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Geography and social networks. Modelling the effects of territorial borders on policy networks

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Geography and social networks
Modelling the effects of territorial borders on policy networks[1]

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Abstract

The present paper examines the importance of integrating geographic contextual effects into the analysis of social networks. By considering spatial structures as both produced by and productive of social relations, geographic space seems to be more than the extent on which places, actors or events are located and separated by distance. Territoriality, bordering processes, the sense of place, spatial inequalities, scalar relations and spatial connectivity are among the socio-spatial arrangements and practices that are likely to affect social action. The present empirical analysis thus focuses on policy interactions within the cross-border region of Lille because the spatial dimension particularly influences relations in this area. Specifically, we examine three spatial effects, namely, distance, territorial borders and cross-border

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territoriality, and we use exponential random graph models to model how these contextual variables influence policy interactions. By addressing multiple spatial effects, we develop a specific approach to control for the interactions that occur between these variables in order to elaborate on the complex processes that lead to the formation of social networks. We also explicitly examine how the spatial interaction function is affected by including in the analysis endogenous network effects, exogenous covariates and border factors. In this regard, we use a novel Monte Carlo-based goodness-of-fit summary in order to demonstrate that the predicted spatial interaction function of our model – net of other effects – matches the empirical spatial interaction function.

Keywords

Policy networks, spatial effects, distance, border, territoriality, exponential random graph model

1. Introduction

Although the integration of spatial context into social network analysis has developed in recent years (Adams et al., 2012; Daraganova, 2009), this topic remains marginal (Borgatti et al., 2009). Moreover, in most works that consider the spatiality of social processes, space is only considered through the notion of distance (Mok et al., 2010). From a theoretical point of view, the influence of spatial proximity on the probability of engaging in social interaction has long been acknowledged in the social sciences. For instance, the principle of least effort suggests that humans want to achieve the greatest outcome for the least amount of work (Zipf, 1949). In terms of social interaction, our desire or need to minimize efforts when forming and maintaining social ties relates to the basic notion of the friction of distance. Indeed, the likelihood of social interaction decreasing with distance has been empirically tested in various networks and contexts. The earliest studies, for example that by Festinger and colleagues of student housing communities, showed that spatial propinquity is a strong predictor of friendship ties (see Festinger et al., 1950). More recently, although friendship networks remain a key topic in investigating the effects of physical distance (McPherson et al., 2001; Mouw and Entwisle, 2006; Preciado et al., 2012), scholars have also examined other types of social relations such as neighbourhood networks (Hipp and Perrin, 2009), family networks (Warnes, 1986), scientific collaborations (Chandra et al., 2007), trade flows (Aten, 1997) and world trade networks (Abbate et al., 2012; Koskinen and Lomi, 2013) as well as the diffusion of political information (Baybeck and Huckfeldt, 2002).

The impact of distance on contacts and exchanges has also been acknowledged not only for individuals, but also for other types of social actors such as organizations (Bevc et al., 2009; Lomi and Pallotti, 2012). In these network studies, different scales have been considered, ranging from intra-organizational networks (Sailer and McCulloh, 2012) to Internet users worldwide (Wellman et al., 2003). For the latter, it is worthwhile noting that despite remarkable changes in communication and transportation technologies, distance-decay on human interaction seems also to hold online even though there have been some modifications (Goldenberg and Levy, 2009; Mok et al., 2010).

The interest of scholars in the notion of distance, however, does not explain the spatial dimension of social networks or the effects induced by the spatial arrangements that

characterize geographic space. In addition to places, events and people being separated by distance, other spatial aspects are likely to change both the way in which social ties are formed and the meaning that can be given to their spatiality (Daraganova, 2009; Daraganova et al., 2012). Although such a perspective remains under-scrutinized in the literature, a few studies have started to pave the way in this regard. Pertinent to this topic, for example, Faust et al. (2000) analysed the spatial arrangement of social and economic networks among Thai villages taking account of such factors as spatial proximity, topography, land use, travel routes and administrative boundaries in order to understand more fully the mobility patterns of both people and agriculture equipment. More recently, several papers have addressed spatial effects other than distance, such as territoriality (Radil et al., 2010), geographic variability (Butts et al., 2012), national boundaries (Takhteyev et al., 2012; Ugander et al., 2011) and the existence of spatial multipoint contact (Lomi and Pallotti, 2012).

As our contribution to the body of knowledge in this regard, the present paper integrates geographic contextual effects beyond just distance into the analysis of social networks. Our main contention is that in addition to spatial proximity, the presence of boundaries, especially political borders, which delineate, separate and differentiate space into distinct territorial units and which determine the territoriality of social actors, influence the way in which interactions occur. As territorial dividing lines, borders frame social action and interaction. However, as social constructs, borders are not fixed but rather subject to contestation and change. Therefore, a processual approach to the notion of borders as a social and political negotiation of space must be considered (Paasi, 1998).

In order to grasp empirically how bordering processes influence social interactions, we rely on original fieldwork and data that were collected from organizations involved in cross-border governance within the Eurometropolis of Lille–Kortrijk–Tournai (France/Belgium) (ELKT hereinafter). In this European cross-border region, two particular processes capture our attention. On the one hand, in the context of European integration, a process of debordering is taking place with the relative opening of national borders that allows the free movement of goods, persons, services and capital and the implementation of various policies that aim to foster cross-border interactions and regional convergence (e.g. Interreg programmes). Given the obvious relativization of the role of the state in economic and social regulation as well as the organization of the political order (Jessop, 2005), the significance of state borders with respect to policy interactions within governance networks is subject to

scholarly interrogation (Anderson et al., 2002). On the other hand, the implementation of formal cross-border cooperation among French and Belgian local authorities in the ELKT highlights a process of re-territorialization and suggests the emergence of a cross-border networked territoriality. The formation and institutionalization of such a cross-border region does not aim to replace state territoriality, but rather overlaps with and articulates a multilevel perspective (Perkmann, 2007). As such, these two forms of spatialities exist relatively and they should not be seen as mutually exclusive.

In an examination of such multiple spatial effects the issue arises of controlling for the interactions that occur between different spatial characteristics and the way in which these can moderate or amplify the effect of one another (Adams et al., 2012). Additionally, spatial effects may be confounded by endogenous network processes, giving rise to tie dependencies for which researchers must also control. To overcome these methodological concerns, first we incorporate different covariates into exponential random graph models (ERGMs) in order to control for actor-based, structural and spatial effects (Daraganova et al., 2012; Robins et al., 2012; Robins and Daraganova, 2013). Second, we develop a specific approach that allows controlling for the interactions that occur among different contextual effects by conditioning spatially defined subsamples. Moreover, because these effects might be contingent on specific types of policy networks, two distinct policy domains are investigated, namely, public transportation (PT) and business location marketing (BLM). Although these two domains reflect different issues, they appear to be highly salient for organizations involved in cross-border governance networks.

The remainder of this paper is organized as follows: section 2 provides an overview of how geographic space is susceptible to affect social connections. Section 3 presents the empirical setting and formulates the research hypotheses. Section 4 describes the data and model specifications. The results are presented in Section 5, which is followed by our conclusions.

