

Measuring border effects in European cross-border regions

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ABSTRACT

This paper presents a new methodology to measure border effects from a different perspective with respect to the standard gravitational approach. The methodology proposed measures supply-side border effects by identifying two types of limits produced by the border to the productive system: inefficiency in exploiting local resources (efficiency needs) and scarce endowment of resources (endowment needs), the former calling for intervention on resource governance, the latter requiring new investment. The methodology, applied to the European Union's Cross Border Cooperation Program regions, suggests a stronger presence of efficiency needs with respect to endowment ones.

KEYWORDS

cross-border regions; border effect; European Union; cross-border cooperation; regional growth

INTRODUCTION

A bird flying over the Upper Rhine sees no borders. The challenge is how to make this happen on the ground.

(Joachim Beck, Director, Euro-Institute, Germany; European Commission, 2011, p. 6)

Political and administrative borders have always attracted the attention of academic and applied research alike because they hamper economic interactions and economic growth (Balassa, 1975; Scitovski, 1958; Thirlwall, 1974). International economics is inherently interested in the advantages gained in trade through integration; within international trade theory, an important area deals with the effects of the creation of customs unions, like the European Common Market (1958) or the Single European Market (1993). Creating customs unions entails the abolition of economic and institutional barriers to international trade through the elimination of customs tariffs, harmonization of technical standards in production, rules on quality certifications of products, the abolition of disparities in indirect taxation of consumption goods and common regulations of capital markets. This usually creates large integrated markets whereby geographical-institutional distance among local markets grants them increasingly lower 'protection' – as testified by the ongoing large-scale globalization.

Boundaries matter also at the regional level, even if they have been often neglected in spatial socio-economic dynamics (Nijkamp, 1994). Batten and Johansson (1991) offer various historical examples showing that removing bottlenecks may impact the growth of regions. At the same time, sociologists and social scientists describe the socio-cultural consequences on states stemming from changes in political borders.

By applying a gravitational model, the seminal work of McCallum (1995) paved the way for studies aiming at estimating the costs of a border in terms of missed economic growth, also at the regional level (Andresen, 2010; Bacchiega, Minniti, & Palestini, 2016; Goffrette-Nagot, Reginster, & Thoams, 2011). This approach remains the most popular way to identify and quantify border effects; it interprets borders only through the existence of tariffs, to link the border effect to pure demand-side effects, and to take care of border effects on trade.

A relatively more recent development that followed up McCallum (1995) stemmed from the theoretical model discussed by Melitz (2003). This approach models and measures border effects focusing instead on the supply side. In Melitz (2003), Krugman's international trade model is extended to take into account heterogeneity in firm productivity: the existence of borders represents a barrier potentially differentiating firms between those

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capable of reaching international markets, and those which instead remain autarchic.

Like the latter approach, this paper focuses on *supply-side border effects*, interpreted as the effects that the presence of a border generates on the efficiency of economic actors, and builds a new methodology able to measure supply-side border effects.

The paper innovates along three main dimensions. First, an institutional border can hamper the mobility of tangible and intangible production factors (labour, capital, knowledge etc.), can limit cooperation among firms, and can limit the availability of production factors. All these effects impact on firms' productivity and, at the aggregate level, on the dynamics of the border region. Secondly, linked to the last statement, the proposed methodology aims at measuring the supply-side border effects directly on regional growth, which is the primary goal of policy actions devoted to the overcoming of regional cross-border effects, as the cross-border cooperation programme. Thirdly, the proposed methodology directly measures the effects of different types of border obstacles (physical, institutional, language, administrative) to regions that are already part of a custom union such as the European market. With respect to the gravitational model, our approach achieves such an aim from the supply-side perspective.

This study also adds some conceptual reflections, disentangling different types of supply-side border effects: a border can in fact be a source of inefficiency in exploiting local resources, because of limited local market dimensions – a situation called here the *efficiency need* – or a source of scarce endowment of a given resource, because of their nature of border areas that prevents investments from being made easily in a potentially problematic area for growth, labelled *endowment need*. The distinction between the two is important for normative reasons. Lack of efficiency calls for intervention on resource governance, while lack of resource endowment requires new investment.

The paper is structured as follows. The next section presents the main strands of the literature on cross-border regions and border effects, highlighting the innovative elements of this paper. The third section discusses the institutional and technical definition of European Union (EU) cross-border regions, which represent a good experiment in the history of international cooperation. The fourth section presents the methodology, while the fifth and sixth sections discuss the results achieved in terms of endowment and efficiency needs respectively when the methodology is applied to the European cross-border regions. Finally, the seventh section concludes with some relevant policy implications of our empirical work.

CONCEPTUAL AND METHODOLOGICAL REFLECTIONS IN MEASURING SUPPLY-SIDE BORDER EFFECTS

A changing geography of countries, a powerful wave of globalization and the emergence of market integration areas (above all, the EU, and the North American Free

Trade Agreement – NAFTA) prompted a number of theoretical analyses and empirical investigations over the last decades, mostly taking for granted the hampering role played by political borders in shaping economic interactions. However, this literature actually comprises two main approaches quite different in terms of aims and methodologies.

