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3 Distance, Proximity and Types of Cross-Border Innovation Systems: A Conceptual Analysis
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6 Abstract

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8 Due to a lack of both theoretical and systematic empirical work, innovation-driven integration
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10 processes in cross-border areas are still poorly understood. Departing from the regional
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12 innovation system (RIS) approach, recent work on different forms of proximity, and the
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14 literature on cross-border areas, this paper seeks to identify in a conceptual way different
15
16 stages in the development of cross-border innovation systems and to highlight the main
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18 characteristics and barriers characterizing each phase. The conceptual model proposed in this
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20 paper can serve as useful framework, guiding more systematic and comparative empirical
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22 work on cross-border innovation systems in different regional and national contexts.
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29 JEL codes: O30, R10

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31 Key words: innovation-driven integration, cross-border areas, regional innovation systems
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1. Introduction

Due to regionalization processes in many parts of the world, the political and economic transformation in Central and Eastern Europe and the continuing enlargement of the European Union cross-border regions have grown considerably in number and importance in the last years (see, for instance, BLATTER, 2004; NIEBUHR, 2008). There is a widespread agreement in the academic literature that in the emerging globalized knowledge economy the long term competitive strength of these areas will rest on their capacity to create an integrated innovation system. This view is often shared by local and European policy makers and other stakeholders promoting cross-border integration and it goes hand in hand with the intention of the Lisbon strategy to transform Europe into the most dynamic and competitive knowledge-based economy in the world.

However, there are also some reasons to doubt whether the vast majority of cross-border areas will have the capacity to build a common innovation system. Many of them might not be characterized by collective learning systems or by socio-cultural and institutional proximity assumed to be important prerequisites for systemic innovation activities (see, for instance, GERTLER, 2003; COOKE et al., 2004). This is related to the embeddedness of cross-border areas in different national and regional innovations systems (NIS and RIS) and their position and roles in national, regional and urban systems.

The different parts of cross-border regions often show very dissimilar economic histories, technological trajectories, institutional set-ups as well as different social dynamics, political visions, governance structures, modes of regulation and cultural identities (ANDERSON and O'DOWD, 1999; HOSPERS, 2006; LÖFGREN, 2008; JOHNSON, 2009). Such differences can be both a key source of innovation and major barriers for interaction and knowledge

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2
3 exchange (see also LUNDVALL, 2010). Simultaneously as these differences create the
4
5 foundation for cross-border growth by offering potentials for new combinations and
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7 unexploited synergies, they also form barriers obstructing successful integration, especially
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9 when it comes to generate, transmit and share innovation-relevant knowledge
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11 (KOSCHATZKY, 2000; HOECKMAN et al., 2009).
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17 From this point of view there are probably 'easier' ways to go than following an innovation-
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19 oriented growth path. At least in the short run and as a first step of cross-border integration
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21 other pathways might be more reasonable. These could include an integration and
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23 enlargement of local consumer and factor markets, increase of labor mobility, extended
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25 division of labor and specialization. Meanwhile, these more 'traditional' integration processes
26
27 are well understood. Little is still known, however, about the nature of innovation-driven
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29 development processes in cross-border areas. Only a few scholars have so far explicitly used
30
31 the RIS approach for empirically analyzing (COENEN et al., 2004; MOODYSSON and
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33 JONSSON, 2007) or conceptualizing (TRIPPL, 2010) integration processes in trans-frontier
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35 regions. Undoubtedly, their work has provided interesting insights into innovation activities
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37 taking place at the cross-border level. Recent conceptual work done by TRIPPL (2010) is
38
39 particularly relevant for our article. Looking at five core dimensions of innovation systems,
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41 she elaborated on some key determinants of innovation-driven integration processes in cross-
42
43 border areas. This analysis has to be acknowledged for shedding light on a set of factors that
44
45 might favor or inhibit the development of a cross-border RIS and for suggesting some first
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47 ideas about the relevance of different types of distance in this regard. Although her conceptual
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49 framework constitutes an important starting point for our analysis, we go beyond this work in
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51 several crucial respects. First, TRIPPL's (2010) analysis is restricted to identifying hindering
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53 and favoring factors for the emergence of cross-border RIS. Our analysis is clearly different in
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3 nature and provides a dynamic perspective on the issue under consideration as our focus is on
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5 developing a typology of cross-border RIS that draws a clear distinction between different
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7 stages of innovation-driven integration processes. Second, our paper advances the existing
8
9 body of work by discussing in a far more systematic way and in more detail the role of
10
11 different kinds of distance and proximity in cross-border regions. Most importantly, we
12
13 conceptualize various types of proximity and distance as both opportunities for and barriers to
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15 cross-border innovation activities. Third, the conceptual model suggested in this paper takes
16
17 explicit account of the importance of innovation linkages to other spatial scales (including
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19 regional, national and international ones).
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27 In this paper it will be argued that cross-border RIS should be seen as the most advanced form
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29 of transnational integration, resting upon the success of previous incremental and less
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31 innovation-oriented modes of development. The key aim of this article is to develop a
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33 conceptual model that draws a clear distinction between these different types of integration.
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35 More specifically, by bringing together three strands of literature – the RIS approach, recent
36
37 insights provided by the ‘proximity school’ and work done on cross-border regionalization –
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39 the paper will deal with the following research questions:
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- 46 • Which stages of cross-border RIS development can be identified in a conceptual way?
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- 48 • What is the role of physical, cognitive, functional and institutional distance in shaping the
- 49 opportunities and barriers for cross-border innovation activities and which kinds of
- 50 proximity and distance are likely to prevail in each stage?
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57 Departing from the RIS approach (see, for instance, AUTIO, 1998; COOKE et al., 2004;
58 ASHEIM and GERTLER, 2005) and its application to cross-border contexts (TRIPPL, 2010)

