




Border blocking effects in collaborative firm innovation

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ABSTRACT

Border regions are not often associated with innovation and economic prosperity. And even when they are prosperous, cross-border interaction is still mostly limited. The opening up of borders in Europe has presented new opportunities for firms located in these border regions to co-operate for innovation and knowledge to flow across borders. Despite the reduction of the importance of borders, firms seeking to access cross-border knowledge resources need still to ‘cross’ the border and address the various effects it brings. This paper therefore asks the question of how the presence of a border affects the processes by which firms attempt to build up productive co-operations for innovation. We use a heuristic of collaborative innovation across borders as building up through four sequential cooperation stages, and each of these different stages is susceptible to different kinds of border effects. Using a case study of firms co-operating across the Dutch-Flemish border, we empirically explore these border crossing processes in order to shed further light on how border processes play out.

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Introduction

Despite the formal removal of borders between countries in the European Schengen area, national borders still appears to blocking European innovation (OECD, 2013) by reducing knowledge spillovers (Fischer, Scherngell, & Jansenberger, 2006; Thompson, 2006) and labour flows (Weterings & Van Gessel-Dabekaussen, 2015). Innovating firms, particularly SMEs, may have limited capacity for building new networks across borders and the area across a border may represent a terra nulla for these firms in the way that their hinterland within their national borders does not (Van Houtum & van der Velde, 2004). At the same time, knowledge institutes such as universities and public research laboratories may prioritize international cooperation with leading commercial partners rather than choosing to work with nearby firms across borders (Goddard & Chatterton, 2003; Van den Broek, Eckardt, & Benneworth, 2018a). Indeed, the persistent failure of cross-border regions with strong innovation potential (such as Lyon-Milan, Toulouse-Barcelona and Øresund) to realize that potential in integrated knowledge spaces suggest that national

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borders may continue to exert a blocking effect upon innovation activities (Van den Broek, Eckardt, & Benneworth, 2018b).

A national border has dual characteristics, serving both as *portal* through which firms may encounter new (knowledge) resources for innovation, but also as a *barrier* that hinders actors in interacting and exchanging resources (Trippel, 2018; Van Houtum, 1998) that might otherwise exist between those actors were they similarly proximate within a single national institutional space (Hjaltadóttir, Makkonen, & Sørensen, 2017). These access/ blocking processes may function simultaneously, obscuring the particular mechanisms by which the border affects innovation (Van Houtum, Kramsch, & Zierhofer, 2005). In this paper we therefore ask the research question of how does the presence of a national border affect the processes by which firms attempt to build up productive co-operations for innovation? To understand this, we develop a more nuanced version of border effects beyond simply blocking collaboration. We instead look at how firms cross borders in building up innovation networks, using a heuristic (Koen, 2011; Marxt & Link, 2002) which stylizes innovation co-operation down into four stages: the decision to co-operate, partner identification, co-operation formalization and innovation co-operation.

We use an exploratory case study to identify border mechanisms in one particular cross-border region, an example of firms co-operating for innovation across the Dutch-Flemish border. Despite considerable similarities across the border, border effects are visible in this relatively economically successful and innovative region and examples of cross-border innovation connections are relatively rare. The case study examines participants in the 'Crossroads' programme, aimed at stimulating cross-border collaborative innovation. We use our heuristic to analyse how firms in the Dutch-Flemish border region deal with the border in different phases of cooperation. We identify clear differences in the border effect in each phase of the innovation relationship development distinguishing between: a network breaking effect, a rationally bounding effect, a structural separation effect and an internationalization effect. On that basis we note that the border is not an absolute but rather has a continual undermining effect on attempts to build new cross-border innovation activities and sustain existing innovation networks; moreover, these processes may also have a wider applicability in understanding the conundrum of other kinds of regional innovation systems that settle into suboptimal equilibria and fail to deliver their potential.

Cross-border knowledge flows and collaborative firm innovation

Cross-border knowledge flows

Knowledge flows between different actors in a region are an important mechanism that help firms to better learn and innovate (Cappelli & Montobbio, 2016; Tödtling, Lengauer, & Höglinger, 2011) but the border forms an obstacle to this flow of knowledge (Thompson, 2006). We here stylize innovation as a process around two key properties, namely that it can be understood as a systemic process (Fagerberg, 2006) and also that it is dependent on interactive learning both within and outside the firm (Revilla Diez & Kiese, 2009). Geographical proximity facilitates interactive learning by allowing face-to-face communication and enabling interpersonal networks of knowledge exchange to form (Howells,

2012), although increasing emphasis is placed on the roles played by alternative (non-geographical) proximities in facilitating knowledge exchange (Hansen, 2015). For regions located at the national border, the border reduces the knowledge flows and spillovers considerably with proximate regions over the border, undermining this positive geographical proximity effects (Fischer et al., 2006). Even in Europe where there have been decades of efforts to integrate across borders, the border remains a substantive barrier to knowledge sharing (Miörner, Zukauskaitė, Tripl, & Moodysson, 2018).

