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Making Regions Great Again: Winning Big with European Integration

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**Making Regions Great Again:
Tirer pleinement parti de l'intégration
européenne**

Par

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Abstract

In this thesis, I examine the opportunities and challenges that regions in the European Union (EU) face during the process of European integration. EU membership grants access to the world's largest common market, but not all regions benefit equally. Peripheral regions or those specialized in less competitive industries may encounter significant obstacles. To counteract such disparities, the EU employs Structural and Investment Funds (EU Funds). The first chapter introduces a novel instrumental variable to address endogeneity concerns and incorporates potential spatial spillovers. The results show that EU Funds foster regional growth, with spillover effects that can even surpass direct impacts. The second chapter investigates the consequences of the Eastern enlargements for border urban municipalities. While borders often constrain development, EU accession transforms them into internal regions of the common market, potentially stimulating growth. The analysis reveals that the benefits of enlargement depend on local characteristics, the nature of the border, and the countries on both sides, with evidence highlighting the role of market potential. Finally, the third chapter studies the 2004 enlargement from the perspective of firms. The findings suggest that firms in new member states close to EU15 borders experience declining profitability relative to interior firms. However, smaller firms in these areas display relatively higher profitability, pointing to competitive pressures from EU15 firms as a potential deterrent for larger firms.

Keywords: EU integration; border regions; EU funds; new member states; border firms; border cities.

Résumé

Dans cette thèse, j'examine les opportunités et les défis auxquels sont confrontées les régions de l'Union européenne (UE) dans le cadre du processus d'intégration européenne. L'adhésion à l'UE donne accès au plus grand marché commun du monde, mais toutes les régions n'en bénéficient pas de manière égale. Les régions périphériques ou spécialisées dans des industries moins compétitives peuvent rencontrer des obstacles importants. Pour contrer ces disparités, l'UE utilise les Fonds structurels et d'investissement (fonds européens). Le premier chapitre présente une nouvelle variable instrumentale pour répondre aux problèmes d'endogénéité et tient compte des retombées spatiales potentielles. Les résultats montrent que les fonds européens favorisent la croissance régionale, avec des retombées qui peuvent même dépasser les impacts directs. Le deuxième chapitre examine les conséquences des élargissements à l'Est pour les municipalités urbaines frontalières. Si les frontières limitent souvent le développement, l'adhésion à l'UE les transforme en régions internes du marché commun, ce qui peut stimuler la croissance. L'analyse révèle que les avantages de l'élargissement dépendent des caractéristiques locales, de la nature de la frontière et des pays situés de part et d'autre, les données soulignant le rôle du potentiel de marché. Enfin, le troisième chapitre étudie l'élargissement de 2004 du point de vue des entreprises. Les résultats suggèrent que les entreprises des nouveaux États membres proches des frontières de l'UE-15 connaissent une baisse de rentabilité par rapport à celles situées à l'intérieur. Cependant, les petites entreprises de ces régions affichent une rentabilité relativement plus élevée, ce qui indique une pression concurrentielle.

Mots clés: intégration européenne; régions frontalières; fonds européens; nouveaux États membres; entreprises frontalières; villes frontalières

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List of Abbreviations

- 2SLS – Two-Stage Least Squares
- ADE – Average Direct Effect
- AIE – Average Indirect Effect
- ATE – Average Total Effect
- ATT – Average Treatment Effect on the Treated
- BAFTA – Baltic Free Trade Area
- BvD – Bureau van Dijk
- CAP – Common Agricultural Policy
- CEECs – Central and Eastern European Countries
- CEFTA – Central European Free Trade Area
- CF – Cohesion Fund
- DMSP-OLS – Defense Meteorological Satellite Program – Operational Linescan System
- E2 – Eastern 2 Enlargement Countries (BG, RO)
- E8 – Eastern 8 Enlargement Countries (EE, LV, LT, PL, CZ, SK, HU, SI)
- EAFRD – European Agricultural Fund for Rural Development
- EBITDA – Earnings Before Interest, Taxes, Depreciation, and Amortization
- EEA – European Economic Area
- EEC – European Economic Community
- EFTA – European Free Trade Association
- ERDF – European Regional Development Fund
- EU – European Union
- EU Funds – EU Structural and Investment Funds
- EU15 – Pre-2004 Member States of the European Union
- EXT – Non-EU Countries

- FDI – Foreign Direct Investment
- FE – Fixed Effects
- FMP – Foreign Market Potential
- GDP – Gross Domestic Product
- HR – Croatia (2013 enlargement)
- IV – Instrumental Variable
- LAU – Local Administrative Unit
- MAUP - Modifiable areal unit problem
- NACE – Statistical Classification of Economic Activities
- NG EU – Next Generation EU
- NGOs - Non-governmental organizations
- NMS – New Member States (countries joining the EU after 2004)
- NUTS – Nomenclature of Territorial Units for Statistics
- OLS – Ordinary Least Squares
- SCI – Sites of Community Importance
- SDM – Spatial Durbin Model
- SPA – Special Protection Areas
- Suomi-VIIRS – Suomi National Polar-orbiting Partnership Visible Infrared Imaging Radiometer
- SUTVA – Stable Unit Treatment Value Assumption
- WGI - World Governance Indicators

General Introduction

I was born in Bratislava, a border region that not so long ago was separated from its western neighbors by barbed wire. After my country's accession to the European Union (EU) and the Schengen Area, these borders became open, making it possible to cross them. An example is a network of cycling routes allowing a cross-border tour that includes a bridge connecting Slovakia and Austria, accurately named "*Freedom Cycling Bridge*". The story of this cycling route captures many of the elements through which I feel a personal connection to the topics addressed in this thesis.

The opening of borders in my region is one of many visible outcomes of the integration within the framework of the European Union taking place after the end of the Second World War to prevent such a catastrophe from happening again through economic cooperation. Consequently, the inhabitants of countries that joined the EU have experienced an unprecedented period of peace, stability, and economic prosperity. The economic cooperation within the EU deepened throughout its existence, intensifying and becoming an economic union with the largest single market. Additionally, the majority of the EU member states have also formed a currency union ([Baldwin and Wyplosz, 2022](#)).

In their analysis of the impact of European integration on each member state, [Campos et al. \(2019\)](#) find significantly positive effects of joining the EU for each country, with the exception of Greece. EU integration may not, however, benefit all regions within a country equally. Regions that specialize in less competitive industries or are located on the periphery of their country may face significant challenges. [Camagni et al. \(2020\)](#) highlight the rising divergence among the regions of the EU15 since the Great

Recession and in the new member states (NMS) since their accession into the EU. The regional dimension and the heterogeneous effects of European integration are relevant more than ever, as regions facing structural economic challenges or outflow of population have recently experienced a surge in the popularity of populist parties [Rodríguez-Pose \(2022\)](#).

Primary policy tools of the EU to counteract the divergence among its regions are the EU Structural and Investment Funds (EU Funds). The EU Funds are primary policy tools of the EU to counteract the divergence among its regions. They allow regions that are either less developed or deal with structural problems to obtain funding opportunities that can increase the attractiveness and competitiveness of these regions. For instance, the aforementioned cycling road and Freedom Cycling Bridge, along with (re-)construction of other border crossings in the area, are examples of projects that were made possible with the help the EU Funds.

[Chapter 1](#) of this thesis is therefore dedicated to the impact of the EU Funds on regional economic growth rate in the EU.¹ The starting point of our road, taken together with Jan Fidrmuc and Olga Zajkowska, was [Dall'erba and Fang \(2017\)](#), who find mixed effects of the impact of EU Funds on regional economic growth. They go on to argue that one of the reasons contributing to the wide range of results is the presence of endogeneity and the failure of most studies' methodological designs to account for it. That is, regions dealing with structural issues have a lower GDP per capita but at the same time receive a higher amount of EU funds to cope with their underdevelopment. Recently, several studies have employed quasi-experimental methods to address the endogeneity of EU Funds in regional growth analyses, primarily relying on regression discontinuity designs exploiting the allocation cutoffs for higher funding ([Becker et al., 2010, 2018](#); [Pellegrini et al., 2013](#); [Gagliardi and Percoco, 2017](#); [Ferrara et al., 2017](#); [Percoco, 2017](#); [Cerqua and Pellegrini, 2018](#)). Instead of a regression discontinuity design, we employ an original instrumental variable approach to account for the potential simultaneity between EU Funds and regional

¹This chapter was published as [Fidrmuc et al. \(2024\)](#).

growth. Our instrument is the proportion of an area of a region that is covered by *Natura 2000* network of protected zones. The idea is that making an area subject to natural protection can restrict some economic activities in the area or make them more costly. As our IV estimates are larger than the OLS estimates, our findings point to a downward bias of the OLS. Additionally, we find evidence of potentially important positive spillovers of EU funds on nearby regions.

The [European Commission \(2021\)](#) report nicknames border regions in the EU as areas that are the “*living labs of European integration*”. The reason is that as EU integration eliminates borders to enable the free movement of capital, goods, labor, and persons, border regions become areas where people interact the most, whether it is due to work or recreational purposes. As such, these interactions can help border regions to become less peripheral within their own country or provide insights on barriers facing European integration. Consider again the construction of the Freedom Cycling Bridge. Projects like this illustrate how EU integration and funding can reduce border frictions and stimulate economic and social activity in border municipalities.

Therefore, in [Chapter 2](#) of the thesis, I analyze the impact of the Eastern EU enlargements on the border urban municipalities separated by borders that transformed from EU external borders to intra-EU borders in the course of the enlargements.² It is important to note here that to define the border units, this thesis employs the EU definition that uses the 25 kilometer threshold from a border, and takes into account only land borders. Additionally, the distance to the nearest border is used, when classifying borders into groups.

I build on the seminal paper by [Brakman et al. \(2012\)](#), which compares the development of border cities and regions of every EU enlargement with the development in the interior of the country in terms population share relative to the national population. [Brakman et al. \(2012\)](#), as well as subsequent analyses at the regional and municipal levels (see, among others, [Wassmann, 2016](#); [Brühlhart et al., 2018](#); [Heider,](#)

²This a solo-authored paper.

2019; Gouveia et al., 2020; Kapanadze, 2021, 2022; Bachtrögler-Unger et al., 2023; Coufalová et al., 2024; Mitze and Breidenbach, 2024; Poehnlein, 2025), generally report a positive impact of Eastern EU enlargements on border areas. However, the studies on the municipal level are most of the time restricted to one or two countries, due to data availability issues. I contribute to the existing literature by assessing the impact of the Eastern EU enlargements on border municipalities across all acceding member states and their EU15 neighbors, using night-time lights data as a proxy for economic development. The analysis also highlights the heterogeneity of these impacts. By employing data at a finer spatial scale, incorporating recent advances in causal inference, and accounting for anticipation effects, this study provides new insights into the differentiated effects of European integration across border regions.

My results can be surprising at first, as they indicate a positive effect for urban municipalities of the same cohort near the borders between two new member states (NMS), while a negative effect for urban municipalities of the 2004 enlargement located in NMS close to borders with EU15. Yet, when I consider possible anticipation of the enlargement, I find a positive impact for the latter group stemming from pre-accession liberalization between EU15 and NMS countries. Correspondingly, the favorable effects of integration precede the EU enlargements and are spread out over a longer period. My findings highlight significant heterogeneity across EU enlargements and among different types of urban municipalities. Notably, border urban municipalities of the 2004 enlargement with foreign market potential in the third quartile experienced an increase in night-time lights, underscoring the importance of market access. Furthermore, smaller urban municipalities of the 2007 enlargement also benefited from EU accession. Finally, I find only limited evidence that natural barriers hampered the accession benefits for border municipalities in the case of the Croatian enlargement.

One benefit of EU integration for border regions is that it allows economic agents to take advantage differences across countries. For example, an inhabitant on the Austrian side of the border can cross into Slovakia to purchase cheaper products, while a resident on the Slovak side may find higher-paying employment in Austria.

These opportunities can increase the attractiveness of border areas for firms, as they provide access to larger markets and a more flexible labor pool. On the contrary, administrative barriers as well as differences in languages or level of EU integration, can reduce the appeal of border areas.

Building on these dynamics, [Chapter 3](#) of this thesis examines the border regions of the 2004 enlargement from the perspective of firms.³ Together with Nicolas Debarsy and Jan Fidrmuc, we use historical Orbis data to compare the profitability of firms located in border areas with those in the interior of the same countries. This analysis allows us to evaluate the attractiveness of border areas and the potential for firm success in the regions affected by the 2004 enlargement. Our work relates to [Fantechi and Fratesi \(2023\)](#), who compare firms located in Italian border areas to the ones located further away. Their results show that firms located immediately close to a border face a disadvantage mainly in the production sectors. Studies on the 2004 enlargement concentrate mainly on the FDI ([Jones et al., 2020](#)), multinational firms ([Merlevede and Purice \(2019\)](#) or just one country ([Braakmann and Vogel, 2010](#)). We contribute to this literature by looking at single unit firms in border areas of the 2004 enlargement as well as firms located close to external borders of the EU and compare their profitability to firms located in the interior of these countries.

In comparison to the night-time lights data used in the previous chapter, the firm level data provides us with more detailed disaggregation information, which can enlighten our understanding of border regions. The downside of the firm level data is that it starts in 1999. As [Chapter 2](#) highlights, the period between 1999 and 2004 is already marked by anticipation effects. Furthermore, the number of firms and quality spatial coverage is fairly low in the first years and improves with time. These factors do not allow us to conduct a clean and precise impact analysis of the 2004 enlargement on firm level. Nevertheless, we can still compare the performance of firms in the border areas of the 2004 enlargement, illustrating differences between them.

³This paper is co-authored with Nicolas Debarsy and Jan Fidrmuc.

Our findings suggest a decrease in profitability for firms located in new member states in the proximity to borders with EU15 countries. This might be an effect of an increase in competition from the other side of the border or persistence of barriers. Moreover, our results suggest that the effects are distributional: only small firms in the NMS near EU15 borders have a higher profitability compared to firms in the interiors, with the effect declining with firm size. Hence, the border areas in NMS close to borders with EU15 remain less attractive for larger firms.

Lastly, by examining variations in impact across sector groups, we observe a stark contrast between firms located in NMS near the EU15 and those near the external borders. Firms close to the EU15 exhibit higher profitability in non-agriculture sectors, while profitability in the agriculture sector is lower and declining. In contrast, profitability in the production sectors is lower in the vicinity of external borders.

It should be emphasized that [Chapter 2](#) and [Chapter 3](#) compare units in border areas to ones located further inland. As such, the negative or insignificant effects found in these chapters do not imply that these border areas do not benefit from EU enlargement. In a similar fashion, a positive effect has its own limitation. For example, a higher growth in night-time lights may represent an expansion of an urban municipality, but if not accompanied by the provision of sufficient amenities, it may not translate into an increase of welfare.

Together, these three chapters highlight some important gains that ensue from European integration, but also suggest that such gains are highly heterogeneous and context-dependent. The chapters now follow the progression in data granularity, moving from administrative NUTS2-level data in the first chapter to night-time lights and firm-level data in the subsequent chapters, allowing for increasingly detailed insights into the effects of integration.

Chapter 1

The long and winding road to find the impact of EU funds on regional growth: IV and spatial analyses

1.1 Introduction

One of the key principles of European integration has always been solidarity. This has been manifested, most prominently, in the funding set aside to support regional development within the European Union (EU): Cohesion Policy, the primary tool of regional policy in the EU's toolbox, accounts for approximately one third of its budget.¹ Its importance, furthermore, has been increasing over time: from less than 10% of the EEC budget in the 1970s and the early 1980s to 32.5% in the 2014-20 EU budget.² This reflects the changing priorities of the EU budget in line with the European Union's expansions. Initially, the EEC comprised six founding members who were at similar levels of economic development so that there was little perceived need for regional redistribution. Rather, on the backdrop of food shortages during the Second World War, the bulk of EU spending was dedicated to supporting agriculture

¹We use the terms Cohesion Policy, EU funds, and regional policy interchangeably throughout the paper as they are broadly similar (though not entirely identical). When referring to Cohesion Policy, we refer not only to the EU's Cohesion Fund but also to other related funding instruments such as the European Regional Development Fund (ERDF), the European Social Fund Plus (ESF+), the European Agricultural Fund for Rural Development (EAFRD), and the European Maritime, Fisheries and Aquaculture Fund (EMFAF).

²The European Economic Community (EEC) was the original name of what later came to be known as the European Community (EC) and finally the European Union (EU).

so as to ensure the security of food supply. However, the accession of Greece in 1981, followed by Spain and Portugal in 1986, resulted in considerable income differentials among the member states and their regions. The Southern European countries were, furthermore, concerned about greater competitive pressure following their entry to the Single Market: the increased allocation of funds to regional policy served to alleviate their fears that they would be adversely affected. These considerations were further strengthened after the German Reunification in 1990 and the Eastern enlargements in 2004, 2007 and 2013. Correspondingly, the relative importance of EU funds has increased and the Cohesion budget has almost caught up with the funding earmarked for the Common Agricultural Policy.

The evidence on the growth-boosting effect of EU regional policy, however, has been rather mixed so far. Some studies do find that Cohesion Policy has had a positive impact on economic growth. Other analyses, however, yield an insignificant or even a negative effect. Broad overview studies by [Dall'erba and Fang \(2017\)](#) and [Marzinotto \(2012\)](#) observe a general lack of consensus in the literature over the sign of the effect of regional policy on growth. Given the considerable amounts of money that the EU spends on Cohesion Policy, it is disappointing that clear and overwhelming evidence of a positive effect remains elusive.

Nevertheless, the absence of evidence of a positive effect does not necessarily imply that no such effect exists. The positive effect could elude the researchers for a number of reasons. First, the analyses can be plagued by measurement errors in data on growth or Cohesion Policy transfers. Second, the estimated impact of EU funds on regional growth is likely to be endogenous, either because of omitted variables (such as structural issues and other factors jointly affecting eligibility for regional aid and economic growth), or because of reverse causality (Cohesion payments being shaped by regional economic development). Third, the effects of an investment in any particular region can spill over to other regions. Not accounting for such spillovers could diminish the estimated regional effect of Cohesion Policy. We discuss these issues in detail in the following section.

In this paper, we join the fellow travellers seeking to correctly identify the effect of Cohesion Policy on regional economic growth. We offer several important innovations. First, we use an updated and more extensive dataset, with Cohesion transfers and growth measured in annual frequency (most previous studies were limited to data measured for the so-called Programming periods comprising six to seven years. Second, we address potential endogeneity concerns by introducing a novel and previously unused instrumental variable, the extent of environmentally protected areas under the Natura 2000 program, linking environmental characteristics to funding allocation in a way that is plausibly exogenous to growth outcomes. Third, we estimate a Spatial Durbin Model (SDM) so as to capture the potential spatial spillover effects of Cohesion Policy.

Our findings underline the strength of this approach. We show that environmental protection, proxied by the fraction of the region's area under protection and the number of protected sites in the region, is positively correlated with the amount of funding that the region receives from Cohesion Policy. The Cohesion Policy funding, in turn, translates into higher regional economic growth. The results of our spatial analysis, furthermore, suggest that Cohesion Policy indeed has important cross-regional spillover effects on growth.

How much bang does the EU get for its Cohesion Policy buck? In the next section, we briefly discuss the existing literature on the impact of Cohesion Policy on regional development. The data we use are described in section 3. In section 4, we explain the construction of our instrument and present our analysis of endogeneity-robust effect of Cohesion Policy on regional economic growth. We then present the result of our spatial analysis in section 5. We summarize our findings and put them into the broader context in the last section.

1.2 The Road So Far

The EU spends around one-third of its budget on Cohesion Policy – regional aid to less-developed regions. This makes Cohesion the second largest expense item, just slightly lower than the CAP. Unsurprisingly, questions have been raised about the merits of dedicating such a large share of EU funds to regional aid.

In principle, Cohesion Policy should stimulate regional development.³ It prioritises lagging-behind regions, often with structural problems, where it targets areas with significant growth-promoting potential: infrastructure improvements, education, innovation, job creation, environmental sustainability and climate change, social inclusion, and ageing (Barca, 2009). Nevertheless, generally, all member states receive transfers from Cohesion Policy, not only the less affluent ones. Therefore, the Cohesion Policy should be seen as relatively uncontroversial and broadly beneficial. Are these optimistic expectations borne out by the evidence?

The existing literature on the effect of EU funds on economic growth paints a rather mixed picture. Some studies find a positive impact on economic growth (Beugelsdijk and Eijffinger, 2005; Bradley et al., 2004; Bradley and Untiedt, 2007; Maynou et al., 2014; Radvansky et al., 2015; Rodriguez-Pose and Fratesi, 2004; Cappelen et al., 2003; Venables and Gasiorek, 1999; Cerqua and Pellegrini, 2018). Others conclude that the effect is either insignificant or even negative (Boldrin et al., 2001; Fagerberg and Verspagen, 1996; Dall’Erba and Le Gallo, 2008; Eggert et al., 2007). The meta-analysis by Dall’erba and Fang (2017) reviews the quantitative evidence in 17 studies which together yield 323 estimates of growth elasticities. The average estimate is close to zero at 0.174 and the range of estimates is high: from -7.6 to 6.3 . Marzinotto (2012), in another survey, also finds the literature inconclusive, and points out that the

³As Rodríguez-Pose et al. (2024) note, with the evolution of economic theory, the understanding of how the EU funds should help regional development is shifting. Initially grounded in the neoclassical growth model, the emphasis was placed on investments in physical infrastructure. With the rise of new economic geography, attention shifted toward enhancing connectivity and accessibility through improved infrastructure. More recently, the focus has expanded to recognize the crucial role of institutional quality in fostering regional development.

effects obtained in empirical studies fall short of those predicted by macroeconomic simulations.

The broad range of findings in the previous literature can be attributed to differences in methodological approaches, or it can reflect heterogeneity in the way such transfers affect regional economies. As for the former, [Dall'erba and Fang \(2017\)](#) observe that the later the research was conducted, the higher was the estimated impact of EU funds. This could suggest that there is a learning effect on the side of the researchers whose methodological approaches improve over time, or that the member states learn over time how to use European subsidies better and more efficiently.

It is reasonable to expect that the member states allocate the resources received from EU Funds first to the projects with the highest rate of (social) return, followed by those with a lower return, and so on. Then, member states with more generous allocations of funds should display lower average rates of return. The effect of EU funds need not be monotonous, however. For example, funding may need to reach a minimum critical mass to have a measurable positive impact on regional growth ([Becker et al., 2012](#)). In line with this reasoning, [Becker et al. \(2012\)](#) estimate a non-linear relationship between Cohesion transfers and regional growth and find that it peaks when the EU funds account for just above 1% of the region's GDP. [Fiaschi et al. \(2018\)](#), in a later study, obtain a higher optimal level of around 3%.

[Dicharry \(2020\)](#) puts forward a different argument: the return to regional policy can depend on the speed of implementation. The reason for this is the EU rules that stipulate that regions lose their Cohesion Policy allocations if the funds are not used within a specified period of time. This may induce them to apply for funding to finance projects that are simple and easy to implement. Such *safe* projects, however, may be lacking in terms of originality and innovative capacity. [Dicharry \(2020\)](#) finds that while the overall impact of Cohesion Policy on regional development is positive, it indeed declines with the speed of absorption. He suggests that inefficiently fast absorption of EU funds may be a factor behind the comparatively poor growth

performance of Southern European countries, in particular.

Several studies argue that the effect of EU funds on regional growth is conditional on other outcomes. The impact of regional policy has been found to be reinforced by sound (national or local) institutions (Rodríguez-Pose and Garcilazo, 2015; Rodríguez-Pose and Ketterer, 2020; Becker et al., 2013; Casula, 2021), quality of human capital (Becker et al., 2013), decentralization of decision-making from the national government to the local level (Bähr, 2008; Védrine, 2020), quality of local government (Crescenzi et al., 2017; De Matteis et al., 2021), and by the effective oversight of how the EU funds are used (Wostner and Šlander, 2009). Hence, the absorption capacity of the recipient regions can crucially depend on the presence (or absence) of specific conditioning factors in the recipient region.

Other contributions find evidence of heterogeneity across different sectors of the economy, or across EU funding objectives. Mohl et al. (2008) and Fiaschi et al. (2018) argue that the positive effect of Cohesion Policy is primarily limited to the Convergence Objective (which was previously known as Objective 1 and targets regions whose regional GDP per capita is less than 75% of the EU average). Percoco (2017) observes that EU funds disproportionately flow into the service sector, where their effect is higher when this sector is still relatively underdeveloped. Rodríguez-Pose and Fratesi (2004), in turn, conclude that investments in human capital and education have a positive impact on economic growth, in contrast to spending on infrastructure or business support. Such differences can matter because member states have different priorities for the use of European funds – the more developed countries tend to invest more in innovation and education while the less developed ones prioritize infrastructure (Berkowitz et al., 2020). Moreover, the less developed countries receive mainly Convergence Objective funding whereas if the more developed member states receive funding, it is under other objectives. Such differences could therefore help explain why the estimated effects funds vary.

Another potentially important explanation for the weak and mixed evidence on the

effect of European funds on growth is endogeneity. This can even stem from the institutional set-up of Cohesion Policy, with less developed regions being given more funding. Consider two regions, both initially at just under 75% of the EU-average regional GDP per capita, and thus eligible for Convergence Objective funding. If one region is stricken by structural problems (such as being dominated by a declining industry), it will tend to report a lower rate of growth. As a result, this region will remain eligible for Cohesion Policy funding longer – and it may even receive additional funding to help it overcome its structural issues. The other region, in contrast, will quickly lose the eligibility for Convergence Objective funding. Being free of structural issues, it may continue growing faster than the first region even after crossing the Convergence Objective threshold. This would result in a negative correlation between fiscal transfers and growth, which would be spurious as it would be driven by an omitted factor – the presence of underlying structural problems in the first region – rather than by a causal negative effect of regional policy.

[Dall’erba and Fang \(2017\)](#) observe that most studies on the effectiveness of Cohesion Policy tend to ignore the challenge posed by endogeneity. This is largely owing to the difficulty with finding suitable instruments for Cohesion Policy. One exception to this is [Dall’Erba and Le Gallo \(2008\)](#), who use geographical distance and travel time to Brussels as IV. However, as these instruments are constant over time, they can be used only in a cross-section analysis. In their analysis, [Dall’Erba and Le Gallo \(2008\)](#) conclude that the process of convergence among European regions is ongoing, but the EU Funds do not play much role in it.

Recently, a number of papers sought to tackle endogeneity by means of quasi-experimental methods. [Becker et al. \(2010, 2018\)](#), [Pellegrini et al. \(2013\)](#); [Gagliardi and Percoco \(2017\)](#); [Ferrara et al. \(2017\)](#); [Percoco \(2017\)](#) and [Cerqua and Pellegrini \(2018\)](#) take advantage of the fact that the bulk of EU funds is distributed in line with the Convergence Objective (recall that under this objective, a large share of Cohesion funds is set aside for regions whose regional GDP per capita is below 75% of the EU average). This makes it possible to apply the regression discontinuity design (RDD):

arguably, regions that are just below and just above this threshold should be very similar to each other in every respect other than their eligibility to receive Cohesion transfers. [Giua \(2017\)](#) and [Crescenzi and Giua \(2020\)](#) follow a similar approach, but consider municipalities and areas on either side of the geographical borders between Convergence Objective regions and adjacent regions that do not qualify for funding under this objective. The studies using RDD find that Cohesion Policy payments have a positive endogeneity-robust impact on growth and, in some instances, also on employment. Again, there is evidence of heterogeneity across regions and countries. [Crescenzi and Giua \(2020\)](#) find especially robust growth effects for German regions, compared to less compelling evidence for Italy and Spain. [Gagliardi and Percoco \(2017\)](#), in turn, conclude that the benefits are especially pronounced in rural regions close to major urban agglomerations.

Other quasi-experimental studies rely on finding (or creating) a suitable control group of regions that are similar in every aspect other than being beneficiaries of regional policy funding. [Barone et al. \(2016\)](#) and [Di Cataldo \(2017\)](#) apply the Synthetic Control Method to construct so-called *synthetic clones* for the regions that have lost the Convergence Objective status (in Italy and the UK, respectively). The clones are constructed as weighted averages of other regions, selected to ensure that the original region and its clone are as similar as possible in the pre-treatment period. This allows them to compare the actual performance of the region with its hypothetical performance had it remained eligible for Cohesion funding. Both studies conclude that the loss of the Convergence Objective eligibility is associated with a deceleration of growth. Finally, [Bachtrögler and Hammer \(2018\)](#) and [Bachtrögler et al. \(2020\)](#) use propensity score matching at the firm level to compare the performance of beneficiaries of Cohesion Policy funding with otherwise similar firms without such subsidies. They find that European funds help firms grow bigger, however, the recipient firms do not seem to become more productive as a result of this funding.

Yet another explanation for weak or insignificant results could be ignoring regional spillovers of the Cohesion Policy ([Berkowitz et al., 2020](#); [Hagen and Mohl, 2011](#)). EU

Funds are disbursed for projects located in specific regions. Most studies therefore seek to identify an impact of such expenditure on the recipient region. The EU, however, is a closely integrated market where goods, services, labor and capital readily cross regional or national boundaries. EU-financed spending, therefore, can also boost output in a broader geographical area if the investments are realized by firms or with deliveries from nearby regions. Similarly, the benefits of these investments, when completed, can accrue to other regions too. However, the results of this part of the literature, are once again mixed. On the one hand, [Fiaschi et al. \(2018\)](#) propose a growth model that stipulates that EU funds can affect regional growth both directly (in the recipient region) and indirectly, by generating spatial externalities. They then present empirical evidence that such spatial spillovers were indeed important in the EU-12 countries. Similarly, [Bachtrögler-Unger et al. \(2022\)](#), using satellite-captured light emissions, find a positive impact of Cohesion Policy both in the recipient regions as well as in the neighboring regions. On the other hand, [Le Gallo et al. \(2011\)](#) conclude that the Cohesion transfers do not contribute to economic growth in a spatial-spillover model estimated for the EU as a whole, although they do appear to boost growth in peripheral regions of the EU (the UK, Greece, and Southern Italy). [De Dominicis \(2014\)](#) similarly fails to obtain a significant impact for the EU as a whole but finds a positive effect for the less developed regions of the EU15. [Dall’Erba and Le Gallo \(2008\)](#) likewise find no overall effect of EU funds on economic convergence, but they identify convergence from core to peripheral regions. [Breidenbach et al. \(2019\)](#) present even more disappointing finding based on a model incorporating spatial spillovers: their results suggest that the EU Funds may have a negative effect on regional growth.

With our analysis, we build on and extend the existing literature by contributing further to the quest to determine the nature and sign of the effect of Cohesion Policy on growth. We utilize a more extensive data set than most previous studies, including both old and new member states. Our study is also one of very few based on annual data. We proceed along two avenues. First, we consider the impact of Cohesion Policy

Table 1.1: Overview of variables.

Abbreviation	Description	Source
Δy_{ijt}	regional GDP per capita growth	Cambridge Econometrics
$\ln(y_{ijt-1})$	natural log of regional GDP per capita lagged by one year	Cambridge Econometrics
$\ln(s_{ijt})$	natural log of the ratio of gross fixed capital formation on regional GDP	Cambridge Econometrics
$\ln(n_{ijt} + g + \delta)$	natural log of the sum of population growth, technology growth and depreciation rate	Cambridge Econometrics.
$wgipca_{it}$	composite indicator of the world governance indicators	Kaufmann et al. (2011)
$\ln(eufr_{ijt} + 1)$	natural log of the yearly ratio of EU funds to regional GDP	DG REGIO
$\ln(area_prop_{ijt} + 1)$	natural log of the proportion of area covered by Natura 2000 sites	European Environmental Agency
$count_{ijt}$	number of Natura 200 sites in a region	European Environmental Agency
$EU10$	binary variable for the regions of the countries joining the EU in 2004	
$EU3$	binary variable for the regions of the countries joining the EU in 2007 and 2013	
$GIPS$	binary variable for the regions of the southern periphery (Greece, Italy, Portugal and Spain)	

funding on recipient regions in OLS and 2SLS framework. For the latter, we use the presence of environmentally protected areas in each region to construct instrumental variables for Cohesion funding. An advantage of this approach is that it allows us to account for the intensity of regional aid received – rather than using a dummy variable to measure qualifying (or not) for a specific objective. Furthermore, it allows us to include funding under all objectives rather than focus only on one objective of Cohesion Policy spending (such as the Convergence Objective). Second, we estimate a spatial model in order to allow for spatial spillovers. We apply these two approaches one at a time, to demonstrate how the results differ from the baseline OLS estimates.