The first approach, typical of most economic analyses, was first proposed by McCallum (1995). This fundamental contribution for the first time identified the so-called *home bias in trade puzzle*, i.e., the overwhelming tendency of regions to trade with other regions located in the same country. This tendency is explained by the fact that international borders represent a break in a continuous economic space. The literature on borders in a sense disproves the idea of the death of distance as not only transportation costs continue to exist but also borders make them discontinuous due to the existence of specific transaction costs over the border.

An international border marks the geography of trade relations and economic development patterns of countries. Most economic studies on borders quantify the effects of integration processes, by estimating the benefits of removing a border, through the elimination of tariffs (Andresen, 2010; Bacchiega et al., 2016; Goffrette-Nagot et al., 2011).

All such studies share a common applied toolbox employed to assess this effect, namely the gravitational approach. Empirically, these works estimate the impact of a border on trade flows between pairs of countries; in the tradition of gravitational models, the economic size of trading regions or countries is discounted by their reciprocal distance, and used as explanatory variable for the intensity of their trade flows. The methodology is replicated for integrated and non-integrated areas; the difference in the results suggests the presence of a border effect. McCallum (1995) finds that, after controlling for market size and distance, Canadian provinces exceeded a province's trade with US states by more than a factor of 20. In other studies, the intensity of the trade bias effect varies from three to 55 depending on the geographical area analysed (Gallego & Llano, 2015).

A feature characterizing these works is the focus on one economic aspect only, namely trade; in fact, most literature following from McCallum (1995) represents a fine tuning of the same approach on different geographical settings, typically with more advanced econometric techniques aiming at minimizing the omitted variables bias.¹

Two major contributions stand out among those following from McCallum (1995). Rauch (1999) makes two important steps forward in the development of this stream of studies. On the one hand, the measurement of political border effects is refined by breaking the border down into physical proximity, common language and colonial ties. On the other hand, his empirical results show that barriers to trade are more relevant for differentiated products than for homogeneous freight. Following from Rauch (1999), Evans (2003) provides a more nuanced picture of border effects, showing that after taking product differentiation,

tariffs and other institutional factors into account, the extent of the home bias effect decreases substantially.

Along with the literature originating from McCallum (1995), a major theoretical development has been provided by Melitz (2003). His model provides a new explanation for border effects, with a focus on the supply side. In this work, Krugman's international trade model is improved to model heterogeneity in firm productivity. In this theoretical setting, borders implicitly represent barriers that split firms into two groups according to their productivity, i.e., exporting firms and autarchic ones. Melitz has spanned a number of theoretical and empirical follow-ups, including, among many, Melitz and Ottaviano (2008) and Helpman, Melitz, and Rubinstein (2008).

More recently, some more empirical studies have been developed using micro-data on shipments of commodities from European ports to test the existence of border effects in more detail (Kashiha, Depken, & Thill, 2016; Kashiha, Thill, & Depken, 2016). The results of these analyses show that a border effect still exists between European countries, despite the existence of a long-established common trade area, and that these border effects are asymmetric and depend on the type of goods and on the type of firms, which is something plausible but could not be tested with data on aggregate trade.

In this literature, border effects are explained by immaterial assets such as different culture, regulations, social and business norms, but the focus remains on trade flows.² This makes the gravity model the most suitable toolbox to capture border effects in this approach.

Around the same period, with a climax leading to a special issue published in *Regional Studies* in 1999, the sociology and political science fields set out to frame the defining features of border regions, often within the theoretical toolbox of territoriality. The latter can be defined as 'the attempt to affect, influence, or control action, interactions, or access by asserting and attempting to enforce control over a specific geographic area' (Sack, 1983, p. 55). In particular, these works analyse what happens to territoriality – the tendency of nation-states to self-define around political borders – as a consequence of the major changes that characterized the 1990s (globalization, the end of the Cold War, and the birth of the EU and NAFTA being typically mentioned as the major exogenous shocks to the political system). Anderson and O'Dowd (1999) find that, as a consequence of these changes, social and communal boundaries could be increasingly delinked from territorial borders. Brunet-Jailly (2005) follows along similar lines and claims that 'agency and structure are mutually influential and interrelated in the shaping of emerging and integrated borderlands' (p. 644).

In this literature, border regions represent extreme cases where boundary effects emerge with evidence. Their very nature of areas typically far from the administrative or power centre, their geographically peripheral location, their nature of boundary and their proximity to other similar areas prompts several analyses of the way local, regional and national authorities react to and try to manage the

major changes taking place at supranational level. Scott (1999) elaborates on the concept of multilevel governance in border regions. Using the EU and North American cases as examples of both bottom-up as well as top-down creation of cross-border cooperation, he clarifies that 'the construction of cross-border regionalism is highly context-sensitive, conditioned by degrees of regional self-awareness, local identities, ideological discourses and the material cooperation incentives generated by interstate integration processes' (p. 606). Other similar works centre around the idea that border regions represent a conceptual subject worth of specific analysis (Church & Reid, 1999; Hall, 2008; Krätke, 1999). These studies share several commonalities: in particular, they all elevate the debate on border effects to the theoretical and conceptual level. The political science and sociology debates revolve around issues such as the historical evolution of international borders, the role of multilevel governance in an era of major political changes, and the cultural and social changes brought about by the evolution of political borders. Cross-border regions represent ideal case studies for understanding the way nation-states define their socio-cultural nature.

