (economic) development as basis for future schemes. As policy creation inherently consumes means of governments testing effectiveness of current policy is relevant to guide decision makers.

To assess cross-border collaboration in the North Netherlands, for this study the proxy of joint patents between international and regional inventors will be used. Joint patents are assumed to be representative for cross-border collaboration because they are outcomes of high value partner collaboration between institutions, firms and persons (Fagerberg, Mowery, & Nelson, 2011). A higher number of joint patents indicates lower barriers for cross-border collaboration. Joint patents have the added benefit of high-quality data linked to spatial locations of inventors exists and thus allowing for statistical analysis (OECD, 2023). The patent data includes all inventors credited and their geographical location. Moreover, patents are assumed to show not only realised and under-construction developments, but also projects that could benefit the region in the future.

Study aim

As introduced the goal of this study will be to assess the effectiveness of policy on cross-border collaboration in the North Netherlands. The policy effectiveness will be measured by innovation collaboration in the North Netherlands, as this is one of the main objectives of cross-border collaboration laid out in the Research and Innovation Strategy for Smart Specialisation 3 (RIS3). To get clear insight into the policy effectiveness this study includes the additional factors of sharing a common language and geographical proximity. These factors being included as they have been used in previous studies with similar goals to this one (Abbasiharofteh, Kogler, & Lengyel, 2023; Bayraktutan, Yilgör, & Uçak, 2011; Kuik, Branger, & Quirion, 2019; Mewes, 2019; Picci, 2010). By using these factors and comparing the results to the previous studies the results for policy influence can be validated on robustness. Next the results of cross-border policy influence will be interpreted for policy evaluation and recommendations.

Academic and societal relevance

The goals of this study serve both an academic and societal relevance. The academic relevance is adding towards the existing debate on the effect of public policy on regional development. Recent years have seen an increased number of academic literature dedicated towards regional development both in the why this might be important as in how this should be realised (Balland & Boschma, 2021; European Investment Bank, 2023; Porter, 2000). This study contributes to the latter academic debate by investigating one aspect of regional development policy attempts. The research gap addressed in the debate of realising regional development by this study, is the measuring of the effectiveness of local cross-border policy towards collaborative joint patents and thus regional innovation power. Furthermore, the research topic contributes to the ongoing academic debates on regional integration of economic systems. Where the interplay of geographical local scale in the highly globalized world economy is investigated and gaining importance.

Next to contributing to academic debates surrounding regional development, this study aims to also serve a direct societal relevance. Since the subject of the study measures real world contemporary data, outcomes can directly be used by policymakers for future schemes. Evidently policymakers of the North Netherlands may use results for direct evaluating their own strategies, but also similar regional entities can use outcomes for their strategic plans. The information can be used in debates and planning towards better policies for economic development within the regions.

Research questions

Following the above, the central research question of this thesis is formulated as '*Does cross-border relations policy correlate with cross-border innovation collaboration in the North Netherlands?'*

Supported by the sub-questions formulated as:

1. *Have cross-border collaborations in the North Netherlands increased since 2016?*
2. *Does policy on cross-border administrative relations by governments in the North Netherlands show evidence of increased cross-border joint patents?*
3. *Are Dutch speaking inventors more likely to create joint patents with inventors based in the North Netherlands?*
4. *Does geographical proximity to the North Netherlands influence the number of joint patents?*

The first sub-question will create the context in which the goal of the research operates. Aiming to capture if an increase in patents can be noted in the North-Netherlands. Moreover, it sets the scene in which ways collaboration can take place. Dividing collaboration in three levels

- Intraregional collaboration within the three provinces.
- Interregional among the three provinces of the North Netherlands.
- Interregional with other countries.

In the theoretical framework section, the current academic discourse regarding patents and cross-border collaboration will be explored in order to get an understanding of what to expect and to be able to give value judgement to the findings.

The second sub-question aims to explore whether government policy and strategies on cross-border collaboration have increased the number of joined patents with inventors from the North Netherlands. To answer and evaluate this question effectively, the theoretical framework section will delve into academic discourse on administrative cross-border relations. Furthermore, existing empirical findings will be discussed.

The third sub-question considers regions that share a common language with the North Netherlands region and the effect on joint patents. Since all three provinces have Dutch as main language this will be the language explored. The theoretical discussion will explore the current academic literature on language similarity and the effect on patent and innovation collaboration.

The fourth sub-question considers the geographical dimension of this study by looking into the geographical proximities of joint patent collaboration. The academic discourse on geographical proximity on innovation and patent creation will be discussed further in the theoretical framework.

Results of this study should function as contribution in the debate for further investigation in effective and strong policy development to boost the region's socioeconomic indicators.

Study outline

This study will consist of several chapters building towards reaching conclusions on the correlation of factors identified in contributing to innovation collaboration in the North-Netherlands.

The first chapter will discuss the theoretical framework used for this study. In this chapter the study will review existing literature and theory, creating a framework in which investigations into the North Netherlands cross-border case is conducted.

The methodological chapter will introduce the data and methods that have been used to investigate joint patent development using the variables of interest cross-border strategies, language, and geographical proximity. Backed by existing academic studies of a similar nature to justify the research method. The data and variables section will introduce and discuss all data used in this study. For background knowledge the section first addresses a brief overview of facts and figures of the North Netherlands. The section is followed by the introduction of datasets. The main data source for this study is the 2023 OECD regional patent database, enhanced with statistical data from other freely accessible sources such as Eurostat. Subsequently in the next section the individual variables and their properties will be introduced and discussed. The last parts of the methodological chapter turn to the introduction of the gravity model, followed by the estimation strategy, presenting equations and discussing the method of regression.

The results and discussion chapter are divided into a descriptive statistics part and model results part. In these sections the sub-questions will be answered following the outcomes of the hypothesis testing. Subsequently the chapter delves into the discussion of the results, assessing them, and exploring implications. The results and discussion chapter concludes with a critical reflection on the techniques and results in the limitations section.

The conclusion chapter summarizes the study and addresses key findings, listing takeaways, gaps, and avenues for further research. Furthermore the conclusion section will delve into

policy implications of the results. The results suggest that cross-border policy had a positive influence on the number of joint patents in the North Netherlands region since 2016. Where the language variable and geographical proximity variable show similar results to previous studies.

Theoretical framework

This study in essence investigates relations through a geographical lens, following concepts of relational economic geography as describe by Harald Bathelt and Johannes Glückler in their 2003 paper. Relations not only being the connection between persons leading to innovation, but also the complex effects of interplay between firms, government, and knowledge institutions. The framework for analysis developed by Bathelt and Glückler involves what they call the four 'ions', organization, evolution, innovation, and interaction. They argue that investigating these relations helps to understand regional growth.

This study aiming to assess effects of cross-border policy on the innovative power of a geographically defined region falling in the innovat'ion' concept. The geographical lens being the North Netherlands region, with relations investigated between inventors from outside of the region. These relations being dependent on size in terms of economic activity, universities, and governmental relations of regions. Relational economic geography is meant to be used as a starting point and framework in which research questions are formulated with human action and context of places in mind (Martin, 2018). This research draws upon this by using geography as the lens and analysing economic, social, cultural, institutional, and political context of that area assuming interdependencies.