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3 we will suggest a conceptual framework that allows for identifying different types or stages of
4 trans-frontier innovation systems. Focusing on different concepts of proximity (BOSCHMA,
5 2005; TORRE, 2008) we will elaborate on a characterization of each stage of cross-border
6 RIS development. Drawing on the literature on cross-border areas, particularly on findings
7 concerning barriers and driving forces connected to different integration processes, will
8 further inform this discussion. This literature is also useful, as it provides some empirical
9 evidence that underlines and supports our conceptual arguments.
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22 The remainder of this paper is organized as follows. Section 2 provides a short literature
23 review on cross-border areas and recapitulates recent insights provided by the ‘proximity
24 school’. Section 3 analyzes in a conceptual way different phases of innovation-driven
25 integration in cross-border areas. Finally, in Section 4, the key arguments are summarized and
26 some conclusions are drawn.
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36 2. Cross-border areas and proximities

37 2.1. Basic features of heterogeneity

38 As a starting point for the conceptual discussion we will initially apply a very broad and
39 simple definition of a cross-border region as an area consisting of adjacent territories
40 belonging to different nation states. This broad definition covers all types of cross-border
41 settings regardless of differences in terms of size, geographic conditions, history, culture and
42 socio-economic conditions. The heterogeneity between different cross-border areas is,
43 however, considerable. On the one extreme they can be very extensive in terms of space and
44 population stretching over several nations and including a larger number of regions located in
45 densely populated economic core areas. A prime example for such a setting is the Centroe
46 region with a total population of more than six million inhabitants, consisting of the two
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3 capital cities of Vienna and Bratislava and adjacent regions in Austria, Hungary, Slovakia and
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5 the Czech Republic. On the other hand this definition also covers cross-border areas including
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7 only two neighboring regions with a small population distributed on a large area in the
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9 geographic as well as the economic periphery far away from core national and international
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11 markets. One example for such a cross-border region is the area around the twin cities of
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13 Haparanda and Torneå located along the northern part of the Swedish and Finish border.
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17 Between these two extreme cases there is wide range of cross-border regions showing a
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19 considerable variation in basic geographical preconditions in terms of scale, size and location,
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21 engendering primary restriction of what kind of integration is likely to occur and what types
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23 of benefits might be related to different integration processes.
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30 Furthermore, the magnitude and character of internal heterogeneity in cross-border areas will
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32 have a strong impact on the possibilities for and constraints to the emergence of an integrated
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34 socio-economic system. Many cross-border regions tend to show very dissimilar economic
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36 histories, technological trajectories and innovation capacities, institutional set-ups and
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38 positions in the regional system of their respective nations, as well as different social
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40 dynamics, political visions, governance structures, modes of regulation and cultural identities
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42 (ANDERSON and O'DOWD, 1999; TRIPPL, 2010). To a certain extent these differences
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44 create the foundation for cross-border growth. They might give rise to complementarities and
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46 synergies which could be capitalized on through interaction. Potential benefits might be
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48 related to an integration and enlargement of local consumer, labor and factor markets,
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50 enhanced competition, extended division of labor and increased specialization. Such
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52 processes could lead to shared growth effects and new opportunities for upgrading the
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54 competitive edge of the economy on both sides of the border. Simultaneously as some of
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56 these differences create the main driving forces for cross-border growth, they could also form
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3 barriers hindering successful integration. Thus, in addition to the political-administrative
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5 borders also economic, cultural and social borders tend to further divide these areas
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7 (ANDERSON and O'DOWD, 1999; SMALLBONE et al., 2007; LÖFGREN, 2008).
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10 11 12 2.2. The complexity of integration processes in cross-border regions 13

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15 Cross-border regionalization is a multi-faceted and complex phenomenon. It takes shape
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17 along nation state boundaries and requires contacts and partnership between public as well as
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19 private actors across borders. The process takes place in what could be labeled as a 'grey
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21 zone' between civil and public law in combination with the emergence of informal and formal
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23 networks between a wide spectrum of actors, ranging from the single citizen and firm to
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25 universities, industrial organizations, trade unions, political parties and cultural organizations
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27 (JÖNSSON et al., 2000). The overall concern of the importance of increased cross-border
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29 integration and the different ways to achieve it can be assumed to vary among the actors,
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31 reflecting conflicting goals and asymmetry in power relations (JOHNSON, 2009).
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33 Furthermore, all these stakeholders are more or less strongly embedded in or have relations to
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35 other spatial scales, from the local community to the global level. This historically rooted
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37 embeddedness shapes routines that will govern the actors' decisions in general, for instance a
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39 firm's decision about what to produce, when and how, investment decisions and search
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41 behavior for networking partners (NELSON and WINTER, 1982; NELSON, 1995; 2008). In
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43 many respects these routines will also frame the actors' potential 'cross-border behavior'.
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53 Furthermore, as noted above, the driving forces for cross-border integration processes, i.e., the
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55 differences in economic structure, innovation capabilities and cost structures giving rise to
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57 new complementarities and synergies, could also constitute major barriers to interaction
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59 between the different parts of a cross-border region. Consequently, to consider and analyze
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3 this tension and interplay between differences working as driving forces on the one hand and
4 as barriers on the other, is essential for enhancing our knowledge about cross-border
5 integration processes. A crucial point of departure for understanding cross-border integration
6 in general and the formation of cross-border innovation systems in particular is to uncover the
7 role of different types of proximity and distance and to explore how they have an influence on
8 what kinds of linkages are likely to be established.
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20 2.3. Distance and proximity