However, this stream of literature seems somehow destined to qualitative empirical verifications. Some of the theoretical concepts and statements are by their very nature difficult to be empirically tested; therefore, this stream of studies perfectly complements the economic approach to the measurement of border effects, which tends instead to err on the side of over-quantifying these effects.

This paper proposes a methodology to measure border effects which reconciles the two conceptual approaches, taking from both the most important features. Firstly, the methodology broadens the analysis from the pure economic effects of removing a border to socio-cultural ones, as suggested by political science and sociology. Similarly to the economic approach, however, border effects need to be measured with a rigorous quantitative approach, providing an empirical assessment of the intensity of border effects, and in particular of supply-side border effects. Without a quantitative measurement, any theoretical discussion risks to deliver only vague insight into this topic.

Secondly, the methodology needs to be flexible enough to leave open the possibility to broaden the analysis of border effects to types of obstacles beyond general political/administrative ones. Political borders, in fact, comprise lines of fracture in terms of languages, institutions and culture, and not only in terms of economic limitations. Disentangling the different effects of each type of obstacles that come with political borders has relevant normative consequences: it offers a useful guideline for addressing the next programming period of the European Cross-border Cooperation Program towards those obstacles that most relevantly hamper economic growth, thus calling for intervention.

Thirdly, the methodology moves to a supply-side measurement of border effects by linking border effects to economic growth (Boschma, Martín, & Minondo, 2017), something that cannot be achieved by means of the gravitational approach. Moreover, the methodology is

flexible and can be applied to other policy goals of the EU, namely social cohesion and environmental sustainability.

Fourthly, our methodology disentangles two different types of supply-side border effects, namely when borders generate efficiency needs and/or when they generate endowment needs. The former takes place when, due to the presence of a border, a region is limited in the way its resources are exploited; this may be due to the presence of a border hampering the possibility to trade and as such to sell locally produced goods and services to nearby regions on the other side of the border. The latter, instead, takes place when regions are scarcely endowed with a resource because the presence of a border prevents investment in a potentially problematic area for cooperation and growth.

The distinction is important, since the two needs call for different normative interventions: while endowment needs call for additional investment, efficiency needs call for intervention on governance.

The methodology is applied to EU cross-border regions, defined in the next section.

INSTITUTIONAL DEFINITION AND IDENTIFICATION OF BORDER REGIONS

European border regions are a unique experiment in the history of international cooperation. In these areas, multi-level governance and both bottom-up and top-down drive for economic and institutional integration prompted the birth of the first official EU border region in 1958, with the creation of EURegio (including the areas of Enschede in the Netherlands and Gronau in Germany; Perkmann, 2003).

Gradually, and with a speedy process after the fall of the Iron Curtain, transnational cooperation initiatives first extended as a result of bottom-up pushes from local boards, then became an official aim of the EU to be. In fact, European Territorial Cooperation, Interreg for short, is now one of the two pillars of Cohesion Policy (European Commission, 2015). Previous waves of the Interreg Program have overlapped with the Cohesion Policy programming periods (1990–93, 1994–99, 2000–06, 2007–13 and 2014–20).

Interreg programmes are explicitly geared at fostering transnational cooperation. Thus, Interreg funds are released under the premise that borders exert major damage to the flow of people, freight and ideas across borders; in other words, funding is provided in order to lubricate a system damaged by the existence of borders. Regions eligible for Interreg programmes represent an interesting study in which to evaluate border effects; the results can indirectly suggest future lines of programming for Interreg.

In order to proceed with our empirical test, EU border regions must be identified. Methodologically, border regions are defined as those NUTS-3 regions that share either a land border or a maritime border. In this respect, we adopt a specific methodology used within a DG Regio project, namely:³

- Land borders are determined by first building a buffer of 25 km around all intra-EU land borders; and second, by defining border regions those NUTS-3 whose territory intersects the buffer.
- Maritime borders are more complex to define. Firstly, a 150 km buffer along country coastlines is created. If coastlines of other countries cross this buffer, they are selected as possibly sharing a maritime border. Secondly, to avoid maritime borders along the same coastline, a second buffer of 150 km is created where the land border between two countries meets the coast. Coastlines of the neighbouring country that are located within this second buffer are deleted from the selection of border coastlines, unless they are neighbouring an opposite coastline at the same time. As a consequence, coastlines are defined as a maritime border if they are located within 150 km from the shore of other countries, but at least 150 km off from the land border with the same country. Maritime border regions at NUTS-3 level are those which intersect a buffer of 25 km from border coastlines.

The resulting EU border regions thus identified total 45 land border regions and 17 maritime border regions, meaning 62 overall border regions, including 616 NUTS-3 regions within a universe of 1398 (see Figures A1.a and A1.b in Appendix A in the supplemental data online). This definition is not devoid of limits. Firstly, there are border regions with different sizes and shapes, so that they can be bordering in some parts of them and quite far from the border in others. This is a modifiable areal unit problem which, however, applies to any statistical data at the regional level. The other limit is the relative arbitrariness of the various buffer distances, which are plausible but not due to any specific analysis. Regions identified with this methodology seem to be representing the true geographical location of areas facing a potential border effect, thereby enabling applied research on its real extent. Using an official definition has the clear advantage of allowing researchers to use the same geographical units which are targeted by the European Commission in its policy design.