Cross-border collaboration

The role of administrative borders for innovation and regional development projects has been subject for academics in recent years (Cappellano, Sohn, Makkonen, & Kaisto, 2022; Castanho, Loures, Fernández, & Pozo, 2018; Jakubowski & Wójcik, 2023). Cross-border collaboration being the main point of interest for this study. Cross-border collaboration is defined as a wide range of policy and strategies that are employed by countries and regions to increase and or enhance collaboration between the countries or regions across their administrative boundaries (Jandhyala & Phene, 2015). Examples ranging from hard infrastructural joint projects such as linking road- or railways to joint programs aimed at boosting a certain industry between the two regions. The definition follows previous work by Cappellano et al. (2022), Castanho et al. (2018).

Cappellano et al. (2022) argue that borders though often being seen as barriers can function as a potential resource for innovation. As the differences arising through borders might actually help innovation in being a portal through which collaboration could be forged. In fact, interregional competitiveness is noted as a positive influential factor when it comes to regional development, by several academic authors (Conti & Giaccaria, 2009; Jakubowski & Wójcik, 2023). Conti and Giaccara (2009) even argue that it is not just the firms that compete with firms outside of an administrative territory, but that the territory itself as entity assumes a competitive role with other regions. Where the competitiveness is assumed to increase economic activity in both regions and lead to cross-border collaboration.

The positive effects identified by Cappellano et al. (2022) are spillover effects, agglomeration economies, economic differentials, economic complementarities, cultural and institutional hybridization and external marketing and branding. However, Capellano et al. (2022) also identify that spillover effects, economic differentials and cultural and institutional differences might also lead to negative effects. Arguing that mental distances of firms and individuals over longer geographical distances, together with incompatible ways of working, slows down collaborative innovation rather than strengthening mutual innovative capabilities.

Furthermore, Cappellano et al. (2022) and Castanho et al. (2018) note that cross-border relations are complex and depend on a wide array of factors. There are many factors needed in order for cross-border collaboration to work, examples being hard infrastructure, setting up joint cross-border policies and political willingness. It can be difficult for officials to get this right, especially for regional governments some of these factors can be very hard to address. Regional governments may not have the sole jurisdiction or the means to tackle them.

Nevertheless, empirical evidence has shown many successes of cross-border relationships in recent years, especially in Europe (Jandhyala & Phene, 2015). The open border system being a very important aspect since it allows individuals to travel between countries easily and freely or even work and live in different places. Moreover, the aligning of physical infrastructure and non-physical ties contribute to increased mutual economic advantages of cross-border regions.

Theory of policy for innovation collaboration

Several initiatives in the North Netherlands have been created with the aim to stimulate innovation, knowledge sharing, entrepreneurship and creating a supportive ecosystem for

businesses to grow and thrive. Notable ones are SNN[3], NOM[4] and UvhN[5], respectively being a governmental lobby agency to attract funds, a regional support organ for entrepreneurs and a newly setup regional knowledge network initiated by the University of Groningen (NOM, 2023; SNN, 2023; UvhN, 2022). With the idea that knowledge generation and innovation will lead to economic development of the North Netherlands region.

Policy to enhance collaborative innovation can take several forms. It can be to diminish barriers such as explored in the works by Cappellano et al. (2022) or it can be through an active role by government such as discussed in articles by Castanho et al. (2018). Though the approaches differ, academic debates agree that collaboration over geographical distances is beneficial for innovative power. The main theory is that a diverse set of actors correlates positively with innovative capacity (Jandhyala & Phene, 2015). Based on assumptions that closed groups run a higher risk of compliance and group think. Whereas diverse dynamic groups from different backgrounds challenge each other and have a higher chance of leading to new insights (Lee, 2015). Theory supports cross-border policies, however some argue that not all approaches are successful and note challenges in getting policy right, such in the study by Jandhyala and Phene (2015). However, the academic debate surrounding cross-border policy seems to be in favour of effectiveness, but divided on how it can be most effective.

Considering the above the endeavour of the local governments in the North Netherlands to increase cross-border relations can be seen as a beneficial move. Limiting the number of rules and thus reduce barriers, as the regional relations are assumed to ease joined ventures across borders of individuals and firms to collaborate. While at the same time by increasing relations over traditional administrative boundaries, perspectives might be incorporated better, making cross-border relation strategies of local governments a potentially worthwhile ambition.

Following theory, the first hypothesis is formulated as follows:

H1 *Innovation collaboration in the North Netherlands region is positively influenced by cross-border collaboration policy adopted in 2016 by North Netherlands governments.*

Theory of shared language for innovation collaboration

An almost given fact when individuals working on innovations and potential patents in a cross-border setting is that their mother tongue will differ from each other. Though it is

[3] https://www.snn.nl/over-het-snn (Accessed on 17-7-2023)
[4] https://www.nom.nl/over-ons/ (Accessed on 17-7-2023)
[5] https://universiteitvanhetnoorden.nl/over-uvhn/ (Accessed on 17-7-2023)

common for academics to be able to speak English, this being a widely used language for research (Fisher, 2015). It might be that for certain innovations high involvement of firms and or professionals is needed that are less proficient in English. This results in a barrier for researchers to collaborate in regions in which they are not able to speak the native language.

Previous studies including language have shown a relation between the presence of a common language and cross-border collaboration (Picci, 2010). The evidence seeming to suggest that sharing a common language indeed increases the chances of cross-border collaboration. Evidence thus suggests that not sharing a common language might pose challenges and barriers for inventors to collaborate and file joint patents. For this reason, this study has chosen to incorporate the common language variable in the testing of cross-border relations affect patent collaboration. Moreover, patent requests need to be done on a national basis meaning that when inventors want to file a patent being in different countries they must decide where to file it (Araghi, Palangkaraya, & Webster, 2023). These filings often must be done in the native language, further complicating cross-border collaboration in the perspective of language.

The correlation of language with cross-border relations may result of language being a proxy of cultural similarity and shared norms and values. A previous study by Irvine et al. (2008) has discussed the relationship between language and cultural understanding. The study has found that sharing a common language is a good indicator of the existence of cultural similarities and shared norms and values (Irvine, Roberts, & Bradbury-Jones, 2008). Arguing this to be the case as language is the means through which these culture, norms and values are codified and shared, and therefore also being a strong predictor of whether they are similar or not. Besides the practical reasons for including language differences in the model discussed above, the cultural aspect language incorporates makes it a potential influential variable when it comes to joint innovation creation.

Following theory, the second hypothesis is formulated as follows:

H2 *Innovation collaboration in the North Netherlands region has increased more strongly in time period 2 between Dutch speaking regions than non-Dutch speaking regions.*

Theory of geographical proximity for innovation collaboration

Economic development can be approached from the perspective of several spatial layers ranging from global to local small-scale units, but in our contemporary globalized world, it should be realised that all these layers are interconnected (Brakman, Garretsen, & Marrewijk,

2019). Globalization has benefited many economies throughout the world, both those that were already prosperous and some that previously lacked behind. However, increasing attention is given to smaller-scale regional places that are regarded as peripheral in their respective countries, especially in the European Union (Barbero & Rodríguez-Crespo, 2022; European Investment Bank, 2023). Recognizing the economic differences on smaller spatial scales, research has increased into the mechanisms and policy interventions of economic development to answer the question of why some regions are prosperous and what can be done to boost lacking regions (McCann & Ortega-Argilés, 2015).

The cluster theories discussed in works by Bettiol et al. (2019) and Porter (2000) is one explanation why geographical proximity remains relevant in the age of readily available communication technologies. The physical agglomeration of individuals and industries in the same sector led to spill-over effects. Face to face contact is more common and easier in settings with shorter geographical distances and chance encounters between individuals that can work to new technologies is higher. Furthermore, resources are more readily available such as (financial) means and equipment (Duranton, 2011). Empirical evidence has also shown that especially complex technologies development benefits from geographical agglomeration (Simensen & Abbasiharofteh, 2022). Furthermore a recent study on the local effects of complex technologies has shown a positive correlation with regional GDP per capita (Mewes & Broekel, 2022).