Indeed, Lundquist and Tripl (2013) contend that cross-border collaboration oriented towards knowledge and innovation is arguably the most complex form of cross-border working. The cross-border region for business innovation represents an ‘*unknown and insecure environment*’ (Koschatzky, 2000, 446) where networks are missing, there are cultural and administrative differences, and collaboration is rare. Hansen (2013) analysed the evolution of co-authorship between Danish and Swedish researchers, observing that removing the physical barrier was insufficient to increase cross-border knowledge collaboration, but that additional deliberate effort to build networks was required. Makkonen’s (2015) analysis of scientific collaboration in the German – Danish border area found that cross-border co-authorships were rare as a result of both the regions’ peripheral status but also different knowledge bases across the region (see also Hjaltadóttir et al., 2017). Even where there are similar knowledge bases, Hahn (2013) also observed negative border effects in his study of the automotive industry in the Saar-Lor-Lux region at the French – German border, finding almost no cross-border networking, which inhibits the exchange of information and the recognition of potential collaboration opportunities.

Secondly, cross-cultural differences hinder mutual understanding and comprehensibility (Van den Broek & Smulders, 2015), with language an obvious difference, where in particular SMEs may lack employees with language fluency skills to co-operate with trans-border partners (Hahn, 2013; Koschatzky, 2000). Beyond language issues, differences in mentality, mind-set and business practices may all undermine cross-border learning (Leick, 2012; Stensheim, 2012). The influence of the border also manifests itself in differing tax systems, social security systems, legislation and vocational training systems (Klatt & Herrmann, 2011), all of which affect the ways in which firms organize their firm innovation processes. Klatt and Herrmann (2011), analysing 30 years of Dutch-German cross-border collaboration, argue that the single most important barrier to cross-border collaboration is information, closely followed by the availability of funding. Both factors facilitate firms to exploit the advantages whilst minimizing cross-border collaboration costs.

Border effects on collaborative innovation

Innovating firms need a wide range of resources (Fagerberg, 2006) that may be found within or outside the firm and which are generally scarce (Nelson & Winter, 1982). One way to secure access to these scarce knowledge resources is in engaging in collaborative innovation, here defined as a learning process aiming at developing a new product, process or technique with efforts shared between two or more firms. Both Marx and Link (2002) and Koen (2011) conceptualized this collaboration as a step-wise process in which firms progress through four stages. Whilst Marx and Link (2002) distinguish

‘initiation’, ‘partner selection’, ‘setup’ and ‘realisation’, Koen (2011) distinguished ‘need’, ‘find’, ‘formalize’ and ‘execute’ phases. Although couched in different languages, both categorisations highlight that the phases are qualitatively different in terms of the extent to which the outside world is involved in the process. In the first phase it is entirely absent, in the second there are possibilities for interaction, in the third, there is a concrete partner with whom links are being developed, and finally, attempts are made to exchange knowledge resources with that partner. We combine these two conceptualisations into a heuristic describing how firms experience collaborative innovation processes (see [Figure 1](#) below). From our perspective:

- The initiation stage involves a firm making a decision to engage in collaborative innovation instead of in-house innovation.
- The partner selection stage involves finding a partner with both useful complementary assets and the ability to develop linkages with the firm.
- The collaboration stage (Marxt & Link, 2002) involves formalizing the agreement (Koen, 2011), regarding the formal and administrative procedures relating to a project.
- The execution stage involves the process of exchanging knowledge resources to create new innovations.

In each phase, firms see reaching over the border as a way of accessing unique resources not readily locally accessible, but what makes it worthwhile as well as difficult differs between phases. We contend that the effects of the border on collaborative innovation may differ between the stages as the challenge shifts from *identifying any potential partner* to *working with one particular partner* (Marxt & Link, 2002). For firms that do not know any potential co-operation partners, the border is a line of uncertainty beyond which little may be known. For firms that are already exchanging knowledge, border barrier effects may be much more imminent, related to the different kinds of symbolic and material practices prevalent on both side of the border. To answer our overall research question we therefore consider how these border effects vary across the different stages of collaborative innovation. By choosing to work across the border, firms signal that the rewards (resources) that can be secured are worth the efforts of working across a barrier.