With these criteria, border regions account for 42% of the total EU-28's (plus Norway and Switzerland) population and 43% of its gross domestic product (GDP).⁴ Whether they differ in any other dimension is a crucial matter for laying down the foundations of our empirical approach. This point will be further discussed below.

MEASURING SUPPLY-SIDE BORDER EFFECTS: A METHODOLOGICAL PROPOSAL

The methodology to measure border effects presented in this paper is simple, and at the same time capable of delivering plenty of insight into the importance of borders in regional economic performance. It is based on a comparison between growth behaviour of border regions and of

Table 1. Conditions for the existence of endowment and efficiency needs.

Needs: conditions for needs' identification	Potential endowment needs	Actual endowment needs	Efficiency needs
t-test for mean differences	Negative and significant	Negative and significant	–
Significance of β_i	–	Equation (1): β_i positive and significant	Equation (2): β_i^b negative and significant

all other regions in terms of endowment and efficiency in the use of productive resources.

Concerning endowment, a simple *t*-test capturing the differences in endowments in economic resources is a first step. A statistically significant negative difference in the endowment of a resource suggests a potential endowment need. However, in order for this lack to cause negative economic effects, and therefore be an *actual* endowment need, these resources have to be identified as strategic for the growth of border regions (Table 1). This aspect is controlled for in a regional growth model, which assumes the following form:

$$dY_r = \alpha + \beta_i * \text{resource}_{i,r} + \gamma * \text{border} + \sum_j \delta_j * \text{control}_{j,r} + \varepsilon_r \quad (1)$$

where dY_r is regional growth; β_i is the coefficient that assesses the impact of each resource i in a generic region r on its growth; and γ is the coefficient for the dummy identifying border regions. Border is a dummy that has the value of 1 in border NUTS-3 regions and 0 on the others. A battery of j controls is also added to the estimations. A positive and significant estimate of β_i for those resources having an under-endowment suggests an *actual endowment need*.⁵

To assess the efficiency needs in border region, equation (1) is expanded as follows:

$$dY_r = \alpha + \beta_i^g * \text{resource}_{i,r} + \beta_i^b * \text{resource}_{i,r} * \text{border} + \gamma * \text{border} + \sum_j \delta_j * \text{control}_{j,r} + \varepsilon_r \quad (2)$$

where β_i^g is the average (generic) coefficient for the impact of each resource i on regional growth; and β_i^b is the (border) coefficient for the differential impact of resources i on the growth of border regions.

Depending on the sign and significance of the differential coefficient β_i^b , we can say whether growth in border regions depends on specific growth asset i more or less than in the rest of the EU and, therefore, whether border regions are less able to use some of these growth assets with respect to non-border regions. This situation takes place when β_i^b is negative and significant, since it suggests an inefficient exploitation of that resource for region r with respect to all other regions (Table 1). The border dummy could in principle be associated with similarities characterizing this group of regions, like different resource endowment, rather than to the presence of the border. This doubt has to be empirically solved by checking whether this group of regions do not cluster for other similarities

than the border. As we shall see in the next section, this is not the case in our analysis.

This simple methodology paves the way for a number of new insights into the measurement of border effects. Firstly, border effects are measured directly on economic growth, avoiding the use of proxies, whose direct linkage with growth might be questionable, through the measurement of efficiency and endowment of production factors, i.e., through the efficiency of the local productive system. Secondly, the inefficient use due to the presence of a border can be grasped on all kinds of resources, including also social and cultural assets. Thirdly, the effects of administrative borders can be divided into their different constituents, including physical, institutional, language and administrative barriers. Last, but not least, equation (2) can be restructured to host social cohesion and environmental sustainability, two important policy goals of the Europe2020 Agenda, as dependent variables. This work applies the methodology for the first two steps, while leaving the others as future research applications.

Resources used to estimate border effects in equation (2) are classified as follows (see Table A1 in Appendix A in the supplemental data online):

- A first group of explanatory variables are selected on the basis of the recent regional growth literature. Knowledge creation and innovation are in this view the main driver of economic development. Traditional literature has stressed the role of human capital (Lucas, 1988), while more recently some suggested the relationship between productivity and technological progress in terms of information and communication technology diffusion (Becchetti & Adriani, 2005). Per capita patent applications capture new knowledge produced within regions (Paci & Marrocu, 2013), while product innovation measures innovation commercialization (Capello & Lenzi, 2015).
- A second group of independent variables cover territorial assets facilitating knowledge and innovation creation. Physical infrastructure increases the accessibility of knowledge from outside (Andersson & Karlsson, 2007; Capello, Caragliu, & Nijkamp, 2011a). Urbanization economies foster knowledge creation and diffusion (Parr, 2002). Moreover, functional specialization in high value-functions also fosters growth.
- Other variables capture both the regional industrial structure, leading to different growth opportunities (Perloff, Dunn, Lampard, & Muth, 1960), and the economic situation of the local economy.