Academic evidence thus seems to suggest that geographical proximity between actors is a good predictor of collaborative innovation. Though it is not always clear what geographical proximity entails. Therefore some scholars argue that it is not so much about real distances but about economic networks or clusters. (Bettiol, Chiarvesio, Di Maria, & Gottardello, 2019; Picci, 2010). Assuming this is the case activities to create or increase such networks or clusters might simultaneously increase geographical proximity and diminish it. Where real distances increase, but because of non-physical ties perceived distances decrease. The assumption that increased networks can be beneficial for innovation on spatial scales is the justification for cross-border relation policies of the North Netherlands region, and the success of these is therefore assumed to be stimulating more collaborative innovations (Bettiol et al., 2019).

Following theory, the third hypothesis is formulated as follows:

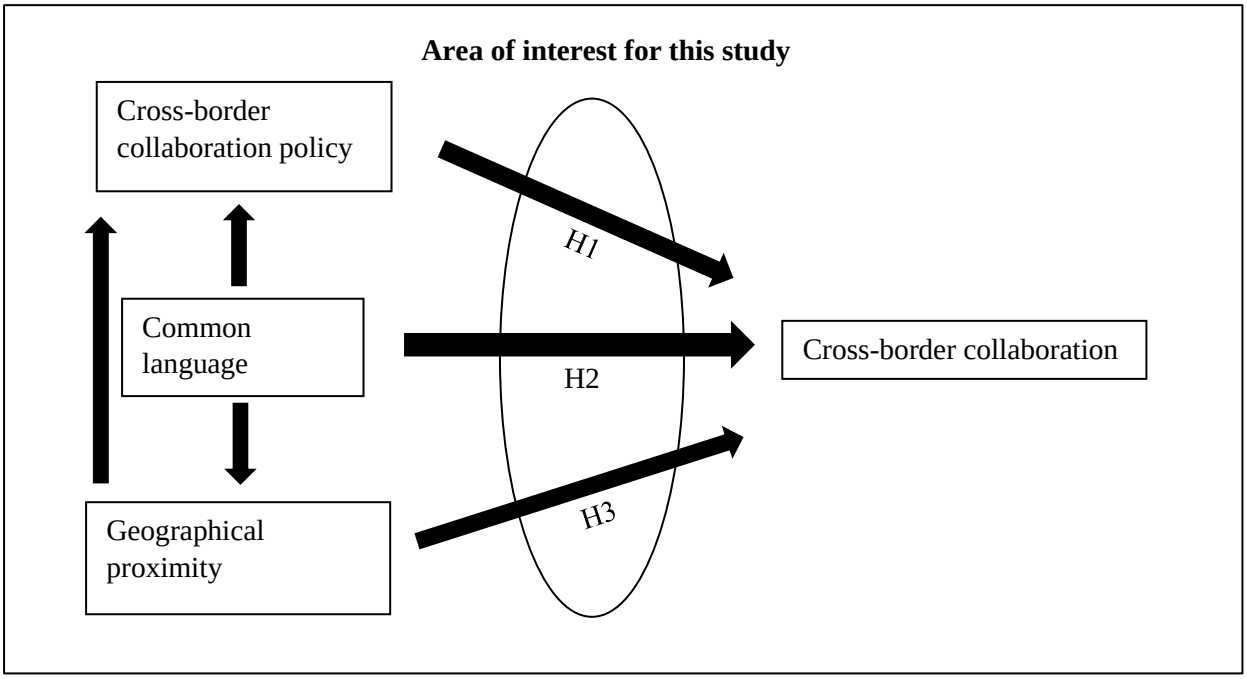
H3 *Innovation collaboration in the North Netherlands region is positively correlated with regions that are geographically close by.*

Conceptual model

The study aim is visualised in the conceptual model found below in Figure 1.

FIGURE 1

Conceptual model – created by the author



Methodological approach

Having introduced the theoretical underpinning of regional development and innovation together with the research aim of the study, this section will focus on the data and methods used to test the hypotheses.

The first part will address information on the North Netherlands region, creating context for the data used. The second part addresses the datasets that have been used to create the data frame. Subsequently moving on to the individual variables and their properties. The third part will introduce the gravity model, the origins of the gravity model are presented and its evolution into an economic geography model is briefly addressed. In the last part the equations for the models, next to the estimation strategy are presented and discussed.

The data

This part will go into the variables their origins and how they have been manipulated to fit in the research goals of this study. Divided into four sections addressing the North Netherlands

region, the datasets, the dependent variable, and explanatory variables. The discussions will include the justification for inclusion of the individual variables, their numerical properties and connect them to their respective data sources.

The North Netherlands region

The geographical region of interest studied is the North Netherlands region. The region encompasses the three provinces Groningen, Friesland, and Drenthe and is characterized by a diverse landscape, with expansive farmlands, waters, nature areas and forests. Furthermore, the provinces of Friesland and Groningen have extensive coastlines. The North Netherlands is home to around 1.7 million people[6].

The North Netherlands economy is diverse and has undergone significant changes over the past few decades. Historically, the region was known for its agriculture, with dairy farming and crop production being important industries (Nederland & Duurzaamheid, 2016). Today, the region's economy is more varied, with a focus on agriculture, tourism, and industry (Edzes, Rijnks, & van Dijk, 2012). Agriculture remains an important industry in the North Netherlands, with the region producing a range of crops, including potatoes, sugar beets, and wheat. The dairy industry is also significant, with Friesland being the largest milk-producing province in the country[7]. Tourism is another important industry in the region, with visitors attracted by the landscape, historic towns and cities, and cultural events. Industry in the North Netherlands is varied, with several important industrial centres in the region. Drachten in Friesland is home to a large Philips factory and hosting an innovation cluster, and the ports located in the province of Groningen are home to a range of industries, including chemical production and renewable energy. Drenthe, moreover, is home to several large food processing plants but also invests in an innovation program in Emmen.

The activities in the North Netherlands already show a number of cross-border relations as the Philips factory has strong relations with other locations around the globe and many of the industrial firms in the Eemshaven either being owned by a foreign company or being in a highly collaborative business. The university and university of applied sciences also have several formal cross-border collaborations such as strong relationships with the Oldenburg university and hosting many international scholars and students. Following from tangible successes of

[6] https://opendata.cbs.nl/#/CBS/nl/dataset/70072ned/table (Accessed 17-7-2023)
[7] https://friesland.databank.nl/Jive/Report?id=barometer (Accessed 17-7-2023)

these cross-border collaborations the sentiment has grown to enhance these through regional policy, culminating in official plans and aims of local policy makers.

MAP 1

Example of existing cross-border relations – Created by author in Flowmap.blue

Introduction of datasets

Using different data sources, the data frame for the model has been build. All data used is existing data that can be freely accessed. Links to access the individual source data sets are provided in appendix A of this study.