There are differences in the calculations that firms make in each level, and the reasons that firms may have for choosing cross-border collaboration. In the first phase, the calculus is a choice between beginning to look over the border or not; suggesting there should be a clear need for collaboration, as cross-border collaboration adds extra complexity and is only necessary where there are no comparable within-region collaborators. In the second phase, a firm chooses a partner in looking at where it does not have existing contact networks, and this greatly increases the uncertainty of the process, which



Figure 1. The four-stage collaborative innovation process (adapted from Marxt & Link, 2002).

may have a discouragement effect. In the third phase, initiation involves deciding whether a single partner is suitable to proceed, and as innovation is already an uncertain and complex process, engaging in any kind of collaborative innovation adds extra complexity (Koen, 2011). Finally, in attempting to make the collaboration and knowledge exchange work, differences in cultures, ways of doing things and language barriers may create hurdles that need to be addressed. In the table below (Table 1), we set out in more detail how these border influences may differ between the four phases of cross-border innovation, and the different reasons that firms have for looking across the border at each phase.

The ‘Crossroads’ project and the Dutch – Flemish border region

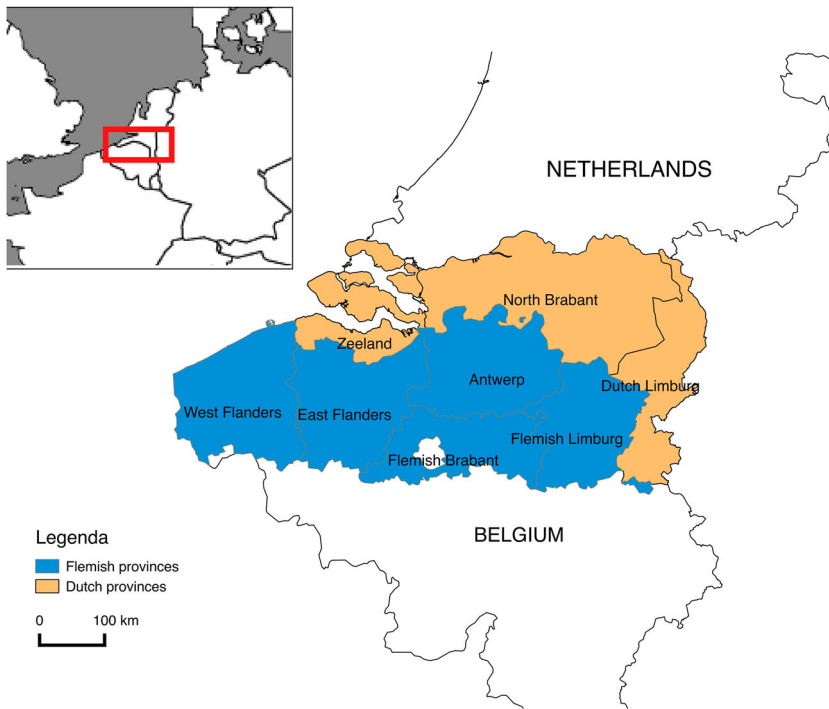
Introduction to the case study region

In this paper, we adopt a single case study of a region where there has been serious attempts at cross-border collaboration, and despite the relative similarity between the two sides of the border, there have been substantive problems in building up cross-border relations. Our focus on this paper is on national borders, because this has been identified elsewhere as having a substantive limiting effect on innovation activity, although we do not argue that there may also be innovation collaboration differences that emerge between regions contained within national borders. Our case study represents what Siggelkow (2007) terms a ‘powerful example’ disclosing cross-border barriers because in terms of various kinds of proximity measures, these regions should be close, and yet this has not led to innovation collaborations. We address our research question by analysing how the border has affected collaboration processes between firms, using our four stage model, with a single case study, in this case the ‘Crossroads’ project in the Dutch – Flemish border region (see Map 1 below).

In this region, there is a strong presence of manufacturing firms, mainly small and medium-sized firms (SMEs), who are working as suppliers of OEMs (Original Equipment Manufacturers) such as Philips, ASML and Janssen Pharmaceutical. The region consists of the Dutch provinces of Zeeland, North Brabant and Limburg, and the Flemish provinces of Antwerp, Flemish Brabant, Limburg, East Flanders and West Flanders. There is much high-tech manufacturing in this region, clustered in the so-called ‘Top Technology Region Eindhoven-Leuven-Aachen triangle’ (TTR-ELAt), and also around Antwerp; both regions

Table 1. Postulating the border effect.