- A variable measures long-run economic resources, namely saving propensity. Higher saving propensity allows regions to postpone present for future consumption, thus providing future investment opportunities (Giannakis & Bruggema, 2017).
- Additional variables measure the regional settlement structure. The presence of cities, and of urban systems, is also conducive to regional growth (Casi & Resmini, 2017).
- A group of variables take account of intangible assets, like cultural and social environments. Cultural events provide an opportunity for places' attractiveness, building culture, trust and sense of belonging in a community, i.e., social capital (Glaeser, Laibson, & Sacerdote, 2002). This element, along with other intangible features, is relevant in contexts, such as the EU, where the endowment of physical growth-enhancing factors is in general quite widespread.

Economic growth is measured with 2008–13 regional gross value-added growth rate at the NUTS-3 level, using total growth.⁶ This period overlaps with the economic crisis; thus, instead of interpreting growth proper, estimations explain resilience, i.e., the capacity of border regions to lose less than the average.

Moreover, due to limitations in the degrees of freedom, equations (1) and (2) were estimated by including one resource per regression, leading to no control of multicollinearity among assets. For this reason, a word of caution is needed. The supply-side border effects generated by each specific resource can be interpreted as the effects that the border generates on regional growth due to the inefficient exploitation of the specific asset and its related ones. The sum of the effects would overestimate the total border effects, and would therefore be misleading.

Table A1 in Appendix A in the supplemental data online reports the indicators, data and sources of the raw data collected at NUTS-3 level for all 28 European countries and the five European Free Trade Association (EFTA) countries.⁷

BORDER EFFECTS: POTENTIAL ENDOWMENT NEEDS OF BORDER REGIONS

In this section, the statistical similarities/differences in the structural characteristics of border regions with respect to the average are tested to prevent the border dummy from including structural differences rather than the border effect itself, and to test whether border regions lack specific resources.

Results of *t*-tests for mean differences (reported in Table A2 in Appendix A in the supplemental data online) suggest that border regions are in general not differently endowed with resources with respect to other regions.⁸ This is particularly true for employment rate, industrial activities, human capital, knowledge and product

innovation. This interesting result underlines the fact that being close to a border does not prevent border regions being as innovative as the rest of the European regions, nor to have the same human capital and manufacturing base. In some cases, means are almost identical, but even when means appear to differ, the fact that they are not statistically different signals the presence of more heterogeneity within border and non-border regions than between them.

Border regions are instead significantly over-endowed with respect to the rest of NUTS-3 regions in terms of cultural events and saving propensity. As for the former, border regions unexpectedly register a more vibrant cultural life than elsewhere.

Unsurprisingly, given to the history and geography of Europe, two growth assets significantly less present in border regions are accessibility and population density. Accessibility as expected is lower than the average in border regions because the continent has historically been organized as nation-states whose infrastructural plans were based on the necessity to reach capital cities, generally placed in central areas to guarantee easier control of the territory and easier defence from external enemies.⁹ Population density is also not surprisingly lower in border regions: borders tend to be remote and to coincide with rivers and mountains. In these areas, lower population densities are customary because of the higher economic costs of building infrastructure.

Border regions are also slightly but significantly less endowed with internal trust, which seems to suggest that from a social point of view the presence of the border hampers the trust of people in others. One could speculate that border regions, which were historically affected by wars and invasions, could have thus suffered from lower social cohesion.

Therefore, lack of endowment in trust, accessibility and population density seems to prevail in border regions. Whether there is an actual endowment need is the object of the next section.

BORDER EFFECTS: ACTUAL ENDOWMENT AND EFFICIENCY NEEDS IN BORDER REGIONS

The empirical results (reported in Table A3 in Appendix A in the supplemental data online due to space limitations) of estimating the baseline model (equation 1) with control variables only, namely the initial value added, regional settlement structure and the dummy identifying regions as being border – respectively, overall, land or maritime borders – meant to capture a significant share of total variance in the data. In other words, they represent the benchmark model against which border effects are going to be measured. The dependent variable is regional GDP growth rate between 2008 and 2013.¹⁰

This first set of estimates shows that on average rural regions, the benchmark against which agglomerated and urban regions are tested,¹¹ grow faster over the observed

Table 2. Estimates of the differential impacts of growth assets (equation 2).

Dependent variable: Growth of value added, 2008–13				
Asset	All regions estimates β_i in equation (1)	Border regions estimates β_i^g in equation (2)	Land border regions estimates β_i^g in equation (2)	Maritime border regions estimates β_i^g in equation (2)
Cultural events	0.02 (32.89)	-0.09*** (60.01)	-0.07** (56.76)	-0.09*** (56.45)
Employment rate	-0.04** (0.02)	0.09 (0.04)	0.02 (0.04)	0.09 (0.05)
Industrial activity	0.25*** (0.04)	-0.17*** (0.06)	-0.08 (0.06)	-0.14*** (0.07)
Product innovation	0.04*** (0.00)	0.01 (0.00)	-0.00 (0.00)	0.03** (0.00)
Knowledge	0.24 (0.00)	0.02 (0.00)	0.03* (0.00)	0.00 (0.00)
Human capital	0.08** (0.04)	-0.02 (0.05)	-0.04 (0.07)	0.01 (0.06)
Population density	0.05 (0.00)	0.03 (0.00)	-0.01 (0.00)	0.03 (0.00)
Accessibility	-0.11*** (0.01)	0.06 (0.01)	0.02 (0.01)	0.11** (0.01)
Saving propensity	0.09*** (0.02)	-0.09* (0.02)	-0.04 (0.03)	-0.07** (0.03)
Trust	0.20*** (0.02)	-0.11 (0.06)	-0.25* (0.02)	0.04 (0.02)
Joint controls ^a	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Heteroskedasticity-robust standard errors	Yes	Yes	Yes	Yes

Notes: Heteroskedasticity-robust standard errors are given in parentheses.