For the patent data needed for this study the regional patent database (REGPAT) created by the OECD is used (*The OECD REGPAT Database*, 2008). The OECD regional patent (REGPAT) database is a European-focused source of patents, based on Patstat[8]. The OECD has pooled this data in a specific European patent database. This makes the database ideal for this study as it is possible to filter patents on European regions. The database has been filtered on joint patents

[8] https://www.epo.org/searching-for-patents/business/patstat.html (Accessed on 17-7-2023)

with at least one inventor in the North Netherlands region. To connect data inputs with geographical locations this study uses nomenclature of territorial units (NUTS) classification (Eurostat, 2022). This system created by the European Union divides the Europe into three different statistical layers, NUTS1, NUTS2 and NUTS3. With NUTS1 equalling country level, the NUTS2 and NUTS3 level subsequently being smaller statistical units. The classification system is built so that statistical analysis cross NUTS levels is possible. This study uses this feature by using data on a NUTS3 level for the North Netherlands region and NUTS1 level for the cross-border regions. Lastly distance measures are drawn from existing data sources, further elaborated on in the variables section.

Variables

The dependent variable

The dependent variable for this study is constructed using the number of joint patents with at least one inventor from the North Netherlands region extracted from the 2023 OECD REGPAT database. Patent granting can take several years to be completed and added to the database, as of writing this study the database has entries for patents up to the year 2021, which thus will be the year up to which analyses will be done. Subsequently equal time periods for comparison have been created beyond and before the identified year of 2016 in which policy and strategies employed by the North Netherlands intensified. This has been done by using the number of years between 2016 and 2021 -being 5 years- and subtracting the same number of years from 2016. The result of this procedure creates the time periods 2010-2015, denoted as time window 1 (t1) and 2016-2021, denoted as time window 2 (t2).

For both time windows columns have been constructed with the number of all patents between region i and j, number of patents for region i and, number of patents for region j. Where region i can be any of the NUTS3 regions in the North Netherlands and region j is any of the included European (NUTS1) countries.

Data structure

The North Netherlands region consists of nine NUTS3 regions, being regions i in the analysis. The European NUTS1 countries totalling 92 as regions j. Since NUTS3 North Netherland regions can have interregional patents and even have joint patents within their own region the N is (92+9) * 9 = 909. However, for several NUTS1 and NUTS3 countries and regions no patents are recorded at all in both t1 and t2 and have therefore been left out of the analysis, leaving 28 countries j and 6 region i. The total N of this study being (28+6) * 6 = 204.

For analysis purposes this study distinguishes between three geographical levels for joint patents being filed with at least one inventor from the North Netherlands region.

The first geographical scale is intraregional to the North Netherlands (intraregional NN), meaning patents with inventors being located in the same NUTS3 area in the North Netherlands (Example: East Groningen + East Groningen).

Secondly, the scale of interregional to the North Netherlands is considered (interregional NN). Meaning joint inventors are located in two different NUTS3 areas but within the North Netherlands region (Example North Friesland + Delfzijl and surroundings).

Thirdly, the interregional cross-border scale, with at least one inventor being located in a foreign country other than the Netherlands (Example Belgium + Rest of Groningen). The four scales and the number of joint patents in each category are shown in figure 1 below.

Figure 1

(n) of joint patents on different spatial scales – created by the author

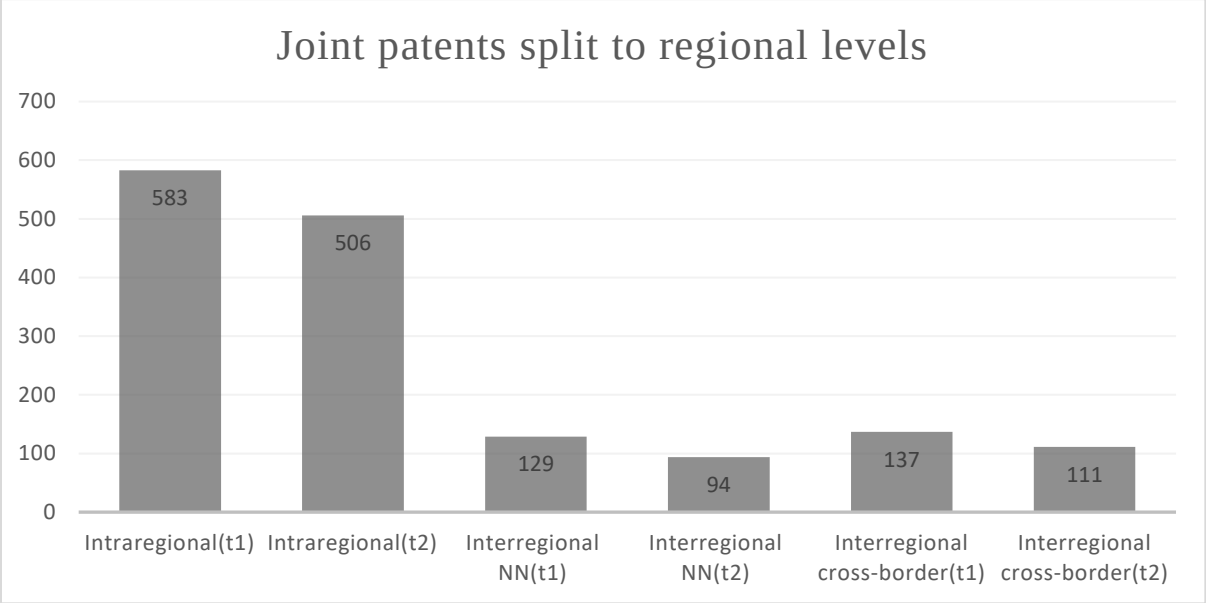


Figure 1 above shows a decline in the number of patents from t1 to t2 in all three categories. This is an unexpected result as current academic literature suggests this is contrary to the world trend of increasing number of patents as shown by Breznitz (2021). The intraregional level showing a decline of 13%, the interregional NN showing a decline of 27% and interregional cross-border a decline of 19%. Compared to a total patent decline for region i (North Netherlands) of 21% from t1 to t2 and a region j decline of 16%. The across-the-board decline of joint patents of the observed cases from t1 and t2 complicates a simple number comparison

to test what the effect has been of cross-border policy since 2016. Therefore, to capture whether innovation collaboration has been affected by cross-border policy since 2016 the dependent variable construction follows a normalization method used by similar studies by Abbasiharofteh et al. (2023) and Mewes (2019), which draw their inspiration from the method originally developed by Teece et al (1994). In the paper by Teece et al. Z-scores are introduced to capture whether changes in time periods follow expectations (Teece, Rumelt, Dosi, & Winter, 1994).

$$(1)\ Z_{i,j} = \frac{O_{ij} - E_{ij}}{\sigma_{ij}}$$

Where O_{ij} is the number of joint patents between i and j. E_{ij} is the expectation of number of joint patents between i and j, calculated by:

$$(2)\ E_{ij} = \frac{n_i - n_j}{N}$$

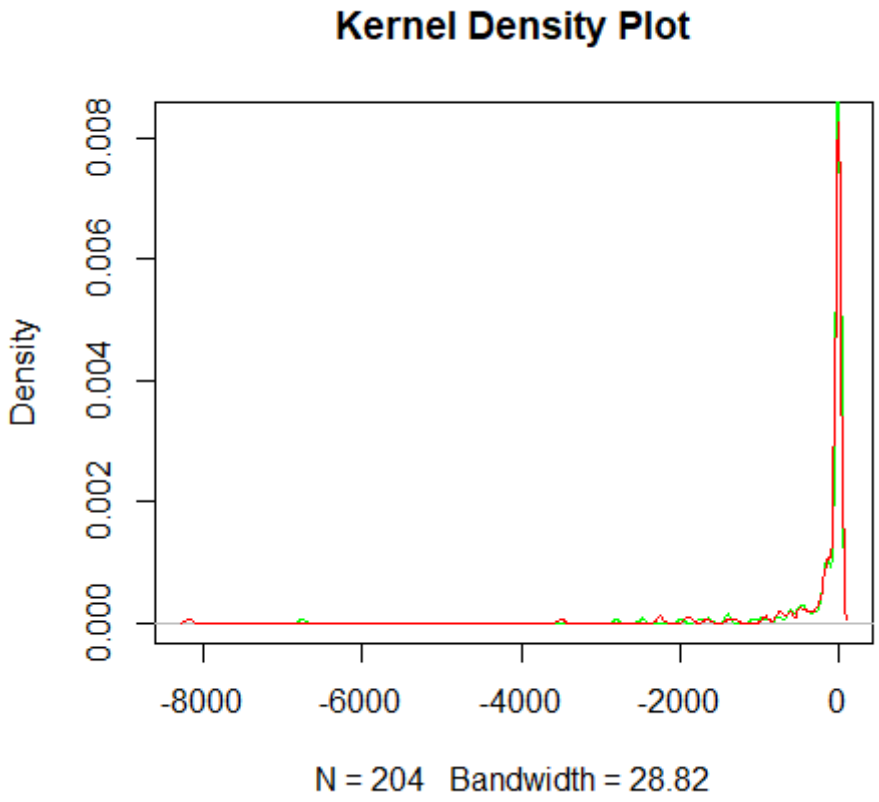
Where n_i is the number of patents in region i, n_j is the number of patents in region j, and N being the total number of joint patents. Lastly σ_{ij} is the standard deviation of the occurred number of joint patents between i and j, calculated by:

$$(3)\ \sigma_{i,j}^2 = E_{ij}(1 - \frac{n_i}{N})(\frac{N - n_j}{N - 1})$$

For this study the calculation of Z-scores will thus tell us whether the number of joint patents between region i and j are what can be expected based on the total number of patents created in region i and j. Where a negative Z-score tell us fewer joint patents then expected have been created and a positive Z-score shows an excess of joint patents to what is to be expected. The kernel distribution shown in figure 1 below. The red line depicting joint patents in t1 and the green line depicting joint patents in t2.

Figure 1

Comparison Z-scores t1 and t2 – created by author



The x-axis represents Z-score values.

The outcomes of the Z-scores between i and j for both time-windows subsequently allow for the construction of a binary variable, which will function as the dependent variable in the gravity model. By comparing the Z-score of each observation in each time-window it can be determined if the change in the number of joint patents has either come closer to the expected value or has deviated. For example, if the Z-score given for the observation of patents between NL111 and Germany has changed from -1,234 in t1 to – 0,891 in t2, it will assume the value of 1 as the observed joint patents have approached the expected value[9]. Whereas the Z-score would have been -1,234 in t1 and -1,345 in t2 the dependent variable would take the value of 0. The resulting binary dependent variable is denoted as **JPAT.**

[9] Note that a negative Z-score indicates that a lesser number of joint patents are observed then expected, while a positive Z-score indicates more patents are observed than expected.

Explanatory variables

In this part the three main explanatory variables are introduced. Aiming to test what the effects are of policies from a North Netherlands perspective for cross-border collaboration, compared to the effects of geographical proximity and sharing a common language.

Cross-border policy

The cross-border policy variable is binary, capturing the intensification of cross-border relations. The threshold for the introduction of policies is the year 2016, which means the model assumes an effect of policies for t1 and no effect of policies for t2. The variable is thus constructed by assuming a value of 0 for all observations on joint patents recorded in t1 and the value of 1 for all joint patent observations in t2. The resulting binary variable is denoted as **CBP.**

Geographical Proximity

Geographical proximity is defined as bordering networks and clusters. These borders depending on the geographical region could coincide with administrative borders, however, also be smaller or even go beyond. The complicated role and changing real sizes of geographical proximity in the context of cross-border collaboration and economic networks make it a somewhat ambiguous factor.

The testing of the geographical proximity hypothesis will answer whether evidence suggest distance determines whether individuals are more likely to work together on patents. The data for the geographical proximity variable is extracted from 'eudistance', configured to the distance between centroids of the North Netherlands NUTS3 (i) regions (Kurbucz & Katona, 2022). As this package was unable to create distances across NUTS levels, FreeMapTools has been used for the distance measures between NUTS3 regions and NUTS1 regions. The values created by eudistance are converted to kilometres and the distance measures from FreeMapTools are also gathered in kilometres.

The data is subsequently used to construct a binary variable. The approach of construction a binary variable is chosen because for the purposes of this study the interest is in geographical proximity of nearby regions. Meaning the model needs to distinguish between direct localities and places beyond the scope of the cross-border policies. Moreover, due to the nature of the language variable and CBP variable a continuous distance variable results in high multicollinearity. Due to languages further away are in almost all cases different as distance increases and CBP policies by definition only apply to regions outside of the North Netherlands.

To avoid multicollinearity issues and capture the purposes of this study distance data gathered will be divided in quantiles of 10% for the regression model. Where the lowest value quantile will assume the value of 1 and all other distances 0. The results should show a negative correlation with the CBP variable for quantiles of 10%, indicating an increase of relations with neighbouring regions. The binary variable is denoted as **geoprox10.**

Language

The Language variable is created on the basis whether a country has the same main language as a North Netherlands regions, which is in all cases Dutch. Therefore, the vector used in the model is assumes 0 for all countries that do not have Dutch as the main language and 1 for all countries with Dutch as main language, independent of the fact of possible other recognized main languages. Therefore, the country of Belgium will in the case of this study assume the value of 1, despite have multiple main languages. The resulting binary variable is denoted as **Language.**

Control variables

Next to the main explanatory variables two control variables will be included in the logistic regression models. The first variable economic activity is a size control and the second one university presence.

Economic activity control

Economic activity can be measured by several indicators, so have previous studies used regional GDP, number of firms and investments. The combination of these indicators can tell us how the regional economies function and whether it is dependent on a few activities or many. It may also tell us something about potential innovation capabilities of a region as many economic activities are enhanced by knowledge generation (Feki & Mnif, 2016). GDP combined with the number of firms and investments such as in R&D are the best predictors toward innovation capabilities of a region. Where GDP tells us about the general success but might be skewed by natural resource extraction. Number of firms tells us whether the region is an attractive area to settle but could also consist of non-innovative activities. And R&D directly shows how much of the total amount generated is spent on innovative activities but has to be seen in perspective. R&D of this indicators has the challenge of being hard to capture in real world data as not all firms clearly classify expenditures as such or are unwilling to share this information, leaving GDP and number of firms as viable alternatives.

For this study however, the economic activity variable is measured by the number of firms in region i. The approach of measuring has been chosen as GDP is believed to not being able to represent economic activity accurately on the NUTS3 level for the North Netherlands. The regions GDP is drastically skewed by the extraction of gas, of which de proceeds largely do not directly benefit the region as such. The number of firms for the North Netherlands NUTS3 areas are therefore believed to be more representable of local economic activity. The firm measure consists of the number of firms in thousands within each of the nine NUTS3 North Netherlands regions. The variable attempts to capture the influence of economic activity within the regions on the number of joint patents. The resulting continuous variable is denoted as **firms_i_K**.

University presence control

The presence of universities control is a dummy variable with the value of 1 if a university is present in one of the nine NUTS3 North Netherlands regions and otherwise assume the value of 0. Denoted as **Uni_i**, the variable is meant to test whether university relations can explain changes in the growth of joint patent filings. In some academic innovation development research universities are included as a factor influencing the innovation potential (Brown, 2016; Florida, Mellander, & Stolarick, 2008). The idea is that universities are a breeding ground for individuals that are likely to move on to create new systems or technologies and universities often have programs in place to nurture new innovations. However, the power of universities to attract regional innovation is also challenged by academics (Brown, 2016). Arguing that universities are unable to tab into the local context of strengths and therefore experience disconnect between what is happening inside the university and the region surrounding it. Since the North Netherlands region is home to a large international university this study has decided to include the variable, despite the academic debate whether universities are theoretically beneficial for regional innovation capability.