2. How spatial effects influence social interactions

The review in this section explains how geographic space, in its various significations, arrangements and components, is likely to influence social action. To this end, it is necessary to consider the ways in which geographic space can be conceived as well as the various

conceptual vantage points that reflect the theoretical frameworks and ideologies. One longstanding and important division is between absolute and relative space (Warf, 2006). On the one hand, the absolute conception represents space as a fixed and asocial substratum on which events take place. Such a Newtonian sense of space contends that space exists independently of how it is measured or what it contains and it is represented by a geometric system that has Cartesian coordinates. On the other hand, the relative sense of space is comprehensible only by reference to specific frames of interpretation, as contended by Leibniz. Relative space is socially made and remade over time, hence it portrays geographies as fluid, mutable and ever-changing (Warf, 2006). Therefore, geographic space, although social in origin, is not simply the product of the multiplicity of actions taken by societies in the course of history, it is also intrinsically bound up with the reproduction of human activity. Spatial structures are thus produced by and productive of social relations. Hence, in such a 'socio-spatial dialectic', space and society are intertwined (Soja, 1980).

Based on a relative sense of space, it is possible to identify several ways in which space is perceived, produced and structured and then to assess how these affect the interactions among distant places, peoples and events. In doing so, we come across the different ways geographers conceptualize space. Many of these concepts are highly contested and sometimes rather disordered, hence we focus on those six aspects that are relevant to the analysis of the spatiality of social interactions:

1. Moving away from a conception of space as a container of social activity and considering it to be a social construct does not diminish the importance of the concept of distance and the friction associated with it. On the contrary, as a socially constructed characteristic of space, distance becomes more complex because it is not solely defined geometrically (e.g. through Euclidian or great-circle distances), but rather can be expressed according to measures such as time, cost, effort, energy or psychological perception which are related to the characteristics of the phenomenon under scrutiny (Deutsch and Isard, 1961). Moreover, distance is not necessarily symmetric within geographic space; its measure from A to B can be different from that between B and A because of slope friction, traffic restrictions or cognitive processes. Ultimately, the constraints of proximity are contingent on the type of contact or exchange considered as well as on the underlying communication technologies.

2. Within geographic space, place is more than just a physical location. According to Agnew (1987), two other fundamental aspects complement this concept: place as locale and the sense of place. Locale refers to the material setting for social relations, the scene where events or actions occur. Place as a specific locale can be distinguished by cultural or subjective meanings through which it is constructed and differentiated, thus it is susceptible to the formation and structuring of social interaction. The sense of place brings to the fore the affective relations and attachments people have with a place. In addition to the feelings and perceptions held by people, this sense may also relate to the identity and character of a given small-scale proportion of space. As Withers (2009: 638) reminds us, "In the face of globalization, questions of locality, sense of place and of identity in place matter now more than ever".

3. Another major characteristic of geographic space is that it is organized into territorial units that are constructed, appropriated, controlled and contested by various social actors, modern states being the most emblematic examples of such territorial organizations. Such territorial arrangements and partitions have been seen as a fundamental part of the geographic context that shapes much of the way in which life is organized on Earth, including social relationships and flows (Soja, 1971). According to Sack (1986: 19), territoriality involves the "attempt by an individual or group to affect, influence, or control people, phenomena, and relationships by delimiting and asserting control over a geographic area". Used as a device to restrict and control access to the territory they demarcate, borders have traditionally been conceived as barriers to flows and interactions. As noted by van Houtum and van Naerssen (2002), territorial borders continuously fixate and regulate mobility, thereby constructing or reproducing places in space. However, open borders can also serve as bridges or interfaces depending on the degree of control and filtering exerted by a territorial power. As social and political constructions, borders are recognized as processes rather than fixed lines, which has led to the growing popularity of the notion of bordering (debordering/rebordering) in contemporary studies of this topic (Newman, 2006).

4. Socio-spatial interactions are not solely restricted to hierarchically similar entities within the boundaries that separate them, but also occur among entities located at different levels (local, regional, national, global). In geography, this idea of hierarchy is captured through the concept of scale, which examines "how change in any one territorial unit is affected by change at other geographic scales" (Sheppard, 2002: 313). As such, places may be separated from one another at one scale but connected through their association at a higher scale. Most scalar analyses thus rely on a set of hierarchical scales that range from the individual to the global level, although as social constructions, scales should not be taken for granted (Marston, 2000).

5. Geographic space is neither continuous nor homogeneous. Rather, diversity, difference and inequality among places, regions and areas constitute its most striking characteristics. Such uneven structuring of space is likely to affect how social contact occurs in various ways. For instance, similar-minded people who live in different places (let us say the inner city vs. the suburbs) may think and act differently because of their interactions with their neighbours. At the same time, many studies have shown that the homogeneity of neighbourhoods influences tie homophily (for a review, see McPherson et al., 2001). The contextual effects related to spatial differentiation and inequality can thus be grasped by measuring spatial distribution (e.g. population densities), homogeneity or specialization (e.g. residential segregation) or hierarchy (e.g. core–periphery settings) (Taylor, 1977).

6. Spatial networks3 such as transportation systems (e.g. airports, railways, seaport terminals) and other infrastructure networks (e.g. roads and streets, power grids, communication networks) are crucial components of geographic space (Haggett and Chorley, 1969). They are also essential elements of our modern societies where mobility is increasingly fundamental to social and economic activities (Barthélemy, 2011). Whereas most previous studies of spatial networks focus on their topological properties (Erath et al., 2009; Gastner and Newman, 2006) or model their interaction effects by using gravity models (Anderson, 1979; Anderson and van Wincoop, 2003), the ways in which geographic accessibility due to transportation networks influences social interaction remains under-scrutinized by researchers (Illenberger et al., 2012).

[3] Spatial networks are defined as having vertices embedded in a metric space whose edges are composed of physical connections (cf. Barthélemy, 2011).

Each of the six socio-spatial dimensions highlighted above shapes and is shaped by social action. However, their relevance and the nature of their effects remain contingent upon the type of social interaction considered as well as the prevailing context. In the remainder of the present paper, we analyse real network data on policy interactions within a European cross-border region (i.e. the ELKT) and focus on three specific spatial effects, namely, spatial distance, territorial borders and cross-border cooperation as a process of re-territorialization.

3. Empirical setting and hypotheses development

The empirical data mobilized in this paper concern policy networks in the ELKT. The public authorities in this region have been actively cooperating since the 1990s under a strong policy-driven cross-border integration process (Durand and Nelles, 2012). Indeed, in 2007, the ELKT was the first cross-border region in Europe to adopt the newly created legal form called the European Grouping of Territorial Cooperation[4].

3.1. Two policy domains in a cross-border setting

As noted in the Introduction, two networks based on different policy domains are considered herein, namely, PT and BLM. First, developing cross-border transportation connections constitutes one of the main aims of the cross-border territorial partnership set up within the ELKT. Since cross-border mobility is crucial for local and regional actors in fostering regional integration and urban competitiveness, it is a key domain that needs to be examined in order to ascertain the capacity of these actors to elaborate on the modes of governance capable of transcending the fragmented policy environment that characterizes cross-border regions.