***Significant at the 99% confidence level; **significant at the 95%, confidence level; *significant at the 90% confidence level.

^aSee Table A2 in Appendix A in the supplemental data online.

period, being less affected by the negative effects of the economic crisis. Conditional convergence does not take significantly place; and, most importantly, that per se border regions did not over- or under-perform with respect to non-border ones. A possible border effect must thus be sought with the above described empirical approach.

Column 1 of Table 2 presents the estimates of the absolute impacts of regional resources on economic growth. This column represents, therefore, the benchmark against which the border effect must be compared¹² and corresponds to the estimated values of the various β_i 's in equation (1). This column provides vital information showing whether resources are on average strategic for regional growth: these include industrial activity, product innovation, human capital, saving propensity and trust. Column 2, fifth row, also unexpectedly suggests that knowledge has a limited impact on regional growth; this result is, however, in line with the recent view that knowledge does not always cause growth (Capello & Lenzi, 2015). In fact, our estimates

suggest that the commercialization of new knowledge (embedded in product innovation) is positively and significantly associated with economic growth. Consistently with other studies (Capello, Fratesi, & Resmini, 2011b; Resmini, 2007), accessibility by itself is not enough as a determinant of regional growth, strengthening the idea that accessibility is a necessary but not sufficient condition for growth (Rietveld, 1989).

Jointly with the *t*-tests results (reported in Table A2 in Appendix A in the supplemental data online), the coefficients reported in column 2 of Table 2 suggest the existence of an actual endowment need. This is in particular true for trust. In fact, among the resources of which border regions are under-endowed, the β_i coefficient is positive and significant for trust only, while accessibility and population density, present in low quantity, are not strategic for regional economic growth and as such do not represent border needs.

The second to fourth columns of Table 2 report the differential impact of resources on border regions, land border regions and maritime border regions respectively, and

Table 3. Growth assets in border regions: actual endowment and efficiency needs.

Significance of assets for the local economy	Assets playing no role in border regions' growth	Assets playing a moderate role in border regions' growth due to the presence of a border	Assets playing a strategic role on border regions' growth
Endowment of assets in the local economy	(β_i not significant in equation (1))	(β_i^g negative and significant in equation (2)) (Efficiency need)	(β_i positive and significant in equation (1) and/or β_i^g positive and significant in equation (2))
Over-endowment (mean differences positive and significant)	Employment rate	Cultural events Saving propensity	–
Similar endowment (mean differences not significant)	Knowledge	Industrial activities	Product innovation Human capital
Under-endowment (Endowment need) (mean differences negative and significant)	Accessibility population density	Trust ^a	–

Note: ^aTrust plays a moderate role only for land border regions.

are therefore consistent with the various β_i^g 's of equation (2).¹³ Negative and significant estimates for these columns indicate that overall, land and maritime border regions exploit that specific resource less efficiently with respect to non-border regions, and therefore identify an efficiency need. Resources that turn out to be inefficiently exploited in border regions include industrial activity, saving propensity and cultural events.

Table 3 offers a synthesis of the results of both endowment and efficiency needs. In the first column, different resources are classified according to their significance for regional growth. In the second column, the list of growth assets exerting a moderate growth effect is presented. This list is of particular importance, since these resources stimulate growth in border regions, but less than in other European regions because of the border. In fact, this is the case in which the presence of the border prevents regions from exploiting their own assets as efficiently as other regions. This applies in particular to cultural events, industrial activity, saving propensity and, only for land border regions, trust. The third column of Table 3 lists growth assets significantly correlated to regional growth and as significantly in border regions as in other regions. These are assets that are fully exploited by border regions, and therefore where border regions do not suffer from border effects. This is the case of the two assets especially linked to the knowledge economy, namely human capital and product innovation.

On rows, Table 3 also reports whether border regions are over- or under-endowed with different assets, a result obtained from the analysis of the previous section. Taken together, results of rows and columns provide an important information; there is no asset in which efficiency and endowment needs are present at the same time, with the exception of trust in the case of land border regions. The latter are less endowed with trust and exploit it less efficiently than the average. For other resources, it is a matter of either endowment or efficiency needs, rather than of

both simultaneously. In most cases, endowment needs, representing lack of critical mass in the supply of these assets, are counterbalanced by an efficient exploitation of resources; efficiency needs instead mainly stem from lack of critical mass in the demand for widely available assets.