Estimation strategy

Introduction to the gravity model

For this study, the model of choice is the so-called gravity model. This model, at its core, followed Newton's law of universal gravitation and was developed with the idea that geographical distances matter in data analyses of places (Shepherd, Doytchinova, & Kravchenko, 2019).

The gravity model has been used in a wide range of studies, often for international trade, but also previously in studying innovation activity with a geographical dimension (Broekel,

Balland, Burger, & Van Oort, 2014; Kuik et al., 2019; Picci, 2010). Empirical findings have shown the robustness of the gravity model and have therefore been accepted as a sound way to measure effects in a geographical context (Shepherd et al., 2019).

The gravity model is meant to weigh areas based on variables, and subsequently using distance measures assess their gravitational pull towards each other. In the case of measuring innovation capacity as in this study outcomes thus show which factors have the most pull effect in increasing innovation of an area (Shepherd et al., 2019). This property of the model makes it ideal for testing the main variables of cross-border policies, shared language, and geographical proximity as a significant positive result in the model would indicate to increase the gravitational pull of the North Netherlands. Where negative outcomes in the distance measures will suggest that distance has a limiting effect on the pull capability of the North Netherlands region. In general, this will allow the inference of effects of the factors and drawing of conclusions regarding policy implications.

Equation

This study uses a logistic regression model to operationalize the gravity model, to estimate whether the explanatory variables of interest influence the number of cross-border joint patents. The equation being:

$$(4)\ JPAT_{ij,t} = \beta_o + \beta_1 CBP + \beta_2 language_j + \beta_9 geoprox10_{ij} + \beta_3 Uni\_i_i + \beta_5(\ln) firms\_i\_K_{i2016} + \varepsilon_{ij}$$

Where the dependent variable *JPAT* represents the increase of joint patents between the NUTS3 region within the North Netherlands and countries from time window 1 to 2. β_o is the intercept. $\beta_2 language_j$ represents the binary language variable. $\beta_9 geoprox10_{ij}$ is the binary variable capturing geographical proximity between i (North-Netherlands regions) and j (Paired countries). $\beta_3 Uni\_i_i$ is the presence of a university in region i. $\beta_5(\ln) firms\_i\_K_{i2016}$ captures the economic activity of region i (in number of firms). Leaving ε_{ij} as the error term.

Results and Discussion

Up to this point the previous chapters have discussed the theoretical framework, current academic standing, and the methodological approach. These all serve the goal of the study, being to test whether cross-border policy by North Netherlands governments had a positive effect on innovation collaboration in the region, in tandem with the role of language similarities, and geographical proximity.

Descriptive statistics

The descriptive statistics of the model data frame including the variables used for the regressions can be found in table 1 below. Note that Firms_i_K is a logged variable and JPAT, CBP, Geoprox10, Language and Uni_i are binary variables.

TABLE 1

Descriptive statistics – created by author

Statistic	N	Mean	St. Dev.	Min	Max
CBP	204	0.324	0.469	0	1
language	204	0.235	0.425	0	1
firms_i_K	204	5.352	0.739	3.912	6.387
Uni_i	204	0.500	0.501	0	1
JPAT	204	0.343	0.476	0	1
geoprox10	204	0.098	0.298	0	1

Next to the descriptive statistics table 2 presents a correlation matrix. The table shows a relatively high correlation between the variables geoprox10 and language. However, this is to be expected as larger distances have an increased likelihood of different languages being spoken. Furthermore, language has a relatively high correlation with cross-border policy, this is also to be expected as Belgium is included in the countries targeted by CBP, which largely shares the common language of Dutch with the North Netherlands. Moreover, addressing the relatively high correlation between geoprox10 and language being due the likelihood of no common language as distances increase. None of the values however are problematic for further estimation.

TABLE 2

Correlation matrix – created by author

Correlation matrix

	1	2	3	4	5	6
(1) CBP	1.00					
(2) Language	0.65	1.00				
(3) Firms_i_K	0.00	0.00	1.00			
(4) Uni_i	0.00	0.00	-0.22	1.00		
(5) JPAT	0.18	0.13	0.17	-0.10	1.00	
(6) geoprox10	0.48	0.59	0.01	-0.03	-0.10	1.00

Model results

Table 3 below reports the results of the logistic regression models. CBP produces significant and robust results across all models. The largest deviation being noted in model 2, where the language variable is introduced. In model 2 the relative high correlation between language and CBP can clearly be noted, as CBP becomes less significant and Language itself produces no significant result at all. This effect being mediated in model 3 by introducing geoprox10. This is due to the relatively high correlation to both the CBP and language variables.

TABLE 3

Model results – created by author

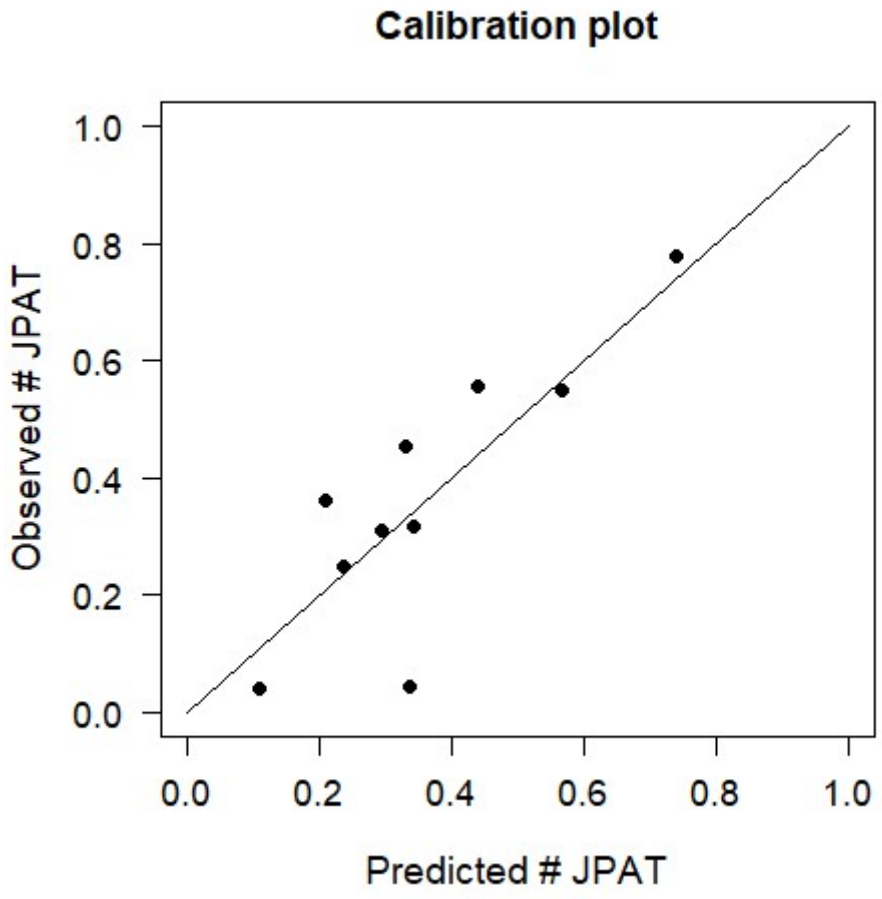
	Dependent variable:			
	JPAT			
	(1)	(2)	(3)	(4)
CBP	0.810***	0.742*	0.939**	0.995**
	(0.311)	(0.408)	(0.408)	(0.420)
language		0.116	0.838*	0.911*
		(0.447)	(0.497)	(0.514)
geoprox10			-2.191***	-2.362***
			(0.695)	(0.715)
firms_i_K				0.572**
				(0.243)
Uni_i				-0.416
				(0.321)
Constant	-0.932***	-0.937***	-0.973***	-3.890***
	(0.189)	(0.190)	(0.192)	(1.373)
Observations	204	204	204	204
Log Likelihood	-127.792	-127.758	-121.931	-117.502
Akaike Inf. Crit.	259.583	261.516	251.862	247.004
Note:		*p<0.1; **p<0.05; ***p<0.01		