	Literature	Cross-border perspective
Initiation	Consider why engage in collaborative innovation instead of in-house innovation (Koen, 2011). Unique assets needed.	Cross-border collaboration adds extra dimension of difficulty and risk to already uncertain and complex process.
Partner selection	Search process mostly starts with nearby partners: own collaborators. Information on possible collaborators is important. (Marx & Link, 2002)	Firms (in border regions) are nationally oriented when searching partner (Van Houtum, 1998; Tripl, 2010) and lack networks across the border (Hahn, 2013; Hansen, 2013)
Setup	Formal agreements about the collaboration are necessary (Koen, 2011).	Formal agreements and administrative procedures differ (Klatt & Hermann, 2011).
Realization	Collaborative innovation requires a high degree of trust and absorptive capacity.	Different business practices and mind-sets on each side of the border lead to different modes of operation (Leick, 2012; Stensheim, 2012).



Map 1. The Dutch – Flemish border region.

have seen much co-operation between firms, government and knowledge institutes (OECD, 2013). Despite this strong potential for cross-border innovation, the region's strong sectors appear to have failed to evolve into dense networks of cross-border linkages, and improving those connections has been a key focus of the INTERREG IVA programme Flanders - Netherlands, financed by the European Regional Development Fund, with nearly half its budget directed towards cross-border innovation and entrepreneurship. INTERREG Flanders-Netherlands provided €3 m to the 'Crossroads' project as part of wider attempts to strengthen cross-border innovation linkages. The Crossroads project is a funding scheme aimed directly at collaborating SMEs in six high-potential regional sectors: embedded vision, remote diagnostics, nano-materials, inkjet technology, and surface treatment and materials. Participating firms received a maximum subsidy of 50% for joint innovative projects; 21 collaborative innovation projects were developed among firms, of which two were stopped during the project. Most projects contained two partners, one on each side of the border. The project received €3 m.

Research methods

In our research, we explored the role of the border on the cross-border innovation practices of Crossroads participants, to provide more detail on the way that bordering processes affect innovation collaboration of firms. This is an exploratory piece of research where we are seeking to better conceptualize the causal mechanisms by which a phenomenon affects a particular set of transactions, namely the way the border affects the

development of innovation collaborations. For this reason a qualitative approach was chosen using semi-structured interviews, supplemented with the Crossroads project plan alongside project information accessed via a Crossroads brochure and the project website. We chose to speak with firms that had successfully completed an innovation collaboration over the border, in order to explore the barriers and disincentives they had experienced as they sought to create cross-border innovation effects. The firm list was drawn up from the project brochure and website, and the responsible individual in each company was identified and approached by email and telephone. Of the 19 successful innovation projects within Crossroads we were able to speak to 13 and conducted a total of 15 interviews.

The interviews were undertaken with the person responsible for collaborating and interacting with their foreign partner, and because our sample was mainly of small firms, this was usually a director, although in four cases we spoke with a project manager or chief engineer. Interviews lasted between 45 and 120 min and were all taped and transcribed. The interviews followed a semi-structured protocol, with prompts grouped around three topics: the innovation itself, the cooperation decision and search process, and the cooperation process. The protocol allowed cross-case comparisons with each interviewee providing responses covering similar topics, whilst also permitting interviewees to place emphasis and talk about the issues and perspectives of greatest personal concern.

Developing cross-border innovation contacts in the crossroads project

The firms we interviewed talked through the processes they undertook in order to arrange and execute cross-border innovation projects. In the course of those narratives, they talked about their decision-making at various critical moments in those attempts. In this section, we present that data grouped around four kinds of processes that they typically undertook, namely in considering whether to access knowledge outside the firm, attempts to locate a partner, negotiations with a partner to set a legal collaboration framework and then the final collaboration activity. What we report here are the ways the respondents described the role played by the border in various ways in making those judgements. That allows us to provide a stylized readings of these four kinds of process, and then in the following section we are able to analyse that data through our conceptual framework to consider the border blocking effects in each putative phase of our border-crossing model.

The role of the border in firms' co-operation initiation decisions

When firms were talking about the decision to begin developing a collaborative relationship with a cross-border firm, the primary considerations which were related in the interviews were the decisions regarding whether the firm needs to access external resources in order to collaborate. This derives from the two main rationales behind collaborations: opportunistic and synoptic. In the opportunistic reasons for cooperation, there was no a priori innovation problem in response to which firms initiated a partner search. Typically they met someone, for example at a conference or exposition, and then picked up the idea that it might be good to co-operate. In the context of the Crossroads project, a number of firms admitted to being stimulated by the desire to access the subsidy for working with a cross-border partner rather

than especially seeking a partner. In such cases, the subsidy resources were used to facilitate or accelerate the innovation project, with several firms stating that without the financial support from the funding scheme the innovation would have been delayed or not have been developed at all. One interviewee noted *'Investing 50.000–100.000 euros is very hard for an SME. That was a very difficult barrier to overcome without the subsidy'*. Indeed, in one of the projects, two Dutch partners searched for a Flemish partner to get subsidy access because *'you needed a foreign [Flemish] partner, so we went looking for one'*.