From the estimated coefficients, the loss of economic growth due to the presence of the border can be calculated. Economic growth could, for instance, be on average 0.30% higher if the border would not prevent the full exploitation of cultural events, and 0.64% and 0.33% higher if no obstacle at the border precluded the full exploitation of industrial activities and saving propensity respectively.

An additional piece of information relevant from a policy perspective is the geographical heterogeneity of the inefficient use of resources in border areas. The latter can be obtained by calculating the elasticity of growth to each asset in each region. Figure 1(a) presents the geographical distribution of the lower economic growth generated by the presence of the border preventing the full exploitation of cultural events. It reports both the relatively lower growth for single border areas (boundary line) and for individual NUTS-3 regions, showing that most southern border areas suffer from an inefficient exploitation of cultural events, while this is not the case for northern border areas. The latter, with the exception of Finland–Norway and France–UK, demonstrate a relatively higher economic growth due to a better exploitation of cultural heritage with respect to southern border areas.

Figure 1(b) shows the endowment of cultural events. Taken together, Figures 1(a, b) suggest that regions more endowed of cultural events, like southern border areas (Figure 1(b)), are mostly unable to exploit this resource for growth (Figure 1(a)). On the contrary, regions that are less endowed, like northern border areas (Figure 1(b)), show a higher capacity to tap this resource in order to achieve economic growth (Figure 1(a)).¹⁴

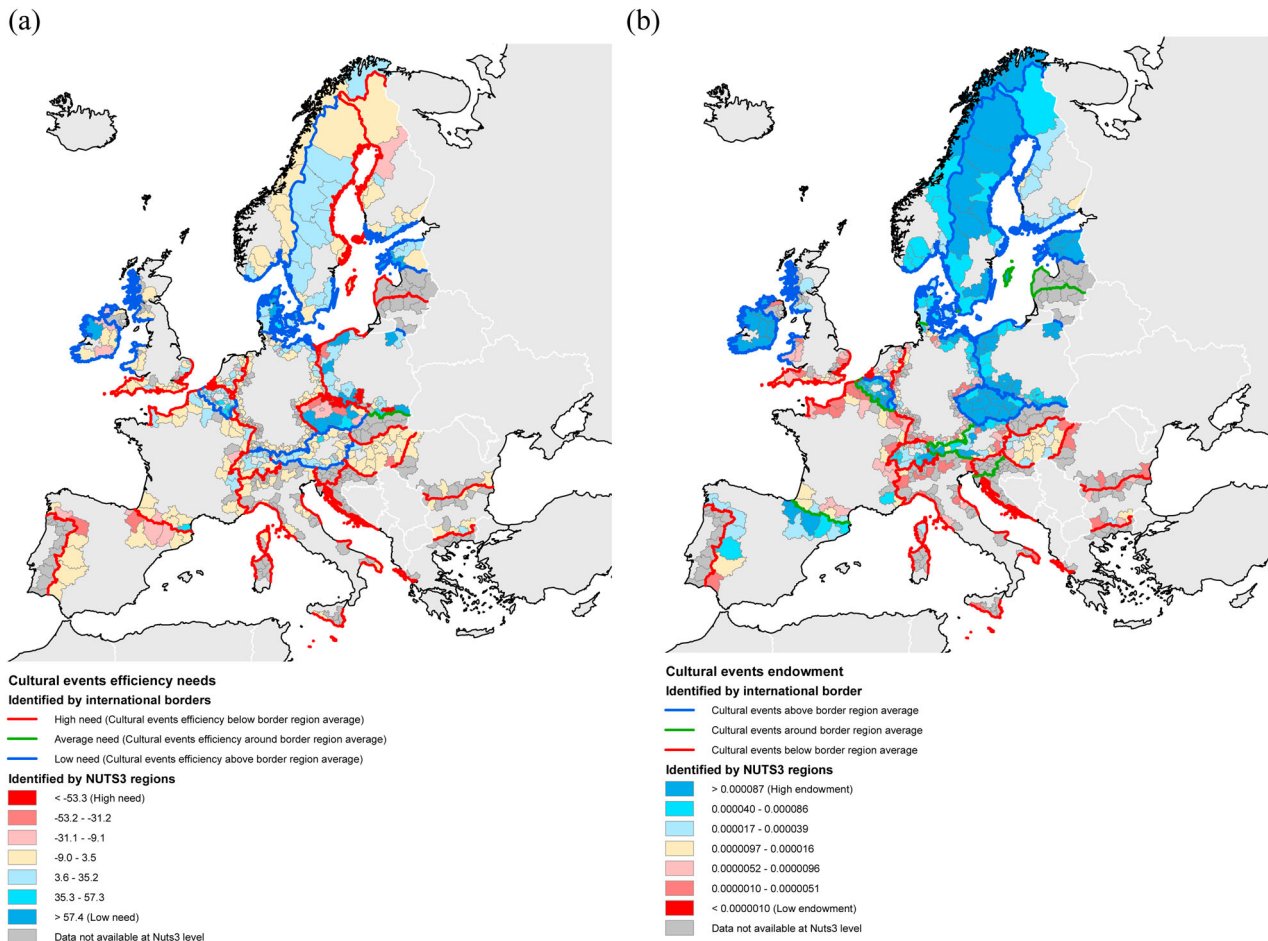


Figure 1. Efficiency needs in (a) cultural events and (b) the endowment of cultural events: a comparison. Source: Authors' elaboration.