Second, BLM aims to promote the attractiveness of the cross-border region for firms and for foreign investment. Such an issue is particularly relevant in the ELKT, which has undergone drastic economic restructuring due to the decline in its traditional industries since the 1960s. Business location marketing is mainly addressed to economic actors via promotion campaigns that aim to influence behaviours, attitudes and beliefs to the benefit of the territory. Such an approach demands a shared view among stakeholders of what constitutes

[4] The European Grouping of Territorial Cooperation is a Community-level cooperation instrument with a legal personality promulgated on 5 July 2006 under EU Council Regulation 1082/2006.

the space of reference for economic development and competitiveness in a globalized economy, a common vision about a development strategy and a coordinated marketing campaign.

The two policy domains are complementary because PT reflects the 'internal' functioning and development of the ELKT, whereas BLM reflects its positioning in the global circuits of production and investment. Put simply, despite having different purposes, the two domains have the same spatial and political settings. The comparative analysis presented in this paper therefore highlights the extent to which the investigated spatial effects tend to be specific to a given policy domain.

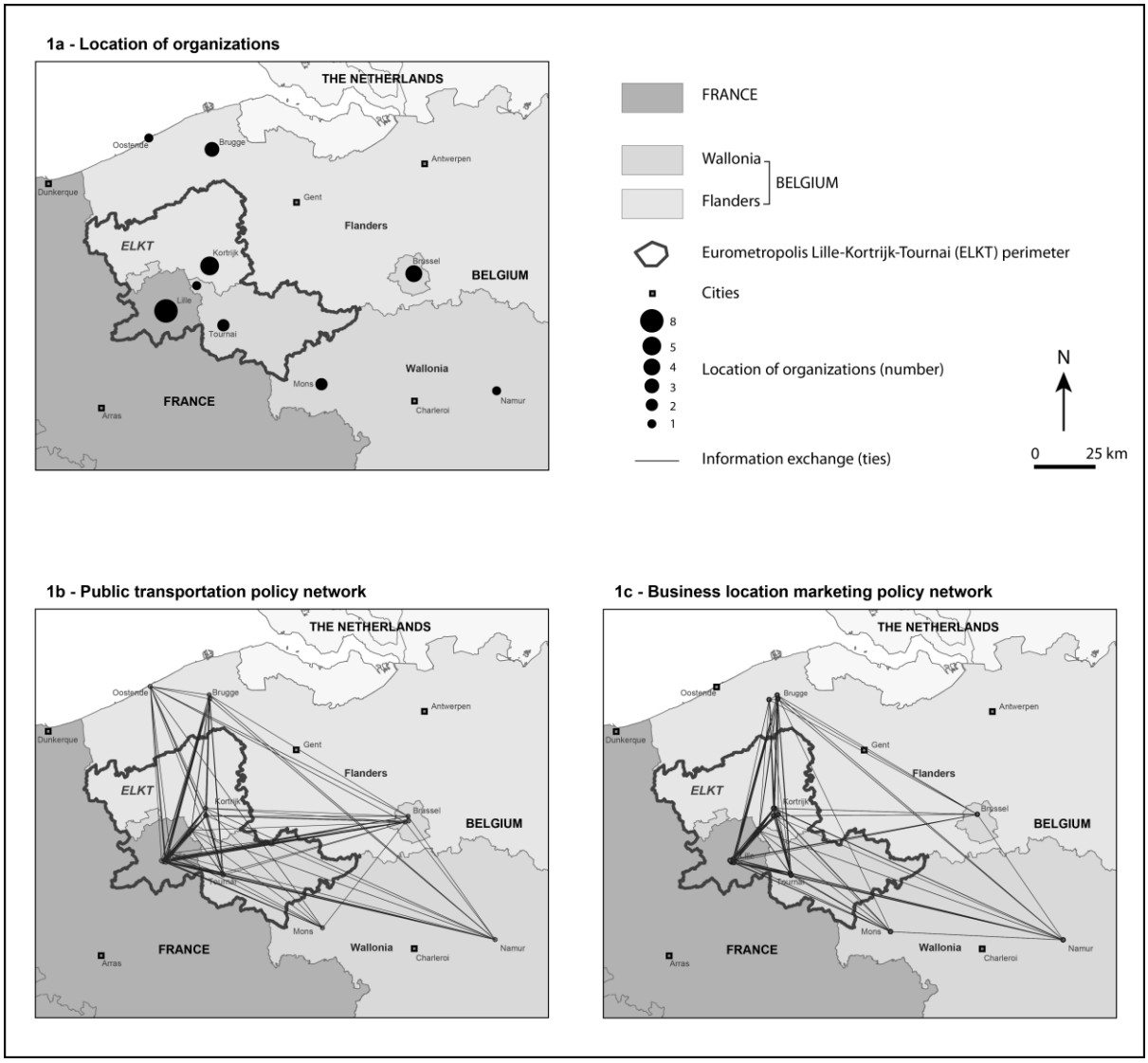

Fig. 1. Territorial setting and geography of the policy networks in the ELKT.
Source: Authors, 2013.

3.2. Hypotheses on the effects of geographic space

Two sets of research questions structure the present paper and give rise to five hypotheses. First, we examine how the three studied spatial effects influence the formation of policy ties. The first spatial effect is the friction of spatial distance (H1). The review of the literature presented in Section 2 highlighted the overall relevance of distance-decay on different types of social interactions, including the exchange of political information (Baybeck and Huckfeldt, 2002; Straits, 1991). As stated by Boschma (2005: 69), "Short distances literally bring people together, favour information contacts and facilitate the exchange of tacit knowledge. The larger the distance between agents, the less the intensity of these positive externalities, and the more difficult it becomes to transfer tacit knowledge". In the policy networks under scrutiny, actors compose a polycentric urban setting because they are concentrated in different cities located within as well as beyond the ELKT (see Figure 1).

The second spatial effect is the resilience of territorial borders. The national border that separates France from Belgium has since 1993 been open to the flow of people, goods, finances and services thanks to the European Union's internal market and the Schengen Agreement. Following van Houtum (1999), we nevertheless hypothesize that the institutional, cultural and mental barriers that persist negatively affect cross-border policy interactions (H2). In other words, just because national borders have become more porous does not imply that the above-mentioned barriers have disappeared (O'Dowd, 2002). Rather, a deficiency of cross-border interaction may occur because unfamiliarity hinders the creation of community (Spierings and van der Velde, 2013) and, by implication, the development of common policy objectives.

The third spatial effect is the process of re-territorialization that arises from cross-border cooperation (Paasi, 1998), notably the creation of the first European Grouping of Territorial Cooperation (see Figure 1). Here, we hypothesize that cross-border cooperation positively affects tie probability by bringing actors closer to one another and strengthening their relations (H3).