In contrast to this, there were firms who had decided to actively search for an external partner and had also attempted to make some kind of rationale judgement of the costs and benefits involved in such a collaboration: neither factor had a specific border dimension to them, namely knowledge access and market access. These three reasons all suggest firms lacked resources and were seeking any partner in order to access resources. This points to the fact that firms lacked a unique and crucial resource for their innovation to succeed. In their decision to initiate a collaborative innovation project and search for knowledge-, market- or subsidy access their first decision was to search for a partner, not for a cross-border partner per se. First, almost all firms with synoptic reasons for cooperation experienced a knowledge gap. One firm mentioned the need to integrate several components on one print board, and doing that effectively required both knowledge and machinery that they did not have nor could they secure in their immediate environment. Another firm described it as a reaction to the pressures of innovation, and the decision being swung by the recognition that *'at some moment in time you reach the limits of your own stints'*. A second reason was the desire to access a new market or a similar market in a different country. One firm specialized in static measurement machines and was seeking to move into the market for small handheld metres. Market access can be access to a new market or to the same market in a different country. A second firm supplied high-end vision-technology systems, and needed to sell the technology as part of an integrated system to many customers simultaneously in order to cover the (expensive) technological development costs. Now working with a large firm over the border they suggested that *'what we developed now would have never been possible on our own'*.

The role of the border in firms' partner selection decisions

The second set of processes where border effects might have been visible were in the decisions that were taken around partner selection. Although most firms interviewed stated that their primary concern was for the most suitable knowledge, they started their partner search processes initially in their direct surroundings, and only searched cross-border in the absence of an immediately accessible local partner. For some this involved a global search, although unsurprisingly our interviewees had found such partners across the border (an artefact of our selection criterion). The firms noted that they had had difficulties in seeking to find partners across the border, and believed that they would also have difficulties in the future for a different kind of innovation issue.

Perhaps the most useful distinction that can be made here is between those firms that already knew their partner (having already 'crossed the border') and those firms that did not. Of those firms who had 'crossed borders' prior to Crossroads, some already had experience with cross-border working, whilst others only knew their partner by name or as a competitor or subcontractor. This process of crossing the border for the first

time involved an experience in which the role of the border shifted, from a boundary (beyond which there is unknown *terra nulla*) into a gateway with potential (new resources) but also problems (barriers to accessing those resources). Our contention is that the border effect in partner selection is likely to be very different for firms that have 'crossed borders' in terms of the event that stimulates border crossing, the search processes they use and their rationales for cross-border searches.

For those firms without cross-border experience, the initial decision to seek a partner was usually followed with attempts to find partners in their own networks. If unsuccessful, they would look more broadly and this network-driven search strategy was affected in various ways by the border. Firstly, the firms that did not previously know their partner tended to initially search in their direct surroundings (their own region and country).

Firms that already knew their partner had in common that they did not have a wide network over the border, and their contact was an isolated example, who shaped their inter-firm cross-border co-operation. A number of interviewees admitted that this raised problems for accessing firms with complementary knowledge for innovation, and it was hard to find firms across the border with knowledge that fitted well with their own in terms of shared innovation processes.

Once crossing the border, firms used various strategies in their partner-search processes. Some were based on more codified knowledge, searching business directories to identify potential partners with the required knowledge. Others sought a social approach, physically going to the places where potential partners might be, such as conferences and network meetings. The partner search technique of other firms was based on 'know-who' via their partners and subcontractors, with the North Brabant development agency (BOM) and Digital Signal Processing Valley (a regional cluster organization) being named by a number of interviewees. One of the firms argued:

we then [after searching inside the region] had to look further, we skimmed the Internet. Via another network (...) we came into contact with [our partner].

The role of the border in firms' project planning decisions

In terms of prospective planning, a collaborating firm will typically make agreements in principle to guide the future collaboration, balance out interests and guarantee that productive partnership. Interviewees made a distinction between two elements of consideration, administrative and practical issues ('how to co-operate') alongside the content of the innovation process ('what to innovate'). The most important element of the practical issues related to the subsidy rules, and in particular administrative hindrances that the border created. There were for example differences in rules regarding treatment for value added tax (VAT), differences in the way employees were contracted and differences in certification. In other areas there was no divergence over the border, e.g. the majority of certification and regulations are Europe-wide, although the European non-discrimination rules sometimes gave rise to discrepancies. One cited example was for vehicle certification where certification in any EU country was valid in another although the rules differed substantially with the Belgian rules being much more stringent than the Dutch rules.