1.3 Data

Given the nature of our analysis, we have to combine data from a number of different sources. First, we use the annual receipts of EU funds at the level of NUTS2 regions as reported by the European Commission.⁴ Until recently, only the total payments

⁴See <https://cohesiondata.ec.europa.eu/EU-Level/Historic-EU-payments-regionalised-and-modelled/tc55-7ysv>. The dataset contains information from the following funds: European Regional Development Fund, European Social Fund, Cohesion Fund, European Agricultural Fund for Rural Development, European Maritime and Fisheries Fund ([Roemisch, 2017](#)).

Table 1.2: Descriptive statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Δy_{ijt}	4896	0.016	0.037	-0.153	-0.003	0.034	0.432
$\ln(y_{ijt-1})$	4896	9.804	0.697	7.368	9.566	10.235	11.501
$\ln(n_{ijt} + g + \delta)$	4896	-2.777	0.151	-7.142	-2.832	-2.711	-2.068
$\ln(s_{ijt})$	4896	-1.533	0.227	-2.922	-1.665	-1.408	-0.415
$\ln(eufr_{ijt} + 1)$	4896	0.007	0.013	0.000	0.001	0.007	0.130
$wgipca_{jt}$	4896	0.375	2.035	-5.415	-1.088	1.879	3.820
$\ln(area_prop_{ijt} + 1)$	4 896	0.134	0.119	0.000	0.035	0.204	0.578
$count_{ijt}$	4896	68.371	109.119	0	7	87	895

Note: Table shows descriptive statistics for variables used in the analyses: growth of regional GDP per capita ($\Delta \ln(y_{ijt})$); the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{jt}$); ratio of the EU Funds to regional GDP ($\ln(eufr_{ijt} + 1)$); proportion of area of a region covered by Natura 2000 protected sites ($\ln(area_prop_{ijt} + 1)$) and the number of Natura 2000 sites in a region ($count_{ijt}$).

over whole programming periods were available at the NUTS2 level. To the best of our knowledge, ours is one of the first papers that use these newly available annual data for an economic analysis of the Cohesion Policy impact.⁵ Only data covering the Cohesion Policy payments during the last three completed programming periods, 1994-1999, 2000-2006 and 2007-2013, have been made available in annual frequency so far, which determines our choice of time period.⁶ Funds allocated to a region in any given year have to be spent during that year and/or the next two (occasionally three) years. Our data record the annual payments (rather than commitments) of Cohesion Policy funds. Because of this, some of the funds committed during the last 2-3 years of the 2007-2013 programming period were only paid out during 2014 to 2016. We keep the information for 2014 (when most of the spending is likely to be funds allocated during the preceding programming period), but drop 2015 and 2016 from our analysis.⁷ Finally, we use only the total amounts of EU funds received by

⁵Most of previous analyses used programming-period averages, or used these averages to intrapolate and estimate annual figures. An example of an innovative approach to constructing annual regional data is Roemisch (2017) who used annual national project-level data to create estimates of regional-level annual data, since project names often contained information about the recipient region. Among the more recent studies that use annual data similar to ours are Rodríguez-Pose and Garcilazo (2015) and Di Cataldo and Monastiriotis (2020).

⁶Cerqua and Pellegrini (2018) also use the new yearly data. However, they restrict their analysis to the regions of the EU15 and 1994-2006 period.

⁷In principle, the same issue applies to the end of each programming period. However, for the 1994-1999 and 2000-2006 budgets, the end-of-budget spending overlaps with spending allocated during the first 2-3 years of the next period, which also appears in our data. It is only the beginning-of-budget spending in the 2014-2020 programming period that our data set misses.

Table 1.3: Correlation matrix.

	Δy_{ijt}	$\ln(y_{ijt-1})$	$\ln(n_{ijt} + g + \delta)$	$\ln(s_{ijt})$	$\ln(eufr_{ijt} + 1)$	$wgipca_{jt}$	$\ln(area_prop_{ijt} + 1)$
Δy_{ijt}	1	.	.	.	.	.	.
$\ln(y_{ijt-1})$	-.2141	1	.	.	.	.	.
$\ln(n_{ijt} + g + \delta)$	-.1670	.4147	1	.	.	.	.
$\ln(s_{ijt})$	.0802	-.0869	.0954	1	.	.	.
$\ln(eufr_{ijt} + 1)$	-.0322	-.3920	-.2133	.1669	1	.	.
$wgipca_{jt}$	-.0452	.7501	.2926	-.0381	-.3674	1	.
$\ln(area_prop_{ijt} + 1)$	-.0943	-.0868	.0015	.2060	.3600	-.2077	1

Note: Table shows correlations for variables used in the analyses: growth of regional GDP per capita ($\Delta \ln(y_{ijt})$); the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{jt}$); ratio of the EU Funds to regional GDP ($\ln(eufr_{ijt} + 1)$) and proportion of area of a region covered by Natura 2000 protected sites ($\ln(area_prop_{ijt} + 1)$).

each region, without breaking it down further by categories of spending.⁸

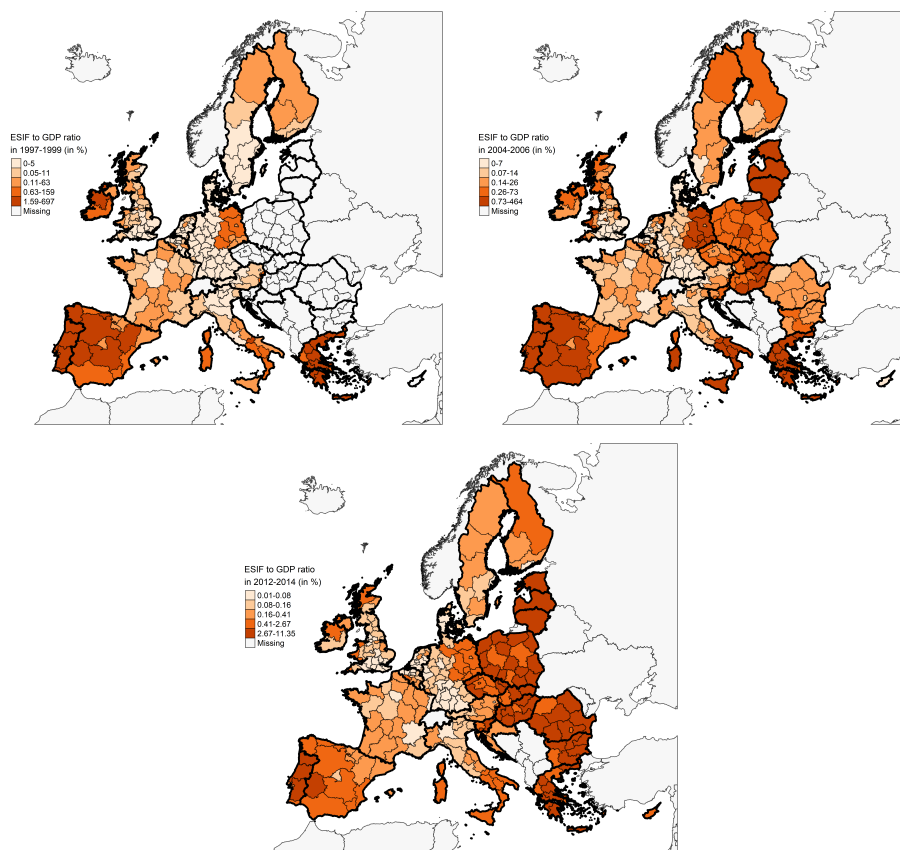
We complement the Cohesion Policy data with regional economic statistics, provided by *Cambridge Econometrics European Regional Database 2016*: regional output per person, population growth, and investment in physical capital.⁹ We also use the *Worldwide Governance Indicators* compiled by Kaufmann et al. (2011). These cover six areas: Voice and Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. We collapse them into a single composite indicator by means of principal component analysis. The governance indicators are available from 1996 until 2016 at the country level only. Furthermore, they are available in yearly frequency only since 2002. Therefore, we impute the missing years using a Monte Carlo simulation of the regression of the composite index on a polynomial of time.

We thus have data from 1997 until 2014 at the NUTS2 level for 272 regions altogether (in their 2013 definitions). An overview of the main variables (including those related to our instruments discussed in the next section) is provided in Table 1.1, while Table 1.2 displays the descriptive statistics. Table 1.3, in turn, reports the correlations between the various variables. The regional distribution of the Cohesion Policy spending is depicted in Figure 1.1. The figure shows averages over three-year

⁸Only information on spending by the various EU funds (European Regional Development Fund, Cohesion Fund, European Social Fund, and European Agricultural Fund for Rural Development) is available in annual frequency. A breakdown by sectors is available for whole programming periods only.

⁹The Cohesion Policy spending could be correlated with investment in physical capital. However, the correlation coefficient reported in Table 1.3 is relatively low, 0.1669.

Figure 1.1: Ratio of approximate yearly structural funds to regional gross domestic product (GDP) in 1997-1999, 2004-2006 and 2012-2014.



Source: Own depiction based on data from Cambridge Econometrics Database and DG Regio.

windows at the beginning of the period considered (1997-1999), in the middle and just after the Eastward EU enlargement (2004-2006), and at the end (2012-2014). The maps clearly show that the geographical focus of Cohesion spending has shifted over time. Traditionally, Cohesion Policy mainly benefited regions at the periphery of the EU15: Southern Europe, East Germany, the northern United Kingdom, and Ireland. After the Eastern enlargements in 2004 and 2007, the bulk of funding was redirected towards the new member states in Eastern and South-Eastern Europe.¹⁰

¹⁰The new member states were ineligible for Cohesion Policy before joining the EU. We therefore assign them zero values of Cohesion Policy funds in the pre-accession years. Given that the regions in the new member states objectively had no receipts from Cohesion Policy in the pre-membership period, this solution seems appropriate. Assigning them zero EU funds values rather than treating the pre-membership years as missing observations increases the variation in the data, thus helping improve the quality of our estimation by adding the before-after dimension. Moreover, missing values would be appropriate if we did not know the actual figures. This is clearly not the case here.

1.4 Impact of Cohesion Policy on recipient regions

1.4.1 Constructing the instrument

To deal with endogeneity of regional aid, we require instruments that are correlated with the transfers that regions receive under Cohesion Policy, but uncorrelated with the error term in the growth equation. We propose to use the presence of environmentally protected areas (designated as such under the EU's Natura 2000 program) in all EU NUTS2 regions. In this subsection, we explain how the Natura 2000 program works, what are the practical implications of bestowing a protected status on an area, and why we believe that environmental protection can serve as an instrument for Cohesion Policy payments.

The Natura 2000 program was established in the EU in 1992 to grant protected status to endangered species and their habitats. The protection granted by the Natura 2000 program is enshrined in two EU directives, the Birds Directive and the Habitats Directive.¹¹ At present, the Natura 2000 program comprises over 27 thousand terrestrial and marine conservation areas, covering some 18% of the EU's land area and 8% of its sea surface. This makes Natura 2000 the largest network of protected sites in the world.

For an area to receive protected status, member states first identify sites that they deem eligible for protection under the Natura 2000 rules.¹² These are then proposed for inclusion in the Natura 2000 network. The merits of the member states' proposals are evaluated by the European Commission with input from the European Environment Agency. The member states' proposals and the Commission's decisions are to be based strictly on objective scientific criteria: the two directives explicitly list the

¹¹Council Directive 79/409/EEC (subsequently updated by the Council Directive 2009/147/EC) and Council Directive 92/43/EEC, respectively. While the Birds Directive was in place already since 1979, it was the adoption of the Habitats Directive in 1992 which laid the foundations for the creation of environmentally protected areas. For further details, see "Natura 2000," European Commission, http://ec.europa.eu/environment/nature/natura2000/index_en.htm.

¹²The member states can also grant conservation status to species and areas under national law if they wish to protect areas that are not eligible for Natura 2000 protection. For further details, see https://ec.europa.eu/environment/nature/natura2000/sites/index_en.htm.

species and habitat types which are considered to be of European importance and eligible for protection. If approved, the sites receive protection under the Natura 2000 Program.

The fact that the species and habitats eligible for protection are determined centrally by the EU makes it less likely that regions receive conservation status based on national or local considerations, including economic motives. Such feedback effect from economic conditions to decisions on conservation status could invalidate our instruments. Another issue would arise if some regions were better at applying for Natura 2000 recognition than others: for example, this could be the case if the administrative capacity or the quality of bureaucracy were correlated with the success of applications for Natura 2000 status. Such local-level factors could also be correlated with the local economic performance. However, such local determinants are likely to be highly persistent over time so that they should be picked up by the regional fixed effects (see the Methodology subsection).¹³

Moreover, once a site receives the Commission's endorsement, it generally keeps the protected status whereas both the regions' receipts from Cohesion Policy and local factors can change over time.

After a proposed site has been approved, the member state designates it as either a Special Protection Area (SPA) or a Site of Community Importance (SCI).¹⁴ The member states then have an obligation to maintain the sites, and even restore them where required, to ensure the long-term survival of the protected species or habitats.

Note that candidates for EU membership are expected to submit similar proposals

¹³Blicharska et al. (2016) also highlight the role of institutional quality in determining the effectiveness of establishing and governing Natura 2000 sites. More specifically, they discuss challenges that arise when the implementation of Natura 2000 directives merely adds additional layers of bureaucracy to existing conservation frameworks, as well as the extent to which NGOs are involved in the management or selection of sites and their integration into other EU policies. Similar to the case of EU funds, these processes may be subject to a learning dynamic. Although we do not control for this directly, we include a variable that aggregates the World Governance Indicators (WGI) into a single measure of institutional quality. The evolution of institutional quality, as captured by the aggregated WGI indicator, may also reflect improvements in the management of Natura 2000 sites over time.

¹⁴The designation used depends on whether the site receives protection under the the Birds Directive or the Habitats Directive, respectively. The practical implications are broadly similar, however.

Table 1.4: Natura 2000: Yearly Changes

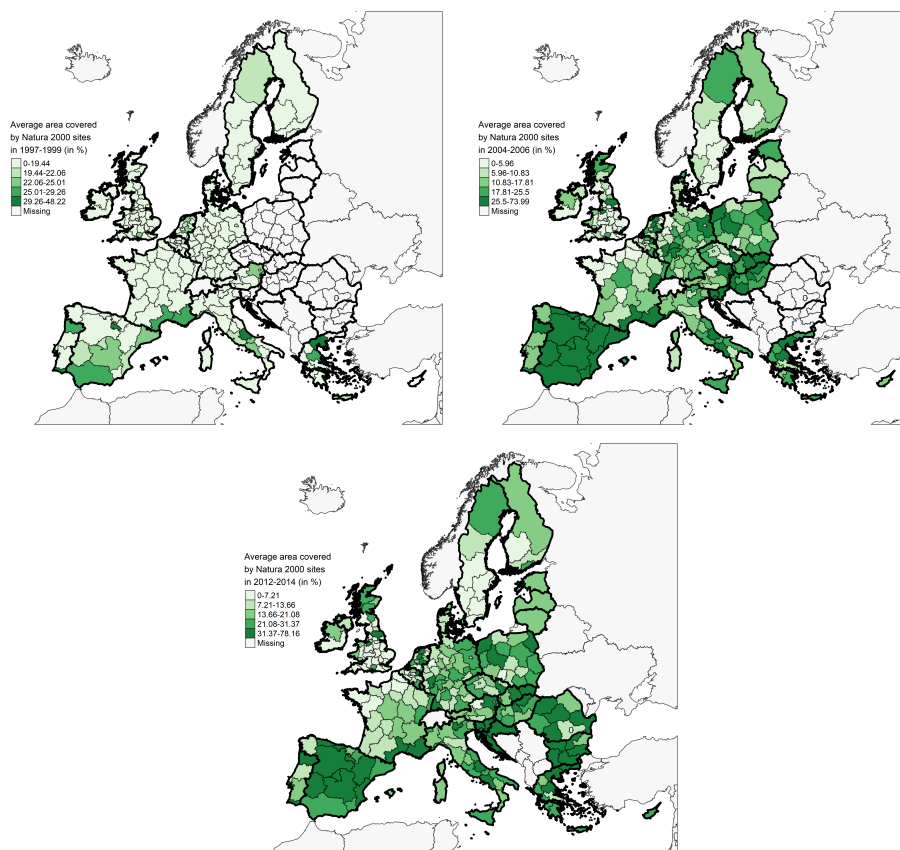
	$\Delta area_prop_{ijt}$	$\Delta count_{ijt}$
1997-2014	0.1493	64.85
1998	0.0161	5.33
1999	0.0112	3.77
2000	0.0078	10.64
2001	0.0105	4.46
2002	0.0143	4.64
2003	0.0081	5.71
2004	0.0303	13.35
2007	0.0055	0.94
2008	0.0012	1.44
2009	0.0055	2.06
2010	0.0039	0.38
2011	0.0023	1.08
2012	0.0042	2.04
2013	0.0002	0.43
2014	0.0012	0.18

Note: Average annual changes in the area under environmental protection, and in the number of protected sites, at NUTS2 level. The figures for 1997-2014 are the overall changes during this period, not the average changes per year.

during the accession negotiations so that new member states can already have several protected sites by the time they join the EU.

Given the bureaucratic nature of the process, the Natura 2000 network has been only growing gradually. This is documented in [Table 1.4](#), which reports the increase in the size of the Natura 2000 network for the average NUTS2 region during the period considered, 1997-2014. The first column reports the change in the area under protection (as share of the overall area), while the second column shows the number of sites added to the network. The average NUTS2 region granted new protection to some 15% of its area during the full period, and this amounts to 65 new protected sites per region on average. Looking at the individual years, the area under protection grew the most in 2004 (by 3.0%) and 1998 (by 1.6%), while the number of protected sites increased the fastest in 2004 (by 13 new sites per region on average) and 2000 (11 sites per region added). [Figure 1.2](#) shows how the size of the network expanded in individual regions. It depicts the proportion of the area of Natura sites to the total

Figure 1.2: Ratio of the area of Natura 2000 sites to a region's total area in 1997-1999, 2004-2006 and 2012-2014.



Source: Authors based on data from EEA and Eurostat.

area of each region over the same three-year windows as those in Figure 1.1: 1997-1999, 2004-2006, and 2012-2014. The size of the Natura 2000 network has increased markedly in the Mediterranean countries (especially Spain, Greece, France) and the new member states (most notably Bulgaria, Romania, Slovakia, and Poland). By 2014, the Natura 2000 network was represented in the vast majority of EU regions.¹⁵

It is important to note that most Natura 2000 sites are not free from human presence or activity. Some 50% of the protected area is forested (but only around 13% is classified as wild), with most of the remaining area (around 40%) being agricultural eco-systems.¹⁶ Some sites are of urban or industrial character: examples include ports,

¹⁵In fact, only six regions had no protected sites in 2014: Guadeloupe, Martinique, French Guiana, Réunion, Inner London and Outer London. The first four of these are French overseas territories located outside of Europe, the remaining two are regions of entirely urban nature.

¹⁶See <https://ec.europa.eu/environment/nature/natura2000/>.

(disused) mines, and roofs of old buildings. The protected sites also vary considerably in size: from 1 m^2 (an abandoned mine in Slovakia which serves as a nesting site for several protected species of bats) to vast national parks and marine conservation areas.

To construct the instrument, we use the information on the location and size of Natura 2000 areas.¹⁷ Based on the geospatial data from the EEA and Eurostat,¹⁸ we match each site (excluding marine areas) with NUTS2 regions based on the coordinates of the centroids of the Natura 2000 sites. In some cases, the centroid of a protected site appears to lie in a different region because of the specific shape of the site and the location of administrative borders of regions.¹⁹ For that reason, we web-scraped the publicly available application forms of the Natura sites and corrected the mistakes that arose in this way. Lastly, we aggregate the individual sites in each NUTS2 regions, yielding two summary regional figures: the proportion of each region's area that is protected by the Natura 2000 program, and the number of environmentally protected sites per regions. These two variables constitute our instruments. Since they are different expression of the same underlying information, we use them one at a time rather than jointly.

The regions with a high density of Natura 2000 sites tend to receive more EU funds: the correlation between the proportion of region's area that is protected by Natura 2000 and the ratio of Cohesion transfers to regional GDP is 0.33: positive although not very high.²⁰ On the other hand, the correlation between the area under protection and the growth of output per capita is close to zero (and in fact moderately negative)

¹⁷These are published by the European Commission: https://ec.europa.eu/environment/nature/natura2000/data/index_en.htm. The precise geographical coordinates of all Natura 2000 sites were required to allocate the sites to individual NUTS2 regions and also to compute the area of each site. The source of the coordinates is the European Environmental Agency (EEA): <http://www.eea.europa.eu/data-and-maps/data/natura-1> and http://bd.eionet.europa.eu/activities/Natura_2000.

¹⁸See <http://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-3> and <https://ec.europa.eu/eurostat/web/gisco/geodata>, respectively.

¹⁹For example, some Natura 2000 sites are constituted by rivers. If the river also is the border of a region and it forms a bend, then the centroid of the site may be located in an adjacent region.

²⁰The moderate correlation can undermine the strength of our findings. Nevertheless, as we discuss below, the first-stage F-statistic is well above the rule of thumb value of 10 in all instances.

at -0.10 (see [Table 1.3](#)). While the exclusion restriction cannot be formally tested, this suggests that our instrument is correlated with the endogenous variable but not with the dependent variable.²¹

We can see several potential reasons why there should be a correlation between environmental protection and Cohesion Policy spending. First, the presence of environmentally protected sites limits the nature and scope of industrial activity and infrastructure building in the region. Because of their protected status, human habitation and economic activity within protected sites have to be environmentally sustainable and are subject to restrictions. This means that some activities may not be allowed at all, such as industrial or agricultural production resulting in excessive pollution, noise, or habitat destruction. Other activities may be possible subject to specific constraints. For example, a new road through a protected area may have to be built according to more demanding specifications (such as adopting noise-reducing measures or having additional features to allow safe and unhindered access to a nesting site of a protected species) or it may have to be planned differently (such as going around the nesting site instead of taking the shortest possible route). Hence, environmental conservation may preclude some investment and activities, while others are likely to be more costly on account of the additional requirements. The net effect on the volume of investment can be either positive or negative.

Second, the regions hosting protected sites are likely to have better access to Cohesion Policy funding. The Natura 2000 network has some dedicated direct funding but this is limited in nature: [Gantioler et al. \(2014\)](#) estimate that the annual funds available to finance Natura 2000 sites are just under €6 million. The primary responsibility for financing the conservation activities in Natura 2000 sites thus lies with the member states. Nevertheless, the member states have various co-financing options from European sources. Specifically, the European Regional Development Fund

²¹In [Table A1](#), we include the instrument in the first stage. The results suggest a weak correlation in the simple regression, which strengthens once the full model is specified. However, as we discuss below, this relationship likely reflects an indirect effect operating through EU funds rather than a direct impact. The mechanisms through which Natura 2000 shapes local economic development remain understudied and thus present an important avenue for future research.

(ERDF), Cohesion Fund (CF), European Agricultural Fund for Rural Development (EAFRD), and also the Common Agricultural Policy (CAP) explicitly offer funding to protect and restore biodiversity and to promote ecosystems (although the bulk of their funding is dedicated to purposes unrelated to environmental conservation).²²

A third possibility is that receiving EU funds affects a region's eligibility for the Natura 2000 recognition. However, with the species and habitats deserving protection being decided centrally, the success of an application for protected status should be primarily determined by the preexisting environmental conditions and biodiversity. The use of EU funds could affect these but mainly adversely: for example, EU funds could be used to build infrastructure which destroys a habitat that would have been eligible for protection. Such a pattern, however, would imply a negative correlation between Cohesion spending and the presence of Natura 2000 sites, which is the opposite of what we observe.

The preceding discussion suggests that the relationship between Cohesion Policy spending and the extent of environmental protection could be either positive or negative. The positive correlation that we observe suggests that the net effect is positive.

1.4.2 Methodology

To assess the impact of Cohesion Policy on regional growth, we estimate a standard Solow-Swan growth model (Mankiw et al., 1992; Islam, 1995) augmented to include Cohesion Policy transfers as well as institutional quality. The model is estimated with annual data at the regional level (NUTS2, except for institutions, which we only observe at the national level, as discussed above). Specifically, we estimate

$$\begin{aligned} \Delta \ln(y_{ijt}) = & \beta_0 + \beta_1 \ln(y_{ijt-1}) + \beta_2 \ln(s_{ijt}) + \beta_3 \ln(n_{ijt} + g + \delta) + \beta_4 w g i p c a_{jt} \\ & + \gamma_1 \ln(eufr_{ijt} + 1) + \gamma_2 \ln(eufr_{ijt} + 1) * obj1_{ijt} + \gamma_3 obj1_{ijt} \\ & + \mu_j + \tau_t + u_{ijt}. \end{aligned} \quad (1.1)$$

²²See <https://ec.europa.eu/environment/nature/natura2000/> and https://ec.europa.eu/regional_policy/en/policy/themes/environment/. We are grateful to an anonymous referee for suggesting this relationship between environmental conservation status and EU funding.

The dependent variable is the log-difference of per-capita output of region j located in country i and observed at time t . The first line of equation (1.1) contains the standard elements of the Solow model: the lagged output per capita y_{ijt-1} , measured in the preceding year, the ratio of gross fixed capital formation to regional GDP, s_{ijt} , and a term containing population growth, n_{ijt} , technological progress, g_{ijt} , and depreciation, δ_{ijt} . Since we do not observe g and δ , we follow the practice common in the literature and replace their sum with a constant term equal to 0.06.²³ To this, we add the weighted average of the World Governance Indicators, $wgipca_{it}$, with the weights determined by principal component analysis.

Next comes our variable of interest: the ratio of the EU funds regional GDP ($eufr_{ijt}$). Since some regions receive no funds in some years, we add 1 to this ratio before taking logs. In the baseline specification the Cohesion Policy can only impact economic growth in the same way across all region types. However, we also estimate an alternative specification where we account for the fact that the less developed regions receive priority access to funding under the Convergence Objective. Therefore, we include a dummy for qualifying for the Convergence Objective, $obj1_{ijt}$. Approximately half of EU funds are set aside for Convergence Objective regions, making these regions the primary beneficiaries of Cohesion Policy.²⁴ Previous contributions, for example Becker et al. (2012) and Fiaschi et al. (2018), find heterogenous effects of regional transfers depending on the objective under which the funds are disbursed. This can be because of the types of investment financed under different objectives, or because some regions display limited absorption capacity as the amount of funding they receive exceeds the growth-maximizing level (Becker et al., 2012). Finally, we also include fixed effects for regions, μ_j , and time, τ_t .²⁵

²³Mankiw et al. (1992) use 0.05. Using 0.05 would result in the loss of two observations, Thessaly in Greece in 2000 and Nord-Est in Romania in 2012, which recorded a negative population growth rate of 5%.

²⁴See https://ec.europa.eu/regional_policy/en/policy/what/investment-policy/. We are grateful to an anonymous referee for suggesting to include this dummy as a regressor.

²⁵The use of a fixed effects model is supported by the result of a Hausman test: the test statistic (for the baseline Solow model augmented to include the ratio of the EU funds to GDP) is 734.11 (p-value 0.00).

Table 1.5: European Funds and Regional Growth: OLS

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$
$\ln(y_{ijt-1})$	-0.095*** (0.020)	-0.107*** (0.022)	-0.137*** (0.022)	-0.135*** (0.020)	-0.152*** (0.022)	-0.157*** (0.022)
$\ln(s_{ijt})$	0.036*** (0.009)	0.033*** (0.008)	0.025*** (0.008)	0.026*** (0.008)	0.022*** (0.007)	0.022*** (0.007)
$\ln(n_{ijt} + g + \delta)$	-0.036*** (0.006)	-0.035*** (0.005)	-0.036*** (0.006)	-0.036*** (0.006)	-0.033*** (0.006)	-0.033*** (0.006)
$\ln(eufr_{ijt} + 1)$		0.395*** (0.145)	0.413*** (0.123)	0.517*** (0.201)	0.231*** (0.110)	0.576*** (0.107)
$wgipca_{jt}$			0.014*** (0.002)	0.013*** (0.002)	0.013*** (0.002)	0.013*** (0.002)
$\ln(eufr_{ijt} + 1) * wgipca_{jt}$				0.068 (0.067)		
$obj1_{ijt}$					0.018*** (0.002)	0.025*** (0.003)
$\ln(eufr_{ijt} + 1) * obj1_{ijt}$						-0.530*** (0.132)
Observations	4896	4896	4896	4896	4896	4896
R ²	0.358	0.364	0.387	0.388	0.402	0.406
F-statistic	150.798***	125.63***	138.52***	113.45***	116.99***	114.99***
Regional FEs	Yes	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Significance: *p<0.1; **p<0.05; ***p<0.01. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{jt}$); ratio of the EU Funds to regional GDP ($\ln(eufr_{ijt} + 1)$) and binary variable denoting objective 1 regions ($obj1_{ijt}$).

1.4.3 Results

We estimate equation (1.1) first by OLS, and then by 2SLS, with the the proportion of the region's area that is taken up by Natura 2000 sites and the number of Natura 2000 sites per region as instruments. Table 1.5 reports the OLS results. In the first column, we report the standard Solow model (Mankiw et al., 1992; Islam, 1995) as a benchmark. The coefficients of all variables are strongly significant and have the expected signs: negative for the lagged output per capita (consistent with real convergence, whereby less developed regions grow faster), positive for the investment rate (higher investment/savings rate implies a higher steady state and, in turn, faster growth rate when the region is below its steady-state level), and negative for the term comprising population growth (the dependent variable is the growth rate of output per capita, so that higher population growth implies that incremental increases in

Table 1.6: European Funds and Regional Growth: 2SLS

	$\Delta \ln(y_{ijt})$	$\ln(eufr_{ijt} + 1)$	$\Delta \ln(y_{ijt})$	$\ln(eufr_{ijt} + 1)$	$\Delta \ln(y_{ijt})$	$\ln(eufr_{ijt} + 1)$	$\Delta \ln(y_{ijt})$	$\ln(eufr_{ijt} + 1)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(y_{ijt-1})$	-0.178*** (0.016)	0.024*** (0.004)	-0.188*** (0.014)	0.020*** (0.004)	-0.151*** (0.013)	0.009 (0.007)	-0.160*** (0.010)	0.006 (0.006)
$\ln(s_{ijt})$	0.016*** (0.006)	0.007*** (0.001)	0.013*** (0.006)	0.007*** (0.001)	0.012* (0.006)	0.007*** (0.002)	0.007 (0.006)	0.008*** (0.002)
$\ln(n_{ijt} + g + \delta)$	-0.030*** (0.005)	-0.003*** (0.001)	-0.029*** (0.005)	-0.013** (0.001)	-0.013** (0.006)	-0.002** (0.001)	-0.011** (0.005)	-0.002* (0.001)
$\ln(eufr_{ijt} + 1)$	1.749*** (0.324)		2.074*** (0.235)		0.687* (0.398)		1.379*** (0.264)	
$\ln(areaprop_{ijt} + 1)$		0.030*** (0.003)				0.022*** (0.003)		
$\ln(count_{ijt} + 1)$				0.003*** (0.0002)				0.0021*** (0.0002)
$wgipca_{it}$	0.014*** (0.001)	-0.0003 (0.0005)	0.015*** (0.002)	-0.001*** (0.0004)	0.009*** (0.001)	0.0006 (0.0004)	0.009*** (0.001)	0.000 (0.0004)
$obj1_{ijt}$					0.018*** (0.003)	0.004*** (0.001)	0.014*** (0.002)	0.003*** (0.001)
Observations	4896	4896	4896	4896	4896	4896	4896	4896
R ²	0.316		0.277		0.390		0.364	
F-statistic	92.28***	126.62***	89.24***	223.90***	112.67***	68.37***	109.85***	109.77***
Regional FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$) in the second stage and first stage and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$) in the first stage. Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$); ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$); binary variable denoting objective 1 regions (obj_{ijt}); proportion of area of a region covered by Natura 2000 protected sites ($\ln(areaprop_{ijt} + 1)$) and the number of Natura 2000 sites in a region ($count_{ijt}$).

output need to be shared among a larger number of individuals).