To test the goodness of fit of the logistic regression models, a Hosmer and Lemeshow GOF test has been performed, producing the result presented below:

Hosmer and Lemeshow goodness of fit (GOF) test
data: JPAT, fitted(model) X-squared = 15.398, df = 8, p-value = 0.05186

The results show a signficiant p-value of 0.05 providing evidence of a good fit of the model. Next a calibration plot has been produced to observe predicted values versus observed values of the logistic model. In figure 2 below the plot shows that most observed values follow the line indicating good fit of the regression model.

Figure 2
Callibration plot – created by author



The following sections address the main explanatory variable outcomes and their implications.

Results on cross-border policy

The first main variable of interest considered is the cross-border policies and strategies (CBP). Following the models in table 3 the coefficient produces a significant result across all models. This result implies that there is evidence of influence of cross-border policies on the number of joint patents. Furthermore, across all models the coefficient shows a positive relationship towards the dependent variable JPAT.

The positive coefficient in the result from the models supports the first hypothesis of a positive effect of cross-border policies on the joint patents in the North Netherlands. This result is in line with the earlier discussed theory and academic evidence of borders being able to play a positive role in innovation and economic development. For example, in the article by Cappellano et al. (2022) the notion is stressed that borders can function to enhance innovation in regions, rather than hinder them. Their qualitative case study method on regions both with open borders (similar to the North Netherlands region) and closed borders has shown that this fact is not necessarily determining innovation collaboration. In fact the attempts local institutions and their successes for cross-border cooperation are of high importance (Cappellano et al., 2022). Moreover, in different qualitative research done by Castanho et al. (2018) it has been found through interviews that the two most critical factors for cross-border relations are ‘common objectives and master plans and political will and commitment’, which is captured by cross-border policy in this research. However also noting that one of the main challenges is also ‘political transparency and involvement’.

The results thus seem to provide evidence in favour of cross-border policies by the North Netherlands. However, as discussed, the effect needs to be checked against other variables that in previous studies have shown to impact innovation collaboration, for this study language and geographical proximity.

Results on language similarity

The second main variable of interest language produces significant values for most models in table 3. Meaning that the language variable seems to produce evidence to have an influence on the number of joint patents filed in the North Netherlands.

This result means the second hypothesis that language influences the number of joint patents is supported by the models. These findings are in line with empirical findings, discussed in the theoretical framework on language in collaborative innovation. In the article by Picci (2010) investigating international inventive collaboration found a significant positive result for

sharing a common language. The results of this study find similar evidence which is treated as a sign that the model is an adequate reflection of the population.

Results on geographical proximity

The geographical proximity variable produces significant values for the models in table 3. The sign being negative meaning that distances in the lower 10% of distances regarded are less likely to result in joint patents in time period 2, the shortest distances representing localities. To fully interpret these results, it is important to compare the lowest threshold to additional thresholds of distances. Table 4 below shows these additional thresholds of 25%, 50% and 75%.

Table 4

Geographical proximity thresholds – created by author

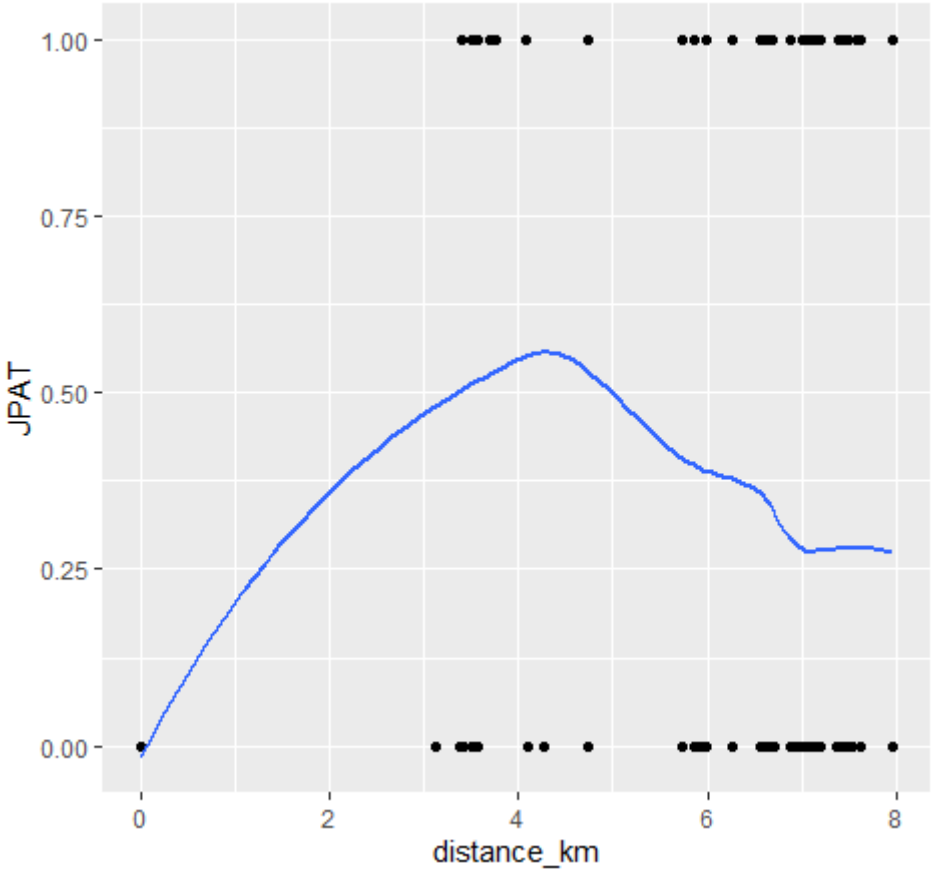
	Dependent variable:			
	JPAT			
	(1)	(2)	(3)	(4)
CBP	1.283***	0.742*	0.654*	0.737**
	(0.354)	(0.408)	(0.377)	(0.343)
geoprox10	-1.738***			
	(0.634)			
geoprox25		0.116		
		(0.447)		
geoprox50			0.264	
			(0.366)	
geoprox75				0.191
				(0.392)
Constant	-0.932***	-0.937***	-1.015***	-1.050***
	(0.189)	(0.190)	(0.224)	(0.311)
Observations	204	204	204	204
Log Likelihood	-123.359	-127.758	-127.534	-127.672
Akaike Inf. Crit.	252.718	261.516	261.067	261.343
Note:		*p<0.1; **p<0.05; ***p<0.01		

The models only produce significant results for geographical proximity in the lower 10%, with no significant results in higher percentages. The interpretation of this result being that the

sample data produces evidence of less local joint patents but does not provide hard evidence for an increase of regional joint patents. To get a better understanding of what is happening a logged version of the distances for each recorded case is plotted against the dependent variable JPAT, shown in figure 3 below.