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22 Recent research findings generated by the 'proximity school' (BOSCHMA, 2005; TORRE,
23 2008) provide a useful foundation for conceptualizing and categorizing different types of
24 differences between the constituent parts of a cross-border area and to discuss their impact on
25 potentials for and crucial impediments to cross-border knowledge interactions. Following the
26 literature, three main categories of proximity, i.e. physical, functional and relational
27 proximity, could be identified as central for this understanding (TORRE and GILLY, 2000;
28 MOODYSSON and JONSSON, 2007; TORRE, 2008). Physical proximity is closely related
29 to the geographical dimension of agglomeration economies, transaction and transportation
30 cost. When it comes to the exchange of knowledge (especially tacit one) which depends on
31 face-to-face contacts the accessibility dimension could be assumed to be very important. As
32 underlined in the literature it has less to do with pure distance measured in kilometers
33 between different actors, but with the efforts it takes for them to interact in terms of time and
34 costs. This could depend on several factors, for instance, the quality of the transport
35 infrastructure and political-administrative set ups that facilitate or hinder mobility of goods
36 and people. The construction of the fixed link between Sweden and Denmark is one example
37 where investments in infrastructure have had a strong impact on reducing the physical
38 distance between different parts of the cross-border area of the Oresund. In the case of
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3 Centrope, the fall of the iron curtain, followed by the EU-membership of the former Eastern
4 countries and finally the Schengen Treaty have gradually decreased the physical distance
5 between different parts of this area triggering the same kind of hope as in the Oresund region:
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8 new possibilities for the creation of a powerful international competitive cross-border region.
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11 Functional distance (MAGGIONI and UBERTI 2007) refers to differences between regions in
12 innovation performance. MAGGIONI and UBERTI (2007) showed that knowledge does not
13 flow easily between areas, if they differ strongly in their innovation capacity. Consequently, a
14 strong asymmetry in performance and capability (i.e., too much functional distance) will limit
15 the opportunities for mutual advantages of integration. Finally, the notion of relational
16 proximity could be used as an umbrella term for a number of non-tangible dimensions
17 discussed in the literature, for instance cognitive, organizational, social, institutional, cultural
18 and technological proximity (see, e.g., TORRE and GILLY, 2000; BOSCHMA, 2005;
19 MOODYSSON and JONSSON, 2007). Relational proximity is associated with the structures,
20 relations and processes that originate, for instance, from the social dynamics, governance
21 structures, regulation and cultural identities that together comprise the embeddedness of social
22 action (GRANOVETTER, 1985). In a growing body of literature (GERTLER, 2003;
23 BOSCHMA, 2005; STERNBERG, 2007) on relational proximity the discussion is centered
24 around the importance of shared norms, institutions and regulation, mutual understanding,
25 trust and codes of conduct and shared organizational and technological cultures for
26 collaboration and knowledge exchange. A certain degree of relational proximity between key
27 actors is a necessary condition for a fruitful knowledge exchange and collaboration in a cross-
28 border area. In the conceptual model discussed in section 3, special attention will be given to
29 the importance of the cognitive and institutional dimension of relational proximity. The
30 cognitive dimension (NOOTEBOOM, 2000; NOOTEBOOM et al., 2007) is about the fine
31 balance between being so close in terms of knowledge bases and technical know-how that the
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3 partners are able to cooperate efficiently, but far away enough to learn something new through
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5 cross-fertilization and the exploitation of new complementarities. Good levels of 'related
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7 variety' (FRENKEN et al., 2007) defined in this sense can be regarded as key drivers of
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9 economic growth and innovation in cross-border regions. The institutional dimension of
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11 relational proximity reflects the significance of differences in both formal and informal
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13 institutions, laws, regulations and also differences in culture and language (BOSCHMA,
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15 2005).
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22 The relation between the three main types of proximity is complex (for a further discussion
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24 see. e.g., COENEN et al., 2004; BOSCHMA, 2005; MOODYSSON and JONSSON, 2007).
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26 Physical proximity, for example, could in some cases be an important facilitator of relational
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28 proximity; in other cases relational proximity can emerge totally detached from physical
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30 proximity. The latter case is in line with GRANOVETTER's (1985) geographically
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32 unbounded view of the concept, where embeddedness can emerge regardless of physical
33
34 proximity (MOODYSSON, 2008). This aspect is important to remember in the discussion of
35
36 cross-border areas. Being geographically close does not automatically mean that relational
37
38 proximity abounds. More fruitful alternative relations might be found elsewhere. However,
39
40 cross-border areas where physical, functional and relational proximity coincide might become
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42 major places of new knowledge generation and dynamic learning. It is this interplay between
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44 certain degrees of physical proximity and appropriate levels of functional and relational
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46 proximity that under certain circumstances shape a unique competitive advantage of cross-
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48 border regions compared to other spatial units. Furthermore, it is vital to understand cross-
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50 border regions in terms of their relations to and dependence on other spatial scales rather than
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52 concentrating only on their internal conditions. The embeddedness of actors and organizations
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54 in existing and historically evolved RISs and NISs as well as the importance of international
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3 linkages must be taken into consideration. These already established linkages on both sides of
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5 the border have been created under similar constraints of physical, functional and relational
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7 proximity and will influence the character of new potential cross-border linkages. From this
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9 point of view it is important to take into consideration to what extent the exploitation of
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11 potential cross-border linkages will be affected by the quality and strength of existing
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13 linkages embedded in other geographical scales. It is still unclear in what ways cross-border
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15 integration reinforces, complements, changes, challenges or even substitutes existing relations
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17 and linkages.
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24 3. Stages of cross-border RIS development