In the next five columns, we explore the effect of adding the variable of interest: transfers under the EU Cohesion Policy. In column (2), we add the ratio of EU Funds to regional GDP: it has a positive and strongly significant effect on regional economic growth. In column (3), we add (country-level) institutional quality, which is also strongly significant and positive: regions in countries with good institutions grow more dynamically. Importantly, adding the quality of institutional environment does not diminish the positive effect of EU Funds; in fact, the estimated impact is somewhat strengthened. Adding an interaction between institutional quality and EU Funds (column 4) changes little: the coefficients of EU Funds and institutions remain approximately the same as before, while the interaction term is insignificant: the effect

of regional policy on growth does not appear conditional on good institutions.²⁶ In column (5), we add a dummy distinguishing regions that qualify for EU funding under the Convergence Objective: as discussed above, the less developed regions are prioritized as recipients of Cohesion Policy transfers. Previous studies (Hagen and Mohl, 2011; Fiaschi et al., 2018) conclude that these regions tend to benefit more from EU Funds than other regions. Our results suggest that the less developed regions indeed grow faster; the effect of Cohesion Policy transfers is diminished somewhat but remains strongly significant. Finally, in column (6), we allow the effect of EU funds to differ in less developed regions and in the rest of the sample. The results are a bit peculiar: the EU funds retain their significantly positive effect on regional growth in the broad sample, and the less developed regions tend to report significantly higher growth overall as signified by the significant and positive Objective 1 dummy. However, the positive effect of EU funding is cancelled out in the less developed regions by the negative and significant interaction term between the EU Funds and the Objective 1 dummy. Hence, less developed regions grow on average faster than other regions, but this growth premium does not appear to be correlated with the amount of regional aid that they receive.

As we argue above, the Cohesion Policy transfers may be endogenous in regional development. If this is the case, the effects estimated in Table 1.5 are likely to be biased. Therefore, in Table 1.6, we report the 2SLS estimates of the effect of EU funds on regional growth, obtained with the presence of Natura 2000 sites as instruments. In column (1), the EU funds to regional GDP ratio is instrumented by the proportion of the area covered by Natura 2000 sites. Column (2) reports the associated first-stage regression. As expected, the instrument is strongly and positively correlated with the ratio of Cohesion Policy transfers to regional GDP. The EU funds, in turn, have a robust and positive effect on growth. The coefficient estimate is approximately four times larger than that obtained with OLS, suggesting that endogeneity biases

²⁶This contrasts with the previous findings by Becker et al. (2013); Rodríguez-Pose and Garcilazo (2015), and others. A possible reason for our findings deviating from the previous literature is that we use country-level rather than regional information on institutional quality.

the estimated effects downwards.²⁷ The results change little when we replace area proportion with the number of protected sites (columns 3-4): the effect of EU funds strengthens a little, and the instrument is again strongly correlated with the Cohesion Policy spending rate. The next four columns replicate these regressions while adding the Convergence Objective dummy. Adding it reduces the estimated impact of Cohesion Policy funding on growth but the effect remains positive and statistically significant (at 10% when using the area proportion as instrument in columns 5-6, and at 1% in columns 7-8 when using the count of protected sites): this mirrors the pattern observed with OLS. Likewise, the Convergence Objective dummy is again positive and statistically significant.²⁸

Our results thus suggest that the effect of Cohesion Policy on regional development in the EU is positive, and that studying this effect by OLS, without accounting for endogeneity, may result in the estimates being biased downwards.²⁹ The high F-statistics in columns (2), (4), (6) and (8) confirm that both instruments are strong: the first-stage F-statistic is always well above the rule-of-thumb threshold of 10.

1.5 Inter-regional Spillovers of Cohesion Policy

1.5.1 Methodology

So far, we considered the impact of Cohesion Policy funding on the recipient regions only. The EU is a single free market with free trade in goods and services and unhindered mobility of labor and capital. Therefore, the effects of regional policy are

²⁷As we argue in the Introduction, this kind of bias could be driven by the fact that slowly-growing regions receive more funds because they remain eligible for Cohesion Policy funding for longer. In contrast, fast-growing regions quickly lose eligibility for transfers.

²⁸As an alternative, we split the sample into two sub-samples according to the Convergence Objective eligibility. These results (available upon request) show a strong and statistically significant effect of EU spending in the less-developed regions and a slightly weaker but still positive effect in the rest of the regions; as before, the effect appears more robust when using the number of protected sights as the instrument.

²⁹It is possible that the EU funds affect regional development with a delay rather than contemporaneously. This could be either due to delays in disbursing the funds, or because the investments themselves take time to build and bear fruit. Therefore, we also re-estimated the previous results – OLS and 2SLS alike – with all the EU funds lagged by one year, and again with all regressors lagged by a year. These regressions results, available upon request, are very similar to those reported with contemporaneous regressions.

unlikely to be confined only to the region receiving the funding. Rather, we can expect the EU funds to translate into an increase in aggregate demand in the recipient region as well as in other (especially nearby) regions. Such cross-regional spillovers can be captured by estimating a spatial model, which allows for linkages among regions based on a chosen spatial weight matrix. The choice of weights reflects the assumptions made in the model. Since some NUTS2 regions are located on islands, we opt for using a spatial weight matrix based on distance rather than contiguity. Specifically, we use the squared inverse of d_{ij} , the great-circle distance between the centroids of regions i and j , in kilometers.³⁰ As [Kopczewska et al. \(2017\)](#) note, the squared inverse distance matrix captures well the global links between all units and local clusters, as the strength of the relationship between regions declines exponentially with distance.

Since far-away regions are unlikely to exert much influence (and given that we use the inverse square distance, their weight would approach 0), we only consider spillovers from regions located within a threshold distance from the recipient region. Specifically, we use quartiles (k) of the overall distribution of the great circle distances among all region pairs. The quartile distance values, $D(k)$, are: $\{D(1) = 660; D(2) = 1090; D(3) = 1594\}$.³¹

Some EU countries have overseas territories far away from the country's mainland. Including these regions would inflate the cut off distances for the quartiles. Moreover, the impact of the nearest EU regions on such remote territories might not be economically plausible. For this reason, we exclude all EU overseas territories from the spatial analysis.³²

Spatial econometrics offers a variety of ways of capturing spatial spillovers. These

³⁰We also conduct regressions with a spatial weight matrix based on k nearest neighbors, with $k = \{5; 10; 15; 25; 50\}$. These results, which are available upon request, indicate that our model is robust to the choice of the spatial weight matrix.

³¹We also use a spatial weight matrix based on a cut-off value the quartiles of great circle distances for each region specifically, which results in an equal number of non-zero values for each region. The difference in results is negligible.

³²The following remote NUTS2 regions were dropped: Madeira, the Azores, the Canary Islands, Ceuta, Melilla, Guadeloupe, Martinique, French Guiana and Réunion. For example, the French overseas territory of Réunion (in the Indian Ocean) is more likely to be economically influenced by mainland France rather than the nearest EU region, which is Cyprus.

include the spillovers in the dependent variable (spatial autoregressive model), independent variable and error terms (spatial error model). Since the Spatial Durbin Model (SDM) nests also several other models, it is recommended to start from the SDM specification and conduct common factor tests to discriminate between the SDM and other models (Beer and Riedl, 2012).³³

We thus estimate a Spatial Durbin Model:

$$\Delta \ln(\mathbf{y}) = \rho(\mathbf{I}_T \otimes \mathbf{W})\Delta \mathbf{y} + \mathbf{X}\beta + (\mathbf{I}_T \otimes \mathbf{W})\mathbf{X}\theta + \mu + \mathbf{u} \quad (1.2)$$

where $\Delta \mathbf{y}$ is a $1 \times nt$ vector of the log differences of output per capita, \mathbf{X} is a $m \times nt$ matrix collecting the explanatory variables, \mathbf{W} is the spatial weight matrix of size $n \times n$, and ρ is the spatial lag, with n , m and t denoting the number of observations, number of explanatory variables, and years, respectively.³⁴ The kronecker product of the identity matrix \mathbf{I}_T with the dimensions $t \times t$ accommodates \mathbf{W} for use in a panel regression. Additionally, θ denotes the coefficients for the spatially lagged explanatory variables in \mathbf{X} . The full spatial model is a spatial version of the model in equation (1.1).

The spatial weight matrix \mathbf{W} has the following form:

$$w_{ij} = \begin{cases} 0 & \text{if } i = j \\ \frac{d_{ij}^{-2}}{\sum_1^j d_{ij}^{-2}} & \text{if } d_{ij} \leq D(k) \text{ for } k = \{1; 2; 3\} \\ 0 & \text{if } d_{ij} > D(k) \end{cases} \quad (1.3)$$

³³The use of SDM in this case is inspired by Ertur and Koch (2007), who present their spatially neoclassical growth model taking the form of a SDM.

³⁴We are mindful of the identification problems when using instrumental variables in spatial models, as highlighted by Gibbons and Overman (2012). In particular, the methodology for dealing with endogenous variables in a panel spatial model is not well established. Therefore, rather than present results that might be questionable and potentially weak, we prefer to implement one contribution at a time. In the preceding section, the objective was to compare OLS and 2SLS estimates. Now, we compare estimates obtained with OLS with those based on a spatial model. The 2SLS analysis has established that the OLS estimates may be biased downwards. Therefore, the SDM results probably also underestimate the true effects of Cohesion Policy in a spatial framework.

where w_{ij} denotes an element of the spatial weight matrix W in row i and column j . That is, w_{ij} equals the inverse of distance squared, as long as the distance is below a critical threshold, otherwise it is zero.

Note that in contrast to OLS or 2SLS, the partial derivatives of the SDM are more complex to interpret. A change in a variable affects the region itself as well as other regions, giving rise to direct and indirect effects. Let \mathbf{S} be defined as:

$$\mathbf{S} = \frac{\Delta \ln(\mathbf{y})}{\Delta \mathbf{x}_{ik}} = (\mathbf{I}_{NT} - \rho \mathbf{I}_T \otimes \mathbf{W})^{-1} (\mathbf{I}_{NT} \beta_k + \mathbf{I}_T \otimes \mathbf{W} \theta_k) \quad (1.4)$$

where x_k and β_k represent the k^{th} column of the \mathbf{X} and β matrices respectively. The average direct effect is then given as $ADE = \frac{1}{nt} \text{tr}(\mathbf{S})$, the average total effect is $ATE = \frac{1}{nt} \iota' \mathbf{S} \iota$ and the average indirect affect is then $AIE = ATE - ADE$. In other words, ADE is the average of the sum of all diagonal elements of \mathbf{S} , AIE is the average of the sum of all off-diagonal elements of \mathbf{S} and ATE is the average of the sum of all elements of \mathbf{S} , with ι being a summation vector of ones.

1.5.2 Results

Table 1.7 reports the results of the SDM estimation of the effect of EU funds on regional growth, which allow for inter-regional spillover in the effects of Cohesion Policy.³⁵ Table 1.8 then summarizes these by reporting the direct, indirect and total effects. The test results in the bottom part of Table 1.7 indicate that the SDM is preferred not only over the OLS model, but also over the Spatial Error Model and the Spatial Autoregressive Model (Gibbons and Overman, 2012; Beer and Riedl, 2012). The coefficient of spatial dependence, ρ , is significantly positive, implying positive spillovers in regional GDP per capita growth rates. The direct effect of the EU funds approaches zero and is insignificant. In contrast, the indirect effect is positive and

³⁵Results from alternative models—both OLS and 2SLS—that include a spatially lagged variable of the natural log of the ratio of EU funds to regional GDP (instrumented by the spatially lagged variable of the natural log of the ratio of Natura 2000 sites to area), added to (1.1), are presented in the appendix to this chapter. The impact of EU funds remains positive in both cases. However, the spatial effect is negative in the OLS model and insignificant in the 2SLS model. The reasons for these inconsistencies in the spatial effects remain to be investigated.

Table 1.7: Cohesion Policy and Inter-regional Spillovers: SDM

	(1) $\Delta \ln y_{ijt}$ $d = 660$	(2) $\Delta \ln y_{ijt}$ $d = 1090$	(3) $\Delta \ln y_{ijt}$ $d = 1594$
ρ	0.740*** (0.0225)	0.776*** (0.0231)	0.795*** (0.0233)
$\ln(y_{ijt-1})$	-0.161*** (0.0165)	-0.151*** (0.0153)	-0.145*** (0.0146)
$\ln(s_{ijt})$	0.00274 (0.00643)	0.00353 (0.00644)	0.00425 (0.00645)
$\ln(n_{ijt} + g + \delta)$	-0.0331*** (0.00425)	-0.0342*** (0.00428)	-0.0349*** (0.00427)
$wgipca_{it}$	0.0117*** (0.00265)	0.0104*** (0.00257)	0.00970*** (0.00256)
$\ln(eufr_{ijt} + 1)$	-0.00527 (0.131)	-0.000145 (0.132)	-0.00129 (0.127)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	-0.0189 (0.0647)	-0.0555 (0.0594)	-0.0763 (0.0599)
$\mathbf{W} * \ln(y_{ijt-1})$	0.131*** (0.0168)	0.125*** (0.0161)	0.121*** (0.0156)
$\mathbf{W} * \ln(s_{ijt})$	0.0219** (0.00915)	0.0229** (0.00997)	0.0241** (0.0107)
$\mathbf{W} * \ln(n_{ijt} + \delta + g)$	0.0339** (0.0162)	0.0359* (0.0191)	0.0395* (0.0206)
$\mathbf{W} * \ln(wgipca_{it})$	-0.00977*** (0.00340)	-0.00820** (0.00378)	-0.00671* (0.00398)
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	0.299 (0.215)	0.349 (0.240)	0.380 (0.255)
$\mathbf{W} * \ln(eufr_{ijt} + 1) * wgipca_{it}$	0.0782 (0.0991)	0.132 (0.106)	0.171 (0.118)
Observations	4734	4734	4734
Log-likelihood	10715.95	10694.94	10683.88
<i>AIC</i>	-21379.9	-21337.9	-21315.8
<i>BIC</i>	-21211.9	-21169.9	-21147.8
Coefficient test $\theta = 0$ (χ^2)	77.92***	76.72***	76.24***
Coefficient test $\theta = -\beta\rho$	29.87***	25.57***	26.65***
Hausman test	156.17***	159.17***	163.47***
Regional FEs	Yes	Yes	Yes
Time FEs	No	No	No

Note: Robust standard errors shown in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Column (1) considers spillovers between regions in the first quartile by distance (up to 660 km), column (2) includes the first two quartiles (up to 1090 km), and column (3) includes the first three quartiles (up to 1594 km). Regions beyond these thresholds are assigned zero weights. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$) and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$). Furthermore, \mathbf{W} represents the spatial weight matrix.

(weakly) significant. The total effect is also positive (but again only weakly significant): EU funds received by a region help the surrounding regions more than the recipient region itself. The same can be said about the investment rate: the direct effect is relatively small, but the spatial spillovers are positive and statistically significant, resulting in a statistically significant and positive total effect. ³⁶

How to make sense of the fact that the indirect effect seem more important? We believe that this result suggests that the benefits from Cohesion spending accrue to the wider local area and not only to the recipient region: in fact, most of the effect accrues to the nearby regions. For example, the investments financed by regional policy could be carried out by firms located in other regions, or the increased spending could increase the imports of goods (e.g. building materials, machinery and the like) from other regions. This should not be surprising: the EU is an integrated market for trade in goods and services. There is no reason to expect the work financed by EU transfers to be carried out only by firms from the the recipient region. Moreover, our estimates only capture the short-term effect of executing the investment financed by Cohesion Policy. The medium and long-term effects of using the resulting improvement or facilities, however, may be more locally based. Finally, the weak significance of the spatial effects suggest that more work may be required to fully determine the nature and importance of inter-regional spillovers.

1.6 Conclusions

In this paper, we report on the results of our journey to identify the effect of the EU Cohesion Policy on regional growth in the EU. We argue that possible reasons for the weak and mixed findings in the previous literature could be attributed to measurement errors, endogeneity of EU Funds in regional economic performance, and/or presence of inter-regional spillovers in the effect of Cohesion Policy on regional growth.

³⁶We conducted additional robustness checks, by replacing the distance-based weight matrix with considering n closest neighbors (with n taking the values of 5, 10, 15, 25, and 50), and omitting the interaction term between the EU Funds and Institutional quality. These results, presented in the Online Appendix, suggest that the effect of the Cohesion spending hovers at the limits of statistical significance. The results of the spatial model, therefore, need to be taken with a grain of salt.

Table 1.8: Cohesion Policy and Inter-regional Spillovers - Direct, Indirect and Total Effects

	(1) $\Delta \ln y_{ijt}$ $d = 660$	(2) $\Delta \ln y_{ijt}$ $d = 1090$	(3) $\Delta \ln y_{ijt}$ $d = 1594$
Average Direct Effects			
$\ln(y_{ijt-1})$	-0.159*** (0.0167)	-0.149*** (0.0155)	-0.144*** (0.0149)
$\ln(s_{ijt})$	0.00602 (0.00671)	0.00670 (0.00667)	0.00747 (0.00665)
$\ln(n_{ijt} + g + \delta)$	-0.0313*** (0.00397)	-0.0325*** (0.00398)	-0.0329*** (0.00403)
$wgipca_{it}$	0.0114*** (0.00248)	0.0103*** (0.00238)	0.00970*** (0.00236)
$\ln(eufr_{ijt} + 1)$	0.0385 (0.125)	0.0464 (0.126)	0.0455 (0.120)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	-0.00696 (0.0608)	-0.0414 (0.0558)	-0.0606 (0.0551)
Average Indirect Effects			
$\ln(y_{ijt-1})$	0.0464 (0.0293)	0.0350 (0.0358)	0.0291 (0.0405)
$\ln(s_{ijt})$	0.0879*** (0.0333)	0.111** (0.0427)	0.130** (0.0503)
$\ln(n_{ijt} + g + \delta)$	0.0382 (0.0554)	0.0453 (0.0776)	0.0623 (0.0938)
$wgipca_{it}$	-0.00385 (0.00677)	-0.0000607 (0.00953)	0.00537 (0.0113)
$\ln(eufr_{ijt} + 1)$	1.049 * (0.630)	1.450* (0.845)	1.728* (1.010)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	0.229 (0.260)	0.373 (0.345)	0.506 (0.424)
Average Total Effects			
$\ln(y_{ijt-1})$	-0.112*** (0.0304)	-0.114*** (0.0376)	-0.115*** (0.0429)
$\ln(s_{ijt})$	0.0940** (0.0368)	0.117** (0.0460)	0.138** (0.0533)
$\ln(n_{ijt} + g + \delta)$	0.00688 (0.0563)	0.0128 (0.0786)	0.0294 (0.0950)
$wgipca_{it}$	0.00755 (0.00620)	0.0102 (0.00885)	0.0151 (0.0106)
$\ln(eufr_{ijt} + 1)$	1.088 * (0.640)	1.497* (0.854)	1.774* (1.017)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	0.222 (0.252)	0.331 (0.337)	0.445 (0.412)

Note: Robust standard errors shown in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.. See notes to Table 1.7 for an explanation of the differences between columns (1) to (3) as well as the notation of variables used in the regression.

To address the first of these potential shortcomings, we use an updated data set covering both old and new member states and with information on Cohesion Policy receipts in annual frequency. In contrast, most of the previous studies were limited to

data covering only whole programming periods. Our data span three programming periods, from 1997 to 2014. Estimating a stylized panel version of the Solow growth model with OLS, we find that EU funds are strongly and positively correlated with regional growth.

Next, we address the potential endogeneity of Cohesion Policy by employing a novel and previously-unused instrumental variable. Specifically, we use the presence of environmentally protected areas under the EU Natura 2000 program as instruments for Cohesion Policy transfers. The presence of such areas is strongly and positively correlated with the amount of EU Funds that NUTS2 regions receive.³⁷ We show that the payments from European Funds significantly boost regional economic growth, both when applying OLS and 2SLS. The IV estimates, however, are larger than those obtained with OLS: this suggests that the OLS estimates may be biased downwards. This may help explain why many previous studies failed to yield significant findings. Our results, furthermore, confirm that there is substantial heterogeneity in the Cohesion impact on economic development, as reported in the literature: not all regions are affected equally. Further research may be needed to satisfactorily identify the sources of this heterogeneity.

Finally, we account for the likely presence of inter-regional spillovers in regional-policy impact by estimating a spatial model of growth. The results suggest that inter-regional spillovers in the growth effects of the EU funds may be important (although our results are at the margins of statistical significance). In fact, the impact of Cohesion Policy seems to take place as much (or even more) in the nearby regions as in the recipient region. Our findings of positive spillover effects on nearby regions is in line with the previous results of [Fiaschi et al. \(2018\)](#) and [Bachtrögler-Unger et al. \(2022\)](#).

³⁷We discuss several potential explanations of the relationship between the EU funds and Natura 2000. However, future research is needed to fully grasp the connection between Natura 2000 and local economies as well as the effectiveness of Natura 2000.

Our results thus confirm that accounting for endogeneity and spillover effects is important when assessing the impact of Cohesion Policy on regional development. Therefore, the preponderance of weak and mixed findings in the previous literature can be attributed to the fact that most of the earlier studies were estimated by simple OLS. As such, they are likely to have underestimated the Cohesion impact on regional growth and economic development.

Our findings, furthermore, give support to the recent effort to mitigate the consequences of the Covid-19 pandemic by increased redistribution through the Next Generation EU (NGEU) instrument. The NGEU envisages an additional spending package of €750 billion, conditional on reforms the member states have pledged themselves to undertake.³⁸ Bańkowski et al. (2022) estimate, that this program will boost output in the EU by up to 1.5 percentage point. The results of our analysis implying the positive results of EU funds as well as improvements of institutional quality. Furthermore, the effect of EU funds strengthens when we include institutional quality in the regression, signifying that a better institutional environment may enhance the effective implementation of EU funds. In turn, this suggests that such favorable predictions of NGEU instrument may indeed be justified.

The results of our analysis are especially reassuring in light of the mixed findings on the economic effects of government spending (Ramey, 2011). A potential explanation of the disappointing findings of that literature is Ricardian equivalence – an observation that the growth-stimulating effect of debt-financed government spending is mitigated by the expectation of a future tax liability required to repay the ensuing debt. As Cohesion spending is financed from European rather than from national sources, the future tax liability of the recipient regions is negligible, so European funds should indeed have a better the growth-boosting potential.

The previous literature on the economic effectiveness of regional aid has been mixed

³⁸See https://ec.europa.eu/info/strategy/recovery-plan-europe_en.

and generally disappointing. The largest item of EU spending, the Common Agricultural Policy, likewise largely fulfills a redistributive function, with little regard for improving economic efficiency. On that backdrop, our finding of a growth-stimulating effect of the Cohesion Policy spending is indeed a positive result.

Our work has utilized a newly made available dataset with a better temporal granularity. Yet, we are still restricted to the NUTS2 regions in the spatial dimension. The NUTS2 regions of the EU are designed to make comparisons among similar regions, mainly in the dimension of administrative borders and population size (see footnote 8 in [Chapter 2](#)). Notice on [Figure 1.1](#) or [Figure 1.2](#) that there are, however, large differences in terms of areas of NUTS2 regions. Such discrepancies lead to the modifiable unit area problem. For this reason, [Chapter 2](#) and [Chapter 3](#) use data on a more granular level. In the case of the EU Funds, a granular level approach for now depends on the possibilities of individual to compile granular datasets as has done by for instance by [Bachtrögler et al. \(2017\)](#). A more granular dataset that is freely available on a more detailed spatial level as well as categories of EU funds might help to further improve the future assessments of the impact of EU funds on economic performance.

Appendix A

Table A1: EU Funds and Regional Growth: OLS with Natura 2000

	(1)	(2)	(3)	(4)
	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$	$\Delta \ln(y_{ijt})$
$\ln(\text{areaprop}_{ijt} + 1)$	0.016 ⁺ (0.009)	0.042 ^{***} (0.009)	0.040 ^{***} (0.009)	0.035 ^{***} (0.009)
$\ln(y_{ijt-1})$		-0.070 ^{***} (0.008)	-0.104 ^{***} (0.008)	-0.110 ^{***} (0.009)
$\ln(s_{ijt})$			0.019 ^{***} (0.006)	0.019 ^{**} (0.006)
$\ln(n_{ijt} + g + \delta)$			-0.036 ^{***} (0.006)	-0.035 ^{***} (0.006)
$wgipca_{it}$			0.012 ^{***} (0.001)	0.012 ^{***} (0.001)
$\ln(eufr_{ijt} + 1)$				0.201 ^{**} (0.066)
N	4734	4734	4734	4734
R ²	0.381	0.399	0.434	0.436
R ² Adj.	0.342	0.361	0.398	0.399
Regional FEs	Yes	Yes	Yes	Yes
Yearly FEs	Yes	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Significance: *p<0.1; **p<0.05; ***p<0.01. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$); ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$); binary variable denoting objective 1 regions (obj_{ijt}) and proportion of area of a region covered by Natura 2000 protected sites ($\ln(\text{area_prop}_{ijt} + 1)$).

Table A2: EU Funds and Regional Growth: OLS with market access

	(1)	(2)	(3)
	$\Delta \ln(y_{ijt})$ $d = 660$	$\Delta \ln(y_{ijt})$ $d = 1090$	$\Delta \ln(y_{ijt})$ $d = 1594$
$\ln(y_{ijt-1})$	-0.101*** (0.010)	-0.101*** (0.010)	-0.101*** (0.010)
$\ln(s_{ijt})$	0.0214*** (0.005)	0.0214*** (0.005)	0.0214*** (0.005)
$\ln(n_{ijt} + g + \delta)$	-0.0370*** (0.006)	-0.0370*** (0.006)	-0.0370*** (0.006)
$wgipca_{it}$	0.012*** (0.002)	0.012*** (0.002)	0.012*** (0.002)
$\ln(eufr_{ijt} + 1)$	0.273*** (0.059)	0.279*** (0.059)	0.277*** (0.059)
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	-0.291* (0.144)	-0.345* (0.156)	-0.365* (0.168)
N	4471	4471	4471
R-sq	0.409	0.409	0.409
adj. R-sq	0.406	0.406	0.406
F	112.2***	112.8***	112.8***
Regional FEs	Yes	Yes	Yes
Yearly FEs	Yes	Yes	Yes

Note: Robust standard errors are shown in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Column (1) considers spillovers between regions in the first quartile by distance (up to 660 km), column (2) includes the first two quartiles (up to 1090 km), and column (3) includes the first three quartiles (up to 1594 km). Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$); ratio of the EU Funds to regional GDP of a region ($\ln(eufr_{ijt} + 1)$) and its neighbors ($\mathbf{W} * \ln(eufr_{ijt} + 1)$)

Table A3: EU Funds and Regional Growth: 2SLS with market access

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\Delta \ln(y_{ijt})$ $d = 660$	$\ln(eufr_{ijt} + 1)$ $d = 660$	$\mathbf{W} * \ln(eufr_{ijt} + 1)$ $d = 660$	$\Delta \ln(y_{ijt})$ $d = 1090$	$\ln(eufr_{ijt} + 1)$ $d = 1090$	$\mathbf{W} * \ln(eufr_{ijt} + 1)$ $d = 1090$	$\Delta \ln(y_{ijt})$ $d = 1594$	$\ln(eufr_{ijt} + 1)$ $d = 1594$	$\mathbf{W} * \ln(eufr_{ijt} + 1)$ $d = 1594$
$\ln(y_{ijt-1})$	-0.153*** (0.016)	0.034*** (0.004)	0.005** (0.002)	-0.153*** (0.016)	0.034*** (0.004)	0.005*** (0.002)	-0.153*** (0.016)	0.034*** (0.004)	0.005*** (0.002)
$\ln(s_{ijt})$	0.017*** (0.005)	0.003 (0.003)	0.001 (0.001)	0.017*** (0.005)	0.003 (0.003)	0.001 (0.001)	0.017*** (0.005)	0.003 (0.003)	0.001 (0.001)
$\ln(n_{ijt} + g + \delta)$	-0.032*** (0.005)	-0.003** (0.001)	-0.002 (0.001)	-0.032*** (0.005)	-0.003** (0.001)	-0.001 (0.001)	-0.032*** (0.005)	-0.003** (0.001)	-0.001 (0.001)
$wgipca_{ijt}$	0.013*** (0.001)	-0.001 (0.001)	-0.000 (0.000)	0.013*** (0.001)	-0.001 (0.001)	-0.000 (0.000)	0.013*** (0.001)	-0.001 (0.001)	-0.000 (0.000)
$\ln(eufr_{ijt} + 1)$	1.543*** (0.327)			1.569*** (0.331)			1.566*** (0.332)		
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	-0.404 (0.430)			-0.586 (0.469)			-0.639 (0.495)		
$\ln(areaprop_{ijt} + 1)$		0.027*** (0.006)			0.027*** (0.006)	0.000 (0.000)		0.027*** (0.006)	0.000 (0.000)
$\mathbf{W} * \ln(areaprop_{ijt} + 1)$		-0.007 (0.006)	0.031*** (0.005)		-0.006 (0.007)	0.034*** (0.005)	-0.006 (0.007)	0.036*** (0.007)	
N	4471	4471	4471	4471	4471	4471	4471	4471	4471
R^2	0.343	0.333	0.562	0.343	0.333	0.562	0.343	0.333	0.562
adj. R^2	0.298	0.329	0.560	0.298	0.329	0.560	0.298	0.329	0.560
F	95.759***	13.358***	31.323***	95.759***	13.358***	44.315***	95.759***	13.358***	44.283***

Note: Robust standard errors are shown in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Columns (1-3) considers spillovers between regions in the first quartile by distance (up to 660 km), columns (4-6) includes the first two quartiles (up to 1090 km), and column (7-9) includes the first three quartiles (up to 1594 km). Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{ijt}$); ratio of the EU Funds to regional GDP of a region ($\ln(eufr_{ijt} + 1)$) and its neighbors ($\mathbf{W} * \ln(eufr_{ijt} + 1)$), instrumented by the proportion of a region covered by Natura 2000 sites ($\ln(areaprop_{ijt} + 1)$) and that of its neighbors ($\mathbf{W} * \ln(areaprop_{ijt} + 1)$).

Table A4: European Funds and Regional Growth: 2SLS, Subsample
Analysis according to Convergence Objective Eligibility

	$\Delta \ln y_{ijt}$ (<i>obj1=1</i>)	$\ln(eufr_{ijt} + 1)$ (<i>obj1=1</i>)	$\Delta \ln y_{ijt}$ (<i>obj1=1</i>)	$\ln(eufr_{ijt} + 1)$ (<i>obj1=1</i>)	$\Delta \ln y_{ijt}$ (<i>obj1=0</i>)	$\ln(eufr_{ijt} + 1)$ (<i>obj1=0</i>)	$\Delta \ln y_{ijt}$ (<i>obj1=0</i>)	$\ln(eufr_{ijt} + 1)$ (<i>obj1=0</i>)
$\ln(y_{ijt-1})$	-0.234*** (0.046)	-0.039** (0.016)	-0.209*** (0.041)	-0.039*** (0.016)	-0.114*** (0.019)	0.026*** (0.002)	-0.133*** (0.017)	0.024*** (0.002)
$\ln s_{ijt}$	-0.012 (0.015)	0.014*** (0.003)	0.021** (0.0012)	0.015*** (0.004)	0.0142* (0.008)	0.005*** (0.001)	0.011 (0.008)	0.005*** (0.002)
$\ln(n_{ijt} + g_{ijt} + \delta_{ijt})$	0.001*** (0.005)	-0.002*** (0.001)	-0.020*** (0.005)	-0.002** (0.001)	-0.039*** (0.007)	-0.003* (0.001)	-0.036** (0.007)	-0.002* (0.001)
$\ln(eufr_{ijt} + 1)$	1.899* (1.024)		2.553*** (0.830)		0.577 (0.511)		1.223*** (0.377)	
$\ln(areaprop_{ijt} + 1)$		0.019*** (0.006)				0.020*** (0.003)		
$\ln(count_{ijt} + 1)$				0.0015*** (0.0004)				0.0017*** (0.0002)
$wgipca_{it}$	0.021*** (0.007)	0.006*** (0.001)	0.017*** (0.006)	0.004*** (0.001)	0.004** (0.002)	-0.0002 (0.0004)	0.0042** (0.002)	0.0006 (0.0004)
Observations	1,267	1,267	1,267	1,267	3,597	3,597	3,597	3,597
R ²	0.400		0.277		0.341		0.336	
F statistic	31.19***	8.90***	24.14***	17.06***	93.21***	35.86***	93.33***	63.42***
Regional FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$) in the second stage and first stage and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$) in the first stage. Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$); ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$); binary variable denoting objective 1 regions (obj_{ijt}); proportion of area of a region covered by Natura 2000 protected sites ($\ln(areaprop_{ijt} + 1)$) and the number of Natura 2000 sites in a region ($count_{ijt}$).