These issues were also experienced by firms with prior experience in working with cross-border partners, who sought to anticipate potential problems that might arise and

to build these certification, registration and other administrative issues into the project planning approaches. These more experienced firms realized that administrative issues also reflected real differences between the two countries, and that effectively planning to deal with those differences would also help optimize the eventual innovation processes (see for example in the next section the fact that power socket licensing reflects differences in the electricity grid supply across national borders). As one interviewee firms stated:

Our [products] have to work for a specific customer. (...) We do not built [a product] to comply with regulations, we built [a product] that works for our customer.

The role of the border in firms' project execution decisions

All the firms we talked to agreed that in the execution of the project there were very few notable differences between innovation projects involving exclusively domestic partners, and those involving cross-border partners. Partly that reflects a fact that innovation projects very rarely run smoothly, and that problems that arise due to the domestic border are not substantially more burdensome than other problems. Nevertheless, project execution reflected the need to minimize those problems, and we saw in several cases that projects were compartmentalized across borders, with activities divided into work packages and that different teams on different sides of the border would be primarily responsible for individual work packages. Although shared meetings co-ordinated across teams, primarily during the project set up and incidentally during execution, there was a separation of responsibility and restricted interaction between these work packages. As one interviewee noted this led to a situation where:

We worked separately on the project, only communicating by e-mail. We have separated [the tasks] on purpose, and this was possible here. Then it is an advantage that you speak the same language, as you could easily speak over the phone.

A recurrent theme in the interviews was a perception that there was a 'cultural difference', although we are here mindful of the risk that interviewees were allowing these 'intercultural differences' to explain a very wide range of outcomes. The typical differences cited by the interviewees were for example in terms of the directness of the Dutch in comparison to the Flemish partners, differences in working hours and work patterns (Dutch work less fulltime), differences in number of meetings and consultations between managers and employees (the Dutch use of meetings to decentralize decision-making), as well as subtle differences between Netherlands-Dutch and Flemish-Dutch. Not all of the partners noted that differences created problems within the projects: one Flemish firm reported of a Dutch partner that did not like their user interface '*they [the Dutch customer] simply say: that one is ugly. Make us another one*' and although the directness was atypical to Flemish culture, the Flemish partner reported appreciating it because it accelerated product development and made the cooperation and decision process more transparent. Interestingly, while the literature sometimes suggests this factor as a problem (Vogels, 2015) in intercultural communication, it was actually a positive factor that indicated a real innovation problem (the user interface's aesthetic shortcomings) prior to addressing that problem.

Next to these cultural differences, there were also some technical differences, and in the context of the firms interviewed, a recurrent problem was that of the electrical infrastructure. The Netherlands and Belgium are superficially different in terms of having different

Table 2. Observed border blocking effects.

	Stylized facts
Initiation	<ul style="list-style-type: none"> • The rational reasons for cooperation point to the fact that firms lacked a unique and crucial resource for their innovation to succeed. • The first decision is to search for a partner, not for a cross-border partner per se. • Firms first look in their local and national networks for a partner.
Partner selection	<ul style="list-style-type: none"> • Firms lack knowledge of potential collaboration partners on the other side of the border. • Especially when it comes to partners with knowledge outside their own core competence.
Setup	<ul style="list-style-type: none"> • All firms experienced administrative and practical differences • Earlier experience with these differences leads to learning effects. • The collaborative innovation process was not seriously hindered by these differences.
Realization	<ul style="list-style-type: none"> • Main problems that are experienced are 'regular' innovation problems. • Small and subtle differences hardly lead to problems.

power sockets (a common sort of Dutch plug socket is illegal in Belgium). Perhaps more importantly, maximum supply voltage varies between countries, and whilst it is diurnally stable in the Netherlands, voltage in Belgium is higher during the day than at night. First, firms needed to be aware of this difference, which is not self-evident. Second, the product has to be adjusted to this because otherwise: *'all the fuses melt ... [and] ... one of the things customers demand is to use the product in their country'*. This is of course not an exclusively border issue (all firms that develop innovations for the international market must address this), and the more general point was made a number of times that collaborating with cross-border partners in practice did not vary greatly from dealing with domestic partners. Indeed, firms in the first instance do not see many differences between cooperating cross-border and cooperating with domestic partners, but that they did have to cope with some, mostly subtle, differences.

Initial analysis & discussions

On the basis of the interviews in the case study, it is possible to stylize a number of 'border blocking effects' that may impede innovation, and to relate them to the four stages of the collaborative innovation process we set out in Section 2.2 (see Table 2 below). The most important point to be made here is that there appears to be a clear difference in the kinds of barriers that exist at the different stages. Alongside this we would also highlight the observable difference between firms who are 'crossing borders' for the first time and those that have more experience in dealing with the challenges the border poses for collaborative innovation. More detail is provided in this stylization below.