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26 This section departs from the RIS concept (AUTIO, 1998; COOKE et al., 2004; ASHEIM and
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28 GERTLER, 2005) and identifies in a conceptual way different stages in the development of
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30 cross-border innovation systems. TRIPPL (2010) who applied the RIS approach to cross-
31
32 border settings, suggested to analyze five different RIS elements and dimensions to
33
34 disentangle those factors that influence a cross-border region's potential for joint innovation
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36 activities. RISs are considered to be made up of a subsystem of knowledge generation &
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38 diffusion including R&D organizations, educational bodies and technology transfer agencies
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40 (RIS dimension 'science base/knowledge infrastructure'), and a subsystem of knowledge
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42 application & exploitation comprising the companies and clusters located in the region (RIS
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44 dimension 'economic structure/specialization pattern'). Intensive flows of knowledge,
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46 resources and human capital within and between these subsystems (RIS dimension 'nature of
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48 linkages') are regarded to be pivotal, constituting the foundations for systemic innovation.
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50 The regional policy subsystem (RIS dimension 'policy structures') is often acknowledged to
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52 be another important RIS element. Finally, the specific institutional and socio-cultural setting
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54 prevailing in the region (RIS dimension 'institutional set-up) is ascribed to play a significant
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3 role. It covers both formal institutions such as laws and regulations and informal institutions
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5 like routines, conventions and habits which have an impact on the behavior of and relations
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7 between actors and organizations.
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12 Focusing on these different RIS dimensions and on the role of various types of proximity, in
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14 the following we will discuss a conceptual framework that draws a distinction between
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16 different stages of cross-border RIS evolution.
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25 [Figure 1 about here]
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31 To guide the discussion, three ideal types of cross-border settings are identified (see Figure 1)
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33 which represent different degrees of integration: weakly integrated systems (stage I), semi-
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35 integrated systems (stage II) and strongly integrated systems (stage III). In the following we
36
37 will pinpoint basic conditions characterizing each stage regarding the main RIS dimensions
38
39 identified above, i.e., economic structure, science and knowledge bases, nature of linkages,
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41 institutional set-ups, and policy structures. Furthermore, we add the dimension 'accessibility'
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43 to take into account the degree of physical proximity.
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50 As shown in Figure 1, the linkages to other geographical scales as well as the effects of
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52 different barriers are crucial for understanding the character and magnitude of cross-border
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54 integration in each stage. Furthermore, two points should be underlined. Firstly, the three
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56 stages represent ideal types. In the real world the distinction between the three stages might
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58 not be as clear-cut as in our conceptual model. Cross-border areas which, for instance, display
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3 semi-integration in one dimension, can be more or less strongly integrated in other
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5 dimensions. Secondly, although we will discuss conditions for further development this does
6
7 not imply that cross-border areas move necessarily or automatically from one stage to the next
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9 one. Table 1 summarizes the main features of the three ideal types of cross-border innovation
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11 systems.
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20 [Table 1 about here]
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25 3.1. Stage I: Weakly integrated systems