Table A5: Cohesion Policy and Inter-regional Spillovers: SDM with knn based spatial weight matrices¹

	(1) $\Delta \ln y_{ijt}$ k = 5	(2) $\Delta \ln y_{ijt}$ k = 10	(3) $\Delta \ln y_{ijt}$ k = 15	(4) $\Delta \ln y_{ijt}$ k = 25	(5) $\Delta \ln y_{ijt}$ k = 50
ρ	0.665*** (0.0148)	0.737*** (0.0174)	0.788*** (0.0163)	0.840*** (0.0153)	0.900*** (0.0133)
$\ln(y_{ijt-1})$	-0.165*** (0.0182)	-0.164*** (0.0167)	-0.160*** (0.0158)	-0.152*** (0.0152)	-0.133*** (0.0134)
$\ln(s_{ijt})$	0.00576 (0.00712)	0.00164 (0.00679)	0.00424 (0.00620)	0.0108* (0.00590)	0.0147** (0.00626)
$\ln(n_{ijt} + g + \delta)$	-0.0336*** (0.00492)	-0.0311*** (0.00413)	-0.0286*** (0.00372)	-0.0290*** (0.00392)	-0.0309*** (0.00425)
$wgipca_{it}$	0.0118*** (0.00305)	0.0121*** (0.00293)	0.0130*** (0.00279)	0.0139*** (0.00246)	0.0113*** (0.00202)
$\ln(eufr_{ijt} + 1)$	-0.0463 (0.124)	-0.0135 (0.141)	-0.0232 (0.149)	-0.116 (0.151)	0.0148 (0.144)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	-0.0188 (0.0696)	-0.0297 (0.0700)	-0.0529 (0.0718)	-0.137* (0.0743)	-0.121* (0.0697)
$\mathbf{W} * \ln(y_{ijt-1})$	0.129*** (0.0174)	0.135*** (0.0164)	0.134*** (0.0159)	0.127*** (0.0158)	0.130*** (0.0149)
$\mathbf{W} * \ln(s_{ijt})$	0.0163** (0.0163**)	0.0241*** (0.0241***)	0.0223** (0.0223**)	0.0144 (0.0144)	-0.00177 (-0.00177)
$\mathbf{W} * \ln(n_{ijt} + g + \delta)$	0.0280* (0.0145)	0.0254* (0.0149)	0.0147 (0.0144)	0.0109 (0.0181)	0.0283 (0.0285)
$\mathbf{W} * wgipca_{it}$	-0.00854*** (0.00331)	-0.00991*** (0.00343)	-0.0114*** (0.00350)	-0.0154*** (0.00359)	-0.00740* (0.00409)
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	0.190 (0.158)	0.150 (0.199)	0.223 (0.233)	0.499* (0.289)	-0.204 (0.422)
$\mathbf{W} * \ln(eufr_{ijt} + 1) * wgipca_{it}$	0.0600 (0.0885)	0.0660 (0.0979)	0.103 (0.111)	0.273** (0.138)	0.130 (0.213)
Observations	4734	4734	4734	4734	4732
Log-likelihood	10680.25	10703.66	10715.68	10659.24	10575.51
AIC	-21308.5	-21359.3	-21379.4	-21266.5	-21099.0
BIC	-21140.5	-21191.3	-21211.3	-21098.5	-20931.0
Coefficient test $\theta = 0$ (χ^2)	291.78***	298.49***	276.73***	249.19***	204.43***
Coefficient test $\theta = -\beta\rho$	71.56***	59.91***	43.47***	26.75***	13.62**
Regional FEs	Yes	Yes	Yes	Yes	Yes
Time FEs	No	No	No	No	No

Notes: Robust standard errors in parentheses. Significance: *p<0.1; **p<0.05; ***p<0.01.

Results are based on spatial weight matrix with k-nearest neighbours: 5 nearest neighbours in column (1), 10 in column (2), 15 in column (3), 25 in column (4), and 50 nearest neighbours in column (5). The remaining regions were assigned zero weights. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$) and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$). Furthermore, \mathbf{W} represents the spatial weight matrix.

Table A6: Cohesion Policy and Inter-regional Spillovers - Direct, Indirect and Total Effects with knn based spatial weight matrices

	(1) $\Delta \ln y_{ijt}$ k = 5	(2) $\Delta \ln y_{ijt}$ k = 10	(3) $\Delta \ln y_{ijt}$ k = 15	(4) $\Delta \ln y_{ijt}$ k = 25	(5) $\Delta \ln y_{ijt}$ k = 50
Average Direct Effect					
$\ln(y_{ijt-1})$	-0.161*** (0.0180)	-0.162*** (0.0170)	-0.158*** (0.0162)	-0.151*** (0.0156)	-0.132*** (0.0139)
$\ln(s_{ijt})$	0.00937 (0.00735)	0.00485 (0.00715)	0.00691 (0.00639)	0.0126** (0.00615)	0.0152** (0.00634)
$\ln(n_{ijt} + g + \delta)$	-0.0320*** (0.00451)	-0.0303*** (0.00411)	-0.0290*** (0.00383)	-0.0297*** (0.00407)	-0.0303*** (0.00456)
$wgipca_{it}$	0.0116*** (0.00283)	0.0118*** (0.00281)	0.0128*** (0.00269)	0.0135*** (0.00240)	0.0114*** (0.00198)
$\ln(eufr_{ijt} + 1)$	-0.0152 (0.122)	0.00759 (0.135)	0.00145 (0.140)	-0.0782 (0.141)	0.00580 (0.131)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	-0.00745 (0.0646)	-0.0210 (0.0655)	-0.0438 (0.0666)	-0.120* (0.0698)	-0.116* (0.0633)
Average Indirect Effect					
$\ln(y_{ijt-1})$	0.0554*** (0.0212)	0.0517* (0.0273)	0.0405 (0.0363)	0.00197 (0.0522)	0.105 (0.109)
$\ln(s_{ijt})$	0.0557*** (0.0210)	0.0923*** (0.0337)	0.117*** (0.0431)	0.143** (0.0679)	0.108 (0.135)
$\ln(n_{ijt} + g + \delta)$	0.0172 (0.0363)	0.0112 (0.0519)	-0.0328 (0.0652)	-0.0781 (0.113)	0.0228 (0.296)
$wgipca_{it}$	-0.00166 (0.00444)	-0.00344 (0.00602)	-0.00471 (0.00835)	-0.0221 (0.0136)	0.0311 (0.0327)
$\ln(eufr_{ijt} + 1)$	0.427 (0.361)	0.480 (0.540)	0.882 (0.796)	2.380* (1.339)	-2.244 (3.732)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	0.129 (0.166)	0.155 (0.220)	0.272 (0.314)	0.950* (0.568)	0.115 (1.687)
Average Total Effect					
$\ln(y_{ijt-1})$	-0.105*** (0.0212)	-0.110*** (0.0292)	-0.118*** (0.0393)	-0.149*** (0.0555)	-0.0277 (0.113)
$\ln(s_{ijt})$	0.0651*** (0.0247)	0.0971** (0.0379)	0.124*** (0.0464)	0.156** (0.0714)	0.124 (0.138)
$\ln(n_{ijt} + g + \delta)$	-0.0148 (0.0373)	-0.0191 (0.0532)	-0.0619 (0.0666)	-0.108 (0.115)	-0.00757 (0.298)
$wgipca_{it}$	0.00991** (0.00386)	0.00836 (0.00530)	0.00812 (0.00758)	-0.00858 (0.0131)	0.0425 (0.0323)
$\ln(eufr_{ijt} + 1)$	0.412 (0.396)	0.488 (0.546)	0.883 (0.794)	2.302* (1.316)	-2.239 (3.709)
$\ln(eufr_{ijt} + 1) * wgipca_{it}$	0.122 (0.160)	0.134 (0.199)	0.228 (0.287)	0.830 (0.536)	-0.000447 (1.650)

Note: Robust standard errors in parentheses. Significance: *p<0.1; **p<0.05; ***p<0.01.

Results are based on spatial weight matrix with k-nearest neighbours: 5 nearest neighbours in column (1), 10 in column (2), 15 in column (3), 25 in column (4), and 50 nearest neighbours in column (5). The remaining regions were assigned zero weights.

Table A7: Cohesion Policy and Inter-regional Spillovers: robustness check for SDM with distance based spatial weight matrices

	(1) $\Delta \ln y_{ijt}$ $d = 660$	(2) $\Delta \ln y_{ijt}$ $d = 1090$	(3) $\Delta \ln y_{ijt}$ $d = 1594$
ρ	0.740*** (0.0226)	0.776*** (0.0231)	0.795*** (0.0233)
$\ln(y_{ijt-1})$	-0.160*** (0.0161)	-0.150*** (0.0150)	-0.144*** (0.0143)
$\ln(s_{ijt})$	0.00255 (0.0161)	0.00319 (0.0150)	0.00386 (0.0143)
$\ln(n_{ijt} + g + \delta)$	-0.0330*** (0.00421)	-0.0339*** (0.00421)	-0.0345*** (0.00422)
$wgipca_{it}$	0.0114*** (0.00160)	0.00972*** (0.00158)	0.00889*** (0.00160)
$\ln(eufr_{ijt} + 1)$	0.0306 (0.100)	0.101 (0.0986)	0.139 (0.0957)
$\mathbf{W} * \ln(y_{ijt-1})$	0.133*** (0.00936)	0.127*** (0.0102)	0.124*** (0.0109)
$\mathbf{W} * \ln(s_{ijt})$	0.0215** (0.00936)	0.0227** (0.0102)	0.0240** (0.0109)
$\mathbf{W} * \ln(n_{ijt} + g + \delta)$	0.0333** (0.0159)	0.0348* (0.0188)	0.0384* (0.0204)
$\mathbf{W} * wgipca_{it}$	-0.00824*** (0.00313)	-0.00582* (0.00353)	-0.00405 (0.00399)
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	0.113 (0.146)	0.0487 (0.159)	-0.00111 (0.171)
Observations	4734	4734	4734
Log-likelihood	10714.99	10693.16	10681.21
<i>AIC</i>	-21386.0	-21342.3	-21318.4
<i>BIC</i>	-21243.8	-21200.1	-21176.2
Coefficient test $\theta = 0$ (χ^2)	293.98	263.51	250.49
Coefficient test $\theta = -\beta\rho$	59.70	51.24	50.24
Regional FEs	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes

Note: Robust standard errors in parentheses. Significance: *p<0.1; **p<0.05; ***p<0.01. Column (1) considers spillovers between pairs of regions only in the first quartile by distance (up to 660 km from each other), column (2) considers the first two quartiles (up to 1090 km), and column (3) includes the first three quartiles (up to 1594 km). The regions with distances above these threshold are assigned zero weights. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$) and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$). Furthermore, \mathbf{W} represents the spatial weight matrix.

Table A8: Cohesion Policy and Inter-regional Spillovers - Direct, Indirect and Total Effects robustness check with distance based spatial weight matrices

	(1) $\Delta \ln y_{ijt}$ $d = 660$	(2) $\Delta \ln y_{ijt}$ $d = 1090$	(3) $\Delta \ln y_{ijt}$ $d = 1594$
Average Direct Effect			
$\ln(y_{ijt-1})$	-0.158*** (0.0162)	-0.148*** (0.0151)	-0.143*** (0.0145)
$\ln(s_{ijt})$	0.00577 (0.00695)	0.00631 (0.00686)	0.00702 (0.00679)
$\ln(n_{ijt} + g + \delta)$	-0.0314*** (0.00389)	-0.0325*** (0.00387)	-0.0329*** (0.00392)
$wgipca_{it}$	0.0113*** (0.00243)	0.00985*** (0.00233)	0.00915*** (0.00237)
$\ln(eufr_{ijt} + 1)$	0.0520 (0.0903)	0.120 (0.0883)	0.154* (0.0848)
Average Indirect Effect			
$\ln(y_{ijt-1})$	0.0538* (0.0283)	0.0478 (0.0334)	0.0451 (0.0373)
$\ln(s_{ijt})$	0.0864** (0.0376)	0.109** (0.0479)	0.129** (0.0557)
$\ln(n_{ijt} + g + \delta)$	0.0310 (0.0512)	0.0345 (0.0719)	0.0494 (0.0872)
$wgipca_{it}$	0.00128 (0.00676)	0.00830 (0.00955)	0.0155 (0.0122)
$\ln(eufr_{ijt} + 1)$	0.493 (0.360)	0.543 (0.478)	0.508 (0.588)
Average Total Effect			
$\ln(y_{ijt-1})$	-0.104*** (0.0276)	-0.100*** (0.0334)	-0.0976** (0.0382)
$\ln(s_{ijt})$	0.0922** (0.0417)	0.115** (0.0517)	0.136** (0.0592)
$\ln(n_{ijt} + g + \delta)$	-0.000394 (0.0520)	0.00200 (0.0727)	0.0165 (0.0882)
$wgipca_{it}$	0.0126* (0.00650)	0.0182** (0.00910)	0.0247** (0.0115)
$\ln(eufr_{ijt} + 1)$	0.545 (0.347)	0.663 (0.463)	0.662 (0.572)

Note: Robust standard errors in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Column (1) considers spillovers between pairs of regions only in the first quartile by distance (up to 660 km from each other), column (2) considers the first two quartiles (up to 1090 km), and column (3) includes the first three quartiles (up to 1594 km). The regions with distances above these threshold are assigned zero weights.

Table A9: Cohesion Policy and Inter-regional Spillovers: robustness check for SDM with knn spatial weight matrices1

	(1)	(2)	(3)	(4)	(5)
	$\Delta \ln y_{ijt}$ k = 5	$\Delta \ln y_{ijt}$ k = 10	$\Delta \ln y_{ijt}$ k = 15	$\Delta \ln y_{ijt}$ k = 25	$\Delta \ln y_{ijt}$ k = 50
ρ	0.665*** (0.0148)	0.738*** (0.0174)	0.788*** (0.0163)	0.840*** (0.0153)	0.899*** (0.0135)
$\ln(y_{ijt-1})$	-0.165*** (0.0179)	-0.164*** (0.0164)	-0.159*** (0.0155)	-0.150*** (0.0148)	-0.133*** (0.0132)
$\ln(s_{ijt})$	0.00567 (0.00717)	0.00145 (0.00687)	0.00389 (0.00624)	0.0105* (0.00583)	0.0145** (0.00621)
$\ln(n_{ijt} + g + \delta)$	-0.0334*** (0.00495)	-0.0309*** (0.00416)	-0.0284*** (0.00373)	-0.0285*** (0.00386)	-0.0305*** (0.00434)
$wgipca_{it}$	0.0116*** (0.00300)	0.0118*** (0.00285)	0.0125*** (0.00273)	0.0130*** (0.00242)	0.0105*** (0.00197)
$\ln(eufr_{ijt} + 1)$	-0.0119 (0.110)	0.0411 (0.102)	0.0733 (0.0980)	0.131 (0.108)	0.220** (0.110)
$\mathbf{W} * \ln(y_{ijt-1})$	0.130*** (0.0175)	0.137*** (0.0168)	0.136*** (0.0161)	0.132*** (0.0155)	0.128*** (0.0149)
$\mathbf{W} * \ln(s_{ijt})$	0.0163** (0.00801)	0.0239*** (0.00896)	0.0223** (0.00935)	0.0135 (0.0104)	0.000109 (0.0134)
$\mathbf{W} * \ln(n_{ijt} + g + \delta)$	0.0276 (0.0144)	0.0252 (0.0148)	0.0144 (0.0143)	0.00977 (0.0178)	0.0272 (0.0279)
$\mathbf{W} * wgipca_{it}$	-0.00762** (0.00299)	-0.00888** (0.00324)	-0.00974*** (0.00335)	-0.0115*** (0.00337)	-0.00742** (0.00364)
$\mathbf{W} * \ln(eufr_{ijt} + 1)$	0.0604 (0.129)	-0.000656 (0.142)	-0.00993 (0.153)	-0.0914 (0.195)	-0.365 (0.227)
Observations	4734	4734	4734	4734	4732
Log-likelihood	10679.40	10704.99	10714.27	10651.74	10.570.67
<i>AIC</i>	-21308.5	-21359.3	-21379.4	-21266.5	-21099.0
<i>BIC</i>	-21140.5	-21191.3	-21211.3	-21098.5	-20931.0
Coefficient test $\theta = 0$ (χ^2)	289.99***	297.32***	274.44***	234.99***	196.51***
Coefficient test $\theta = -\hat{\beta}\rho$	70.35***	59.42***	42.92***	20.89***	10*
Regional FEs	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Results are based on spatial weight matrix with k-nearest neighbours: 5 nearest neighbours in column (1), 10 in column (2), 15 in column (3), 25 in column (4), and 50 nearest neighbours in column (5). The remaining regions were assigned zero weights. Dependent variable is the growth of regional GDP per capita ($\Delta \ln(y_{ijt})$). Independent variables are: the level of regional GDP per capita in the previous year ($\ln(y_{ijt-1})$); ratio of gross fixed capital formation on regional GDP (s_{ijt}); term containing population growth, technological progress and depreciation rates ($\ln(n_{ijt} + g + \delta)$); quality of institutions ($wgipca_{it}$) and ratio of the EU funds to regional GDP ($\ln(eufr_{ijt} + 1)$). Furthermore, \mathbf{W} represents the spatial weight matrix.

Table A10: Cohesion Policy and Inter-regional Spillovers - Direct, Indirect and Total Effects robustness check with knn based spatial weight matrices

	(1) $\Delta \ln y_{ijt}$ k = 5	(2) $\Delta \ln y_{ijt}$ k = 10	(3) $\Delta \ln y_{ijt}$ k = 15	(4) $\Delta \ln y_{ijt}$ k = 25	(5) $\Delta \ln y_{ijt}$ k = 50
Average Direct Effect					
$\ln(y_{ijt-1})$	-0.160*** (0.0176)	-0.162*** (0.0165)	-0.158*** (0.0158)	-0.149*** (0.0152)	-0.132*** (0.0136)
$\ln(s_{ijt})$	0.00931 (0.00755)	0.00463 (0.00737)	0.00652 (0.00655)	0.0122** (0.00616)	0.0151** (0.00639)
$\ln(n_{ijt} + g + \delta)$	-0.0321*** (0.00447)	-0.0303*** (0.00411)	-0.0290*** (0.00380)	-0.0294*** (0.00401)	-0.0301*** (0.00460)
$wgipca_{it}$	0.0116*** (0.00283)	0.0116*** (0.00275)	0.0125*** (0.00265)	0.0129*** (0.00239)	0.0105*** (0.00197)
$\ln(eufr_{ijt} + 1)$	0.00105 (0.0992)	0.0479 (0.0930)	0.0815 (0.0896)	0.135 (0.0977)	0.211** (0.0987)
Average Indirect Effect					
$\ln(y_{ijt-1})$	0.0583*** (0.0215)	0.0576** (0.0279)	0.0515 (0.0353)	0.0409 (0.0467)	0.0919 (0.0833)
$\ln(s_{ijt})$	0.0561** (0.0227)	0.0915** (0.0376)	0.117** (0.0478)	0.135* (0.0747)	0.125 (0.152)
$\ln(n_{ijt} + g + \delta)$	0.0124 (0.0341)	0.00571 (0.0488)	-0.0404 (0.0615)	-0.0907 (0.105)	-0.00702 (0.276)
$wgipca_{it}$	0.000756 (0.00410)	-0.000158 (0.00639)	0.00156 (0.00865)	-0.00182 (0.0140)	0.0233 (0.0302)
$\ln(eufr_{ijt} + 1)$	0.142 (0.218)	0.0993 (0.336)	0.195 (0.478)	0.0683 (0.810)	-1.736 (1.655)
Average Total Effect					
$\ln(y_{ijt-1})$	-0.102*** (0.0200)	-0.104*** (0.0278)	-0.106*** (0.0366)	-0.108** (0.0487)	-0.0402 (0.0849)
$\ln(s_{ijt})$	0.0655** (0.0270)	0.0961** (0.0423)	0.123** (0.0515)	0.147* (0.0784)	0.140 (0.155)
$\ln(n_{ijt} + g + \delta)$	-0.0197 (0.0349)	-0.0246 (0.0501)	-0.0695 (0.0629)	-0.120 (0.106)	-0.0371 (0.278)
$wgipca_{it}$	0.0123*** (0.00278)	0.0115* (0.00399)	0.0140* (0.00541)	0.0111 (0.00886)	0.0338 (0.0209)
$\ln(eufr_{ijt} + 1)$	0.143 (0.206)	0.147 (0.323)	0.276 (0.461)	0.204 (0.776)	-1.525 (1.627)

Note: Robust standard errors in parentheses. Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Results are based on spatial weight matrix with k-nearest neighbours: 5 nearest neighbours in column (1), 10 in column (2), 15 in column (3), 25 in column (4), and 50 nearest neighbours in column (5). The remaining regions were assigned zero weights.

Chapter 2

Out of the Dark into the Light? Border Urban Municipalities and Eastern EU Enlargements

2.1 Introduction

In the presence of borders, one typically imagines a series of checkpoints and outposts separating two countries, aimed at controlling or reducing the flow of persons and goods. Such hard borders constitute an important impediment to economic exchange between neighboring countries. In Europe, an extreme example was the Iron Curtain dividing the Soviet sphere of influence from the rest of the continent during the second half of the 20th century. At the opposite end of the spectrum is the European Union's (EU) single market, which has eliminated many barriers to the free movement of goods, capital, labor, and people. Crucially, the Central and Eastern European Countries (CEECs), formerly located behind the Iron Curtain, were given the opportunity to join the EU in the 2000s. The significant reduction in border regulations between the *new* and *old* member states (NMS and EU15 henceforth), as well as among the NMS themselves, had the potential to increase cross-border interactions and stimulate economic activity. The favorable impact of the EU enlargement should be felt particularly strongly in the regions surrounding these borders, as these regions evolve from being at the economic and geographic periphery to conduits for flows of goods, services, and people.

The central question therefore is whether urban municipalities near the treated borders benefit more from economic integration than those located in the hinterland of these new member states.¹ Or, as [Petraikos et al. \(2008\)](#) put it, whether EU integration builds bridges that connect border regions on both sides or tunnels that bypass them and rather improve the economic development in the hinterland.

If the removal of border barriers in the course of European economic integration is understood as a reduction in transport costs, it can also be seen as an increase in market potential for firms, opening access to new customers across the border. Households may likewise relocate to border areas and commute to jobs in the foreign market without leaving their country, particularly when wages abroad are more attractive. In this sense, lower trade costs improve border regions' access to foreign markets ([Niebuhr et al., 2002](#)). Border areas may also offer firms cheaper production factors and workers more affordable amenities. On the other hand, [Crozet and Soubeyran \(2004\)](#) and [Petraikos et al. \(2008\)](#) highlight the competitive pressures that accompany trade liberalization. As a result, border regions must be sufficiently productive to remain competitive, and the benefits of liberalization may be distributed asymmetrically across borders.

The seminal work evaluating the impact of EU enlargements on border areas is [Brakman et al. \(2012\)](#). The authors analyze the impact of all EU enlargements that occurred until 2012 on cities located close to treated borders, using the remainder of the cities in their sample located further from the border as the control group.² Using the share of population of cities in the country's population as a proxy for economic development, they find that border cities benefit more from EU enlargements than the cities in the hinterland. Focusing on the 2004 and 2007 Eastern enlargements, they find that the impact of these specific expansions is greater in magnitude compared

¹As treated borders, I define land borders that became internal borders of the EU after the respective enlargements. Those can be either borders between the acceding new member states or between the existing EU members and new member states.

²This approach is inspired by [Redding and Sturm \(2008\)](#) who assess the effect of German division on the population of cities located close to the border separating former East Germany and former West Germany.

to the overall effect of EU widening. Subsequent studies at the regional (Wassmann, 2016; Mitze and Breidenbach, 2018; Gouveia et al., 2020; Kapanadze, 2021; Mitze and Breidenbach, 2024) and municipal levels (Brühlhart et al., 2018; Heider, 2019; Kapanadze, 2022; Poehnlein, 2025; Bachtrögler-Unger et al., 2023; Coufalová et al., 2024) generally report a positive impact of Eastern EU enlargements on border areas.

In this paper, similarly to the previous literature, I approach the impact of EU enlargement on border areas by comparing urban municipalities close to the treated borders of the Eastern enlargements to municipalities located in the hinterland.³ My main contribution to the literature is the use of granular annual data covering the new member states of the Eastern Enlargements as well as the adjacent EU15 countries. In addition, I draw on recent advances in causal inference to compare urban municipalities at the border with those in the hinterland. I further emphasize differences depending on whether the urban municipality is located in an established or a new member state, and on which of the two lies across the border (*structural heterogeneity*). Lastly, I also highlight the anticipation effects stemming from the pre-enlargement liberalization into account (*temporal heterogeneity*).

To be more concrete, I am able to overcome obstacles associated with the availability of yearly data at the municipality level, for multiple countries, by using the growth of nighttime lights (NTL) as a proxy for economic development. Since the satellites have difficulties detecting NTL stemming from the low density areas, the data attributed to rural areas may be just overflow from urban areas.⁴ Therefore, I summarize the data using spatial data on urban clusters in the EU from GISCO that allows me to eliminate the noise in non-urban areas in the nighttime lights data. Moreover, I compute relative

³The term “*Eastern EU enlargements*” is commonly used to denote the 2004 and 2007 enlargements of the European Union, while the 2013 accession of Croatia is usually referred to as the first “*Western Balkans EU enlargement*”. For simplicity, however, I use the term “*Eastern EU enlargements*” throughout this paper to cover all three accession rounds (2004, 2007, and 2013). Furthermore, I exclude two island countries, Cyprus and Malta, who were part of the 2004 enlargement, as they do not have any land borders with other EU member states. Similarly, I do not consider municipalities close to sea borders (such as the border between Poland and Sweden, as such borders constitute a significant geographic impediment to flows of goods and people compared to land borders.)

⁴Another possibility of granular data is the use of firm level data, that we employ in [Chapter 3](#). In [Chapter 3](#) we also discuss the differences between NTL data and firm level data.

levels of NTL for urban municipalities by dividing their NTL by the total NTL of all urban municipalities within the same country, thereby improving cross-country comparability. I use difference-in-differences to compare the border municipalities with the ones located in the hinterland. To prevent spillovers from the treatment to the control group, I implement a buffer zone.

Overall, there is no significant effect of the Eastern EU enlargements on border urban municipalities. Nevertheless, examining structural heterogeneity reveals significant effects. What initially appears surprising is that the 2004 EU enlargement had a positive impact on urban municipalities in the NMS located near borders with other NMS, but a negative impact on municipalities near borders with EU15 countries. Investigating potential anticipation effects may help explain these patterns: I find a positive effect in the pre-accession period for NMS municipalities close to EU15 borders. A possible explanation could be trade liberalization in the pre-accession period. While the trade between the EU15 and the NMS underwent gradual and important liberalization already occurred during the accession negotiations, the EU enlargement liberalized trade also among the NMS themselves. Due to a higher degree of trade liberalization, [Richter \(1998\)](#) and [Egger and Larch \(2011\)](#) note that these agreements stimulate trade between NMS and the EU15 rather than between NMS. Exploitation of asymmetries in terms of prices and institutional differences in the pre-accession period could also be an explanation. Hence, the EU accession constituted a larger shock for municipalities in the proximity of borders of two NMS.

Note that the insignificant or negative results for the later two enlargements does not mean that the urban municipalities did not benefit from the accession into the EU. It just signifies that there is no difference between them and the urban municipalities located in the hinterland, or, in case of negative effects, that the interior regions benefited more strongly than the border areas.

I examine characteristics that may explain the heterogeneous impacts of EU enlargement. Specifically, I consider the size of an urban municipality, its foreign market

potential, and the elevation at the nearest border point. The results suggest that different factors shaped the outcomes across enlargement waves.

Less populated border municipalities in the 2007 enlargement benefited from EU accession, while municipalities with higher market potential saw positive effects in the 2004 enlargement. By contrast, I do not find much evidence that municipalities located near natural barriers, experienced negative impacts. An exception may be constituted by urban municipalities near the Croatian enlargement border that fall within the first quartile of elevation.

These results remain robust across a range of sensitivity checks. Whether it is alterations of the methodological setup, changes of the control and treatment groups, changes in the sample or in the computation of the NTL, results do not change qualitatively.

Related literature. My results primarily contribute to the understanding of the impact of economic integration on the economies of border regions. [McCallum \(1995\)](#) coined the term *border effect* based on his finding, using a gravity model, that due to the transaction costs posed by the border, intra-national trade is far larger than international trade. In other words, borders limit the potential for trade between countries. Subsequent studies have found similar results, as documented by a meta-analysis of [Havranek and Irsova \(2017\)](#). This border-induced limitation on trade potential has been exploited by [Redding and Sturm \(2008\)](#); [Nakajima \(2008\)](#); [Nagy \(2018\)](#); [Kochnev \(2019\)](#); [Hoffstadt \(2022\)](#); [Coufalová et al. \(2024\)](#); [Behrens \(2024\)](#) to analyze the impact of establishment of new borders on the economic development of the surrounding regions. Similarly to these papers, I underscore the importance of market potential.

While previous papers investigate several cases in which a loss of market potential due to disintegration or an increase in trade impediments, I highlight the relevance of market potential when the trade barriers are removed. With that I contribute to the literature on the impact of EU enlargements on border areas [Brakman et al.](#)

(2012); Wassmann (2016); Mitze and Breidenbach (2018); Heider (2019); Brühlhart et al. (2019); Kapanadze (2021, 2022); Mitze and Breidenbach (2024). My paper combines the granularity of data used in Brakman et al. (2012) with a more regular frequency and the focus on structural and temporal heterogeneities of Mitze and Breidenbach (2024).

In this paper, I also contribute to the literature on the impact of EU enlargement on regional disparities. That is, along the lines of Camagni et al. (2020) and Jakubowski and Wójcik (2024), I point to differences across and within enlargements in terms of regional development. As such, understanding the barriers of development in border regions can help in designing policies that help in overcoming left-behindness in the EU (Rodríguez-Pose et al., 2024). Lastly, my paper is also related to findings on EU enlargement in general, following the work of Campos et al. (2019) and Badinger (2005). However, in contrast to those papers, negative or insignificant results do not stipulate that the border regions do not benefit from joining the EU, but rather that they profit less than or as much as the inland areas.