Second, taking into account different geographic effects simultaneously allows us to explore the way in which one may be affected by another. In particular, two interaction effects capture our attention. First, we examine the extent to which territorial borders moderate or accentuate how distance affects policy interactions. Hence, the fourth hypothesis (H4) states

that distance-decay is stronger on cross-border ties than it is on domestic ties. The fact that crossing a border increases distance-decay is explained by a cumulative process between these two negative effects; in other words, the further away from a border, the less familiar the potential alter is and the higher is the friction of distance. The second interaction effect is between territorial borders and cross-border cooperation, namely, the extent to which the development of cross-border cooperation changes how national borders affect tie probability. According to the last hypothesis (H5), formal cross-border cooperation is a process of re-territorialization that generates a common sense of belonging and increases trust, and this tends to moderate how national borders affect policy interactions.

4. Data and methods

Information on the two policy domains under scrutiny was derived from face-to-face interviews conducted in the spring of 2011. We identified the most prominent actors to be interviewed based on a reputational analysis. In order to comprehensively capture the policy networks, we tested the robustness of the implied network boundaries by asking interviewees to nominate, in their opinion, the most prominent actors in both policy fields. Based on these interviews, we decided to augment the node set by actors mentioned more than three times. These actors were then followed up and interviewed. As shown in Table 1, we interviewed 33 out of 42 organizations identified with the field of PT and 27 out of 34 with the BLM domain. The overall response rates were 78.6% and 79.4% for transportation and marketing networks, respectively.

Table 1
Number of organizations interviewed/identified and response rates.

	PT	BLM
Representatives of primary actors	28/34	24/28
Nominated representatives of primary actors	5/8	3/6
Total	33/42	27/34
Response rate (%)	78.6	79.4

4.1. Dependent variable

The network data used in this paper correspond to the exchange of information among organizations between 2009 and 2010. Information exchange includes all interactions through face-to-face contact, phone, email, social media or the circulation of documents to a specific person/officer within and between organizations. This does not include generally distributed emails or memos. For large organizations, more than one informant was interviewed and their answers were then pooled. As shown in Table 2, the number of studied organizations is rather limited in both policy domains (22 for PT and 20 for BLM), but the level of interactions between them is high (0.50 and 0.63) as is the level of reciprocity (0.459 and 0.621). To some extent, such dense exchanges of information reflect the high intensity of cross-border cooperation in the ELKT as a result of 20 years of political engagement.

The distribution of organizations by nationality shows that there are more Belgian actors than French, reflecting the differences in the prevailing institutional settings in these two countries. A large variety of organizational types can also be noted. In addition to public actors at the local, regional and central levels as well as cross-border organizations, the BLM network includes several chambers of commerce and regional development agencies and the PT network includes firms (e.g. railways and bus companies). Altogether, the two networks have 14 organizations in common, typically multifunctional government organizations (e.g. local and regional authorities) that are involved in both policy domains.

Table 2
Description of policy networks.

	PT	BLM
Number of organizations interviewed	22	20
Number of edges	232	240
Network density	0.50	0.63
Dyad-based reciprocity	0.459	0.621
Distribution by nationality		
French organizations (N)	8	5
Belgian organizations (N)	12	13
Cross-border organizations (N)	2	2
Distribution by type of organization		
Local authorities	5	5
Regional authorities	5	5
Central states (ministries)	2	0
Cross-border organizations	2	2
Chambers of commerce	2	4
Development agencies	1	3
Firms	5	0
Others	0	1

4.2. Independent variables

Given the extent of geographic concerns in our analysis of cross-border policy networks, the main independent variables of theoretical interest in this paper are the three spatial variables, which are treated as dyadic covariates (see Table 3).

Table 3
Description of independent variables.

Name	Measure	Type of variable
Distance	Log of Euclidian distance (dyadic covariate)	Continuous
Territorial borders	Territorial affiliation (dyadic covariate)	Binary
Cross-border cooperation	Cross-border cooperation structure affiliation (dyadic covariate)	Binary
Important actors	Frequency of nomination	Binary

The first variable is Distance. The spatial location of each organization was assessed by its street address (its main seat in the case of multiple locations) and Euclidian distance was

calculated from one address to another by using latitude and longitude coordinates. Table 4 summarizes the geographical data for the two networks and shows that both present a wide range of distances, although the PT network has a higher mean distance compared with BLM.

Despite the common assumption in the literature that the probability of social interaction decreases with distance, the precise relationship between these two variables remains unclear (Scellato et al., 2011). Based on the findings presented by Butts (2003), we thus modelled the effect of distance by using an attenuated power-law function expressed as a natural logarithm of distance (see also Daraganova et al., 2012). Further, because very small distances (close to zero) disturbed the fit of the model, tie variables for dyads with pairwise distances close to zero were treated as fixed in the estimation.

Table 4
Tie distances for the two policy networks.

	PT	BLM
Mean (km)	47.5	42.0
S.D.	40.3	37.6
Min	0.3	0.1
Max	143.0	143.0

The second spatial variable is Territorial borders, which indicates whether two organizations belong to the same territorial unit, specifically whether they share 'domestic' ties (coded 0) or share 'cross-border' ties (coded 1). For both policy networks, the first level of territoriality is the national level, namely, Belgium and France. However, the political structure of Belgium requires that the boundary between the two Belgian regions of Wallonia and Flanders[5] is also taken into account. As a matter of fact, the tie density between Walloon and Flemish organizations is low in comparison with within-group densities and the tie densities between Belgian and French organizations (see Table 5). This results in three territorial units, namely, France, Flanders and Wallonia. Hence, Belgian federal organizations were considered to share 'domestic' ties with both the Walloon and Flemish organizations. Similarly, cross-border organizations were considered to be 'tri-national' (i.e. they have 'domestic' ties with other actors in each of the three territorial units).

[5] The region of Brussels was not considered because of the absence of actors affiliated to this regional level. The organizations located in Brussels tend to be either federal ministries or firms.

Table 5
Tie densities within and between territorial groups.

	Walloon organizations		Flemish organizations		French organizations	
	PT	BLM	PT	BLM	PT	BLM
Walloon organizations	0.667	1.000	0.333	0.375	0.344	0.750
Flemish organizations	0.333	0.656	0.667	0.696	0.313	0.550
French organizations	0.625	0.700	0.542	0.575	0.679	0.950

The third spatial variable, Cross-border cooperation, serves as a control of the affiliation of organizations to the ELKT cross-border cooperation structure (coded 1) or not (coded 0). Tie density seems to be higher within the ELKT cooperation structure than with non-member organizations or between the two groups (Table 6). This result reinforces our hypothesis that information is more likely to be exchanged between actors that belong to the ELKT structure.

Table 6
Tie densities within and between groups.

	Members of the ELKT cooperation structure		Other organizations	
	PT	BLM	PT	BLM
Members of the ELKT cooperation structure	0.647	0.818	0.350	0.444
Other organizations	0.496	0.677	0.444	0.542

Given the heterogeneity of the studied policy networks (see Table 2), an attribute variable labelled Important actors was also included in the analysis in order to control for the effects of different types of actors. This binary variable was computed from the answers that survey respondents provided to the question: ‘Considering cross-border business location marketing (public transportation), could you nominate the most prominent actors?’ All those organizations nominated more than five times were considered to be important actors (coded one) and zero otherwise. The correlation with in-degree centrality that reflects the prestige of organizations was 0.644 (p<0.01) for PT and 0.565 (p<0.01) for BLM. Tests for the other attribute variables were also conducted, notably the distinction between political actors and others; however, because of the absence of significant effects, they were not included in the final models.