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27 Weakly integrated systems are characterized by low levels of cross-border economic relations
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29 in general and a lack of knowledge interactions and innovation linkages in particular. Various
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31 'Euroregions' seem to represent a case in point in this respect (HASSINK et al., 1995; VAN
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33 GEENHUIZEN et al., 1996). Integration processes – if any exist or develop at all – show a
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35 dominance of asymmetric cost-driven linkages, mainly exploiting internal price and cost
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37 differences. Such an asymmetric pattern of integration has been reported in several analyses
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39 of cross-border regions (see, for instance, the work by KRÄTKE (1999) and KRÄTKE and
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41 BORST (2007) on the German-Polish border area or the study done by TRIPPL (2008) on the
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43 Centropo region). There are two main reasons for such a situation, i.e. lack of synergies and
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45 under-exploitation of synergies.
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53 Lack of synergies: Non-integration can be the outcome of missing synergies for cross-border
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55 linkages. On the one hand, too strong differences in the scientific specialization, knowledge
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57 bases, and economic structures (i.e. cognitive distance) make interaction useless, because
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3 none of the involved regions can draw benefits from integration. On the other hand, if the
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5 regions are too similar in terms of their knowledge bases (reflecting too much cognitive
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7 proximity) also little can be learnt from interaction. Consequently, the potential benefits that
8
9 result from establishing relations and investing in new cross-border linkages can be assumed
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11 to be rather low compared to those which are likely to result from further developing and
12
13 capitalizing on already existing links with actors at other spatial scales. If sub-optimal levels
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15 of cognitive distance are the main reason for missing linkages, at least in the medium term,
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17 the prospects for the development of more advanced and interactive knowledge interactions
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19 are poor, regardless if it is possible to the remove other types of barriers. Absence of
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21 synergies might also be the consequence of too high levels of functional distance. Although
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23 there might be some similarities in the scientific or economic specialization pattern there is no
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25 interaction because the regions differ too strongly in their respective innovation capabilities,
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27 performances and receiver competences. For the strong region little can be learnt from the
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29 weak region, whilst the weak regions might potentially learn a lot but might miss the
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31 absorption capacity. Such a constellation has been observed for example in the US-Mexican
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33 border region (SCOTT, 1999) and in the Centrope area (TRIPPL, 2008). Consequently,
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35 functional distance results in an unequal distribution of benefits from interaction and is
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37 closely related to the problem of absorptive capacity. Barriers related to functional distance
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39 can take decades to erode if ever. One key point in this respect is whether or not the form of
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41 asymmetric cost-driven integration can also generate a certain amount of learning for and
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43 knowledge spillovers to the weak side of the border. FDI activities, mobility of managers and
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45 key labor in general might be important mechanisms in this regard.
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57 Under-exploitation of synergies: Some cross-border areas exhibit potentials for synergies in
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59 innovation, but several kinds of distance create borders and prohibit actors to establish
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3 contacts and capitalize on the learning potential. Physical distance might have such effects. If
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5 the accessibility is restricted (resulting in high time costs to cross the border), the possibilities
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7 for exploiting potential synergies connected to enlarged and enhanced agglomeration
8
9 advantages may be jeopardized. This type of distance could be one of many reasons for a low
10
11 level of linkages and flows in general. Furthermore, a high degree of physical distance has a
12
13 negative influence on knowledge linkages and learning processes which often contain a large
14
15 proportion of tacit knowledge and therefore require frequent face-to-face contacts. The
16
17 importance of physical proximity has been highlighted in many cross-border studies,
18
19 especially in relation to debates about the benefits or drawbacks of new infrastructure
20
21 investments in cross-border regions (see, for example, the case of the Oresund region
22
23 documented in MATTHIESSEN, 2004). Arguably, barriers resulting from physical distance
24
25 can be easier dealt with than those resulting from cognitive and functional distance. New
26
27 investment in infrastructure or minimizing the cost to use it for crossing the border will for
28
29 instance have a positive impact on accessibility.
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39 Furthermore, various manifestations of institutional distance can lead to an under-exploitation
40
41 of synergies. This could include differences in both hard institutions such as laws and
42
43 regulations and soft institutions such as the lack of a common culture and language (VAN
44
45 HOUTUM, 1998; KLATT and BRÖCKER, 2006). Weakly integrated systems are often
46
47 characterized by institutional thinness depending on very few cross-border institutions and the
48
49 absence of trustful cross-border 'leadership', reflecting a lack of legitimacy (HALL, 2008)
50
51 and conflicting goals between different actors. One important aspect of this is, for instance, a
52
53 low or asymmetric support and interest from the involved nation states (see JOHNSON'S
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55 (2009) insightful study on cross-border co-operation between Eastern Germany, Western
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57 Poland and the Northern Czech Republic). Strong forms of embeddedness of actors in their
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3 RIS and NIS or in other contexts and relations might also be a powerful impediment. Such
4 well-established, long lasting and trust-based linkages have many advantages for actors and
5 organizations, including lower search costs and a reduction of uncertainty due to strong social
6 proximity. Consequently, actors who are inserted in such well-established links might be less
7 prone to create new ones at the cross-border level.
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17 The combination of institutional thinness and strong forms of embeddedness on the one hand
18 and a very low social acceptance of building a cross-border region among firms and citizens
19 on the other hand will not only be a barrier to many forms of integration. It will also shape a
20 very weak cross-border identity, and it has an influence on the positioning of the cross-border
21 region in the global arena (HOSPERS, 2006). This means that it is more or less impossible to
22 'brand' the cross-border area as an attractive location for foreign direct investment.
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34 3.2. Stage II: Semi-integrated systems