2.2 Eastern EU Enlargements and the Border Areas

The Eastern enlargements took place in three phases: in 2004 ten countries (Estonia, Latvia, Lithuania, Poland, Czechia, Slovakia, Hungary, Slovenia, Malta and Cyprus) joined the EU, followed up by Romania and Bulgaria in 2007 and Croatia in 2013.⁵ As the bulk of the candidate countries were formerly planned economies, whereas the EU operated based on functional principles of the market economy, we observe in Table 2.1 that the accession process was rather gradual in order to give the prospective NMS time to reduce the differences between them and the EU15. Prior to the accession, the prospective NMS had to fulfill requirements that were formalized as the Copenhagen criteria: mainly requiring institutional changes, which would guarantee a functioning democracy, rule of law and human rights, and economic reforms that

⁵Even though they were part of the 2004 enlargement, Cyprus and Malta are not considered in further analysis due to them not sharing a land border with another EU country.

would warrant a market economy that can deal with the competitive pressure from the single market (Baldwin and Wyplosz, 2022). Additionally, the prospective NMS signed bilateral free trade agreements with the EU15 countries, called the Europe agreements, as well as created free trade areas among themselves: the Central European Free Trade Area (CEFTA) and the Baltic Free Trade Area (BAFTA). The magnitude of trade liberalization varied across these free trade agreements, as the Europa Agreements went further than CEFTA in lowering tariffs across all sectors, with the exception of agriculture. Furthermore, the Europe agreements encouraged the imports of machinery that could have served to promote the modernization in the CEFTA countries (Richter, 1998). In fact, Egger and Larch (2011) suggest that Europe agreements might have strengthened the trade between NMS and EU15 countries at the expense of trade between the NMS themselves. Despite having a more ambitious nature by completely liberalizing regional trade, the impact of BAFTA was similar to that of CEFTA (Kosma et al., 2003).

Similarly, accession to the EU itself did not remove all barriers. While accession granted the NMS access to the single market, primarily by reducing trade barriers, obstacles to the free movement of persons and labor remained in place. Although these barriers were eliminated by 2011 for the 2004 enlargement cohort (and by 2023 for Croatia and 2025 for the 2007 cohort), they were often relaxed or circumvented.⁶ Yet, as Campos et al. (2019) discuss, it is difficult to differentiate between the accession effects from the subsequent deepening processes. They note that it could be the case that the deepening process could have made the effects from joining the EU more persistent.

The positive impact of Eastern EU enlargements on areas located near treated borders stems from the idea that accession to the EU single market removes tariff and non-tariff barriers that restrict their market access to the other side of the border. As such, border areas can be more economically dependent on the cross-border ties because

⁶For instance, limited access to the labor markets of the EU15 countries could be bypassed by registering individuals from the newly acceded countries as self-employed (Ulceluse and Kahanec, 2023).

Table 2.1: The accession process of the Eastern enlargements.

Date	Event
1991	Signing of the First Europe agreement
21.12.1992	Establishment of CEFTA (PL, CZ, SK, HU)
21.-22.3.1993	Accession candidates that sign Europe agreements can join the EU if they fulfill Copenhagen criteria
13.9.1993	Establishment of BAFTA (EE, LV, LT)
31.03.1998	Entry negotiations start (EE, PL, CZ, HU, SI)
15.02.2000	Entry negotiations start (LV, LT, SK, RO, BG)
13.12.2002	E8 entry negotiations end
01.05.2004	EU accession of E8
17.12.2004	E2 entry negotiations end
20.11.2005	HR entry negotiations start
01.01.2007	EU accession of E2
01.01.2007	SI adopts the Euro
21.12.2007	E8 join the Schengen Area
01.01.2009	SK adopts the Euro
01.01.2011	EE adopts the Euro
01.05.2011	Remaining EU labor market restrictions for E8 end
30.06.2011	HR entry negotiations end
01.07.2013	EU accession of HR
01.01.2014	Remaining EU labor market restrictions for E2 end
01.01.2015	LT adopts the Euro
01.07.2020	Remaining EU labor market restrictions for HR end
01.01.2023	HR adopts the Euro and joins the Schengen area
01.01.2025	E2 countries join the Schengen area
01.01.2026	BG adopts the Euro

Source: Baldwin and Wyplosz (2022). **Note:** Europe agreements with other prospective NMS signed by 1995. CEFTA later expanded to other past (SI, HR, RO, BG) or current (MD, RS, BH, ME, MK, AL, XK) EU enlargement candidates among the CEECs. E8 denotes the eastern eight countries (Estonia, Latvia, Lithuania, Poland, Czechia, Slovakia, Hungary and Slovenia), while E2 represents the eastern two (Romania and Bulgaria). Countries are denoted by their ISO 3166-1 alpha-2 codes. Malta and Cyprus also entered the EU in 2004, but as they are not part of the analysis, I do not include them in the table.

of being disadvantaged in terms of domestic market access due to their marginal position within their own country. That is, being located in the interior of the country can offer better connectivity to the rest of the country and thus serves as a more attractive location for economic agents. In their analysis of the impact of German division, Redding and Sturm (2008) suggest that the loss of market potential on the other side of the border was a significant factor that led to the depopulation of West German border cities. Reversing this mechanism results in the municipalities near the treated borders of the Eastern enlargements benefiting from gaining in terms of market potential across the formerly-external border of the EU. Building on the argument that proximity to the border reduces transport costs, Crozet and Soubeyran (2004) demonstrate that trade liberalization between two countries attracts firms to border regions due to increased foreign demand.

Yet, the impact of EU enlargement on border areas may not be only positive. The border regions can be also caught up in a vicious cycle due to lack of agglomeration effects.⁷ For instance, [Crozet and Soubeyran \(2004\)](#) mention that the attractiveness of the border region could be in its lower production costs, while the competition from abroad may deter firms from moving to the border regions. As such, [Petraikos et al. \(2008\)](#) mention that the gains and losses of trade liberalization may be asymmetrically distributed across borders, relating them to the pre-enlargement state of the development of the region. For less developed areas they stress the importance of being productive enough to compete in the new economic environment. [Niebuhr et al. \(2002\)](#) also stress the importance of vertical linkages between firms on either side of the border so that border regions could benefit from spatial concentration of firms.

2.3 Data and methodology

The impact of Eastern enlargements on border areas can be evaluated in two ways. Using aggregate data, such as NUTS regions, allows the use of standard economic variables such as GDP per capita. However, as the population density is higher in the EU15, the NUTS regions tend to be smaller in the EU15 countries.⁸ Consequently, border areas tend to cover a greater geographical space in the NMS than in the EU15. Moreover, using the data at the NUTS level might lead to a Modifiable Unit Area Problem as it aggregates the data that may lead to loss of information and an increase in estimation uncertainty ([Grasland et al., 2006](#); [Simonovska and Tafenau, 2024](#)). On the other hand, using municipalities (or grids) as spatial units of interest allows for more flexibility in defining the border areas, which could be also defined

⁷Historically, border areas were mainly conflict zones that frequently changed hands, or buffer zones to protect the hinterland. Consequently, [Allen \(2023\)](#) shows that borders in Europe tend to be located equidistant between capital cities of two neighboring countries.

⁸The NUTS regions are defined by three principles: to have population within defined ranges to be comparable, to fall within administrative divisions of a country to have available data and in case of need to be able to be amended every three years. As a result of the combination of the first two criteria, for instance, the NUTS3 regions of Germany are based on the third German administrative subdivision (Kreise), while in the case of Czechia it is the first level (Kraje) ([Commission et al., 2020](#)).

symmetrically on both sides of the borders. However, the unavailability of regular economic data, especially whose definitions are comparable across countries, often leads to the use of proxies of economic activity. [Brakman et al. \(2012\)](#) and [Heider \(2019\)](#) resort to using population growth rates as proxies of economic development. Yet, yearly data on city population are difficult to obtain beyond the scope of a single country.⁹

A suitable alternative to population as a proxy of economic growth at a granular level is the nighttime lights (NTL) data, which has been employed in several recent analyses ([Brühlhart et al., 2019](#); [Kapanadze, 2022](#); [Bachtrögler-Unger et al., 2023](#)).¹⁰ The underlying logic is that consumption of almost all goods in the evening requires the use of lights. With rising income, the night light intensity increases, as a consequence of a surge in private consumption of goods, investment activities or production activities. An increase in light emissions of a city may reflect its expansion or, to some extent, a boost in well-being in existing parts of the city (see [Henderson et al., 2012](#)).¹¹

NTL data are available from two satellite/sensor programs: the Operational Linescan System of the U.S. Air Force Defense Meteorological Satellite Program (DMSP-OLS) and the Suomi National Polar-orbiting Partnership Visible Infrared Imaging Radiometer Suite (Suomi NPP-VIIRS). The data from the DMSP-OLS satellites span 1992-2013 and are collected by satellites, which observe every location on Earth at some point between 7:30 pm and 10:00 pm local timezone.¹² This allows a relatively long pre-treatment period before the Eastern Enlargements. Yet, the data from the DMSP-OLS suffer from several caveats. Firstly, the data are available for 30 arc second grid cells (an area of 0.86 km^2 at the equator), where each cell has a value

⁹[Brakman et al. \(2012\)](#) use population data for cities from the whole EU, however the sample is limited by the number of cities and the frequency of the data is irregular (they have 2140 cities in their sample and overall 6286 observations yielding an average of around 2.61 years per city).

¹⁰Another possibility of granular data lies in the yearly firm level data. This possibility is further discussed [Chapter 3](#).

¹¹Note that NTL may contain both information on consumption and production of some goods, resulting in double-counting, while underestimate production of goods and services occurring during prevalently during daytime, such as financial services.

¹²F10 satellite collected data from 1992 to 1994, F12 from 1994 to 1999, F14 from 1997 to 2003, F15 from 2000 to 2007, F16 from 2004 to 2009 and F18 from 2010 to 2013.

(digital number) ranging from 0 (dim) to 63 (bright). Hence, the digital values are top-coded. Since the values in the city center mostly have the top-coded value of 63, this makes it impossible to register NTL growth of cities stemming from the growth in their centers. Another problem is that the data are blurred. In other words, due to the way the satellite processes the data and the lack of onboard memory to store fine data, the attribution of the NTL from the DMSP-OLS satellites might not be entirely precise. Even though the size of a pixel is not larger than 0.86 km^2 , luminosity stemming from this pixel is attributed to an area of around $2.7 \times 2.7 \text{ km}$.¹³ Importantly, even though [Elvidge et al. \(1997\)](#) calibrate the data to facilitate their inter-temporal comparison, such comparisons might still be difficult due to the data stemming from various satellites ([Gibson et al., 2020](#)).

Several techniques have been developed to address the problems of the DMSP-OLS dataset. Notably, [Abrahams et al. \(2018\)](#) use Gaussian filters to reduce the blurring of the data DMSP-OLS data. Alternatively, [Bluhm and Krause \(2022\)](#) work out a procedure to correct the top-coding of the digital values of DMSP-OLS. Yet, both approaches still produce the data on the level of satellite-years, not solving cross-sensor or cross-year calibration problems. On the contrary, [Li et al. \(2020\)](#) apply stepwise calibration to produce a dataset more suitable for intertemporal comparisons and extend the time series by incorporating Suomi NPP-VIIRS data, but they do not address the issues of top-coding and data blurriness. As such, there is no single solution that resolves all the limitations of the DMSP-OLS dataset; the appropriate approach ultimately depends on the researcher's priorities.¹⁴

Due to these challenges, NTL are often recommended as a proxy for economic activity when GDP data are unavailable or unreliable. This can result from poor data aggregation and measurement ([Chen and Nordhaus, 2011](#)), manipulation of official statistics ([Martinez, 2022](#)), or a substantial presence of informal or shadow economic

¹³[Tuttle et al. \(2013\)](#) have released high pressure sodium lamps powered by portable generators in wilderness to measure the precision of the F16 and F18 satellites orbiting at that time. They found that this point was present in the DMSP-OLS images for between 4 and 10 pixels.

¹⁴See [Nguyen and Noy \(2018\)](#) and [Gibson et al. \(2020\)](#) for a survey of the use of NTL in empirical literature.

activity (Tanaka and Keola, 2017). Moreover, NTL provide spatially detailed information at the sub-national level, where no other consistent economic data may exist. As the NTL data provide yearly economic information on municipalities, I use them to analyze the questions at hand. Additionally, NTL captures aspects of the informal economy in border areas.

To have data that make inter-temporal comparison more viable, I consider the dataset provided by Li et al. (2020).¹⁵ A second benefit of the dataset is that it combines the DMSP-OLS data with the NTL data from the Suomi NPP-VIIRS. This yields a dataset that covers a period from 1992 to 2021, adding eight years to the DMSP-OLS data. Therefore, I have sufficient information on the economic development in urban areas before and after the Eastern enlargements.

I then sum up the of NTL for urban areas of LAU municipalities.¹⁶ I use the definition of urban areas in the data made available by GISCO (henceforth urban municipalities). As such, urban clusters are defined as groups of contiguous raster cells with a population density of at least 300 inhabitants per km^2 and an overall population of at least 5000 inhabitants based on 2018 data.¹⁷

To improve comparability of NTL across countries, I compute, for each urban municipality i , its share of national NTL in country c (rel_NTL_{ic} , henceforth relative NTL):

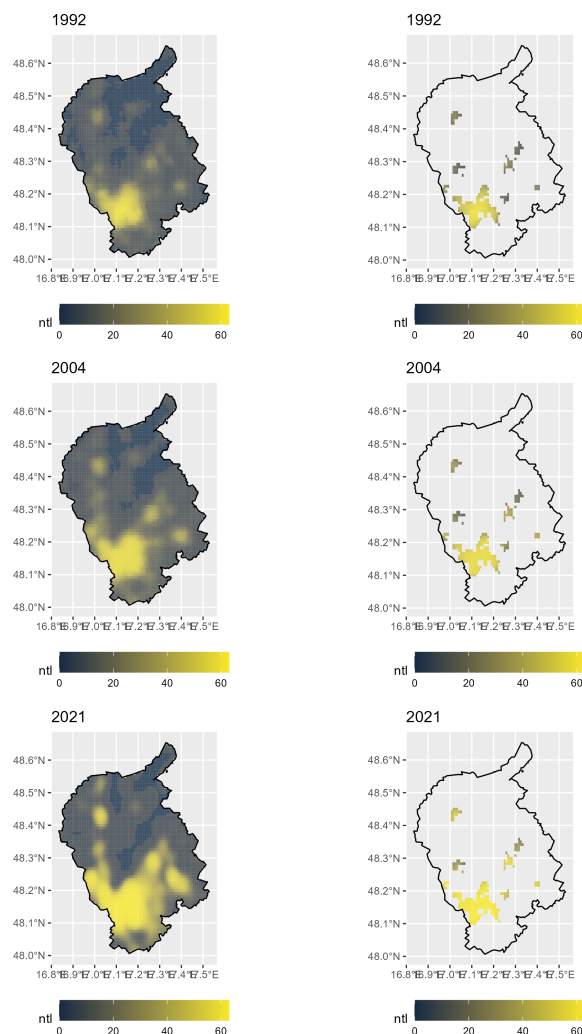
$$rel_NTL_{ic} = \frac{NTL_{ic}}{NTL_c} \quad (2.1)$$

¹⁵Figure B2 displays the distribution of digital numbers across the entire observation period. Values above 55 account for roughly 30% of all cells in the sample, with those exceeding 60 representing about 10.5%, and the maximum value of 63 making up 3% of the data. To address the top-coded nature of the data, I also perform robustness checks by calculating weighted sums of NTL for each urban municipality (Table B5).

¹⁶The cities of Bratislava and Košice are divided into multiple districts on the LAU2 level. I merge the districts together to have them as one city and be consistent with the rest of the sample.

¹⁷The definition and data are available here <https://tinyurl.com/bdz59e7p> under the section "Urban 2018".

Figure 2.1: Luminosity in the Bratislava Region.



Note: The figure shows luminosity (intensity of NTL) in the Bratislava Region (bordering Austria, Czechia and Hungary) as a whole (left) and for the urban municipalities (right) in 1992 (top row), 2004 (middle row) and 2021 (bottom row). [Figure B1](#) shows the satellite view of the region for comparison.

where NTL_{ic} denotes the nighttime lights intensity of municipality i in country c , and $NTL_c = \sum_i NTL_{ic}$ is the total nighttime lights intensity of that country. All observations associated with urban municipalities that exhibited extreme values—growth rates of relative NTL exceeding 100%, equal to -100%, or missing—have been excluded.¹⁸

¹⁸This exclusion affects 20 units in the treatment group and 75 units in the control group. [Table B5](#) includes results where only individual observations are excluded, showing no substantial differences in outcomes.

Figure 2.1 displays the raw data of Li et al. (2020) on the Slovak NUTS3 region of Bratislavsky Kraj, which neighbors Austria, Czechia and Hungary. The left side shows the data for the whole area, while the right side exhibits the data for the urban municipalities, both in terms of luminosity.¹⁹ Much of the apparent rural luminosity likely reflects urban overglow, especially in the central Bratislava Region where the Malé Karpaty mountains are located (Figure B1). By concentrating on the urban municipalities, I therefore remove areas with volatile levels of luminosity. This has the advantage of removing certain noise from the data, which can be attributed to either fluctuations of NTL themselves or overglow from the urban to the rural areas. The rows of Figure 2.1 present the development of the luminosity in the border area (from top to bottom) in 1992, 2004 and 2021. Notice, that it is possible to observe an increase in the luminosity of some of the urban areas over time, denoting a possible expansion of economic activity (most visible when considering at Bratislava itself, the largest city in the eponymous region).

Finally, I calculate the minimal direct distance (in kilometers) from the centroids of the urban municipalities to the borders.²⁰ I then construct a minimum value to a treated category of borders (EU8, EU2, HR), the external border of the EU as well as the borders that became internal EU borders in the previous enlargements.

To evaluate the effect of the EU enlargements on border municipalities, I opt for a similar strategy as the previous literature by comparing the development of urban municipalities in the vicinity of treated borders of the Eastern enlargements to those located further away. To define the treatment, I apply the EU definition, which refers to NUTS3 regions with a majority of their population living within 25 kilometers of a land border.²¹ That is, the treatment group consists of urban municipalities located

¹⁹Luminosity here denotes the digital number a pixel exhibits, ranging from 0 to 63. The more NTL in a pixel, the higher the digital value (Elvidge et al., 1997).

²⁰For the distances of urban municipalities to borders outside their country (for instance the distance from a Lithuanian municipality to a border between Hungary and Croatia), I set the value to 9999.

²¹"It [border typology] identifies border regions in the European Union (EU) as those regions with a land border, or those regions where more than half of the population lives within 25 km of such a border." For instance, the Croatian NUTS 3 of Grad Zagreb does not border any country, but as majority of its population lives within 25 kilometers of a border it is a border region. See <https://tinyurl.com/me6arbf6> or <https://tinyurl.com/49zv79v8>.

within 25 kilometers of a border affected by the EU enlargement. For this threshold, the value for the nearest border is taken into account.²²

Such a design can violate the Stable Unit Treatment Value Assumption (SUTVA). The reason is that the control group is also being affected by the EU accession. However, it is difficult to find an alternative that would ensure a comparable control group without any effect of the treatment. For instance, considering a control group consisting of urban municipalities located in non-EU and non-EFTA countries near the border with the EU might not solve the problem, as these spatial units could suffer from a potential movement of economic activity from the external border of the new EU member states to the proximity of the internal EU borders. Going beyond the proximity of the external border of the EU might solve the issue of not violating the SUTVA, but then the issue of similarity between the treatment and control groups is debatable and might be subject to selection bias.²³

Another problem is the possibility of spillovers from the treatment to the control group. To cope with this, I implement a buffer between the treatment and control groups. Hence, the control group is composed of urban municipalities located between 50 and 100 kilometers from the treated borders of the EU enlargement.

Figure 2.2 displays an overview of my sample in terms of distance from the treated borders. Notice that some restrictions have been imposed on the sample. As urban municipalities located within 50 kilometers of the borders that became internal with the German reunification (1990) and the Neutral enlargement (Austria, 1995) might still be influenced by long-term developments from these enlargements, I do not consider these municipalities in the control group. I also exclude the urban municipalities

²²For example, in the aforementioned Bratislava Region in Figure 2.1, Bratislava is 5.06 km from Austria, 17.43 from Hungary and 51.83 from Czechia. To determine the treatment and the border classification the minimum value, in this case I consider the distance from the Austrian border.

²³Kapanadze (2021) propose an innovative approach of using regions of countries that acceded later into the EU (Bulgaria, Romania and Croatia) as well as one non-EU country (Norway) in the donor pool to create the synthetic counterfactuals of the 2004 enlargement regions. Yet, this approach creates another problem of being able to compute only the short term effects of the 2004 enlargements as accession of Bulgaria and Romania in 2007 limits the post-treatment period to 2004-2006. Furthermore, this does not fully eliminate the problem, as anticipation effects could be present for Bulgaria and Romania.

located within 50 kilometers of the external EU borders, since these could be affected by trade diversion.²⁴

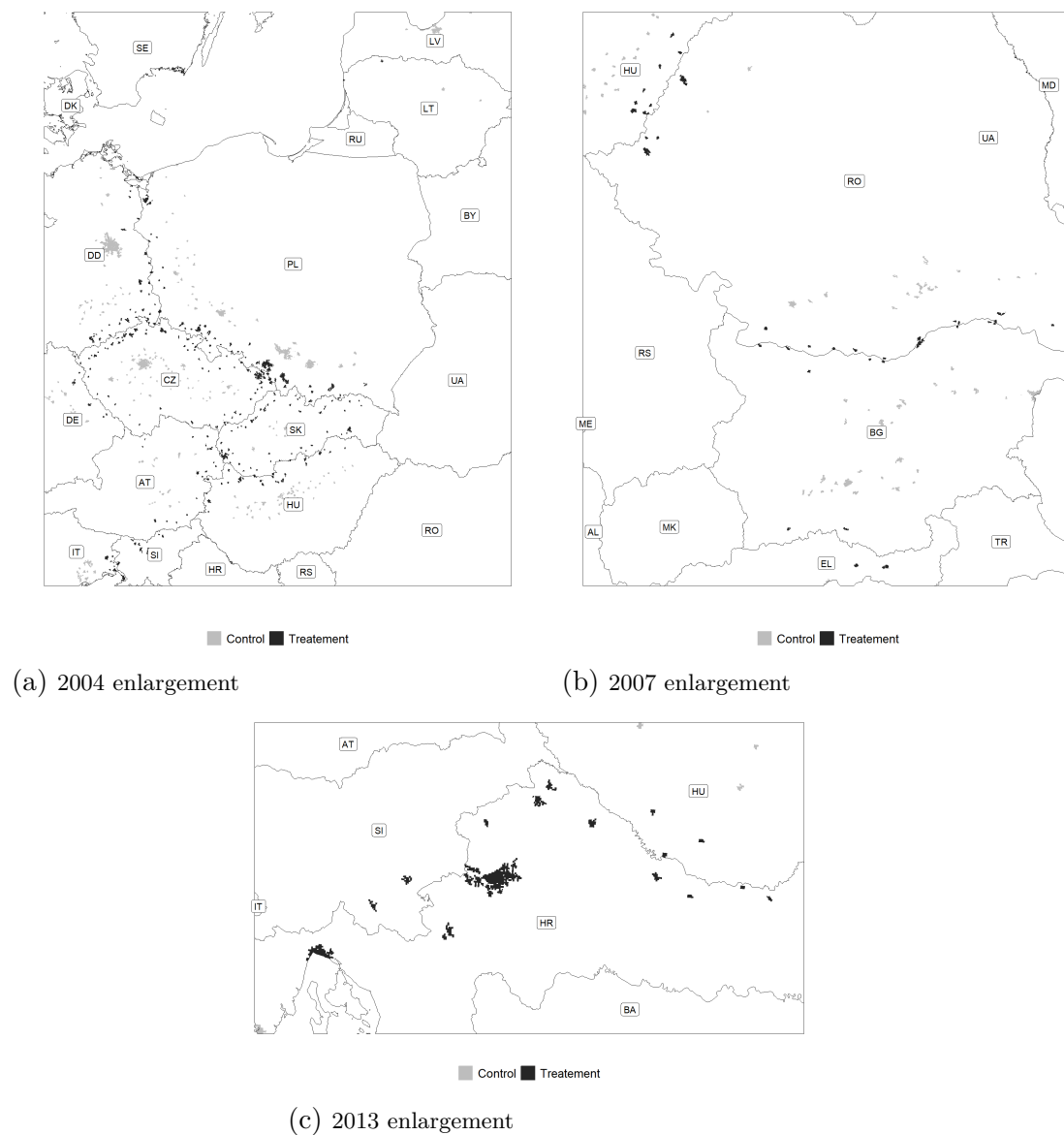
The evaluation of the impact of the Eastern Enlargements on border municipalities assumes that the EU accession shock is exogenous for these areas. As the countries for the Eastern Enlargements were selected based on the pre-treatment similarities with the existing member states as well as geographic proximity, the treatment based on country selection was not random. However, the exogeneity of the treatment of border municipalities stems from the fact that it is determined solely by their geographical locations: economic agents located in border areas could be affected due to their proximity to a new market. The larger the distance to the treated border and from other borders, the better the areas are expected to be connected to the interior of the country.

As the Eastern Enlargements occurred in three waves, I have a staggered treatment. Recent developments in the difference-in-differences methodology put forward drawbacks in the two-way fixed effects estimator as it can lead to biased results in the presence of staggered treatment and/or heterogeneity in treatment. That is, when comparing groups to each other, the two-way fixed effects also uses the earlier treated group in the control group for the later treated group leading to the “negative weight problem”, which may lead to estimating negative effects even when the true impact is positive (De Chaisemartin and d’Haultfoeuille, 2023; Roth et al., 2023).

To account for the heterogeneity of the impact across treatment groups, I rely on the Callaway and Sant’Anna (2021) estimator. In comparison to other recent difference-in-differences approaches, the strength and weaknesses of Callaway and Sant’Anna (2021) approach stem in their reliance on comparing each post-treatment period to a chosen pre-treatment reference period. This flexibility makes the method less sensitive to violations of strict parallel trends and allows dynamic treatment effects to be

²⁴Also in this case, the value of the nearest border is taken into account. For instance, the city of Szeged in Hungary is located 16.30 km from Romania and 9.75 km from Serbia. As it is closer to an external border of the EU, I excluded it from the sample.

Figure 2.2: Location of urban municipalities in sample and their distance from border.



Note: Maps show urban municipalities in my sample located in proximity of treated borders of the E8 enlargement (Figure 2.2a), E2 enlargement (Figure 2.2b), Croatian enlargement (Figure 2.2c). By near to the borders, means that they are within 100 kilometers from the border, the enlargement border is the closest one and they are at least 50 kilometers away from other borders. Black color denotes real proximity to the border (up to 25 kilometers from the enlargement border), grey color denotes that urban municipality is in the hinterland (50-100 kilometers from the enlargement border). Estonian urban municipalities are not included due to missing values in 2002. Table B1 and Table B2 contain cross-sectional counts of observations per country and nearest border, respectively.

estimated. However, if treatment is anticipated before its official start, estimates may be biased unless the reference period is chosen appropriately. Yet, Rüttenauer and

Aksoy (2024) add that this can be solved by changing the reference period.²⁵

I apply the staggered difference-in-differences approach of Callaway and Sant’Anna (2021), using not-yet-treated units as part of the control group. In other words, until 2007 and 2013, respectively, urban municipalities near the borders affected by these enlargements are included in the control group for municipalities close to the 2004 enlargement borders. Formally, let $g \in \{0, 2004, 2007, 2013\}$ denote the treatment cohorts with $g = 0$ for not-yet-treated municipalities and G_g be a binary variable equal to 1 the first time a unit is treated ($G_{ig} = \mathbf{1}\{G_i = g\}$). Then, the Average Treatment effect for cohort g at time t , $ATT(g, t)$, labeled as *group-time average treatment effect* by Callaway and Sant’Anna (2021), is as follows:

$$ATT(g, t) = \mathbb{E}[Y_{it}(g) - Y_{it}(0) | G_{ig} = 1]$$

where $Y_{it}(g)$ denotes the potential outcome that unit i would experience at time t if they were to first become treated in time period g . In this case, I consider as outcome the growth of relative NTL of an urban municipality at time t . Hence, the $ATT(g, t)$ identifies the average treatment effect for cohort g in period t . Callaway and Sant’Anna (2021) estimator makes it possible to provide also *aggregate group-time average treatment effects*:

$$ATT(g) = \frac{1}{T - g + 1} \sum_{t=g}^T ATT(g, t)$$

In other words, this computes the overall impact for each enlargement cohort separately. The control group in this staggered approach is made up of not-yet-treated units.²⁶

²⁵When comparing the recent difference-in-differences estimators, Rüttenauer and Aksoy (2024) show that the extended two-way fixed effects estimator by Wooldridge (2021) is more robust to anticipation effects. For this reason, I use the Wooldridge (2021) method as a robustness check

²⁶Table B5 provides a robustness check of using only never-treated units in the control group.

Table 2.2: Descriptive statistics of the main variables.

		E8			
		1993-2003		2004-2021	
		0-25	50-100	0-25	50-100
<i>NTL</i>	N	327	287	327	287
	Mean	919.97	1422.51	990.41	1537.15
<i>rel_NTL</i> (in %)	95% Conf Int.	[878.58; 961.36]	[1245.25; 1599.76]	[955.01; 1025.81]	[1396.98; 1677.31]
	Mean	0.47	0.52	0.48	0.5
ΔNTL (in %)	95% Conf Int.	[0.43; 0.51]	[0.42; 0.61]	[0.45; 0.51]	[0.43; 0.57]
	Mean	5.26	5.82	1.83	1.68
Δrel_ntl (in %)	95% Conf Int.	[4.52; 6.01]	[5.07; 6.57]	[1.4; 2.27]	[1.24; 2.12]
	Mean	1.75	2.1	0.66	0.69
<i>pop_1990</i>	95% Conf Int.	[1.26; 2.23]	[1.63; 2.58]	[0.35; 0.97]	[0.39; 1]
	Mean	24323.75	44188.57	24323.75	44188.57
<i>border_elev</i> (in m)	95% Conf Int.	[23007.89; 25639.6]	[37034.9; 52355.87]	[23295.15; 25352.34]	[38707.29; 50683.49]
	Mean	495.84	368.53	495.84	368.53
<i>FMP</i>	95% Conf Int.	[23007.89; 25639.6]	[36686.52; 51690.62]	[23295.15; 25352.34]	[38324.31; 50052.83]
	Mean	17311.62	1487.45	17311.62	1487.45
	95% Conf Int.	[16844.15; 17779.09]	[1409.33; 1565.57]	[16946.2; 17677.04]	[1426.38; 1548.52]
		E2			
		1993-2006		2007-2021	
		0-25	50-100	0-25	50-100
<i>NTL</i>	N	51	66	51	66
	Mean	634.22	690.9	805.67	896.36
<i>rel_NTL</i> (in %)	95% Conf Int.	[573.86; 694.57]	[625.34; 756.46]	[735.01; 876.33]	817.83; 974.9
	Mean	0.45	0.66	0.46	0.68
ΔNTL (in %)	95% Conf Int.	[0.4; 0.49]	[0.58; 0.74]	[0.42; 0.5]	[0.61; 0.76]
	Mean	6.17	5.58	3.02	3
Δrel_NTL (in %)	95% Conf Int.	[4.4; 7.93]	[4.07; 7.09]	[1.89; 4.16]	[2.14; 3.87]
	Mean	1.82	1.47	1.14	1.06
<i>pop_1990</i>	95% Conf Int.	[0.64; 3]	[0.51; 2.44]	[0.19; 2.1]	[0.39; 1.73]
	Mean	31193.65	33664.72	31193.65	33664.72
<i>border_elev</i> (in m)	95% Conf Int.	[28135.56; 34251.73]	[29590.7; 37738.74]	[28239.39; 34147.9]	[29728.98; 37600.46]
	Mean	203.54	288.4	203.54	288.4
<i>FMP</i>	95% Conf Int.	[177.38; 229.7]	[255.2; 321.6]	[178.27; 228.81]	[256.33; 320.47]
	Mean	8555.52	1081.44	8555.52	1081.44
	95% Conf Int.	[7921.8; 9189.24]	[1010.3; 1152.57]	[7943.32; 9167.73]	[1012.72; 1150.16]
		HR			
		1993-2012		2013-2021	
		0-25	50-100	0-25	50-100
<i>NTL</i>	N	28	3	28	3
	Mean	1632.84	850.84	1891.55	952.48
<i>rel_NTL</i> (in %)	95% Conf Int.	[1296.28; 1969.41]	[674.47; 1027.21]	[1333.04; 2450.07]	[605.11; 1299.86]
	Mean	1.87	0.76	1.82	0.76
ΔNTL (in %)	95% Conf Int.	[1.53; 2.2]	[0.61; 0.9]	[1.36; 2.28]	[0.54; 0.99]
	Mean	5.99	4.09	-0.82	-0.26
Δrel_NTL (in %)	95% Conf Int.	[4.47; 7.51]	[0.53; 7.64]	[-2.11; 0.48]	[-3.77; 3.25]
	Mean	1.59	0.21	-0.71	-0.23
<i>pop_1990</i>	95% Conf Int.	[0.53; 2.66]	[-1.92; 2.33]	[-1.75; 0.32]	[-2.87; 2.41]
	Mean	42073.39	33497.15	42073.39	33497.15
<i>border_elev</i> (in m)	95% Conf Int.	[32321.79; 51824.98]	[29050.99; 37943.32]	[27523.07; 56623.71]	[26827.9; 40166.4]
	Mean	328.91	170.03	328.91	170.03
<i>FMP</i>	95% Conf Int.	[310.39; 347.43]	[146.89; 193.18]	[301.28; 356.54]	[135.32; 204.75]
	Mean	9094.01	1393.68	9094.01	1393.68
	95% Conf Int.	[8608.91; 9579.11]	[1188.35; 1599.01]	[8370.19; 9817.82]	[1085.68; 1701.68]

Note: E8; E2 and HR denote the 2004, 2007 and 2013 enlargements respectively. N represents the number of units, *NTL* and ΔNTL represent the luminosity and its growth rate, respectively. Similarly *rel_NTL* and Δrel_NTL are the relative luminosity and its growth rate, respectively. Level of population in 1990 is denoted by *pop_1990*, while *border_elev* is the elevation at the nearest border point and *FMP* represents the sum of population on the other side of the border within 100 km of of the urban municipality, discounted by distance.