Figure 3

JPAT in relation to distance – created by author



The pattern in the graph again shows a decline of local joint patents, similar to the model results. Contrary to the model results however, it shows a clear optimal distance where the number of joint patents has increased from time window 1 to time window 2. This pattern can be interpreted as evidence in favour of cross-border policies as these joint patents outside the local scale are more likely to occur in time period 2. The results discussed above allow us to reject the third hypothesis, stating that geographical proximity is likely to increase the number of joint patents.

Relating the results to literature the outcomes of this study are both supported and contested. Many empirical works have shown the importance of agglomeration effects and geographical

distances for places to prosper and excel in innovation. The articles by Porter (2000) and Picci (2010) for example clearly showing this correlation. In contrast to articles pointing to geographical proximity as an important predictor of innovation capability other scholars have produced works that show less emphasis on immediate geographical distance. Rather the article by Maggioni et al. (2007) for example, shows that physical and non-physical ties are better predictors were real distances matter less. These results are more in line with the results of this study. Showing that regions just outside of the local geographical proximity are more likely to produce joint patents.

Limitations

Though the methods of researching the effect of cross-border policies, sharing a common language, and geographical proximity and their influence on innovation in the North Netherlands have been selected carefully, the study does suffer from certain limitations.

First off, as discussed earlier, no direct measure exists to test whether policies and strategies work, forcing any model to use proxies. The proxy of patents used in this research is believed to capture the effect to a great extent but has its limits. The dataset only extends to 2021 as patent applications can take up to several years to be granted, these lags in outcomes are frustrating for many policymakers as outcomes and potential inefficiencies are discovered at late stages.

Moreover, not all innovations will be patented, and as the literature shows, real innovation often takes place in the form of building on existing technologies and will thus not be patented as such (Breznitz, 2021). Using this proxy might thus underreport the real innovation of a region. In addition, though innovations might be done in a certain geographical place, this does not necessarily mean its benefits will be brought in the same region as well (Breznitz, 2021). The patent could be sold to other places limiting the impact for the regions it has been filed in. Paradoxically for this study, current patent systems have even been criticised as being inherently anti-innovation as they hinder development through protection and create barriers of entry for new innovative firms, slowing down innovation (Breznitz, 2021). Though empirical evidence does suggest this is a real phenomenon, patents are still one of the few ways to measure innovation. Other indicators that could potentially be used, such as R&D expenditure, have less high-quality data available and cannot easily be determined for specific types of innovations and NUTS3 regions. Moreover, previous studies into innovation capacity have used patents as

a proxy, such as Maggioni et al. (2007), leaving the patent proxy the most viable option for the research scope of this thesis.

A more general limitation of this study is the omission of variables that influence collaborative innovation in the North Netherlands. Using past research explored in the theoretical section, important variables influencing the study topic have been identified and incorporated. However, due to the complex nature of the innovation collaboration, influential factors might have been omitted, with the potential of biasing the results. These effects are attempted to be captured by an error term in the gravity model used.

Lastly, the results of this study might be biased by spatial data differences. The NUTS classification system is a high quality dataset, and researchers at the OECD go to great lengths to make the datasets as detailed as possible (Eurostat, 2022). However, the NUTS region classification can vary quite drastically in terms of geographical size as in demographic sizes depending on the country. For the explorative aim of this research, testing possible methods of assessing policy effectiveness, the differences are accepted. However, the NUTS classification system does complicate direct comparisons between certain countries somewhat, as it can be argued the regions are not of equal standing, which means that certain regions might seem more influential than others and have a larger 'gravitational' pull which is artificially created by the classification of NUTS3 regions[10]. The only way to address this is to reweight regions based on population and size, disregarding administrative borders. Doing such a reweighting is beyond the scope of this study but should be kept in mind.

One of the largest limitations of the approach of this study, however, has been the focus on patents and the assumption that endogenous inventions correlate with economic development and future innovation within the region. As discussed in the theoretical section, empirical findings do not always favour the correlation of inventor location conversion to local benefits (Breznitz, 2021). Because of this, to measure if the focus on collaborative innovation is indeed a catalysator for regional economic development more direct factors should be considered in further research. An example of this could be to analyse the number of jobs as a direct result of the implementation of a new technology following patent filing.

[10] https://ec.europa.eu/eurostat/web/nuts/principles-and-characteristics (Accessed on 17-7-2023)

Conclusion

In this study an attempt has been made towards empirically measuring the effects of the regional policy, sharing a common language, and geographical proximity on collaborative innovations in the North Netherlands with foreign regions. Results of research types as these aid governments, but also other regional stakeholders, in making effective choices and allocating available means as efficiently as possible. Hence previous academic studies towards assessing effects have been done, form which this study draws inspiration. The study contributing to this by attempting to use a gravity model approach on NUTS3 local scale, previously mostly used for higher geographical scales such as country level (Kuik et al., 2019; Picci, 2010).

Using joint patents and a gravity model, the effect of cross-border policies has been investigated, compared to known influential factors on innovation collaboration. Returning to the original main research aim of this thesis formulated as '*Does cross-border relations policy correlate with cross-border innovation collaboration in the North Netherlands?'*. The policies for cross-border relationships (CBP) variable as shown by the results in Table 1 indicate a significant positive coefficient. Meaning that the policy does show an effect on the number of joint patents in the North Netherlands region. This is an encouraging result for the approaches taken by local governments in the North Netherlands and should be seen as a signal that continuing such policies in the long term could increase the number of joint inventions involving the North Netherlands region. The policies adopted of concentrating on regional strengths and direct neighbouring potential partners have been described as efficient endeavours by academic theory, which this study draws upon (Cappellano et al., 2022; Florida et al., 2008). Together this can be used as backing for the continuation of such policies and strategies and potentially justify the intensification and allocation of additional means.

The language variable in the model results of table 1 has shown a significant and positive result. Seeming to indicate that indeed joint patents filed in the North Netherlands are correlated with regions speaking the Dutch language. This is an expected outcome as existing academic literature found similar results and can be explained by lower communication barriers. The geographical proximity variable in the model results shows a positive significant correlation to the number of cross-border joint patents in the North Netherlands. Following theory this has been the expected outcome, from which confidence in the model can be derived.

Combined the results of the hypothesis testing leads to the overall conclusion that local cross-border policy by the North Netherlands has a positive effect on the number of joint patents in

the North Netherlands regions. This result holding when accounting for influence of geographical proximity and sharing common language.

Regional economic development and innovation strategies are hot topics and have the potential to influence the lives of many individuals positively. This study hopes to have aided in promoting their relevance and making the effects more accessible. Theory and empirics can be quite daunting for policymakers, either disregarding valuable guidance tools or misinterpreting them. By increasing the number of academic studies regarding the effectiveness of policy and presenting results as accessible as possible, better-informed policies can be developed and adopted, benefiting both people and regions.

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Appendices

Appendix A
Datasets

Patents: https://stats.oecd.org/ (Accessed 17-7-2023)

Universities: Author count per region

Firms: https://ec.europa.eu/eurostat/databrowser/view/BD_ENACE2_R3/default/table?lang=en (Accessed 17-7-2023)

Language: Author count per region

CBP: Author count per region

Distance: https://rdrr.io/github/mtkurbucz/eudistance/ (Accessed 17-7-2023) / https://www.freemaptools.com/measure-distance.htm (Accessed 27-7-2023)

Excel files used available on request: teunhavinga@gmail.com