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36 In semi-integrated settings we might observe what can be referred to as an emerging
37 knowledge-driven system. Such systems feature decreasing levels of asymmetry and provide
38 opportunities for new and more mutual beneficial linkages on both sides of the border. In
39 addition to links drawing on pure internal price-cost differences resulting in increased
40 economies of scales and the opening up of new markets, there are also windows of
41 opportunities leading to economies of scope and increased cross-border learning processes in
42 a few selective parts of the economy. These more interactive linkages can be observed in
43 narrow segments of the science base and economic structure where good levels of cognitive
44 and functional proximity prevail. Consequently, in semi-integrated systems we might find a
45 few networked cross-border clusters exhibiting such sound degrees of cognitive and
46 functional proximity (see, for instance, the case of the Canada-US cross-border region of
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3 Cascadia (Pacific North West) as described by BRUNET-JAILLY (2008). Innovation
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5 networking, however, is not a system-wide or region-wide phenomenon yet, but occurs in
6
7 these few clusters only. In this stage of development, thus, one might identify innovative
8
9 cross-border clusters but not a coherent trans-frontier innovation system. Apart from
10
11 networking in a few clusters, cross-border knowledge links are still of subordinate importance
12
13 when compared to linkages to other contexts.
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20 The emerging knowledge-driven form of integration could also be partial in the sense that it
21
22 only includes single steps in an innovation process as indicated by MOODYSSON and
23
24 JONSSON (2007) in their empirical analysis of the biotechnology sector in the Oresund area.
25
26 Furthermore in semi-integrated systems the linkages are also likely to be geographically
27
28 concentrated to selective parts of the cross-border area and leaving out others, as indicated by
29
30 an analysis of the internal heterogeneity of the Oresund region where only the core parts on
31
32 both side of the border seem to have some degree of appropriate functional and cognitive
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34 proximity (LUNDQUIST and WINTHER, 2006).
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41 These innovation activities of the cross-border area could be described as rather isolated
42
43 'islands of innovation' in an otherwise fragmented cross-border innovation system. However,
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45 these small segments of the economy could be important role models and drivers of change.
46
47 Actors who are involved in such processes might turn into what LÖFGREN (2008) has called
48
49 'regionauts'. Through their daily experience in working in a cross-border area they are able to
50
51 identify the barriers in terms of accessibility, institutions, laws, regulation and also trustfully
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53 suggest how these could be transformed or removed in order to facilitate further cross-border
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55 integration.
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3 Compared to stage I, physical accessibility is no longer a major obstacle for interaction. We
4
5 might observe an increase of exchange of students, researchers, highly qualified people,
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7 scientific collaborations, university-industry partnerships, and enhanced institutional
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9 networking. Interaction at the cross-border level becomes essentially promoted by the
10
11 emergence of bridging-organizations (often related to areas where good levels of functional
12
13 and cognitive proximity exist), an increasing societal acceptance of cross-border projects and
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15 a growing consensus among different actors about potential benefits of increased integration.
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22 3.3. Stage III: Strongly integrated systems

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24 This stage of cross-border RIS development represents the most advanced form of innovation-
25
26 driven integration. We look at an ideal type of integration, where the distinct RIS in the
27
28 constituent regions of the cross-border area become more and more melted into a single one.
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30 Strongly integrated trans-frontier RIS are characterized by a considerable flow of knowledge,
31
32 expertise and skills across the border, brought about by a high intensity of mobility of
33
34 students and labor, innovation related networking among firms, academic collaborations,
35
36 university-industry partnerships, etc. These knowledge interactions have reached a level at
37
38 which they form a central underpinning of the innovation performance of the cross-border
39
40 region. This does not mean that innovation linkages at other spatial scales have lost in
41
42 significance. The argument is that cross-border innovation linkages have grown in strategic
43
44 importance and are no longer subordinate when compared to other innovation linkages. These
45
46 linkages reflect the existence of substantial synergies for cross-border interaction and
47
48 learning. Such synergies result from the co-existence of high levels of functional proximity
49
50 (i.e. similar high levels of innovation abilities and knowledge generating capacities) and
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52 optimal levels of cognitive distance (related variety) in both the business systems and the
53
54 knowledge bases. In contrast to stage II such synergies could not only be found in a few
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3 fields, but in many economic and scientific sectors. Consequently, we might observe a
4
5 dynamic evolution of several fully developed and highly innovative cross-border clusters with
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7 strong collective learning mechanisms.
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12 Strongly integrated cross-border RIS do not only provide good synergy potentials as they
13
14 have been described above, but they offer also favorable conditions which enable and support
15
16 actors to make effectively use of them. They exhibit an excellent transportation and
17
18 communication infrastructure, thus, allowing for easy accessibility and interaction (physical
19
20 proximity). Furthermore, other kinds of borders and barriers have been dismantled rather
21
22 successfully, allowing for the establishment of cross-border interactions. Arguably, most
23
24 critical and difficult to reach in this context is a good level of institutional proximity in the
25
26 cross-border area. We might observe a high societal acceptance of building a strongly
27
28 integrated cross-border RIS, probably even a gradual emergence of a common culture and
29
30 identity and a high density of bridging institutions which help to deal with socio-institutional
31
32 and cultural barriers (like differences in language) which might never vanish. A key feature of
33
34 stage III is, indeed, that solving common problems at the cross-border level is becoming part
35
36 of normal life, seeking and mobilizing knowledge that is available at the other side of the
37
38 border are turning into routine activities and cross-border RIS development is widely accepted
39
40 in business, academic and other societal spheres. Such processes are tightly connected to
41
42 advanced forms of cross-border political governance (PERKMANN, 1999, 2003, 2007;
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44 GUALINI, 2003). In strongly integrated RIS we might find fully working cross-border
45
46 governance structures and high levels of institutional thickness. There are not only many
47
48 organizations and policy actions geared towards innovation-driven integration, but they form
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50 a coherent whole and reflect a successful implementation of institutionalized and stable
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52 mechanisms for long-term policy coordination. Specialized organizations responsible for
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3 steering cross-border issues and a common innovation strategy and policy might be essential
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5 elements in this regard. In the best case we find transparent and democratic structures which
6
7 allow for inclusive forms of governance and civic participation (see also the respective claims
8
9 made by HALL, 2008) and which are vital for the emergence of societal acceptance and a
10
11 common identity at the cross-border level. From a conceptual point of view, this final stage
12
13 could be referred to as the 'utopia' of cross-border region building. Whilst some areas might
14
15 succeed in reaching stage III in a few dimensions, in the real world it is probably very hard
16
17 for most cross-border regions to meet the final stage in all dimensions outlined above.
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19 However, the utopian world of stage III might play a powerful role in the development of
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21 visions, animating and guiding actors in search for enhancing innovation-driven integration
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23 processes.
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32 4. Conclusions