To account for the structural heterogeneity mentioned by [Mitze and Breidenbach \(2024\)](#), I divide the treated urban municipalities into three groups: those near borders between two NMS, those in the EU15 near borders with NMS, and those in NMS

near borders with EU15 countries.²⁷ The reason for this distinction lies in different initial conditions. It does not only represent the differences in terms of economic and institutional development due to being already part of the EU versus entering the EU, but also the distinction in terms of pre-accession trade liberalization.

Beyond addressing structural heterogeneity, I also tackle the issue of temporal heterogeneity. To account for anticipation effects, I set the treatment start date to as early as five years prior to the accession:

$$ATT(g) = \frac{1}{T - g + \delta + 1} \sum_{t=g+\delta}^T ATT(g, t, \delta) \quad \text{with } \delta \in [-5, 0]$$

where δ represents the years before treatment used to account for anticipation.

Table 2.2 reports the descriptive statistics broken down by control and treatment groups as well as the pre- and post-accession periods. Besides the NTL variables, the table contains also the variables used to evaluate potential factors behind the results: level of population in 1990, elevation of the nearest border point and foreign market potential.²⁸ Observe that with the exception of the 2013 Croatian accession, the areas closer to the border exhibit a lower level of luminosity, as the capital city of Zagreb is located close to the border with Slovenia, with a lower number of other urban municipalities present in the border area. This is also reflected in the higher level of average population of the border urban municipalities of the Croatian enlargement. It seems that growth rates were higher in the pre-accession period than in the post-accession period, which may reflect the general economic slowdown in the EU. Lastly, because they are closest to the core economic areas of the EU15, the border urban

²⁷Mitze and Breidenbach (2024) use the term structural heterogeneity to denote the differences between enlargement waves as well as between established and new member states.

²⁸See Section 2.4.3 for a discussion about the sources and computation of these variables.

Table 2.3: Baseline results.

	(1) All $\Delta \text{rel_NTL}$	(2) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(3) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(4) <i>NMS-NMS</i> $\Delta \text{rel_NTL}$
ATT (E8)	0.0269 (0.0165)	0.0432 (0.0274)	-0.0808* (0.02)	0.0567* (0.0172)
ATT (E2)	0.0177 (0.0464)	-0.0593 (0.048)	-0.0664 (0.0606)	0.033 (0.0581)
ATT (HR)	-0.1126 (0.0793)			-0.1126 (0.0731)
Buffer	Yes	Yes	Yes	Yes
N (overall)	753	449	431	591
N (treated)	394	90	72	232
T	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3

Note: Clustered standard errors in parentheses. Significance: ‘*’ 90% confidence band does not cover 0. The rows indicate group-time treatment effects for municipalities belonging to respective cohorts. The first column shows the results of a general model. The next columns correspond to subdivisions of the treatment group: urban municipalities located near EU15-NMS border on the EU15 side (2) or NMS side (3) or near the borders between two NMS countries (4).

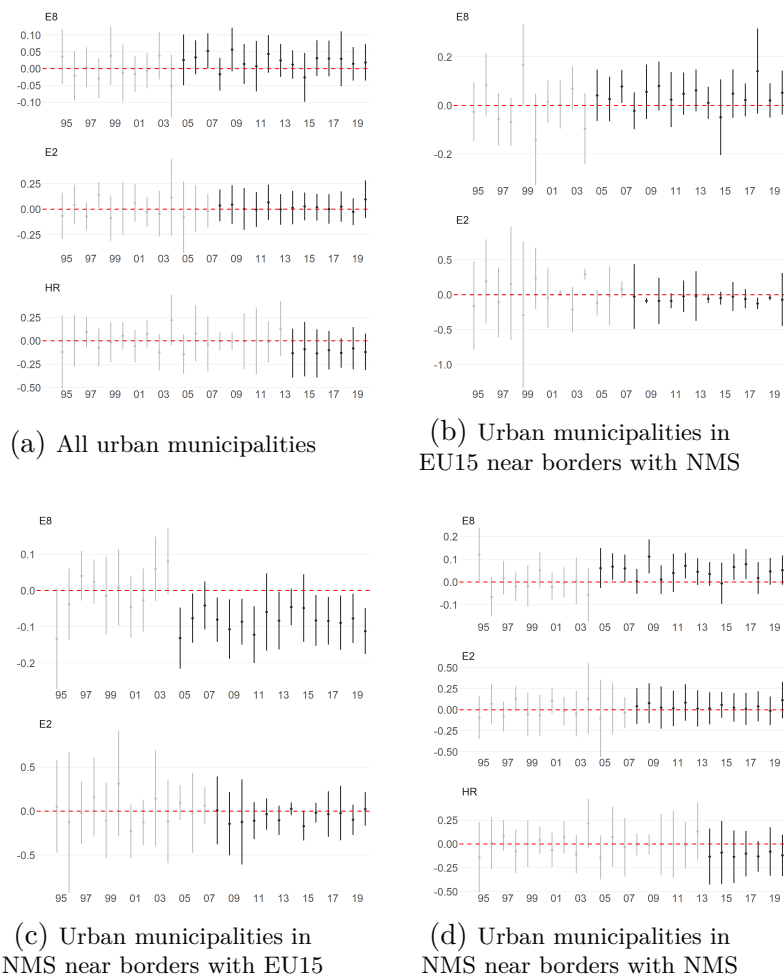
municipalities affected by the 2004 enlargement exhibit the highest levels of foreign market potential.

2.4 Results

2.4.1 Baseline Results

[Section 2.4](#) presents the baseline results. In the first column, I observe that the EU enlargement had no significant impact on the border urban municipalities. Although the main effects are insignificant, some differences may arise when looking at structural heterogeneity by dividing the treated urban municipalities into several groups based on the category of their closest border. Indeed, the other columns of [Section 2.4](#) reveal that the main benefactors of the 2004 enlargement are urban municipalities located in the new member states, in the proximity of borders with other new member states. Surprisingly, border urban municipalities in the NMS decreased their share of

Figure 2.3: Dynamics of the baseline results.



Note: Figures show the dynamics of the impact for urban municipalities in the respective cohorts. The pre-treatment values on this figure correspond to the ATTs (what would have been the effect of participating in the treatment if that given year were a year with treatment participation). Urban municipalities in the treatment group are located within 25 kilometers of borders part of the 2004, 2007 and 2013 enlargements (Figure 2.3a). In the other subfigures the treatment group is made up of urban municipalities located in EU15 near borders with NMS (Figure 2.3b), in NMS near borders with EU15 (Figure 2.3c), in NMS near borders with other NMS (Figure 2.3d), respectively. Control group is made up of urban municipalities located between 50 and 100 kilometers from the border for all cases.

national NTL in comparison to the control group. Likewise, treated urban municipalities in EU15 close to borders with NMS of the E8 enlargement experienced a relative downturn after the 2004 enlargement.

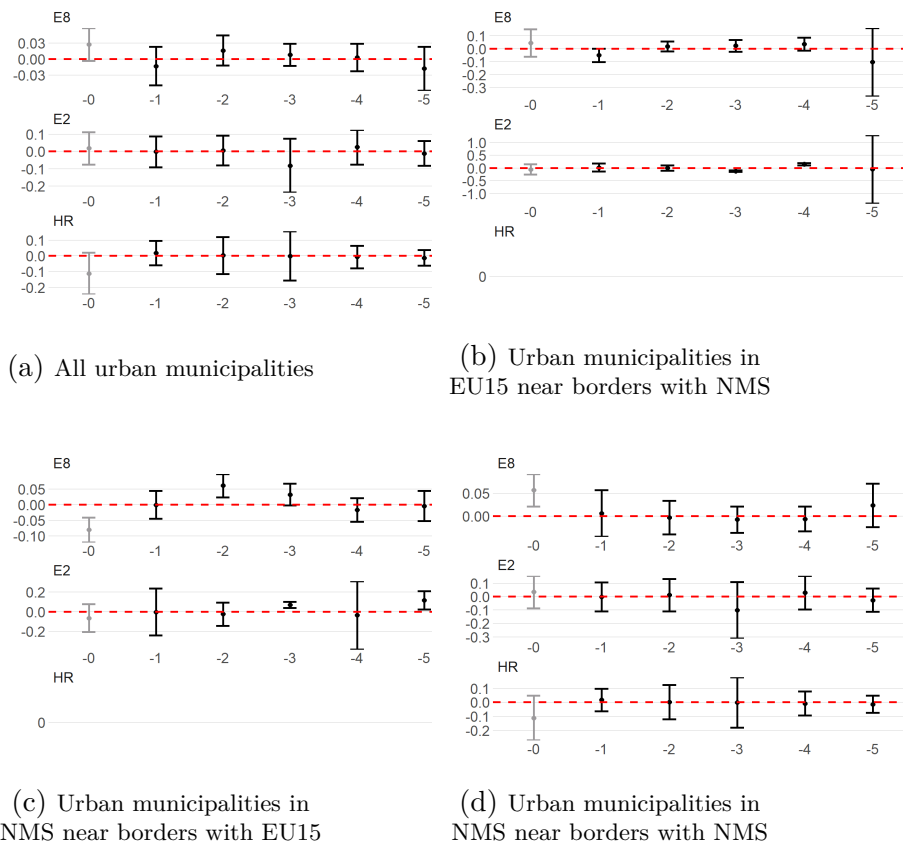
Note that a negative or insignificant impact reported in some columns does not mean that the EU enlargement is not beneficial for these urban municipalities. It only shows

that the benefits are smaller or just as big when compared to urban municipalities located in the hinterland. Furthermore, due to the top coded nature of the NTL, a positive effect most likely reflects a spatial expansion of the urban municipality or population inflow to its suburban areas. Whether or not this has welfare-enhancing effects depends on the development of amenities.

2.4.2 Temporal heterogeneity

The Eastern Enlargements were a gradual process, with trade liberalization taking place in the pre-accession period and further deepening of the integration after the enlargements happened ([Table 2.1](#)). Looking at the dynamics of the impact presented in [Section 2.4.1](#), we can observe a potential of anticipation effects, especially for the different subgroups of the nearest border categories. A possible explanation could be the trade liberalization that happened in the run-up to the EU accession, which can have two implications for the results, presented in columns (2)-(4) of [Section 2.4](#) and [Section 2.4.1](#). Firstly, the Europe agreements could have had an effect in the pre-accession period on the urban municipalities in the vicinity of border areas between the EU15 and the NMS. Secondly, as CEFTA had a lower degree of liberalization, EU accession might have constituted a stronger trade-liberalization shock for the borders between the NMS. Hence, the urban municipalities near a border between two NMS that joined the EU in 2004 benefited more from the enlargement, while the results are insignificant for urban municipalities near the border between an EU15 and NMS country.

[Figure 2.4](#) depicts the results taking anticipation into account. Notice the difference between the different groups of municipalities. Urban municipalities located in the NMS close to borders with an EU15 country might be positively impacted by the enlargement a few years before the E8 took place. This is interesting when taking into consideration that the effect for these treated municipalities becomes negative in 2004. Taken together with the more ambitious liberalization between NMS and EU15 in the 1990s, it might reflect that the border areas in NMS close to EU15 were

Figure 2.4: Anticipation effects with $\delta \in [-5, 0]$.

Note: Figure depict the ATT coefficient for each accession group five years before and after accession and the 90% confidence interval. Detailed results are available in the appendix. On the (Figure 2.4a) are the results containing all urban municipalities, while the other figures depict the results for urban municipalities located in EU15 near border with NMS (Figure 2.4b), urban municipalities located in NMS near border with EU15 (Figure 2.4c) and urban municipalities located in NMS near border with other NMS (Figure 2.4d). Detailed information on the results is in Table B3.

attractive in the pre-accession period, offering the firms a springboard to new market. Coufalova et al. (2024) find that better foreign market access lead to an increase of number of retail firms on the Czech side of the border with Austria in the 1990s. As such, this may indicate that, during this period, EU15 inhabitants increased their demand for goods and services in the NMS, taking advantage of price differences. Furthermore, another potential aspect is the possibility of an informal economy in the border areas, utilizing the institutional differences between the NMS and the EU15.

On the contrary, urban municipalities located in NMS close to borders with other NMS began to benefit only once the enlargement took place. The factors mentioned above are less representative for borders between two NMS countries. This contrast may be reflected in the differing results between the border groups.

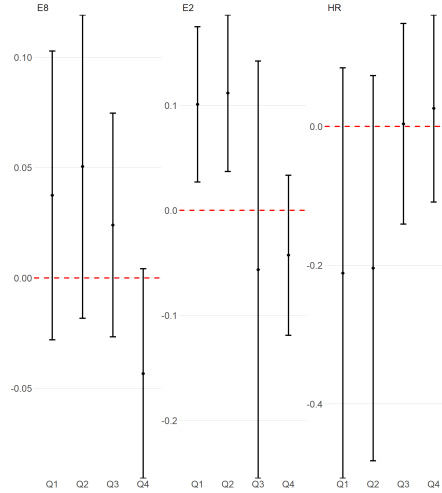
2.4.3 Potential factors

As the treated municipalities as well as the borders they are close to are quite diverse in terms characteristics, I evaluate some of these differences that might influence the extent of the impact of EU enlargement on these urban municipalities. The impact of EU accession on border urban municipalities may depend on the size of the urban municipality. Assuming that the impact of trade liberalization on the surrounding area diminishes with distance means that the shock is a local one. As such, trade liberalization can have a bigger impact on smaller cities than on larger ones, as they are less connected to the global economy and thus more dependent on the local development ([Redding and Sturm, 2008](#)). Another way to see it is that larger cities can have more diversified economies, which absorb the shock. The trade shock also impacts the cities' labor markets differently, depending on the city size. [Brühlhart \(2011\)](#) uses the congestion effect of rising population on the availability of amenities to explain why persons might prefer to settle in smaller cities. Only with a wage premium would they prefer to settle in larger cities. Consequently, when looking at relative effects, trade liberalization can pose a higher shock for populations of smaller municipalities, while impacting more the wage in larger cities.

I use the grid level data on the level of population in 1990 from [Schiavina et al. \(2022\)](#) to compute the population of the urban municipalities in my sample. This provides me with a baseline measure from 1990, i.e., prior to the start of my sample period, and thus unlikely to be affected by the treatment. I then divide the treated group into quartiles based on their population in 1990 and run four models for each quartile, while keeping the control group constant to be able to compare the results.

The results are shown in [Figure 2.5](#). The impact of EU accession is significant only

Figure 2.5: Results by quartile of urban municipality population size.



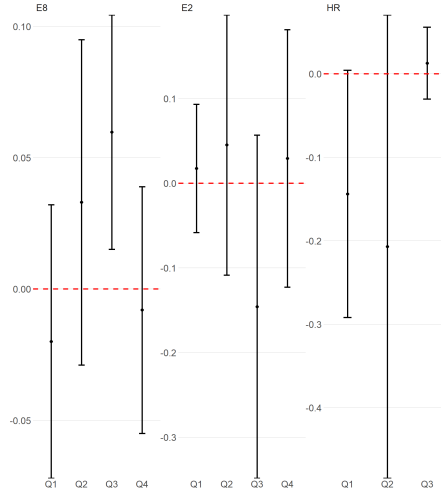
Note: Figures depict the ATT coefficient of each accession group and the 90% confidence interval by quartile of distribution of population size of urban municipalities. Detailed results are available in the appendix. Quartiles have been defined on the whole sample, but used only to subset the treatment group to have the same comparable control group for evaluation of the impact. The quartile ranges are: [3697.46-8117.26) for Q1, [8117.26-12285.16) for Q2, [12285.16-24547.78) for Q3 and [24547.78-748565) for Q4. Detailed information on the results is in [Table B4](#). Spatial distribution of the quartiles is displayed in [Figure B3](#).

for the first two quartiles of population size of treated urban municipalities of the E2 cohort. In other words, the results for the 2007 enlargement are consistent with the findings of [Redding and Sturm \(2008\)](#) and [Brülhart \(2011\)](#), who attribute this to a higher likelihood of local shocks for smaller municipalities or a higher labor supply elasticity, respectively.

Population on the other side of the border can be an important factor. Trade liberalization in the form of EU accession improves the access to markets on the side of the border. A higher number of potential customers on the other side of the border can attract more firms and individuals in the border area [Redding and Sturm \(2008\)](#); [Ahlfeldt et al. \(2015\)](#); [Coufalova et al. \(2024\)](#). To evaluate this mechanism, I use the data from [Schiavina et al. \(2022\)](#) to construct a measure of foreign market potential within 100 kilometers of the border urban municipality, based on [Harris \(1954\)](#):

$$FMP_{i,1990} = \sum_{j \in \mathcal{F}(i)} \mathbf{1}(d_{ij} \leq 100) \frac{P_{j,1990}}{d_{ij}} \quad (2.2)$$

Figure 2.6: Results by quartile of foreign market potential for border urban municipalities.



Note: Figures depict the ATT coefficient of each accession group and the 90% confidence interval by quartile of distribution of foreign market potential of urban municipalities. Detailed results are available in the appendix. Quartiles have been defined on the whole sample, but used only to subset the treatment group to have the same comparable control group for evaluation of the impact. The quartile ranges are: [0-6445.74] for Q1, [6445.74-10385.55] for Q2, [10385.55-21740.46] for Q3 and [21740.46-79147.85] for Q4. Detailed information on the results is in [Table B4](#). Spatial distribution of the quartiles is displayed in [Figure B3](#).

where $j \in \mathcal{F}(i)$ represents the set of cities in foreign country F within 100 kilometers of the city i , P_j is the population of the city j in 1990 and d_{ij} is the distance between the cities i and j . I then divide the treated municipalities into quartiles based on their foreign market potential and calculate the ATT for each quartile separately without making changes in the control group.

The results displayed in figure [Figure 2.6](#) do not indicate much differences of the effects between the quartiles of foreign market potential. With exception being the urban municipalities located close to the 2004 enlargement borders, for which the effect is positive for the third quartile. Interestingly, the impact becomes insignificant for the fourth quartile. A possibility could be that within localities with a large foreign market potential the increased competition from abroad may also play a role ([Crozet and Soubeyran, 2004](#)).

A higher elevation of a border can limit the impact of EU integration on the surrounding areas. To overcome high elevation border, investments in infrastructure development are required, which might be restricted by environmental protection.²⁹ Hence, municipalities close to the more elevated borders might benefit less from the accession, compared to the hinterland [Capello et al. \(2018\)](#). Rivers also constitute barriers. As [Frensch et al. \(2023\)](#) note, crossing a river requires building bridges, or alternative transport such as ferries. At the same time, they remark that rivers also provide pathways for trade.

To investigate this, I use data from [ESA \(2018\)](#) to calculate the average elevation of border segments of treated borders and classify them into quartiles. For the calculation of the ATTs, I subset the treated group by quartile and leave the control group untouched to have comparable results across quartiles.

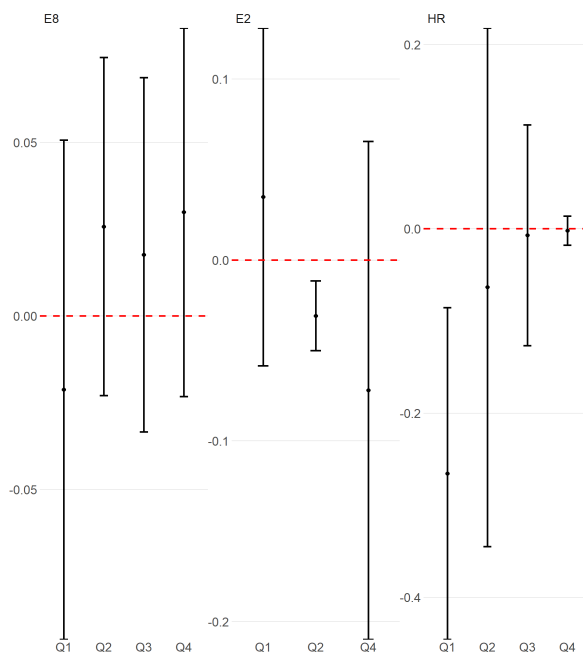
The results are presented in [Figure 2.7](#). Similarly, the quartiles of the elevation of the nearest border point show little significance. Interestingly, the effect is negative for the third quartile of the urban municipalities close to borders of the 2007 enlargement and first quartile of the Croatian enlargement. The latter case comprises mainly urban municipalities near to the eastern part of the border between Hungary and Croatia, which is marked by the Drava and Danube rivers, potentially confirming the barriers posed by first nature geography. However, the former case is puzzling, as it mainly concerns urban municipalities along the northern Hungary–Romania border, an area without obvious natural barriers. Only a handful of treated municipalities lie close to borders defined by natural obstacles.

2.4.4 Robustness checks

Methodological changes. To check for robustness of the results, I first consider alterations in the methodological setup (Panel A in [Table B5](#)). Another way to include

²⁹For example, a large share of the border between Greece and Bulgaria is part of national parks (Kerkini Lake, Rodopi Mountain Range). Similarly, parts of the border area Germany and Czechia have protected status (Český les and Šumava). Infrastructure projects are possible in such areas but are subject to additional restrictions due to the protected status of the region.

Figure 2.7: Results by quartile of elevation of nearest border segment.



Note: Figures depict the ATT coefficient of each accession group and the 90% confidence interval by quartile of distribution of closest border segment of urban municipalities. Detailed results are available in the appendix. Quartiles have been used only to subset the treatment group to have the same comparable control group for evaluation of the impact. The quartile ranges are: [3.33-131.58) for Q1, [131.58-334.12) for Q2, [334.12-683.43) for Q3 and [683.43-1760.09) for Q4 (in meters). Detailed information on the results is in [Table B4](#). Spatial distribution of the quartiles is displayed in [Figure B3](#).

within country developments than computing relative NTL is to add country fixed effects as the covariates. Additionally, I also include level of population in 1990 as another covariate to be able to compare similar urban municipalities. I report the results in columns (1)–(4), computed using the double-robust estimator of [Callaway and Sant’Anna \(2021\)](#), with covariates included in both the outcome regression and the inverse probability weighting. Notice that the ATT for all municipalities in E8 as well as both ATT for the 2013 enlargements become significant. However, the dynamics in [Figure B4](#) suggest greater bias than the baseline results in [Section 2.4.1](#), likely due to violations of the parallel trends assumption in the pre-treatment period.

Another possibility is to use a distinct difference-in-differences approach. I opt for

the [Wooldridge \(2021\)](#) extended two way fixed effects as it can be robust to anticipation and more efficient ([Rüttenauer and Aksoy, 2024](#)). The results, in columns (5)-(8), show minor changes. Namely, the coefficient for the E8 urban municipalities in NMS close to borders with EU15 loses significance, while the ones for the E2 urban municipalities on either side of the EU15-NMS borders become significant.

Altering the control group. I continue with adjusting the control group (Panel B in [Table B5](#)). [Callaway and Sant’Anna \(2021\)](#) allows to have options for a control group made of not-yet treated units or never-treated units. While in the baseline results I opted for the former, in columns (1)-(4) I display the results for the latter case. The choice of the control group has little impact on the coefficients. I undertake a second change of the control group to include just the urban municipalities in the same countries as the treatment group in the lower part of the table. However, the impact, reported in columns (5)-(8) remains very similar to the baseline results.

Modifying the treatment group. Urban municipalities located in NUTS3 border regions may still be subjected to benefits and obstructions associated with proximity to a border. For instance, when examining the firms located close to the Italian borders, [Fantechi and Fratesi \(2023\)](#) find that not only firms close to the border lag behind the ones further away, but also the ones located in Italian NUTS3 border regions experience lower levels of productivity. Hence, I change the definition of the treatment group to encompass urban municipalities that are part of a NUTS3 border region while being 50 kilometers from any other enlargement to see whether how the treatment effects change when the treatment group expands. I also remove the buffer zone between the treatment and control groups, leading to a higher number of observations in the treatment and control groups.³⁰

The results, documented in Panel C of [Table B5](#), remain significant for the E8 cohort in NMS, but increase numerically. This may indicate that urban municipalities that

³⁰This does not change much the estimated coefficients. For instance, the coefficient for E8 in column (4) of [Table B5](#) would be 0.634 (and significant) with the buffer in place.

are in the border region and further away from the border, have higher growth rate than the ones located in direct proximity of the border.

Restricting the sample. I proceed with general changes in the sample (Panel D of [Table B5](#)). In the baseline specification, I excluded all urban municipalities with growth rates above 100% or equal to -100%, as well as those with missing or zero values. As an alternative, I remove only the individual observations, which results in an unbalanced panel. I present the results in columns (1)-(4). The switch to an unbalanced panel does yields negligible changes. When examining the shares of individual urban municipalities on national NTL, it is the capital cities that exhibit the highest shares ([Figure B5](#)). Being outliers in this aspect, I remove them from the sample as a further robustness check (columns (5)-(8)). What changes is that the general result for the border urban municipalities of the E8 cohort and the Croatian enlargement becomes significant.

Using alternative relative NTL measurements. Although the harmonized NTL dataset of [Li et al. \(2020\)](#) provides the NTL over an extensive period, the data remains top-coded. As an alternative to simply summing NTL across an urban municipality, I compute weighted sums. Specifically, I weight the NTL digital numbers by the frequency with which individual values occur within that municipality in a given year, before calculating relative NTL. This approach, inspired by [Pinkovskiy and Sala-i Martin \(2020\)](#), allows me to mitigate the censored nature of the data by assigning less weight to the top-coded cells (fewer than 3% of the sample) while better capturing the heterogeneous distribution within each urban municipality. The results, reported in columns (1)-(4) of Panel E in [Table B5](#), do not differ much from the baseline results. Similarly, in columns (5)-(8) I report results, where I use population in 1990 on grid-level as weight for the weighted sum of NTL, before calculating relative NTL. In this case, the coefficients for the E8 border urban municipalities located in NMS numerically increase numerically. Moreover, the general ATT for the treated urban municipalities of the 2004 and 2013 cohorts becomes significant. However, all is limited with the use of urban municipalities.

Lastly, the NTL data provided by [Li et al. \(2020\)](#) combines data from the DMSP-OLS (1992-2013) and VIIRS satellites (2014-2021). To assess whether the combination of these data impacts the result, I restrict the sample to cover only data from the former satellites (last part of Panel E). This constraint does not qualitatively alter the results.

Overall the sensitivity checks show that the significance of the result for treated municipalities of the E8 enlargement located in NMS, either near borders with EU15 countries or other NMS countries, are robust to various changes in the specification. A few of the robustness checks indicate significant results for the E8 and the 2013 enlargement, though the evidence is not consistent.

2.5 Conclusions

In this paper, I assess the impact of three Eastern EU enlargements on urban municipalities located in the proximity of the borders affected by these enlargements. To enable a long-run evaluation of the impact at a granular level of urban municipalities, I calculate the growth rates of the proportion of each municipality's sum of nighttime lights in total national nighttime lights, based on the harmonized NTL data developed by [Li et al. \(2020\)](#), as a proxy for economic development. The [Callaway and Sant'Anna \(2021\)](#) difference-in-differences estimator allows me to account for staggered treatment timing across the three cohorts of EU Eastern enlargements, avoiding the drawbacks of the two-way fixed effects estimator. I also consider structural heterogeneity of the effect. That is, I calculate the impact for subsets of treated urban municipalities based on whether they are located near a border between two NMS as well as separately for both sides of for the borders between NMS and EU15.

My results suggest that the results are significantly positive for the municipalities located in acceding countries of the 2004 enlargement close to a border with other new member states. On the other hand, the effect of the 2004 enlargement urban municipalities of the NMS near borders with EU15 countries is negative. This result seems at first surprising, as one would expect the beneficiaries to be located on both

sides of the border between new member states and EU15 countries, considering that this provides one side of the border with access to new markets and the other side with access to a market located in a more developed economy. Yet, accounting for anticipation effects, I observe that urban municipalities on the NMS side of the EU15-NMS borders might have benefited from the liberalization before the enlargement. The reason being that trade between the NMS themselves was less liberalized in the run-up to the accession than between the NMS and the EU15 (Egger and Larch, 2011).

Upon examining potential factors influencing the impact of the enlargement, I find that that urban municipalities of the 2004 enlargement with a higher market potential benefited from the enlargement. Lack of significance among the quartiles for the urban municipalities of the other enlargement, might suggest that closeness to EU15 helped the 2004 enlargements. Smaller municipalities of the E2 cohort have significantly positive effects in comparison to the urban municipalities in the hinterland. This aligns with results from Redding and Sturm (2008) and Brülhart (2011) who suggest that smaller cities are more sensitive to local shocks or have a higher labor supply. I also evaluate, whether the impact of enlargement differed across quartiles of elevation at the nearest border point. My findings indicate that the first quartile of the 2013 enlargement and second quartile of the E2 cohort were dampened upon enlargement. In the former case, it could be argued that natural barriers impeded the effect of accession, since these municipalities are located along sections of the Croatia–Hungary border crossed by the Drava and Danube rivers.

My results are robust to alternative specifications. These include changes in the methodological approach (different dependent variable with matching and different difference-in-differences estimator), adjustments of the control group (never-treated instead of not-yet treated and inclusion of observations from the same countries as treated observations), alteration of the treatment definition (observations located in NUTS 3 border regions), and changes restricting the time period to years covered by the DMSP-OLS satellites (1992-2013) as well as weighting the raw NTL data. None

of the adjustments lead to qualitative changes in the results.

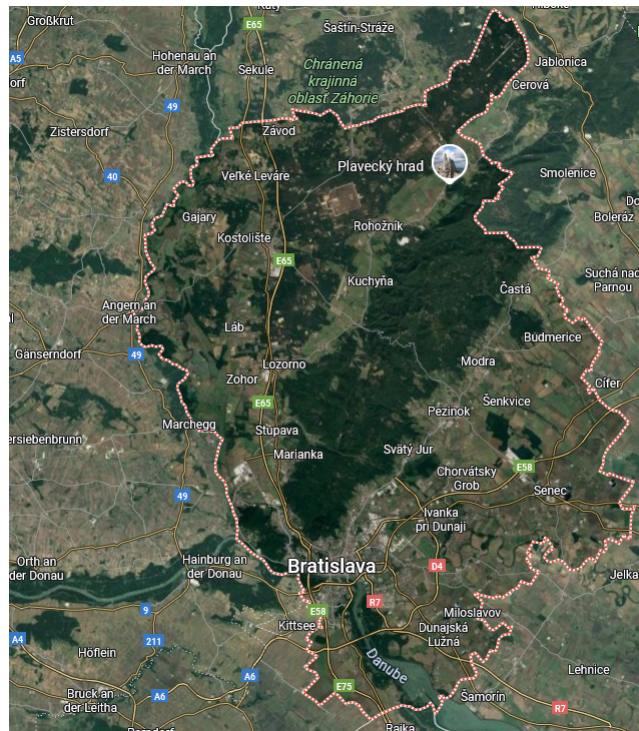
Yet, it needs to be noted that a negative or an insignificant result does not imply that an urban municipality failed to benefit from the enlargements. Rather, it suggests that their measured impact is either small or indistinguishable from that of urban municipalities in the hinterland, and must also be understood relative to developments within their own countries. Similarly, a positive effect does not necessarily mean it is also welfare enhancing. This depends also on the policies accompanying expansion and development of the urban municipality.