The spatial effects in our models reflect the three dimensions of the geographic space that are somewhat dependent on each other. As shown in Table 7, there is a significant correlation between Territorial borders and Distance with a coefficient of 0.415 for the PT network and 0.271 for the BLM network. This result suggests that − other conditions being equal − the distance between organizations is smaller in domestic settings than it is in cross-border settings. The other correlations among the spatial variables were weaker and not significant.

Table 7
Quadratic assignment procedure correlations between the spatial dyadic variables.

	PT		BLM	
	Territorial borders	Cross-border cooperation	Territorial borders	Cross-border cooperation
Distance	0.415*	0.083	0.271*	0.124
Territorial borders		0.064		0.114

* $p<0.01$ (simulated p-value obtained from the quadratic assignment procedure)

4.3. Analytical strategy

To assess the effects of geographic space on policy network processes, ERGMs were fitted to each of the policy domains scrutinized[6]. Such statistical models for social networks (sometimes called p* models) allow researchers to model the structure of a network and infer the underlying processes that contribute to its formation (Lusher et al., 2013; Robins et al., 2007). Exponential random graph models provide a framework for integrating different network theories and statistically testing the derived hypotheses. According to Lusher and Robins (2013), three main categories of tie formation processes can be integrated: network self-organization, actor attributes and exogenous contextual factors. When seeking to infer the effect of space, ERGMs offer a way in which to control for the endogenous dependencies between tie variables.

In this research, the three spatial effects presented in Section 4.2 were treated as exogenous dyadic covariates. The structural effects that arise from self-organizing network and attribute-based processes were also considered, although no specific hypotheses were formulated because they were used primarily as controls for the examination of the spatial effects.

[6] All ERGM modelling was performed in MPNet version 1.04 (Wang et al., 2009).

For controlling the structural effects, eight basic parameters were entered into the models. The effects specify a so-called Markov model (typically, a Markov model only fits data well when networks are very dense; Lusher et al., 2013). The Arc effect is the baseline effect that reflects the propensity for tie formation. Whether ties are reciprocated or not is examined with the Reciprocity effect. The in-2-stars (In2Star) and in-3-stars (In3Star) are star-like structures with two or three ingoing ties from the central node that are often described in terms of 'popularity'; essentially, these parameters help model the shape of the in-degree distribution. Similarly, out-2-stars (Out2Star) and out-3-stars (Out3Star) are out-star structures that represent activity-based configurations for modelling the out-degree distribution. Finally, Transitive-Triad and Cyclic-Triad reflect closure patterns within triads, either through transitivity or cyclic effects (see Lusher et al., 2013). In order to control for attribute-based processes, the variable Important actors was considered according to three parameters: the Sender effect reflecting activity, the Receiver effect reflecting popularity and Interaction reflecting homophily.

The interactions among the spatial variables were examined according to the following method. In order to assess whether the effect of distance on information exchange varies according to territorial borders, both the PT and the BLM networks were split into two subsets (domestic ties and cross-border ties). We then modelled each of these subsets using ERGMs *conditional* on the other subset. In other words, we analysed domestic (cross-border) ties while treating cross-border (domestic) ties as exogenous[7]. The examination of how cross-border cooperation affects information exchange was carried out according to the same logic. Cooperation and non-cooperation ties were also separated in an equivalent fashion, alternating between considering one fix and the other modelled, and two ERGMs were ran separately for each policy domain.

Comparing the parameter estimates of the models allowed us to detect specific interaction effects. The interaction between borders and distance is thus represented by the differences in the distance parameter between the models conditioned on cross-border ties and domestic ties, respectively. As argued above, the effect on the distance interaction function (DIF) (i.e. whether the distance-decay on tie formation is affected by borders) was examined by

[7] In practice, this is performed in MPNet using 'structural zeros': a zero for a tie variable indicates that it should be considered to be fixed, whereas a one indicates that it should be modelled.

comparing the predictive distributions. A specific fit for the DIF based on goodness-of-fit (GOF) parameters was thus performed.

5. Results

The presentation of our results is separated into two parts. First, we consider the overall effects of space on the two policy networks. Second, we focus on the interactions between different spatial effects. All the final models presented have converged and show an excellent fit to the data[8].

5.1. General effects of space

Table 8 presents the parameter estimates (and standard errors) for the general model applied to the PT and BLM networks. Among the endogenous structural effects included in the model, transitivity is shown to have a positive and significant effect in both networks, indicating a tendency for hierarchical path closure (Lusher and Robins, 2013). Further, we find a negative and significant effect for cyclic closure for both networks, which is consistent with the interpretation of the positive effect for transitivity in terms of the local hierarchy.

Concerning the actor attribute effects, we note a positive and significant *Sender* effect for important actors in the BLM network. This finding suggests that important BLM actors tend to be more active exchangers (i.e. they send more information) compared with others in the network. By contrast, the *Receiver* effect is positive and significant for both networks, suggesting that important actors receive more ties compared with others (i.e. they are more popular). However, we find that the interaction effect between important actors is negative but not significant, implying the absence of a homophily process within these policy networks.

By controlling for structural- and actor-related effects, we can make grounded inferences about the spatial effects in the studied policy networks. In line with the principle of distance-decay, the effect of distance is negative for both networks, but significant only for PT. Of

[8] Following the approach taken by Robins and Lusher (2013), the GOF t-ratios for the fitted statistics are all smaller than 0.1 in absolute terms. Moreover, all auxiliary statistics (available in MPNet) have GOF statistics smaller than 2 in absolute value, indicating a good fit (with the only exception being A2P-T, which was -2.1 in one of the models); The full GOF parameters may be obtained from the authors upon request.

particular interest is the substantial negative effect of territorial borders for PT and BLM. This result confirms the persistence of a barrier effect in terms of cross-border policy interactions. However, such border-related hindrance does not seem to concern all actors equally because the effect of cross-border cooperation is positive and significant for both networks. Other conditions being equal, this result suggests that ELKT members tend to exchange more information with one another compared with among non-members. In conclusion, the results obtained herein validate H1, H2 and H3. In other words, there seems to be no differences between the two policy domains because the parameter estimates show the same types of effects for both PT and BLM.

Table 8
Parameter estimates for the PT and BLM models.