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34 Cross-border regionalization is a multi-faceted and complex phenomenon. Firstly, there is a
35
36 wide range of cross-border regions showing a considerable variation in basic geographical
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38 preconditions in terms of scale, size and location causing primary restriction of what kind of
39
40 integration is likely to occur and what types of benefits can result from different integration
41
42 processes. Secondly, cross-border regionalization is a process taking place in a 'grey zone'
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44 between civil and public law in combination with the emergence of informal and formal
45
46 interaction among diverse organizations and actors. The overall interest in increased cross-
47
48 border integration and the ability to engage in such processes can be assumed to vary among
49
50 the actors reflecting conflicting goals and asymmetry in power relations. Thirdly, these
51
52 stakeholders are more or less strongly embedded in or have relations to other spatial scales,
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54 from the local community to the global level. This historically rooted embeddedness has an
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56 influence on the actors' decisions in general and on their 'cross-border behavior'. Fourthly,
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3 the driving forces for cross-border integration processes, e.g. the differences in economic
4 structure, innovation capabilities and cost structure give rise to new complementarities and
5 synergies, but often also generate the barriers that exist between the different parts of a cross-
6 border region. Consequently, this tension and interplay between differences working as
7 driving force on the one hand and as barriers on the other hand is crucial for understanding
8 cross-border integration processes. As argued in this article, an essential point of departure to
9 enhance our knowledge about cross-border integration in general and cross-border RIS
10 development in particular is to uncover the role of different types of proximity and distance,
11 and to explore how they influence driving forces and barriers and determine what linkages are
12 likely to be established.
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29 There is a consensus in both academic and policy circles that in the globalizing knowledge
30 economy the long term competitive advantage of cross-border areas will be based on their
31 capacity to create a common innovation system. As a general statement this is a rather
32 undisputed one. However, a crucial question raised in this paper is how achievable this is for
33 most cross-border settings as many of them are not characterized by the collective learning
34 systems or the socio-cultural proximity that are assumed to be important prerequisites for
35 successful innovation systems. In order to unleash this paradox, we suggested a conceptual
36 model that distinguishes between three ideal stages of cross-border integration: weakly
37 integrated systems (stage I), semi-integrated systems (stage II) and strongly integrated
38 systems (stage III). To summarize, the three types are characterized by very different levels of
39 physical, functional, cognitive and institutional proximity which in turn lead to very different
40 possibilities for cross-border knowledge interactions to emerge. Cross-border RIS constitute
41 the most advanced form of cross-border region building and will often be based on the
42 success of previous incremental and less advanced modes of integration.
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6 The conceptual model suggested in this article could constitute a useful theoretical
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8 background, guiding systematic and comparative empirical work on the development of
9
10 cross-border innovation systems in different national and regional contexts. So far, empirical
11
12 studies have only looked at single dimensions of cross-border RIS development and neglected
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14 others. Our model could serve as a conceptual framework for empirical work that takes into
15
16 account several dimensions and their interplay. Such empirical studies might also lead to
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18 conceptual adjustments.
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24 Finally, the conceptual analysis provided in this paper might also have far reaching policy
25
26 implications. There are at least two broad and general conclusions for policy which can be
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28 drawn immediately. First, the opportunities and prospects for successful policy interventions
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30 in cross-border RIS formation are subject to the types of barriers and sub-optimal levels of
31
32 proximities prevailing in a specific cross-border setting. Whilst physical distance and some
33
34 manifestations of institutional distance (particularly laws and regulations) can be dismantled
35
36 rather easily, cognitive distance and differences in culture or language will probably never
37
38 vanish or could be reduced only in the long term, requiring enormous efforts on the part of
39
40 policy actors and other stakeholders. Second, our work on different stages of cross-border RIS
41
42 development challenges any uniform policy models for promoting innovation-driven
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44 integration in cross-border regions and provides essential foundations for more tailor-made
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46 policy approaches. Arguably, the role of policy can be expected to differ strongly, depending
47
48 on the respective phase of cross-border RIS evolution. In weakly integrated systems (stage I)
49
50 which suffer from massive differences (particularly in terms of functional and cognitive
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52 distance) between adjacent regions, it might be more efficient for policy actors to address
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54 other issues than promoting cross-border innovation-driven integration. The lack of synergies
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3 calls for a 'hands off' policy approach. The situation is clearly different, if poor integration
4 results from unexploited synergies. Weakly integrated systems (stage I) of this type require a
5 very proactive policy approach oriented on removing various forms of impediments in
6 different RIS dimensions. Promoting a socio-cultural shift towards a stronger acceptance of
7 cross-border integration processes, establishing cross-border governance structures,
8 improving transport infrastructure and thus accessibility might be key policy tasks.
9
10 Furthermore, fostering knowledge interaction in a few fields which could serve as role models
11 for other sectors should be on the policy agenda. To be sure, to support a transition of a
12 weakly integrated system towards a more innovation-driven one is outstandingly challenging,
13 calling for comprehensive measures and – given the long time span which such a
14 transformation requires – a 'patient' policy system. In later phases of cross-border RIS
15 evolution, there is a need for adjusting the innovation policy portfolio. A further strengthening
16 of ongoing integration efforts in the economic, scientific, institutional and socio-cultural
17 spheres, and broadening and deepening cross-border learning processes will become key
18 policy tasks. Elaborating more on specific and adequate policy approaches required for
19 different stages of cross-border RIS development and dealing explicitly with the question how
20 crucial policy making is for the transition from one stage to the next one are worthy subjects
21 for further research.
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Table