CONCLUSIONS

This study investigated the border effects in European border regions by applying a new methodology that opens up new opportunities with respect to the gravitational approach in the measurement of border effects. In fact, rather than measuring border effects in terms of lost trade, as most of the literature does, the methodology suggests a way to measure the effects that institutional borders have on the exploitation of economic and social resources for regional growth, thus focusing on supply-side border effects rather than on demand-side effects. Moreover, the methodology disentangles two types of supply-side border effects, namely endowment needs and efficiency needs, overcoming some of the limitations of other existing approaches to the measurement of supply-side border effects.

Once applied to the European cross-border regions, the methodology shows that European border regions in general do not suffer from lack of resources. Instead, border regions mostly suffer from efficiency needs; in other words, they are unable to use their resources as efficiently as other regions because of the presence of the border. Among the territorial resources that are inefficiently exploited by border regions are hard ones such as industrial

activities and softer ones such as cultural events and saving propensity.

An additional interesting result is that, with the exception of trust (and only for land border regions), there is no growth asset for which border regions simultaneously suffer from an efficiency and an endowment need.

These results contain clear policy suggestions. The most straightforward is that European Cross-Border Cooperation policy should be targeted to the improvement of the governance of local resources, rather than addressing the issue of growth asset endowments in these regions. Governance policies required to address efficiency needs are unfortunately more difficult to implement, but also cheaper to operate with respect to the investment policies that would be needed to address endowment needs.

Our findings also suggest some promising future research avenues. The first concerns the study of different types of barriers to the development of border regions, in line with what the sociology and political science literature suggests through qualitative discussion, by applying a rigorous quantitative approach like the present methodology flexible enough to allocate different types of borders.

The second research line left open in this paper concerns the study of the possibility of using external resources to complement internal ones. In fact, it is possible that

regions under-endowed or unable to use their internal resources could use external ones more effectively, but border regions might not be as effective as others in complementing internal with external resources because they are limited in their possibility to interact with regions on the other side of the border.

A third and last possible future enhancement of our findings is related to the different development models that may characterize groups of border regions. Our findings highlighted the fact that border regions grow like non-border ones because the way they are defined hides a remarkable internal heterogeneity. A possible step forward for this work may consist in a more fine-grained definition of the different development paths existing *within* border regions. This would pave the way for more precise policy suggestions, taking account of regional idiosyncratic features.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed at <https://doi.org/10.1080/00343404.2017.1364843>.

NOTES

1. In fact, this literature defines border effects as ‘the downward impact of national boundaries on the volume of trade, i.e., that two different countries trade far less with each other than do two locations in the same country, after controlling for factors such as income, alternative trading opportunities, and distance’ (Evans, 2003, p. 1291).

2. Among the few relevant exceptions, Chandra, Head, and Tappata (2014) assess the strength of border effects on individual travel decisions, while Persyn and Torfs (2015) model the intensity of commuting across Belgian municipalities to measure the intensity of regional border effects.

3. Border regions have been identified in the study entitled ‘Collecting Solid Evidence to Assess the Needs to be Addressed by Interreg Cross-Border Cooperation Programmes’, Framework Contracts 2014CE16BAT010/2014CE16BAT011/2014CE16BAT012 (Service Request 2015CE160AT044), in which the authors were partners.

4. That is, border regions comprise 220 million inhabitants and make up for almost €6 nominal billion (out of 520 million inhabitants and almost €14 billion respectively). Taken together, these figures suggest that border regions are also on average as productive as the average EU region – if anything, per capita value added in border regions is slightly higher than in the rest of Europe.

5. This methodology implicitly assumes that border and non-border regions follow similar development models, i.e., the strategic importance of a resource on average

hold also for border regions. While this could be disputable, we are confident that this assumption can be accepted since the within-border regions heterogeneity makes the latter diverse enough not to allow the identification of a border regions-specific development model. This is also reflected in a non-significant estimate of the border dummy in equation (1), which suggests that border regions grow exactly like non-border ones.

6. Robustness checks on a longer period, namely 2006–13, were run. Signs and significance of the different regressors remained stable.

7. Since NUTS-3 classifications have been frequently updated in EUROSTAT, a remarkable effort in data harmonization has taken place.

8. The same analysis has also been performed excluding from the sample the regions hosting large cities to test whether the results are due to the presence of cities. The results remain unaffected.

9. Additionally, accessibility is measured in terms of the population that can be reached from the region, and when the region has a coastline, nobody lives on the other side of the border by definition.

10. Analytically, the dependent variable is calculated as $(GDP_{2013} - GDP_{2008})/GDP_{2008}$.

11. For a discussion of the identification of agglomerated, urban and rural regions, see Capello and Chizzolini (2008).


12. For ease of presentation of the results, the usual statistics (R^2 and joint F -test of significance) are reported in Table A4 in Appendix A in the supplemental data online.

13. The β_i^S of equation (2) is not significantly different from the β_i of equation (1).

14. A second graphical example is provided and commented on in Appendix A in the supplemental data online.

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