[Petrakos et al. \(2008\)](#) asked whether EU integration will turn borders from barriers separating two countries to bridges connecting their border areas or tunnel bypassing them. In a similar way, I ask here whether the enlargement brings more light into border areas. My answer is very similar to [Mitze and Breidenbach \(2024\)](#): it depends on the characteristics of the municipalities, the border that separates them and the countries on both sides of the border. Yet, my results might also support the previous arguments stressing the importance of market potential. Rapid advancements in the availability of granular data and improvements in econometric methodology can shed further light in the future regarding the obstacles and boosters of economic integration of these enlargements.

It is essential to find the barriers that hinder the integration of border areas into the EU. If we are able to identify them, we can learn lessons for future enlargements, as well as helping the current border areas to escape or avoid development traps. Identification of problems of current border areas of the EU and border of areas of prospective EU accession countries (mainly countries of the Western Balkans and Ukraine) is also necessary and can be achieved with granular data.

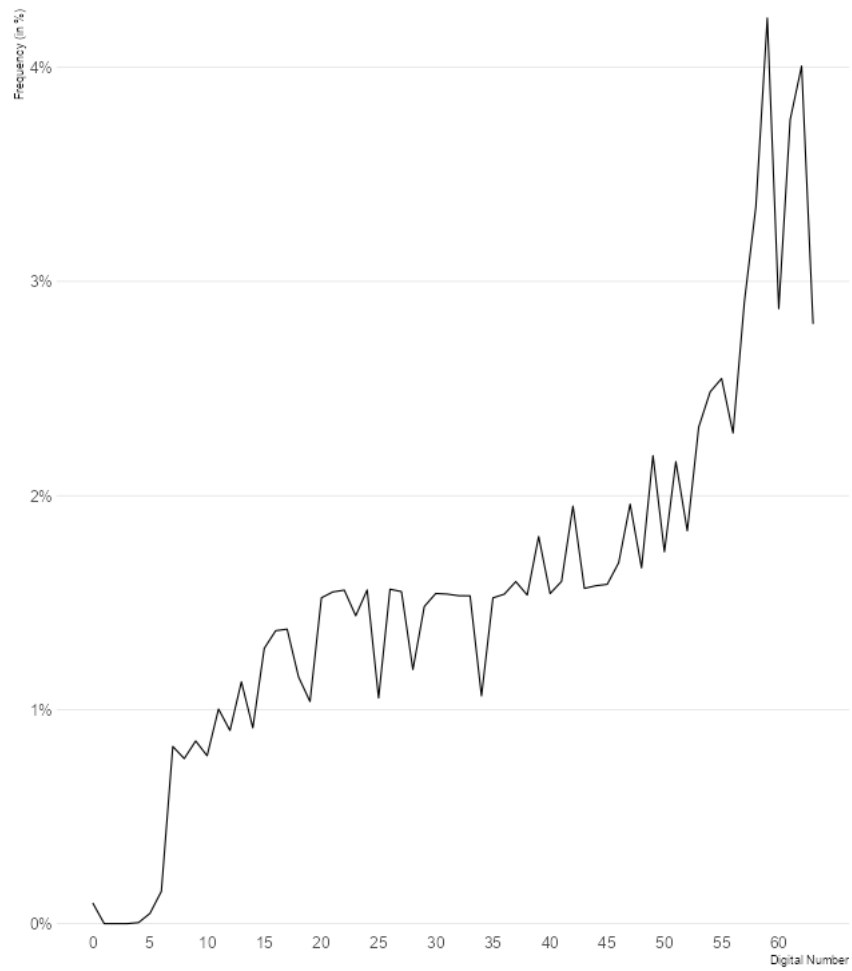
Appendix B

Figure B1: Satellite image of Bratislava Region.



Note: The figure shows a satellite image of the Bratislava Region (bordering Austria, Czechia and Hungary) to illustrate the NTL data in figure [Figure 2.1](#). Source: Google Maps.

Figure B2: Distribution of the digital number.



Note: Distribution of total number of cells of the area covered by the digital number they represent throughout the period observed.

Table B1: Number of observations by country.

CNTR_CODE	N
AT	36
BG	44
CZ	128
DD	95
DE	31
EL	3
HR	22
HU	110
IT	43
LT	4
LV	6
PL	109
RO	47
SI	14
SK	61

Notes: The table reports cross-sectional count of observations by country, denoted by their ISO 3166- further denotes the former German Democratic Republic.

Table B2: Number of observations by nearest border (treated group only).

Nearest border	N
AT-CZ	9
AT-HU	11
AT-SI	14
AT-SK	10
BG-EL	8
BG-RO	23
CZ-DD	45
CZ-DE	17
CZ-PL	66
CZ-SK	22
DD-PL	28
HR-HU	10
HR-SI	18
HU-RO	20
HU-SK	43
IT-SI	20
LT-LV	3
LT-PL	1
PL-SK	26

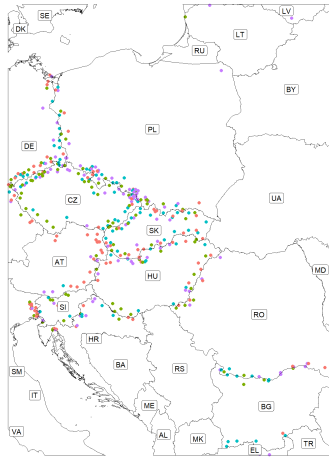
Notes: The table reports cross-sectional count of observations by nearest border, denoted by the ISO codes of the countries separated by the border. DD further denotes the former German Democratic Republic.

Table B3: Anticipation effects with $\delta \in [-5, 0]$.

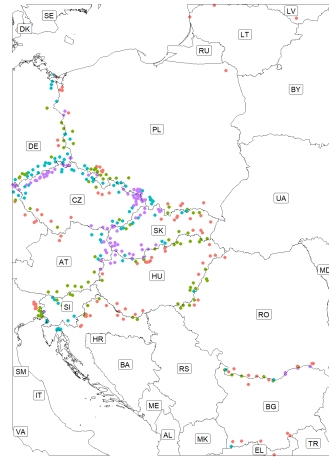
	(1) All $\Delta \text{rel_NTL}$	(2) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(3) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(4) <i>NMS-NMS</i> $\Delta \text{rel_NTL}$	(5) All $\Delta \text{rel_NTL}$	(6) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(7) <i>EU15-NMS</i> $\Delta \text{rel_NTL}$	(8) <i>NMS-NMS</i> $\Delta \text{rel_NTL}$
ATT (E8)	-0.0135 (0.016)	-0.0521 (0.0286)	-0.0011 (0.0206)	0.0055 (0.0267)	0.0158 (0.0132)	0.0171 (0.0194)	0.0605* (0.0218)	-0.0038 (0.0173)
ATT (E2)	-0.0018 (0.0459)	0.0171 (0.0337)	-0.0032 (0.1215)	-0.0028 (0.0537)	0.0054 (0.0435)	-0.0033 (0.0527)	-0.0251 (0.0618)	0.0101 (0.0553)
ATT (HR)	0.0166 (0.0425)			0.0166 (0.0426)	0.0016 (0.0593)			0.0016 (0.064)
Anticipation	T-1	T-1	T-1	T-1	T-2	T-2	T-2	T-2
N (overall)	753	449	431	591	753	449	431	591
N (treated)	394	90	72	232	394	90	72	232
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
ATT (E8)	0.0078 (0.0111)	0.0211 (0.0219)	0.0318 (0.015)	-0.0081 (0.0142)	0.0028 (0.0125)	0.0352 (0.0231)	-0.0174 (0.0193)	-0.0068 (0.0132)
ATT (E2)	-0.0824 (0.0907)	-0.1223* (0.012)	0.0687* (0.0146)	-0.1019 (0.1047)	0.0247 (0.0516)	0.15* (0.0217)	-0.0369 (0.1526)	0.0276 (0.0537)
ATT (HR)	-0.0018 (0.0864)			-0.0018 (0.0872)	-0.0083 (0.0377)		(0.0397)	-0.0083
Anticipation	T-3	T-3	T-3	T-3	T-4	T-4	T-4	T-4
N (overall)	753	449	431	591	753	449	431	591
N (treated)	394	90	72	232	394	90	72	232
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
ATT (E8)	-0.0183 (0.021)	-0.1042* (0.0457)	-0.0045 (0.0234)	0.0236 (0.02)				
ATT (E2)	-0.0112 (0.0381)	-0.0496 (0.1294)	0.1156* (0.0482)	-0.0271 (0.0387)				
ATT (HR)	-0.0141 (0.0286)			-0.0141 (0.0284)				
Anticipation	T-5	T-5	T-5	T-5				
N (overall)	753	449	431	591				
N (treated)	394	90	72	232				
T	29	29	29	29				
Cluster	NUTS3	NUTS3	NUTS3	NUTS3				

Note: Clustered standard errors in parentheses. Significance: ‘*’ 90% confidence band does not cover 0. The rows indicate group-time treatment effects for municipalities belonging to respective cohorts. The first and fifth column show the results of a general model. The next columns correspond to subdivisions of the treatment group: urban municipalities located in near EU15-NMS border on the EU15 side ((2) and (6)) or NMS side ((3) and (7)) or near the borders between two NMS countries ((4) and (8)).

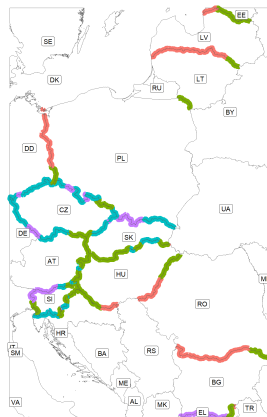
Figure B3: Average elevation of border segments.



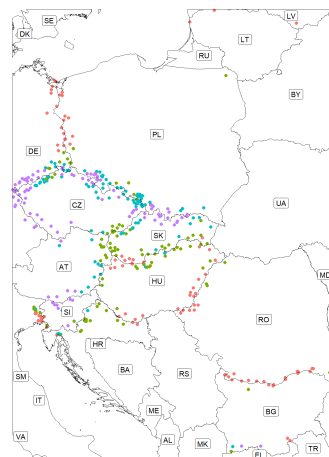
(a) Quartiles of urban municipality populations



(b) Quartiles of the size of foreign market potential of urban municipalities



(c) Quartiles of elevation of border segments



(d) Quartiles of average elevation by municipality

Table B4: Results based on quartiles of population size and nearest border segment elevation.

	(1) All Δ rel_NTL	(2) EU15-NMS Δ rel_NTL	(3) EU15-NMS Δ rel_NTL	(4) NMS-NMS Δ rel_NTL	(5) All Δ rel_NTL	(6) EU15-NMS Δ rel_NTL	(7) EU15-NMS Δ rel_NTL	(8) NMS-NMS Δ rel_NTL
ATT (E8)	0.051 (0.0368)	0.0354 (0.0363)	0.0415 (0.0267)	-0.0392 (0.0255)	0.0044 (0.033)	0.0319 (0.0364)	0.0562* (0.0295)	-0.0045 (0.0291)
ATT (E2)	0.1115* (0.0375)	0.1009* (0.0484)	-0.0565 (0.1187)	-0.0427 (0.0393)	0.0234 (0.0358)	0.0431 (0.1108)	-0.1459 (0.1204)	0.0293 (0.0925)
ATT (HR)	-0.2041 (0.148)	-0.2113 (0.1571)	0.0038 (0.096)	-0.1438* (0.0811)	-0.2069 (0.0846)	0.0128 (0.1674)		
Model	Size	Size	Size	Size	FMP	FMP	FMP	FMP
Quartile	1	2	3	4	1	2	3	4
Quartile range	[3697.46 - 8117.26]	[8117.26-12285.16]	[12285.16-24547.78]	[12285.16-748565.00]	[0-6445.74]	[6445.74-10385.55]	[10385.55-21740.46]	[21740.46-79147.85]
N (overall)	458	458	457	457	458	458	457	457
N (treated)	99	99	98	98	99	99	98	98
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
	(9) All Δ rel_NTL	(10) EU15-NMS Δ rel_NTL	(11) EU15-NMS Δ rel_NTL	(12) NMS-NMS Δ rel_NTL				
ATT (E8)	-0.0201 (0.0458)	0.017 (0.0245)	0.0405 (0.0301)	0.0314 (0.027)				
ATT (E2)	0.0349 (0.052)	-0.0309* (0.0098)	-0.0072 (0.07)	-0.0722 (0.0707)				
ATT (HR)	-0.2659* (0.1051)	-0.0636 (0.1303)		-0.0021 (0.0084)				
Model	Altitude	Altitude	Altitude	Altitude				
Quartile	1	2	3	4				
Quartile range	[3.33 - 131.58]	[131.58-334.12]	[334.12-683.43]	[683.43-1760.09]				
N (overall)	458	458	457	457				
N (treated)	99	99	98	98				
T	29	29	29	29				
Cluster	NUTS3	NUTS3	NUTS3	NUTS3				

Note: Robust standard errors in parentheses. Significance: ** 90% confidence band does not cover 0. Table shows results for treated urban municipalities belonging to different quartiles of size in terms of population (column (1) to column (4)), market potential (column (5) to column (8)) and elevation of the nearest border segment (column (9) to column (12)), with the quartile descriptions provided in rows quartile and quartile range.

Quartiles have been defined on the whole sample, but used only to subset the treatment group to have the same comparable control group for evaluation of the impact.

Table B5: Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	<i>EU15-NMS</i>	<i>EU15-NMS</i>	<i>NMS-NMS</i>	All	<i>EU15-NMS</i>	<i>EU15-NMS</i>	<i>NMS-NMS</i>
	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL
Panel A: Methodological changes								
ATT (E8)	0.0297*	0.0431	-0.0692*	0.0702*	-0.0029	-0.02	-0.0061	0.0078*
	(0.0147)	(0.0286)	(0.0325)	(0.0168)	(0.0066)	(0.0139)	(0.0079)	(0.0045)
ATT (E2)	-0.0177	-0.062	-0.0529	-0.0004	-0.0092	-0.0269*	-0.0199*	-0.0069
	(0.0444)	(0.0465)	(0.0688)	(0.0529)	(0.0074)	(0.0142)	(0.011)	(0.0077)
ATT (HR)	-0.2488*			-0.2184*	-0.0195			-0.0195
	(0.0843)			(0.0755)	(0.0128)			(0.0128)
Model	Matching	Matching	Matching	Matching	Wooldridge	Wooldridge	Wooldridge	Wooldridge
N (overall)	753	449	431	591	753	449	431	591
N (treated)	394	90	72	232	394	90	72	232
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
Panel B: Control group changes								
ATT (E8)	0.0211	0.0431	-0.0806*	0.0507*	0.0269	0.0399	-0.0793*	0.0607*
	(0.0161)	(0.0272)	(0.0198)	(0.0166)	(0.0182)	(0.0273)	(0.0238)	(0.02)
ATT (E2)	0.0177	-0.0593	-0.0664	0.033	0.0177	-0.0503	-0.0709	0.0288
	(0.0482)	(0.0385)	(0.0662)	(0.0603)	(0.0493)	(0.0293)	(0.0702)	(0.0588)
ATT (HR)	-0.1126			-0.1126	-0.1126			-0.11
	(0.071)			(0.0743)	(0.0767)			(0.0786)
Model	Never-treated	Never-treated	Never-treated	Never-treated	Homogenous	Homogenous	Homogenous	Homogenous
N (overall)	753	449	431	591	753	208	313	473
N (treated)	394	90	72	232	394	90	72	232
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
Panel C: Treatment group changes								
ATT (E8)	0.0289	0.0166	-0.064*	0.0613*				
	(0.017)	(0.0213)	(0.0203)	(0.0163)				
ATT (E2)	0.0307	-0.0514	-0.0476	0.0435				
	(0.0322)	(0.0388)	(0.036)	(0.0371)				
ATT (HR)	-0.0715			-0.0741				
	(0.0665)			(0.0589)				
Model	Region	Region	Region	Region				
N (overall)	1078	515	473	811				
N (treated)	731	159	117	455				
T	29	29	29	29				
Cluster	NUTS3	NUTS3	NUTS3	NUTS3				

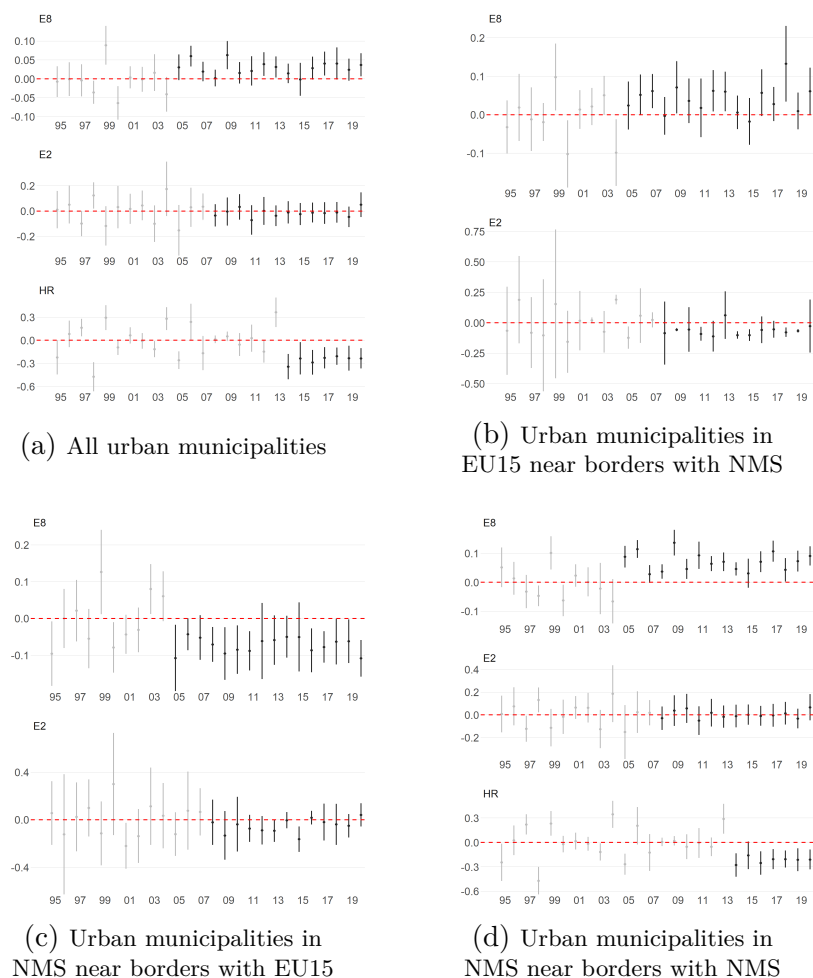
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Table B5 – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	<i>EU15-NMS</i>	<i>EU15-NMS</i>	<i>NMS-NMS</i>	All	<i>EU15-NMS</i>	<i>EU15-NMS</i>	<i>NMS-NMS</i>
	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL
Panel D: Sample restrictions								
ATT (E8)	0.0241 (0.0157)	0.0417 (0.0289)	-0.089* (0.02)	0.0541* (0.0166)	0.0268* (0.0161)	0.0423 (0.0284)	-0.0797* (0.0215)	0.0559* (0.018)
ATT (E2)	0.0162 (0.0471)	-0.0639 (0.0532)	-0.071 (0.0766)	0.0305 (0.0537)	-0.06 (0.0452)	-0.0672 (0.0614)	0.0322 (0.061)	(0.0626)
ATT (HR)	-0.1099 (0.07)			-0.1099 (0.0666)	-0.1185* (0.0687)			-0.1185 (0.0794)
Model	Unbalanced	Unbalanced	Unbalanced	Unbalanced	No capitals	No capitals	No capitals	No capitals
N (overall)	828	506	487	663	748	446	427	587
N (treated)	414	92	73	249	392	90	71	231
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
Panel E: Alternative NTL								
ATT (E8)	0.027 (0.0164)	0.0385 (0.0273)	-0.0786* (0.0205)	0.0588* (0.0166)	0.0377* (0.0161)	0.0229 (0.0274)	-0.0592* (0.0227)	0.0789* (0.0163)
ATT (E2)	0.0213 (0.0457)	-0.0556 (0.0464)	-0.0628 (0.0627)	0.0366 (0.0614)	0.027 (0.0501)	-0.0793 (0.088)	-0.0704 (0.0825)	0.0456 (0.0584)
ATT (HR)	-0.1139 (0.0751)			-0.1139 (0.0769)	-0.1328* (0.0654)			-0.1328 (0.0688)
Model	Index	Index	Index	Index	Weighted	Weighted	Weighted	Weighted
N (overall)	753	449	431	591	753	449	431	591
N (treated)	394	90	72	232	394	90	72	232
T	29	29	29	29	29	29	29	29
Cluster	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3	NUTS3
ATT (E8)	0.0298 (0.0172)	0.0402 (0.0276)	-0.0833* (0.0199)	0.0608* (0.0174)				
ATT (E2)	0.0225 (0.051)	-0.0568 (0.044)	-0.0696 (0.095)	0.039 (0.0623)				
ATT (HR)	-0.1327 (0.0955)			-0.1327 (0.0963)				
Model	Until 2013	Until 2013	Until 2013	Until 2013				
N (overall)	753	449	431	591				
N (treated)	394	90	72	232				
T	21	21	21	21				
Cluster	NUTS3	NUTS3	NUTS3	NUTS3				

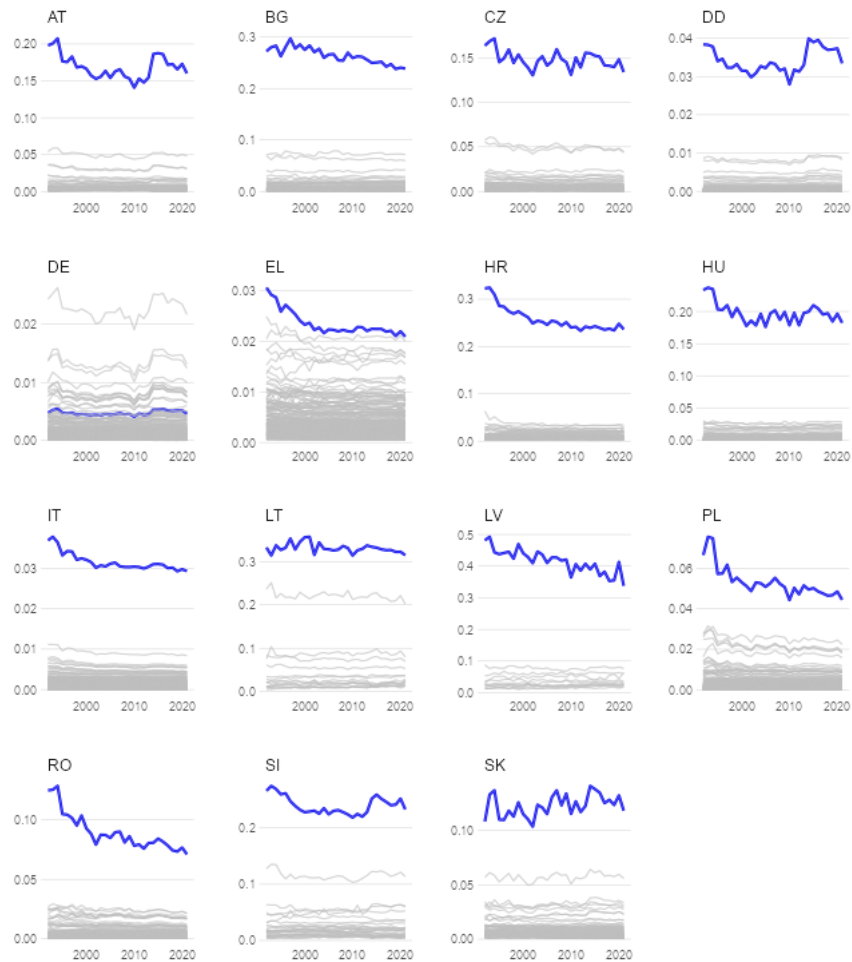
Note: Clustered standard errors in parentheses. Significance: ** 90% confidence band does not cover 0. The results of a general model are presented in columns (1) and (5). The next columns correspond to subdivisions of the treatment group: urban municipalities located near EU15-NMS borders on the EU15 side ((2), (6)) or NMS side ((3), (7)) or near the borders between two NMS countries ((4), (8)). Matching denotes using matching with covariates within the [Callaway and Sant'Anna \(2021\)](#) estimator, Wooldridge is the use of the [Wooldridge \(2021\)](#) estimator, never-treated is the control group restriction to never-treated observations, Homogenous is the control group restriction to observations from the same country, Region is the change of the treatment group to border region, Unbalanced is the change of specification to unbalanced panel, no capitals excludes capital cities, and index, weighted and until 2013 denote various alternatives of relative NTL used.

Figure B4: Dynamics of the matching results.



Note: Figures show the dynamics of the impact for urban municipalities in the respective cohorts. The pre-treatment values on this figure correspond to the ATTs (what would have been the effect of participating in the treatment if that given year were a year with treatment participation). Urban municipalities in the treatment group are located within 25 kilometers of borders part of the 2004, 2007 and 2013 enlargements (Figure B4a). In the other subfigures the treatment group is made up of urban municipalities located in EU15 near borders with NMS (Figure B4b), in NMS near borders with EU15 (Figure B4c), in NMS near borders with other NMS (Figure B4d), respectively. Control group is made up of urban municipalities located between 50 and 100 kilometers from the border for all cases.

Figure B5: Share of capital cities on national NTL.



Note: The figure shows the development of the share on the national NTL for all urban municipalities in the sample, with capital cities in blue. In the case of the pre-1989 division of Germany, Bonn is marked as the capital city for Federal Republic of Germany (DE) and Berlin for the German Democratic Republic (DD).

Chapter 3

Growing in the Desert: A Comparative Analysis of Firms Located in Border Regions of the 2004 Enlargement

3.1 Introduction

Border areas are akin to deserts in terms of economic landscape. That is how [Lösch \(1944\)](#) described the disadvantage economic agents face, when located in the border areas. His conclusion relies on the assumption that a firm chooses its location to best serve its demand subject to profit maximization. If a border is part of the area a firm supplies, transaction costs may arise when it wants to supply goods or services on the other side of the border. Consequently, the firm might rather decide to settle in the hinterland, where the entire market area lies within a single country. That would lead to border areas being mainly populated by smaller firms, which require smaller markets. As such, the lack of economies of scale makes it less profitable for firms to locate close to borders. In other words, borders create spatial disequilibria ([Van Houtum, 2000](#)). As such, eliminating borders by economic liberalization can increase the potential of firms in border areas.

One example of such an event is the 2004 enlargement of the European Union (EU). The old and new EU member states (henceforth referred to as the EU15 and the NMS, respectively) were separated for the duration of the Cold War by borders that

were almost impermeable.¹ With the dissolution of the Eastern Bloc, several formerly communist countries started their path towards joining the EU, with the first 8 countries being integrated in 2004. To access this new market, the NMS had to implement fundamental reforms so as to meet the democratic and free-market principles of the EU. Additionally, the pre-accession period was marked by trade liberalization with the EU15 countries as well as among the NMS themselves, within the scope of the so-called *Europe Agreements* and *Central and Baltic European Trade Agreements*, respectively (Baldwin and Wyplosz, 2022). Integrating the EU meant gaining access to the largest single market and benefiting from the free movement of goods, labor, and capital. Joining the Schengen area in 2008, furthermore, resulted in an extension of the free movement of persons for the new member states (NMS).

The removal of barriers posed by borders has the potential to fundamentally alter the nature of border regions, making them more attractive for both existing and new firms. Although joining the EU single market eliminated customs between the acceding countries and the EU15, as well as among the acceding countries themselves, the benefits for firms extend beyond this aspect. Already during the pre-accession period, candidate countries are required to adapt the *acquis communautaire*—the body of existing EU laws—so that they are institutionally and legally prepared to join the EU (Baldwin and Wyplosz, 2022). This harmonization reduces institutional barriers between countries. Together with the removal of barriers to the free movement of goods, services, capital, and persons, this fosters an increase in cross-border trade and economic integration. Border areas, being at the forefront of this exchange, can thus become attractive to economic agents, including firms, serving as springboards into new markets.

Yet EU integration does not eliminate all barriers. Capello et al. (2018) categorize these into institutional (different degrees of EU integration or lack of cross-border

¹The NMS that joined the EU in 2004 are Estonia, Latvia, Lithuania, Poland, Czechia, Slovakia, Hungary and Slovenia along with Malta and Cyprus. We omit the last two countries from the analysis due to their nature of being island countries. As EU15 countries we have in the scope of this analysis Austria, Italy and Germany.

cooperation), physical (such as rivers or mountains), and socio-cultural (including trust, language, and legal differences). The persistence of these barriers may restrict the attractiveness of border areas for firms.

In this way, the enlargements of the EU and the Schengen Area should, at least in theory, make border regions less desert-like. In this paper we use data from the Orbis database to analyze the performance of firms in border areas that were affected by the 2004 enlargement. We define border firms as those located in municipalities within 25 kilometers of countries' borders. We allow for heterogeneous effects depending on border's location. First, we consider the effect on firms located in the EU15 border regions affected by the enlargement. Second, we consider the NMS perspective and allow the effect of firms in the borders to vary depending on whether they are close to an EU15 border, another NMS border, or contiguous to an exterior (after the enlargement) border as they could be subject to trade diversion.

As the time frame of our data, from 1998 until 2021, also captures the pre-accession anticipation effects, we cannot assess causal effects of EU enlargement, but rather compare the performance of firms near the affected borders. In other words, we compare the level and growth of their profitability to firms located in municipalities in the hinterland. Profitability, as a measure of efficiency, can indicate whether firms are able to fully exploit the opportunities offered by larger markets.

We use earnings before interest, taxes, depreciation, and amortization (EBITDA) per employee as our main dependent variable, as it captures firm-level productivity while being less affected by financial structures or cross-country tax differences. For robustness, we also consider EBITDA per asset, which reflects capital productivity without distortions from interest, taxes, or accounting rules. Compared to alternatives such as return on assets or turnover growth, these measures better capture firms' operating performance. This allows us to assess whether the border effects we identify pertain to labor or capital productivity.

In areas with EU integration and cross-border cooperation, market access expands and

transaction costs decrease, enabling firms to operate more efficiently and potentially achieve higher EBITDA per employee. Conversely, lower levels of profitability may signal the persistence of transaction costs at the border, even after formal barriers have been removed.

The aim of our analysis is to see whether firms located in internalized border areas of the 2004 enlargement can benefit from the increase in market potential. Assuming border areas are peripheral within their own countries, they provide firms with lower production costs and improved market access that can act as a springboard for exports. Yet, agglomeration effects associated with more densely populated areas may dissuade companies from moving to border areas. Furthermore, despite the new economic integration, impediments persist in the EU that hamper the development of border areas. Firstly, some borders are shaped by the natural topography, such as mountains or rivers, which may stipulate further transactions on trade (Capello et al., 2018). Secondly, institutional barriers between countries, such as differences in laws and administrative procedures, remain important. This is also connected to socio-cultural differences such as languages and perceived trust (Camagni et al., 2020). Lastly, the border areas in the proximity of external borders could be affected by trade diversion.

Our results indicate lower growth in profitability for firms located in border areas between an NMS country and an EU15 country. Examining aggregate sectors, we observe contrasting trends. Firms in the construction sector in NMS near borders with EU15 countries experience profitability growth. Alongside construction, firms in production and services at the same borders also exhibit higher profitability, whereas firms in the agriculture sector show a decline. Furthermore, firms in NMS near borders with non-EU countries generally show lower level of profitability in production sectors.