Table 1: Characteristics of different stages of cross-border RIS integration

RIS dimensions	Stage I	Stage II	Stage III
	Asymmetric cost-driven system (Weakly integrated)	Emerging knowledge-driven system (Semi-integrated)	Symmetric innovation-driven system (Strongly integrated)
Economic structure / specialization pattern	<ul style="list-style-type: none"> ▪ Strong differences in specialization → cognitive distance (lack of synergies) ▪ Functional distance 	<ul style="list-style-type: none"> ▪ Emerging synergies and complementarities (cognitive proximity) and functional proximity in a few business areas 	<ul style="list-style-type: none"> ▪ Related variety, complementarities (cognitive proximity) and functional proximity in a wide range of business areas
Science base / knowledge infrastructure	<ul style="list-style-type: none"> ▪ Strong differences in specialization → cognitive distance (lack of synergies) ▪ Functional distance 	<ul style="list-style-type: none"> ▪ Fruitful synergies (cognitive proximity) and functional proximity in a few scientific fields 	<ul style="list-style-type: none"> ▪ Related variety, complementarities (cognitive proximity) and functional proximity in a wide range of scientific

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9	Nature of linkages	▪ Cost-driven	▪ Decreasing	▪ Intensive cross-
10		asymmetrical	asymmetry →	border knowledge
11		linkages	interactive links in	exchange
12			selected fields	
13		▪ Lack of knowledge		▪ Reshaping the
14		flows	▪ Links to existing	importance of
15			RIS / NIS / global	established links
16		▪ Strong		
17		embeddedness in	level more	
18		established RIS /	important	
19		NIS / international		
20		linkages		
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37	Institutional	▪ High degree of (hard	▪ Decreasing levels	▪ Low levels of (hard
38	set up	& soft) institutional	of (hard & soft)	& soft) institutional
39		distance	institutional	distance /
40			distance	remaining distances
41		▪ Institutional thinness		mediated by
42		at the cross-border	▪ Rise of institutional	specialized bridging
43		level	set-up at the cross-	organizations
44			border level	
45		▪ Low acceptance of		
46		cross-border	▪ Increasing	▪ Institutional
47		integration processes	acceptance of	thickness at the
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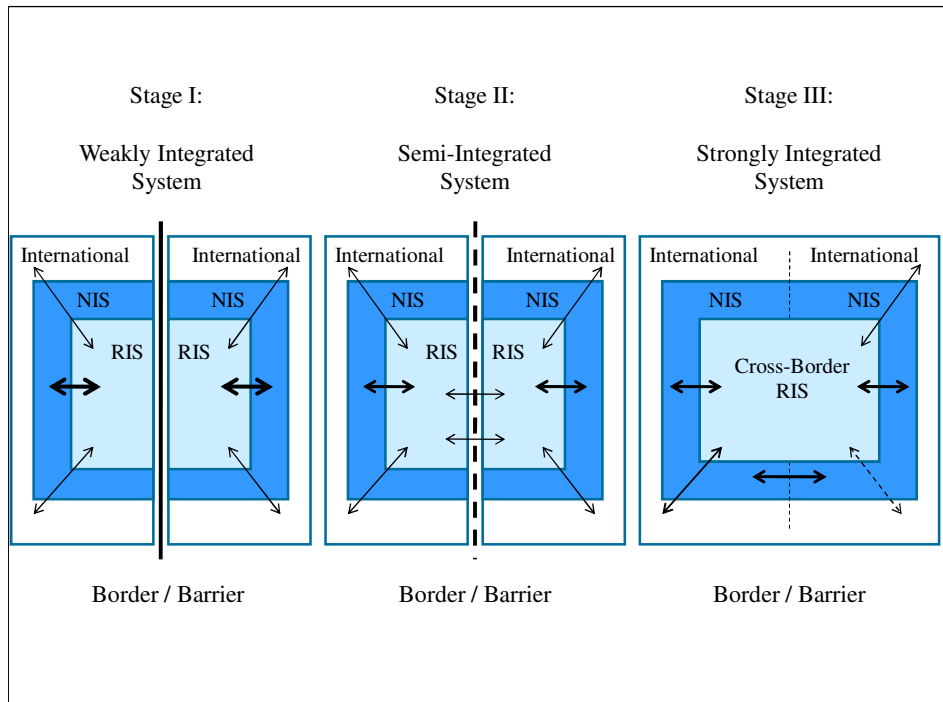
		building a common	cross-border level
		cross-border region	▪ High acceptance of
			creating a common
			innovation system
Policy structures	▪ Absence of policy	▪ Emergence of	▪ Transparent &
	‘leadership’ with	mechanisms for	democratic
	vision & lack of	coordination of	governance
	legitimacy	innovation policies	structures
	▪ Low or asymmetric		▪ Inclusive forms of
	support from nation		governance & civic
	states		participation
Accessibility	▪ Low / medium	▪ Medium / high	▪ High degree of
	degree of physical	degree of physical	physical proximity
	proximity	proximity	

Source: Own compilation

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Figure

Figure 1: Ideal types of different levels of cross-border integration



Source: Own compilation

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