Analysing border blocking effects by phase

In the initiation phase, we found that most firms first searched for national, mostly regional, partners within their existing networks. Only when they could not find a suitable partner in their direct surroundings where they stimulated to look for a distant partner. But this was not necessarily a preference for partners just over the border; they could be located anywhere. Firms that looked for the best available partner globally were those that already had extensive experience in locating and working with foreign partners. This represents an internal vs. external decision, and in case they choose to go externally, they then proceed to the second phase, partner selection. The nature of the border in the

initiation phase is completely opaque to firms that have not yet crossed the border. For those that have, their primary consideration is whether they already know of firms over the border who may be able to provide the complementary resources they require. This has a substantial damping effect on spill-overs which rely on spontaneous contact and interaction between firms not yet in contact but with the potential to mutually profit from interaction.

Also the partner selection phase shows a substantial damping effect. Some firms had earlier connections that they could use to find a partner, but most firms were forced, in quite a haphazard and opportunistic way, to draw on their much wider network of suppliers and customers as well as their contacts within regional development agencies, Chambers of Commerce and regional cluster organizations. Although firms tended to have very good knowledge about their competitors, they knew much less about firms with complementary knowledge, and were seeking access to networks of firms that were typically unfamiliar to them. The border effect in this phase can be stylized as distancing firms from geographically proximate partners that they might be able to work with more easily were they collocated within a single region. Alongside this it was possible to see a second effect for firms deciding not to co-operate with existing partners and therefore had to undertake a search process guided, at best, by bounded rationality. The border here functions by further bounding that rationality – although this is not an absolute effect, it makes it more likely that firms settle for a ‘good enough’ search process and locate a firm immediately across the border rather than to identify a broader set of potential partners.

In the setup phase, firms experienced some difficulties related to the administrative and material aspects of the cross-border collaboration. In some cases this demanded that firms makes substantive investments of time and money, making innovation projects more costly. However, the firms we interviewed tended to regard the extra costs incurred as investments in future profitable collaborative activity. There was also a tendency to plan the project activities in separate work-packages split between the partners, on both sides of the border, although this may be a primarily administrative issue rather than a true border effect. Nonetheless, these compartmentalisations weakened interactive learning opportunities and therefore represent a structural hole in the firms’ innovation network. From the regional perspective, this may also undermine the formation of a wider regional knowledge pool in particular high-value knowledge fields which would undermine specialization and the development of innovation-based regional competitive advantage.

In the realization phase, firms did not experience working with cross-border partners as being different from working with domestic partners. They were aware of some differences and did report differences that can be related to language, norms and values and business culture, but this did not substantially influence the collaboration. It appeared that cognitive proximity (between engineers in high tech fields) was sufficient for smooth cooperation. Where the border did play a role in this phase, it was no different from the effects that emerge from international collaborations more generally, despite the fact that, in this case, the international partner was geographically proximate. In the specific case of the Dutch-Belgian border, there is a popular discourse around cultural dissonances across the border but that seemed not to have played an important role.

Towards a more systematic typology of border blocking effects

We see a clear evolution in the nature of the border effect; its blocking effects reduce over the phases as the potential benefits become more concrete and achievable. It is possible to distinguish an apparently dominant effect at each of these stages, and this forms the basis for our overall contribution. In the initiation phase, the border acts as an end—point for networks, with the cross-border area representing a professional terra nulla that actors are unwilling to enter. In the partner selection phase, the border has an effect to bound rationality and adds to uncertainty in the process because of the absence of complementary networks by which knowledge about partners can be obtained. In the set-up phase, the border has the effect of creating and reinforcing structural holes in wider innovation networks, as partners create projects in ways that are separated by the border within projects. Finally, in the realization phase, the dominant border effect appears to be a version of the internationalization effect, i.e. hindrances that arise when working with international partners wherever they are located.

In the initiation phase, we see a network breaking effect, that actively prevents knowledge spilling over the border. In making an internal decision to seek external resources, potential assets located across the border are not considered because they lie outside the firms' cognitive field. Our research suggests two reasons for this. First, the absence of the cross-border networks means that there are no serendipitous or second order contacts that make people aware of opportunities. There is a self-reinforcing nature to this situation because the absence of networks undermines the decision to create a transaction, there are no transactions across the border that might form the basis for bilateral relationships, these bilateral relationships do not broaden out through regular use into wider networks, and ultimately they do not have the structuration effect kind necessary to lead to the formation of cross-border institutions that may facilitate other innovative firms crossing the border (cf. Lundquist & Trippel, 2013).

The second effect takes place once the firm has decided to seek a partner across the border, and this is a rationality bounding effect. In taking a 'good enough' decision about prospective collaboration partners, a border raises the costs of getting information on locally-located firms and makes it harder to include them in the consideration. This is arguably where two kinds of border blocking effects are strongest (and beneficial effects are weakest). Firstly, firms start their search in their immediate environment and mentally exclude proximate foreign firms once an adequate national partner is identified. Secondly, a lack of network connections with firms or other organizations across the border increases the costs of gaining information on proximate foreign firms.