Parameters	PT		BLM	
Structural effects				
Arc	0.360	(1.232)	4.641	(3.207)
Reciprocity	0.681	(0.347)	0.501	(0.571)
In2Star	−0.113	(0.148)	−0.321	(0.227)
Out2Star	−0.101	(0.139)	−0.731	(0.48)
In3Star	−0.002	(0.013)	0.015	(0.018)
Out3Star	0.001	(0.012)	0.029	(0.045)
Transitive-Triad	0.216*	(0.051)	0.298*	(0.078)
Cyclic-Triad	−0.263*	(0.064)	−0.461*	(0.095)
Actor attribute effects				
Important actors Sender	0.536	(0.299)	3.742*	(1.105)
Important actors Receiver	1.063*	(0.37)	2.057*	(0.735)
Important actors Interaction	−0.517	(0.428)	−0.277	(0.816)
Spatial effects				
Distance	−0.110*	(0.055)	−0.115	(0.118)
Territorial border	−0.499*	(0.193)	−1.549*	(0.376)
Cross-border cooperation	0.327*	(0.164)	0.918*	(0.393)

* Significant effect

5.2. Interactions among spatial variables

Borders and distance

The first interaction effect of interest is between territorial borders and distance. Since H4 hypothesizes a cumulative process between these two negative effects, we expect the probability of a tie to decline with distance, and even more so when the tie crosses a border. Following the analytical strategy presented in Section 4.3, two models are thus defined for each policy domain, one for domestic ties and another for cross-border ties (Table 9).

Table 9
Parameter estimates for the PT and BLM models (domestic vs. cross-border ties).

Parameters	PT				BLM			
	(Dom)		(CB)		(Dom)		(CB)	
Structural effects								
Arc	−0.454	(1.643)	−4.585	(2.548)	7.441*	(3.481)	−1.014	(5.838)
Reciprocity	0.457	(0.54)	0.703	(0.492)	0.322	(0.697)	0.718	(0.755)
In2Star	−0.095	(0.205)	0.013	(0.218)	−0.289	(0.266)	−0.117	(0.413)
Out2Star	−0.077	(0.215)	−0.203	(0.191)	−1.020	(0.518)	−0.483	(0.567)
In3Star	0.003	(0.018)	−0.018	(0.024)	0.015	(0.024)	−0.007	(0.031)
Out3Star	−0.003	(0.02)	0.014	(0.017)	0.079	(0.044)	−0.003	(0.049)
Transitive-Triad	0.235*	(0.07)	0.227*	(0.059)	0.254*	(0.088)	0.377*	(0.124)
Cyclic-Triad	−0.218*	(0.095)	−0.247*	(0.082)	−0.342*	(0.103)	−0.432*	(0.154)
Actor attribute effects								
Important actors Sender	0.826	(0.513)	0.127	(0.419)	1.369	(0.884)	6.738	(3.63)
Important actors Receiver	1.633*	(0.53)	0.087	(0.527)	0.780	(0.841)	4.676	(3.501)
Important actors Interaction	−1.543*	(0.703)	0.273	(0.596)	−0.407	(0.987)	−4.527	(3.539)
Spatial effects								
Distance	−0.132	(0.073)	0.302	(0.178)	−0.263	(0.144)	−0.266	(0.162)
Cross-border cooperation	0.132	(0.346)	0.603*	(0.26)	2.434*	(1.072)	0.174	(0.437)

* Significant effect

For the PT network, the effect of distance on the probability of interaction varies according to territoriality: the signs of the coefficients are in the direction of distance having a negative (positive) effect on domestic (cross-border) ties; however neither of which coefficients are statistically significant according to the customary criteria[9]. These findings for the distance effects are inconclusive because we cannot reject unequivocally that the parameters are zero. However, we can conclude that the significant distance effect in the model for PT in Table 8 must be completely accounted for by domestic ties. It is thus tempting to interpret the insignificance solely as being a result of a loss of power (i.e. because the covariate and structural effects are competing for the 'same variance'). These results do not support H4 because we expected to find a negative effect for distance in both domestic and cross-border ties. However, a positive effect of distance on cross-border ties could be explained by the presence of important actors such as the Ministry of Transport or national railway companies, which are located far away from the border (usually in the capital city) and with whom local

[9] According to standard praxis using the approximate Wald test, a parameter is judged to be statistically significantly different from zero if the parameter estimate divided by its standard error is smaller or larger than 2 in absolute value (Lusher et al., 2013).

and regional actors need to exchange information whatever the distance. For BLM, the effects of distance are negative but not significant in either case.

Following Daraganova et al. (2012), we know that a negative coefficient for log distance in a dyad-independent ERGM implies a DIF that takes an attenuated power-law form. While the fit of the DIF to the data can be assessed for a dyad-independent model, the conditional DIF in a Markov model is not available in an analytically tractable form. In order to validate and understand the effect of distance over and above the other covariate effects and endogenous dependencies, we thus rely on the predictive distributions implied by our fitted models. Specifically, we generate a GOF distribution according to the fitted model (Hunter et al., 2008; Robins et al., 2005) and compare the empirical DIFs of the replicate data to the observed DIFs. For the empirical DIFs, we then fit a LOESS curve of tie probability to distance (note that these LOESS curves are net of all the other effects in the model as well as the effect of conditioning on exogenous ties).

In the next step, we apply the above-described procedure in order to refine the interaction effect between borders and distance to investigate the differences between PT and BLM. We produce GOF distributions for each pair of models (i.e. cross-border and domestic ties) and for both policy domains. Figures 2 and 3 illustrate the PT and BLM domains, respectively. For each figure, the first graph represents the entire network (all ties), the second corresponds to domestic ties and the third to cross-border ties (with the other fixed). The observed tie values are also included in the figures for reference (as indicated by circles); at the given distances, the circle is at zero or one on the vertical axes according to whether the tie is absent or not, respectively.

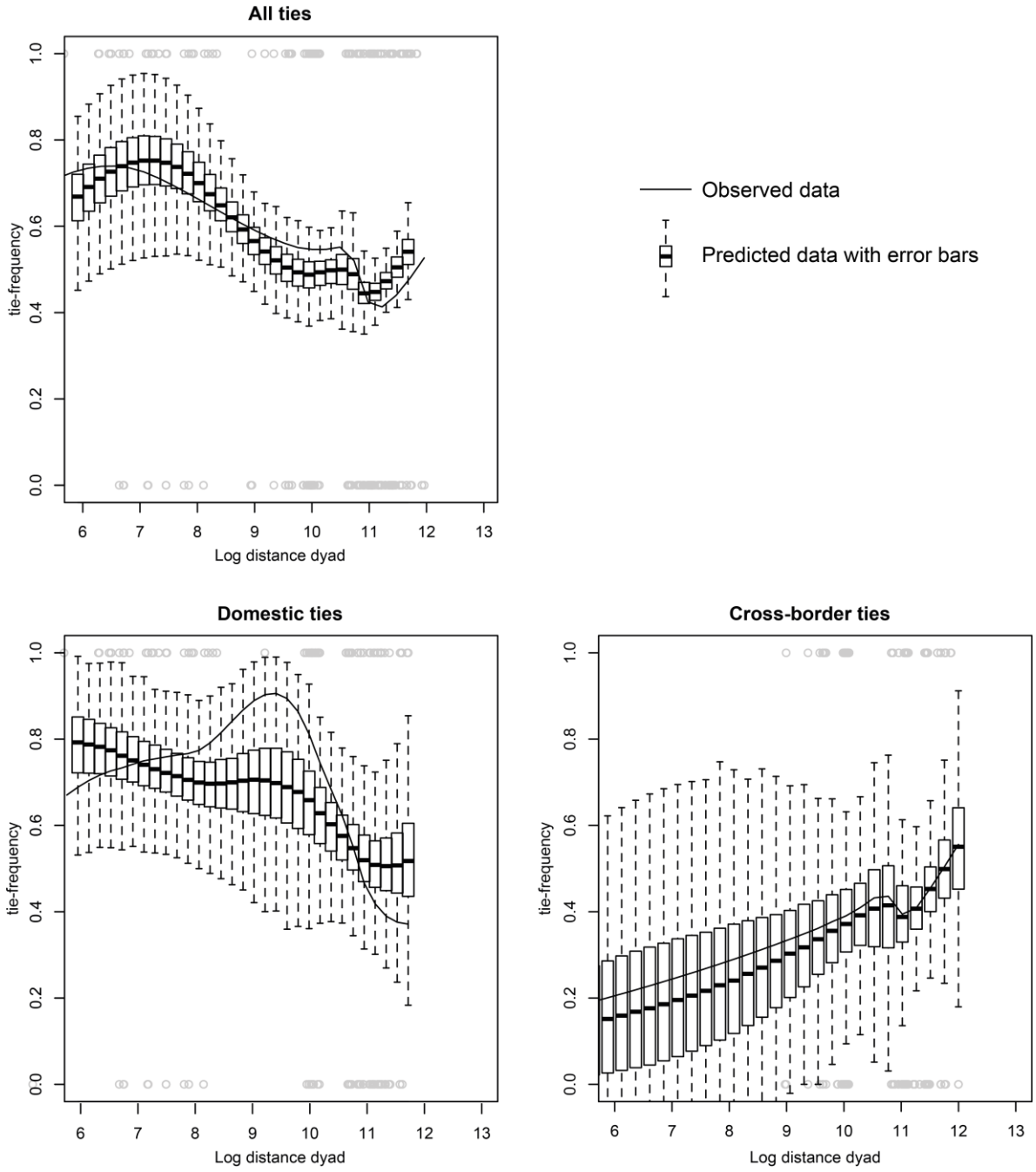

Fig. 2. GOF for tie frequency according to distance. Empirical DIF LOESS curves for observed and predicted data for PT.

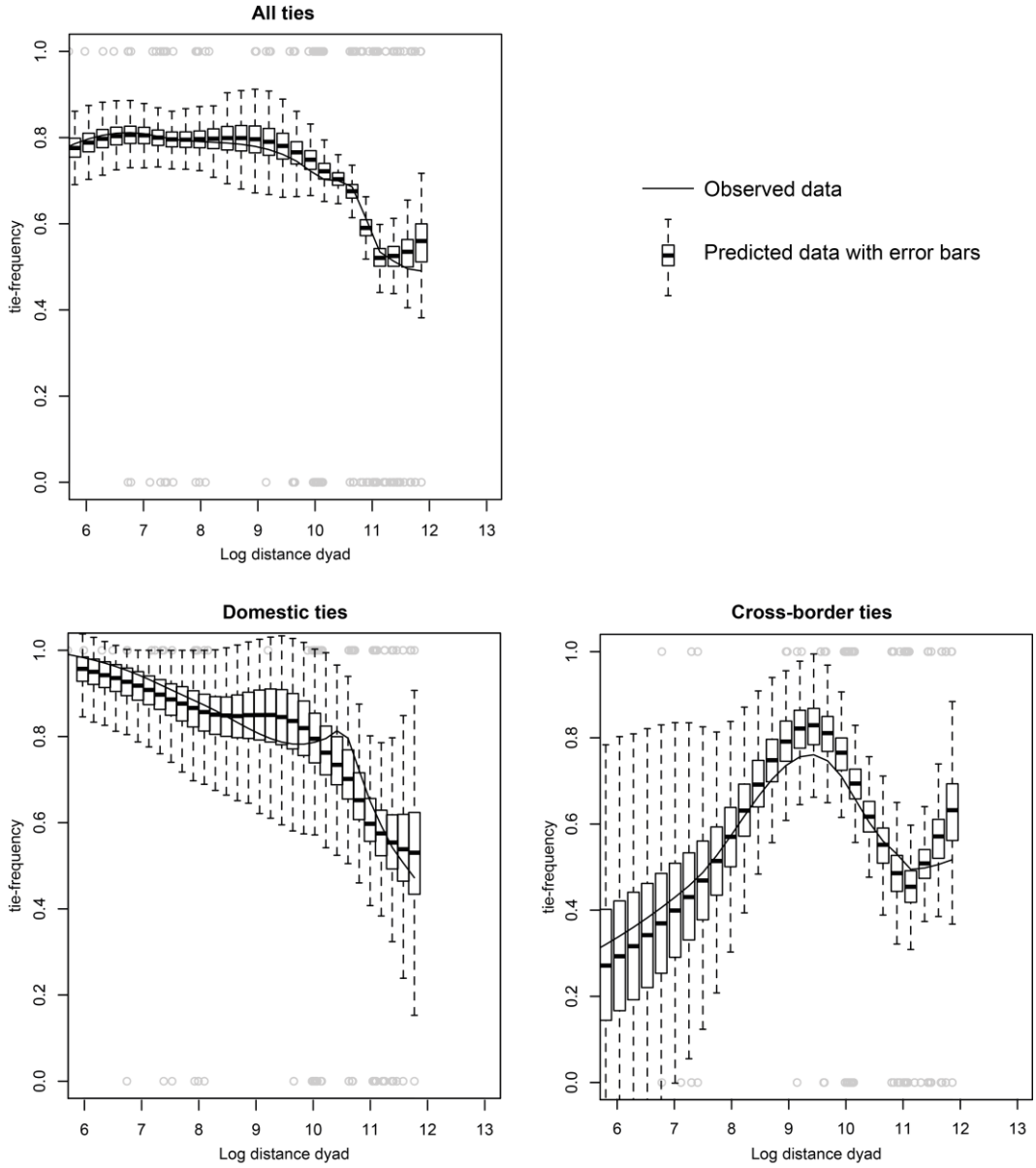

Fig. 3. GOF for tie frequency according to distance. Empirical DIF LOESS curves for observed and predicted data for BLM.

For the PT domain, the interaction probability decreases with distance for domestic ties, whereas it increases for cross-border ties, the latter remaining below the former for all distances. Overlapping the two graphs would thus reveal the gap between the curves, which represents the barrier effect of the border and the way in which it changes according to distance. This gap is rather wide at short distances and narrows at larger distances, implying that the barrier effect tends to decrease with distance and virtually disappears at large

distances as the two curves meet. Moreover, it is illuminating to consider the dyad distributions for different distances. For example, we see that the 'bump' in the charts around nine (log) kilometres for domestic PT ties occurs because of the gap in the distribution of dyads in the approximate range of 8–10 (note the absence of circles). This finding illustrates the effect of spatial clustering on the DIF. Another example of this phenomenon is the absence of cross-border PT dyads at distances below nine (log) kilometres.