In the set-up phase, the border has a structural separation effect, encouraging partners to create working structures that follow the existing national organization structures rather than optimize knowledge community dynamics. It is not clear from our research whether this reflects the fact that there are different cultures in different teams across the border, but it was very common for the firms to be 'innovating together apart'. This creates structural holes (cf. Burt, 2004) in the networks that undermine their value for other firms crossing the border. There is a strong network attenuation effect here through the recommendation effect; the absence of regular project meetings in which partners develop detailed mutual understandings of mutual capacities

and needs makes it hard for them to introduce third parties into these relationships across these borders.

In the realization phase, the border reverts to having an internationalization effect, creating uncertainties and differences, but also offering opportunities and solutions for firms that have the skills to exploit them. In the absence of regular interactions, exchange and build-ups of mutual interdependence, we surmise that the border still has an effect on these collaborating firms. The effects of working with firms across the border does not differ substantively from working with other international partners, with the advantage of permanent geographical proximity (Hansen, 2015). However, we did not see that there were more permanent forms of temporary collaboration being created between the collaborating firms (such as shared office space or regular co-creating project meetings).

Conclusions

In this paper we asked the overall research question of how does the presence of a national border affect the processes by which firms attempt to build productive co-operations for innovation? Drawing on a case study of cross-border innovating firms in the 'Crossroads' project in the Dutch-Flemish border region, we have been able to distinguish a number of border blocking effects on innovation collaboration. The dominant effects appear to differ with each stage of the development of cross-border innovation networks, and corresponds to different elements of the institutionalization process. Our question seeks to address a broader phenomenon in border regions which is why cross-border knowledge flows are still rather limited despite apparent substantial incentives for sharing knowledge across the border (Cf Hjaltadóttir et al., 2017).

In dealing with that more general issue, we note that – particularly in economic literature – there has been a tendency to reduce the border in a binary way, as something that either blocks interaction or does not, rather than as a gateway which is more or less accessible. Our first contribution is to argue that innovation studies should not treat the border in a binary way, but consider its aggregate effect on cross-border innovation network development. In particular, the border continually undermines the development of these connections and therefore undermines the formation of network and collective knowledge assets in border regions which, in turn, undermines the development of a critical mass of knowledge in these cross-border spaces. This undermining process occurs in different ways – the borders serve to create, divide and split in unexpected places, in the ways that firms can draw on their extended networks (network-breaking), in firms' cognitive fields in decision-making (rationality bounding), and also in the structures by which learning activities are planned (structural separating). These effects may block innovation, but as the case study showed, they shape the way that innovation collaboration takes place and the way firms deal with the border. A typical heuristic of a cross-border regional innovation system (for example Lundquist & Trippl, 2013), sees an evolution from no connections to dense connections as corresponding with a kind of disappearance of the border. From our perspective these four mechanisms continually undercut the evolution of these cross-border institutions. This helps us to explain why despite early enthusiasm for the creation of strong cross-border RISs it has proven extremely difficult to sustain cross-border institutions and interactions over time.

Our second contribution is that these effects may not be limited to attempts to develop novel cross-border innovation networks, but may also be evident in a range of extant cross-border network activities. Our approach sees the development of networks as an evolutionary process in which actors make efforts that are shaped by circumstances that in turn alter the environments in which actors are located. The fact that there is not a simple dissolution of the border means that these feedback loops, in conjunction with these qualitatively different border effects, may lead to unexpected outcomes. Given that it has proven difficult to stimulate many different kinds of cross-border knowledge flows – far more than would appear rational given the potential to unlock latent opportunities – these different effects, and their interplays from a dynamic perspective may provide new perspectives and tools for understanding the complex dynamics of these cross-border spaces.

As a final contribution to these debates, we also contend that these effects may also be evident in other innovation contexts, particularly where regional innovation systems have settled into particular sub-optimal equilibria. Therefore, these four kinds of blocking effects (network-breaking, rationality bounding, structural separating and internationalization), may also have their analogue in problems that afflict sparse innovation systems that have settled into strongly suboptimal equilibria. These four processes can be linked to the extant models of RIS institutionalization to provide more insights into why these RISs might not emerge despite the very strong potential benefits to be realized. Likewise, we see a resonance with Rodríguez-Pose's (2013) argument that the regional innovation challenge is primarily an institutional challenge. Regions with weaker innovation systems have systematic institutional failures, and these four mechanisms provide a set of explanations for how these institutional failures emerge and persist.

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