For the BLM domain, the interaction probability decreases with distance for domestic ties, whereas the curve for cross-border ties is an inverted U-shape, that is to say, it increases at small distances and decreases at large distances. Similar to PT, the domestic curve remains above the cross-border curve, again highlighting the barrier effect. However, this barrier effect, contrary to our hypothesis of a cumulative effect between distance and borders, tends to decrease with distance.

In summary, Figures 2 and 3 indicate a good fit of the implied DIF net of any other effects (the LOESS curves from the GOF distributions are necessarily smoother than the observed values). In combination with the good fit of the standard GOF statistics of our fitted models, therefore, we have adequately accounted for not only the endogenous dependencies (the Markov model), but also the spatial effects.

Borders and cross-border cooperation

The second interaction effect considered is that between territorial borders and cross-border cooperation. H5 states that institutionalized cross-border cooperation, as a process of re-territorialization, moderates the negative effect of borders on tie probability. Put differently, we expect the border effect to be nil (or even positive) for those ties that occur among organizations that cooperate and negative for other ties. The parameter estimates that result from the breakdown of the models between cooperation and non-cooperation ties (Table 10) suggest that territorial borders negatively and significantly affect non-cooperation (cooperation) ties for the PT (BLM) network, while the other parameters are not significant.

In order to validate the relevance of these contradictory findings, we also consider the results presented in Table 9 that highlight the inverse relationship between the two studied spatial variables. This validation aims to determine the effect of cooperation on the probability of interaction for domestic and cross-border ties. Since territorial cooperation has a positive and

significant effect on cross-border ties for PT, it seems as though border effects are reduced by the existence of territorial cross-border cooperation. This result is consistent with the fact that borders negatively affect those ties that link non-cooperating organizations for PT. As for BLM, cooperation has a positive and significant effect on the probability of forming domestic ties, in line with the fact that borders also negatively influence cooperation ties in BLM.

Table 10

Parameter estimates for the PT and BLM models (cooperation vs. non-cooperation ties).

	PT				BLM			
Parameters	(Cooperation)		(No cooperation)		(Cooperation)		(No cooperation)	
Structural effects								
Arc	4.760	(3.586)	−1.374	(1.602)	9.792	(13.97)	6.453*	(3.087)
Reciprocity	−0.395	(0.796)	0.731	(0.391)	1.342	(1.53)	0.777	(0.542)
In2Star	−0.242	(0.308)	−0.031	(0.203)	−0.646	(1.102)	−0.416	(0.225)
Out2Star	−0.231	(0.278)	0.039	(0.201)	−3.200	(2.192)	−0.842	(0.453)
In3Star	0.006	(0.027)	0.002	(0.019)	0.023	(0.081)	0.032	(0.018)
Out3Star	0.007	(0.025)	−0.004	(0.019)	0.227	(0.175)	0.057	(0.039)
Transitive-Triad	0.362*	(0.089)	0.094	(0.072)	0.633*	(0.252)	0.256*	(0.07)
Cyclic-Triad	−0.301*	(0.112)	−0.140	(0.093)	−0.677*	(0.326)	−0.364*	(0.093)
Actor attribute effects								
Important actors Sender	1.325	(0.984)	0.303	(0.365)	10.884	(6.671)	1.565	(0.822)
Important actors Receiver	1.358	(1.02)	0.863*	(0.388)	4.663	(5.453)	1.100	(0.714)
Important actors Interaction	−1.054	(1.222)	−0.375	(0.499)	−6.586	(5.562)	0.112	(0.773)
Spatial effects								
Distance	−0.516*	(0.211)	−0.003	(0.07)	0.249	(0.35)	−0.255*	(0.111)
Territorial border	−0.344	(0.498)	−0.746*	(0.261)	−2.910*	(1.211)	−0.500	(0.28)

* Significant effect

According to these results, national borders as barriers to communication seem to matter more for BLM than they do for PT. This finding highlights the contingencies of the interaction effects on network specificities and that governance within cross-border PT is mainly driven by functional integration, particularly the growing mobility of people and goods that cross the territorial border on a daily basis. Since these flows are embedded in different territorial jurisdictions separated by a border, the solutions that stakeholders are asked to provide, such as new bus lines or enhanced railway connections, need to be discussed at the cross-border level. In contrast, our results tend to demonstrate that national borders still shape the behaviour of local and regional stakeholders as far as BLM is

concerned. Therefore, economic competitiveness and the need to attract businesses and investors do not necessarily need to be addressed at the cross-border level; rather, the local or national setting might be favoured for cross-border cooperation in this specific policy domain.

6. Conclusions

The present paper argued that space is more than just distance by investigating how a number of geographic contextual effects influence the formation of policy networks. In line with the 'spatial turn' that has marked social theory in the past decade or so, space is conceived as constituting social and political relations, implying the need for network analysis and for theory to be more sensitive to space as well as to its diverse socio-spatial arrangements, practices and understandings.

In order to ground this claim in an empirical approach, three specific spatial effects were taken into consideration to analyse the structural patterns of the PT and BLM policy networks embedded within the ELKT, namely, the distance between organizations, the presence of territorial borders and the emergence of a cross-border territoriality driven by cooperation. In the first step, all three spatial effects were modelled jointly with structural effects and actor attributes as control variables using ERGMs. For both policy networks under scrutiny, the effects of distance and borders were shown to be negative, whereas cross-border cooperation had a positive effect. This result suggests that net of any distance effect, the territorial borders between France and Belgium as well as those between Flanders and Wallonia serve as barriers to policy interactions. As far as cross-border cooperation that results in the formation of the ELKT is concerned, the positive effect on policy interactions also highlights a process of cross-border territoriality.

In the second step, this paper also investigated the interactions among the spatial effects studied herein in order to examine how the effect on one predictor could be modified according to the value of another. Two specific hypotheses were tested. First, we analysed how distance affects policy interactions by territoriality (i.e. domestic vs. cross-border ties). In this respect, we hypothesized that there is a cumulative process between distance and borders that results in an increasing barrier effect. In other words, we expected both domestic

and cross-border tie probabilities to decline with distance, but the latter to a greater extent than the former. By making use of simulated predictive data derived from the model specification, we were able to plot the distribution of tie probability as a function of distance for both domestic and cross-border relations. Instead of increasing with distance, however, the barrier effect seems to be strongest at short distances and weakens as distance grows. For both policy domains, the presented findings thus suggest that local actors tend to neglect their cross-border counterparts in favour of foreign actors located some distance from the border, especially ministries and other key players located in capital cities and beyond.

In the second interaction between the contextual variables, we considered the relationship between cross-border cooperation and territorial borders. We hypothesized that the negative effect of borders on policy interactions would be moderated by cross-border cooperation. In other words, we suspected that debordering does not affect all cross-border relations, but tends to be restricted to cooperating actors. The model results supported this hypothesis for the PT network, but not for BLM. In the former, actors have been able to transcend the territorial borders that separate them in order to engage in a process of governance capable of addressing the issues that arise from cross-border functional integration. In contrast, for BLM, dealing with economic positioning and competitiveness, national and regional territoriality seems to prevail over cross-border relations and imaginaries. Ultimately, such a contrasting result highlights the contingent and contextual character of bordering processes (debordering as well as rebordering) and their effects on social interactions.

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