Firm size also plays a significant role. Among firms in NMS, small firms near borders with other NMS or EU15 countries have higher level of profitability. The level of profitability declines with firm size. Similar development can be observed at the

external borders of the NMS.

Our paper mainly contributes to the literature on the impact of European economic integration on border areas. Most of the analyses on this topic concentrate on the effect on the regional or municipal level using the differences-in-differences approach to compare the development of the border areas to the ones located further away (Brakman et al., 2012; Wassmann, 2016; Mitze and Breidenbach, 2018; Heider, 2019; Brühlhart et al., 2019; Kapanadze, 2021; Coufalová et al., 2024; Mitze and Breidenbach, 2024). The literature mostly finds a positive impact of EU enlargement on the border areas, but also stresses the importance of the market potential on the other side of the border as a key determinant. Mitze and Breidenbach (2024) highlight also the role of structural, temporal and spatial heterogeneities between the different EU enlargements that took place from 1986 until 2007. Other papers use data on multinational firms (Merlevede and Purice, 2019) and foreign direct investments (FDI) (Serwicka et al., 2024) to show the importance of EU economic integration for productivity increases through backward linkages and increases in FDI. Our paper is closely related to the literature examining the performance or establishment of firms located in border areas on a granular level. Mainly, Fantechi and Fratesi (2023) compare firms located in Italian border areas to the ones located further away. Their results show that firms located immediately close to a border face a disadvantage mainly in the production sectors. Besides, for firms located in the administrative border region but further away from the border, a negative impact is observed across multiple sectors, although a reduction of the border penalty appears. Focusing on the services sector, Braakmann and Vogel (2010) find a positive effect shortly after the 2004 enlargement for the performance of small German firms near the Polish border. Similarly, Kapanadze (2022) and Coufalova et al. (2024) show that the 2004 enlargement led to the creation of new firms in consumption sectors in cross-border cities. These results suggest that consumption sectors, such as wholesale and trade, accommodation and food, and health services, can attract more customers with the opening of borders. Customers may take advantage of differences between countries,

such as pricing disparities, differing healthcare standards, or cultural attractions.

3.2 Data and methodology

To compare the development of firms located in border areas with the ones in the hinterland, we use historical data from the Orbis database. The Orbis global database is constructed and maintained by Bureau van Dijk (BvD). It mainly includes financial variables for firms based on their financial statements, income statements, and balance sheets. BvD collects the data from different government and commercial providers and harmonizes them to make international comparisons possible. Besides, the dataset also provides information on the legal information of firms, their location, and the industry to which they belong (Kalemli-Özcan et al., 2024). The dataset covers the period from 1998 to 2021. For the analysis, we restrict the sample to the countries that joined the European Union during the 2004 Eastern enlargement, as well as their neighboring established member states.

The data is compiled by BvD for each unit of a firm and is assigned a unique ID. Additionally, BvD categorizes the units based on the type of financial statements using a consolidation code. In this work, we focus on standalone firms. As such, we select entities which report unconsolidated accounts only (U1 in the BvD categorization). We also exclude companies whose legal form states that they are either a branch of another company or part of a multinational group. Lastly, we restrict the sample to active companies only. While this may introduce survivor bias, including inactive firms could distort results through repeated or outdated firm entries.²

To construct our sample, we follow the recommendations by Kalemli-Özcan et al. (2024). We drop individual observations of firms with not available data for employment and total assets. Moreover, we remove firms which record a negative or zero value for employment, total assets, total tangible assets, and those with negative sales.

²We made these sample restrictions to discard multiple location firms to avoid making decision about the distribution of the performance across locations.

We use the information on firms' postal codes to classify them as located in the proximity of a border or further away.³ The next step consists of assigning the postcodes to LAU level municipalities. We then use the spatial data on municipalities to calculate distances to the nearest border point and assign the firms to border categories that we use in the empirical analysis.⁴

The primary objective of our analysis is to compare the long-term performance of firms located near borders with those in the hinterland. Our focus is on observed differences rather than causal effects. The observation period begins in 1998, when the acceding countries were already preparing for EU membership. During this period, countries implemented reforms to meet the Copenhagen criteria and liberalized trade through bilateral agreements with EU15 members and regional arrangements such as the Baltic Free Trade Area and the Central European Free Trade Agreement. As documented by [Brühlhart et al. \(2018\)](#), [Campos et al. \(2019\)](#), and [Coufalova et al. \(2024\)](#), economic activity in border regions had already started to change prior to formal accession. [Chapter 2](#) also highlights anticipation effects in the lead-up to the 2004 enlargement. Accordingly, this paper does not claim to estimate causal effects of EU accession. Rather, we describe and compare the evolution of firm performance between border and hinterland areas.⁵ The number of observations prior to the enlargement ([Figure 3.1](#)) is limited, and the increasing number of firms in later years mainly reflects improvements in Bureau van Dijk's data collection rather than new firm formation.⁶

It is important to note that all firms in the sample have been affected by the enlargement: firms located in border areas close to the borders of the 2004 enlargement could profit from becoming a springboard to a new market, while those located close to the

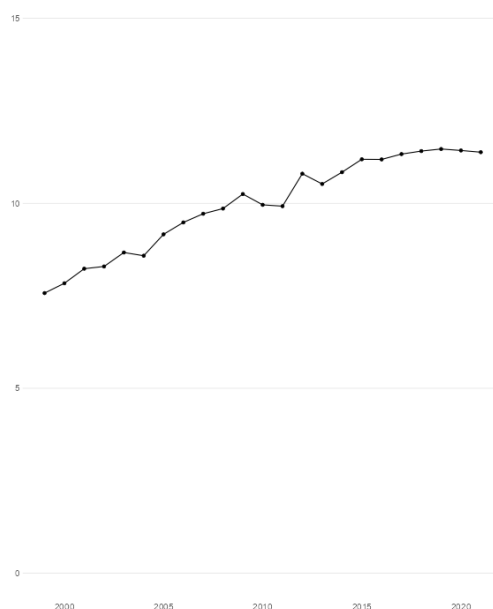
³The postal code is the most precise geographical location provided by the Orbis dataset for firms.

⁴All the files on spatial locations stem from the GISCO database downloaded with the giscoR package ([Lahti et al., 2017](#)).

⁵This contrasts with the nighttime lights (NTL) data used in [Chapter 2](#), which cover a longer period but require aggregation at the municipality level. The firm-level data provide greater detail on firm characteristics but are limited in early years, restricting the analysis to descriptive comparisons.

⁶Firms appearing for the first time in the sample during the first five years have an average age of around 31 years, compared to 17 years for firms entering in the last two years.

Figure 3.1: Number of observations per year.



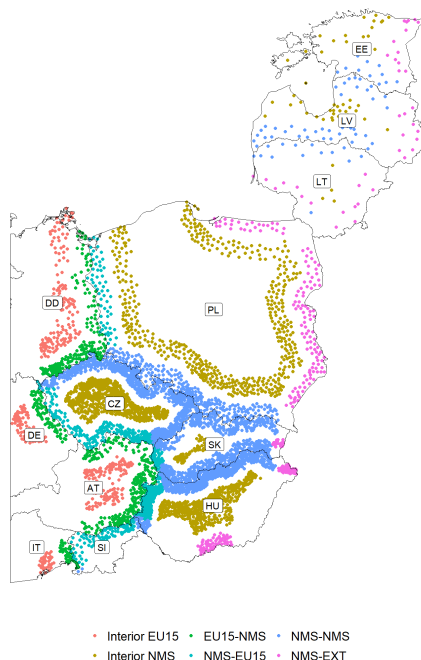
Note: The figure shows the number of observation in the data in a given year in log terms.

external borders can suffer from trade diversion. Besides, the enlargement could also have strengthened the agglomeration effects in the hinterland of the 2004 cohort. Comparing border firms with those located in another country could be problematic due to their potential dissimilarity and because they could lead to a selection bias.

[Fantechi and Fratesi \(2022\)](#) present three possible variables for measuring firm performance. While two of them — value added per employee and total factor productivity — capture productivity, the third—Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) — captures profitability. Unfortunately, for productivity variables, our dataset contains mainly missing data. Yet, we are able to evaluate the performance of firms in terms of profitability by relying on the EBITDA per employee. To compare both the statics and dynamics of firm performance between border areas and the hinterland, we use the growth rates as well as the levels of EBITDA per employee.⁷ To account for missing data in the construction of the growth rate, we divide the growth rates by the number of years that separates them to obtain a

⁷As a robustness check, we use EBITDA per asset of the company.

Figure 3.2: Firm locations in treatment groups and control group.



Note: The figure shows the LAU municipalities, in which the firms in the sample are located, divided into comparison and study groups. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new member states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. Interior EU15 and interior NMS represent the firms from 50 to 100 kilometers from the borders of the 2004 enlargement or EU exterior borders located in EU15 and NMS respectively.

yearly growth rate. For the level of EBITDA per employee, we rely on the hyperbolic arcsine transformation to account for possible negative values (due to loss report for instance) while reducing the asymmetry in the variable (Burbidge et al., 1988).

Border firms are defined as being located within 25 kilometers of the borders. We differentiate here, whether the firm is located in an established EU member state or in a NMS close to the border with a EU15 country or another country of the 2004 cohort. Additionally, we also consider the enlargement effect for firms within 25 kilometers from external borders of the EU. The hinterlands, composed of firms in municipalities located between 50 to 100 kilometers from any border, are shown in Figure 3.2.⁸ To avoid spillovers between the hinterlands and border regions, we

⁸Notice that in comparison to Figure 2.2 we have more observations, especially in the Baltic countries.

consider a buffer of 25 km. Similarly, we consider a 25-kilometer buffer between the groups of borders that became internal EU borders during the 2004 enlargement and the external borders of the EU, as well as between the previous EU enlargements and the 2004 enlargement borders.

We employ a standard OLS model to compare the performance of firms across different border areas while controlling for firm- and location-specific characteristics. The aim is to describe differences in performance between firms located near borders and those in the hinterland, without implying causal effects of EU accession.

Border proximity may affect firm performance due to differences in market access, transaction costs, or regional integration, consistent with new economic geography and spatial economics theory (Lösch, 1944; Krugman, 1991; Capello et al., 2018; Fantechi and Fratesi, 2023). We include firm-level controls such as age, size, and sector, which influence productivity and growth dynamics according to the literature on firm heterogeneity (Haltiwanger et al., 2011; Altomonte et al., 2016). Location-specific characteristics are also included, since local conditions and infrastructure can affect firm performance independently of borders, and firms may strategically select locations to maximize their operational efficiency.

Our regression thus takes the following form for a firm i in municipality m at time t :

$$\begin{aligned}
 y_{imt} = & \alpha + \beta_1 EU15_NMS_m + \beta_2 NMS_EU15_m \\
 & + \beta_3 NMS_NMS_m + \beta_4 NMS_EXT_m \\
 & + \gamma_1 age_{it} + \gamma_2 nace_group_i + \gamma_3 size_category_{it-1} + \\
 & + \delta_1 density_1995_m + \delta_2 border_elev_m + \delta_3 fmp_1995_m \\
 & + \theta_t + \rho_r + \epsilon_{it}
 \end{aligned} \tag{3.1}$$

where the dependent variables we consider are the growth and level of profit per employee (EBITDA per employee), with robustness checks using profit per asset (EBITDA per asset). The reason being that with taxes, interest rates, depreciation

Table 3.1: Descriptive statistics by treatment and control group.

	control_EU15	EU15-NMS	control_NMS	NMS-EU15	NMS-EXT	NMS-NMS
Panel A: Number of Observations						
N	31108	25651	264672	78838	15165	117949
Panel B: Outcome variables (mean [Conf. Int.])						
Δ profit_empl	-0.03 [-0.04; -0.03]	-0.06 [-0.06; -0.05]	-0.06 [-0.06; -0.06]	-0.05 [-0.05; -0.05]	-0.07 [-0.08; -0.07]	-0.05 [-0.05; -0.05]
profit_empl	10.01 [9.97; 10.04]	9.73 [9.68; 9.77]	8.48 [8.47; 8.50]	9.33 [9.31; 9.36]	8.22 [8.15; 8.30]	8.85 [8.83; 8.87]
Panel C: Firm and location characteristics (mean [Conf. Int.])						
border_elev (in m)	258.16 [254.92; 261.39]	488.76 [483.69; 493.83]	246.73 [245.72; 247.73]	555.66 [551.87; 559.44]	120.58 [118.65; 122.51]	364.31 [362.45; 366.16]
age (in years)	27.91 [27.74; 28.08]	29.18 [28.97; 29.38]	20.51 [20.48; 20.55]	20.38 [20.32; 20.44]	20.55 [20.39; 20.71]	20.72 [20.67; 20.77]
for_potential	1607.49 [1578.43; 1636.55]	16774.21 [16685.87; 16862.54]	2477.83 [2463.40; 2492.26]	30142.76 [30032.72; 30252.80]	6294.48 [6173.20; 6415.76]	26715.93 [26575.43; 26856.43]
density_1995	3.83 [3.79; 3.87]	10.43 [10.31; 10.55]	8.79 [8.76; 8.83]	11.52 [11.39; 11.66]	2.97 [2.9; 3.05]	4.56 [4.53; 4.58]
Panel D: Firm Size (%)						
Small	24.32	31.63	49.54	51.72	61.01	46.68
Medium	54.61	52.81	37.00	36.76	33.45	40.63
Large	18.85	13.86	12.02	10.47	5.43	11.55
Very Large	2.21	1.70	1.45	1.05	0.11	1.14
Panel E: NACE Group (%)						
Agriculture	1.87	1.76	6.07	3.33	12.30	7.62
Production	41.30	27.94	20.00	24.47	20.08	25.87
Construction	9.02	9.48	7.92	8.93	7.34	8.66
Services	47.80	60.82	66.02	63.27	60.28	57.85

Note: Table shows the descriptive statistics of the dependent and independent variables by treatment and control group. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. *contr_EU15* and *control_NMS* represent the control groups for EU15 and NMS, respectively. The number of observations refers to the overall number of observations over 21 years, not the cross-sectional number. Agriculture corresponds to NACE A sector; production sectors comprise NACE sectors B, C, D and E; construction corresponds to NACE F sector and services are NACE G, H, I, J, K, L, M, N, O, P, Q, R, S and T sectors. Very large companies are those with an operating revenue above 100 million EUR, total assets above 200 million EUR and at least 1000 employees. Large companies have an operating revenue between 10 and 100 million EUR, total assets between 20 and 200 million EUR and a number of employees between 150 and 1000. Medium sized companies have an operating revenue between 1 and 10 million EUR, total assets between 2 and 20 million EUR and a number of employees between 15 and 150. The rest of the companies are classified as small firms.

rates and amortization not yet being subtracted from the profits, the variable pertains homogeneity of measurement between countries.

We are primarily interested in the β coefficients of (3.1) that show the differences between the firms located in borderlands to the ones in the hinterland. We differentiate whether the company is located in an EU15 country (*EU15_NMS*) or NMS (*NMS_EU15*) in the proximity of the border between established and acceding member states, or if it is located in a NMS close to a border with another NMS (*NMS_NMS*). The last group (*NMS_EXT*) represents entities located in NMS near the external borders of the EU. Note that a negative or an insignificant effect does not mean that border firms perform poorly, rather just that they perform worse or same as the firms located in the interior of the countries observed.

It is important to control for factors that might confound the border effects. To do so, we introduce several firm-levels control variables. Firms' performance might first be determined by their age with younger firms being more dynamic and innovative, while older being more robust (Fantechi and Fratesi, 2022). To address this issue, we compute the age of the firm as the difference between the last year in our sample (2021) and the year the firm was registered in (age_{it}). Performance may also depend on firm's size. Smaller firms can be more dynamic, but also less stable as they have a higher pace of job creation and destruction at the same time (Haltiwanger et al., 2011). While being less dynamic, larger firms tend to be better established in the region and exhibit a great influence on the economic development of a region (Altomonte et al., 2016). To account for this, we compute the BvD categories based on the BvD manual: small, medium, large and very large companies.⁹ Due to possible simultaneity issues, we include the first lag of the company size category in the model ($size_category_{it-1}$). Furthermore, we control for the sector activity, defined as follows: agriculture, production sectors, construction and services ($nace_group$).¹⁰

The location of a firm may not be random. More productive firms tend to be in more densely populated areas (Oberfeld et al., 2024). Hence, we add a variable for the population density in the municipality of the firm. Population data for municipalities in the EU for multiple countries is not available for each year. We opt for the data from 1995, before the beginning of our period study. Not only the local economic conditions are important, but also the foreign market potential a firm has on the other side of the border. As documented by Redding and Sturm (2008); Ahlfeldt et al. (2015); Coufalova et al. (2024) higher demand on the other side of the border can be an attraction for firms. To approximate the foreign market potential (fmp_1995_m)

⁹Very large companies are those with an operating revenue above 100 million EUR, total assets above 200 million EUR and at least 1000 employees. Large companies have an operating revenue between 10 and 100 million EUR, total assets between 20 and 200 million EUR and a number of employees between 150 and 1000. Medium sized companies have an operating revenue between 1 and 10 million EUR, total assets between 2 and 20 million EUR and a number of employees between 15 and 150. The rest of the companies are classified as small firms (van Dijk, 2011).

¹⁰Agriculture corresponds to NACE A sector; production sectors comprise NACE sectors B, C, D and E; construction corresponds to NACE F sector and services are NACE G, H, I, J, K, L, M, N, O, P, Q, R, S and T sectors.

without introducing simultaneity, we calculate it as the sum of the population living outside the country of the municipality in which the firm is located and within 100 kilometers of that municipality ($P_{j,1995}$), discounted by distance (d_{mj}):¹¹

$$fmp_1995_m = \sum_{j \in \mathcal{F}(m)} \mathbf{1}(d_{mj} \leq 100) \frac{P_{j,1995}}{d_{mj}} . \quad (3.2)$$

Topology can also impact the decision of a firm's location, as overcoming barriers stemming from physical geography can impose further costs. If a border is formed by a geographical barrier, such as a river or mountain, the available crossings for firms on both sides are more limited, which increases the costs of reaching the other side of the border (Capello et al., 2018). To control for that, we use data to calculate the average elevation of the nearest border point to the municipality a firm is located in using the data from ESA (2018). The variable is denoted as *border_elev_m* in (3.1).

Since firms' locations are time-invariant, we cannot include firm fixed effects. Instead, we estimate the model with NUTS3 fixed effects and year fixed effects (last row of (3.1))

In Table 3.1, we present the descriptive statistics of the dependent variables by control and treatment groups. The table shows several significant differences between the groups. Notably, the level of profit per employee is higher in the EU15 countries than the NMS. Because of this, we split the firms in the interior into two groups and conduct separate regressions for EU15 and NMS countries. This approach is justified by the differing starting points and institutional environments of the firms. EU15 countries were established market-oriented economies, whereas NMS were in transition to market economies at the beginning of our observation period. Comparing firms in the border areas of the EU15 to those in the hinterland of NMS could potentially

¹¹Note that the foreign market potential may be underestimated for firms located near some of the EU's external borders, as GISCO does not provide standardized shapefiles for Ukraine, Russia, and Belarus. We plan to explore alternative data sources to address this limitation.

lead to an upward bias in the results. We can further observe in [Table 3.1](#) that, while border firms in EU15 countries near NMS borders have lower profits per employee than interior firms, in the NMS it is the firms near EU15 borders that exhibit the highest profitability. All firms appear to experience a decline in profitability, with the largest drop observed for NMS firms near the EU's external border. These firms may be particularly affected by trade redirection.

When examining the independent variables in [Table 3.1](#), we observe that firms in the EU15 tend to be older, reflecting their longer experience with a market economy. There are also notable differences in the distribution of firms by size. Within the EU15, border areas contain a higher proportion of small firms than interior regions. The share of small firms is even higher in the NMS, peaking at the EU's external borders. Furthermore, there are clear differences in sectoral composition. In particular, production firms are more prevalent in EU15 regions bordering the NMS, whereas agricultural firms are more common near borders between NMS themselves and at the EU's external borders.

3.3 Results

[Table 3.2](#) displays the baseline results. When examining performance through the lens of profitability, we do not find major differences between firms located in the proximity of the border and the ones located in the hinterland in EU15. On the contrary, the results for the firms in NMS close to the enlargement borders with EU15 countries indicate a decline in profitability. A possible explanation is an increase in competition as consequence of the opening of the borders. A negative or insignificant coefficient here should not be understood as evidence of poor performance among border firms, but simply that their performance does not surpass—or differs little from—that of firms located further inland. ¹²

¹²We plan to control for the number of competitors. It could be also possible to have the treatment group split into quartiles based on the quartiles of the number of competitors and investigate the differences to see if it plays a role.

Table 3.2: Baseline results

	(1)	(2)	(3)	(4)
	$\Delta profit_empl$	$profit_empl$	$\Delta profit_empl$	$profit_empl$
EU15-NMS	-0.028 (0.034)	0.479 (0.303)		
NMS-EU15			-0.007+ (0.003)	0.016 (0.115)
NMS-NMS			-0.003 (0.003)	0.007 (0.071)
NMS-EXT			0.003 (0.004)	0.051 (0.054)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.047	0.028	0.032	0.082
R2 Adj.	0.045	0.027	0.032	0.081
RMSE	0.33	3.38	0.36	4.74
Firm level controls	Yes	Yes	Yes	Yes
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

Note: The impact of firm location on growth and profitability (EBITDA per employee). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. Comparison group contains firms located 50-100 kilometers from treated borders.

These first homogeneous results may however hide some heterogeneity that we will now study. To do so, we first interact the groups of border areas with the aggregated main NACE sector of firms. We present these results in [Table 3.3](#). The growth of firms in the construction sector in border areas of NMS near EU15 countries may reflect increased construction activity driven by a broader boost in economic activity in these regions. Another contributing factor is likely the inflow of European Structural and Investment Funds supporting infrastructure development in these border areas. Similarly, production and services firm have a higher level of profit per employee in the NMS near borders with EU15. At the same time, firms operating in the agriculture sector in the same regions exhibit a lower level of profitability. In contrast, production sectors firms near external borders of the NMS have a lower level of profitability.

We interact also the border groups with the lag of the company size categories. Our results in [Table 3.4](#) indicate that, in EU15 countries, there is not much difference between the different sizes of companies. In contrast, in the NMS, small firms near borders with EU15 countries exhibit higher profitability. Profit per employee tends

Table 3.3: Results by sector.

	(1)	(2)	(3)	(4)
	$\Delta profit_empl$	$profit_empl$	$\Delta profit_empl$	$profit_empl$
EU15-NMS*Aggricuture	-0.059 (0.047)	-0.726 (2.059)		
EU15-NMS*Construction	0.025 (0.030)	1.101 (1.979)		
EU15-NMS*Production	0.026 (0.029)	1.312 (2.024)		
EU15-NMS*Services	0.039 (0.029)	1.179 (1.970)		
NMS-EU15*Aggricuture			-0.008 (0.006)	-0.500+ (0.256)
NMS-EU15*Construction			0.020** (0.007)	0.834** (0.283)
NMS-EU15*Production			0.008 (0.007)	0.638* (0.290)
NMS-EU15*Services			-0.005 (0.007)	0.502+ (0.294)
NMS-NMS*Aggricuture			0.005 (0.006)	-0.023 (0.252)
NMS-NMS*Construction			-0.006 (0.008)	0.067 (0.300)
NMS-NMS*Production			-0.011 (0.007)	-0.039 (0.252)
NMS-NMS*Services			-0.008 (0.006)	0.059 (0.272)
NMS-EXT*Aggricuture			0.013 (0.008)	0.859 (0.534)
NMS-EXT*Construction			-0.021 (0.021)	-0.589 (0.466)
NMS-EXT*Production			-0.016 (0.011)	-1.102+ (0.632)
NMS-EXT*Services			-0.009 (0.012)	-0.925 (0.639)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.047	0.029	0.032	0.082
R2 Adj.	0.045	0.027	0.032	0.082
RMSE	0.33	3.38	0.36	4.74
Firm level controls	Yes	Yes	Yes	Yes
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

Note: The impact of firm location on growth and profitability (EBITDA per employee). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. Comparison group contains firms located 50-100 kilometers from treated borders. Agriculture corresponds to NACE A sector; production sectors comprise NACE sectors B, C, D and E; construction corresponds to NACE F sector and services are NACE G, H, I, J, K, L, M, N, O, P, Q, R, S and T sectors.

to decline with firm size relative to internal regions. This pattern may suggest that, despite integration, border areas between NMS and EU15 remain less attractive for larger companies, possibly due to the advantages of economies of scale and urbanization available in the hinterland. A similar pattern emerges in the proximity of the borders between NMS and non-EU countries.

Table 3.4: Results by company size.

	(1)	(2)	(3)	(4)
	$\Delta profit_empl$	$profit_empl$	$\Delta profit_empl$	$profit_empl$
EU15-NMS*Small	-0.028 (0.035)	0.441 (0.327)		
EU15-NMS*Medium	0.003 (0.004)	-0.149 (0.122)		
EU15-NMS*Large	-0.004 (0.007)	0.179 (0.185)		
EU15-NMS*Very Large	0.017 (0.018)	-0.020 (0.362)		
NMS-EU15*Small			-0.003 (0.004)	0.459* (0.222)
NMS-EU15*Medium			-0.008* (0.004)	-0.720** (0.254)
NMS-EU15*Large			-0.006 (0.007)	-0.997** (0.360)
NMS-EU15*Very Large			-0.002 (0.013)	-1.546*** (0.431)
NMS-NMS*Small			0.000 (0.003)	0.235 (0.155)
NMS-NMS*Medium			-0.007* (0.003)	-0.467+ (0.257)
NMS-NMS*Large			-0.009* (0.004)	-0.543 (0.387)
NMS-NMS*Very Large			-0.011 (0.010)	-0.318 (0.491)
NMS-EXT*Small			0.007 (0.005)	0.304* (0.124)
NMS-EXT*Medium			-0.012 (0.007)	-0.657* (0.277)
NMS-EXT*Large			-0.017 (0.016)	-0.767* (0.360)
NMS-EXT*Very Large			0.073 (0.092)	-2.796 (3.061)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.047	0.028	0.032	0.083
R2 Adj.	0.045	0.027	0.032	0.082
RMSE	0.33	3.38	0.36	4.74
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
Firm level controls	Yes	Yes	Yes	Yes
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

Note: The impact of firm location on growth and profitability (EBITDA per employee). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. The comparison group contains firms located 50-100 kilometers from treated borders. Very large companies are those with an operating revenue above 100 million EUR, total assets above 200 million EUR and at least 1000 employees. Large companies have an operating revenue between 10 and 100 million EUR, total assets between 20 and 200 million EUR and a number of employees between 150 and 1000. Medium sized companies have an operating revenue between 1 and 10 million EUR, total assets between 2 and 20 million EUR and a number of employees between 15 and 150. The rest of the companies are classified as small firms

3.4 Robustness checks

In [Table C1](#), we interact individual sectors with the border groups rather than using the broader sector aggregates. Again, we do not observe any significant differences across sectors between firms located near borders between the EU15 and the NMS

and those in the EU15 interior. In the border areas of the NMS, however, firms in the construction sector near borders with the EU15 show both higher levels and stronger growth of profitability. Particularly noteworthy is the higher profitability of firms in the financial sector near EU15 borders, contrasted with the lower profitability of firms in the retail sector near external NMS borders. The former may reflect cross-border financial integration and greater demand for financial services driven by investment inflows, while the latter could be linked to lower purchasing power, trade barriers, and the prevalence of informal trade in these areas. Moreover, retail firms located close to borders between two NMS also exhibit a lower growth rate of profitability.

In [Table C2](#), [Table C3](#), and [Table C4](#), we replace profit per employee with profit per asset as an alternative measure of profitability. This change results in somewhat less significant estimates. Nevertheless, several previous patterns remain robust, especially when we interact the treatment groups with the lag of the firm size categories. That is, smaller firms in the NMS located near borders with the EU15 exhibit higher levels of profits per asset, with the effect declining as firm size increases. On the contrary, the results differ when we interact the border groups with the groups of sectors. In the case of profit per asset, we observe significant results for the NMS-NMS borders (negative for agriculture and positive for other sectors).

3.5 Conclusion

In this paper, we compare the profitability, measured as EBITDA per employee, of firms located in the proximity of borders that were internalized in the course of the 2004 EU enlargement. In other words, we analyze whether the border effect penalizes firms located in these areas. A general comparison shows that firms located in NMS close to borders with other EU15 or other NMS are experiencing a decline in profitability, when compared to the firms in the interior. This might be a consequence of increased competition at the 2004 enlargement borders.

The analysis reveals notable heterogeneity across sectors and firm sizes. Firms in construction, production, and services tend to perform better in the NMS border areas adjacent to the EU15, while agricultural and production firms near external NMS borders show lower profitability. When accounting for firm size, we find that smaller firms in the NMS near EU15 borders are more profitable, whereas profitability declines with firm size. This pattern suggests that border regions may offer advantages primarily to smaller firms, while larger companies may benefit more from the agglomeration economies present in interior regions. Alternatively, in the NMS, due to the EU enlargement, border areas became more dynamic to attract smaller innovative firms. A second reason could lie in vertical linkages between large firms in EU15 and small firms on the NMS side of the border. These findings highlight the complex interplay of economic integration, firm characteristics, and regional factors in shaping border area profitability.

Overall, firm-level data provide valuable insights into the performance of firms located in the border regions of the new member states. In contrast to the analysis based on nighttime lights data in [Chapter 2](#), the available firm-level data do not allow us to directly evaluate the impact of the Eastern enlargements themselves. However, they enable us to observe firm performance over a longer period, revealing differences across groups of border areas as well as between NMS and EU15 countries. Further analysis is still needed to establish more robust evidence for these observed patterns.

We further plan to improve this analysis by providing additional insights. First, to enhance comparability between firms located in border areas and those further inland, we could conduct propensity score matching for each year separately using the independent variables included in the regression model (first results displayed on figures [Figure C1](#) and [Figure C2](#)). Second, [Figure 3.2](#) shows an increasing number of firms in the sample, which does not necessarily reflect newly established companies. Examining the registration dates of the firms in the registry could provide additional information on changes in the number of firms in border areas. We could also aggregate the number of firms on the level of municipalities, in the style of [Coufalova](#)

[et al. \(2024\)](#), and see how this changed throughout the observation period. Employing spatial differencing ([Belotti et al., 2018](#)) in this case is also an option. Third, we can use firm characteristics to assess the presence of other sources of heterogeneity in the results. For instance, firm age could be used to restrict the sample to companies that were established before the enlargement, in order to mitigate concerns about endogenous location choices. We plan to control for the number of competitors. It could be also possible to have the treatment group split into quartiles based on the quartiles of the number of competitors and investigate the differences to see if it plays a role.

Appendix C

Table C1: Results by individual sectors

	(1)	(2)	(3)	(4)
	$\Delta profit_empl$	$profit_empl$	$\Delta profit_empl$	$profit_empl$
EU15-NMS * Agriculture	-0.058 (0.047)	-0.675 (2.094)		
EU15-NMS * Mining	-0.087+ (0.051)	0.604 (2.309)		
EU15-NMS * Manufacturing	0.028 (0.029)	1.322 (2.034)		
EU15-NMS * Electricity	0.009 (0.047)	-0.293 (2.098)		
EU15-NMS * Water management	-0.010 (0.035)	1.454 (1.820)		
EU15-NMS * Construction	0.025 (0.030)	1.124 (1.987)		
EU15-NMS * Retail	0.036 (0.027)	1.126 (2.000)		
EU15-NMS * Transportation	0.043 (0.029)	0.822 (1.850)		
EU15-NMS * Accommodation	0.031 (0.033)	1.116 (2.337)		
EU15-NMS * Publishing	0.034 (0.032)	1.028 (2.075)		
EU15-NMS * Telecommunication	0.051 (0.039)	1.078 (2.084)		
EU15-NMS * Financial	0.050 (0.031)	0.885 (2.043)		
EU15-NMS * Real Estate	0.032 (0.028)	1.555 (1.790)		
EU15-NMS * Scientific	0.057 (0.036)	1.736 (1.877)		
EU15-NMS * Public administration	-0.020 (0.041)	1.604 (2.142)		
EU15-NMS * Education	0.051 (0.033)	1.313 (2.220)		
EU15-NMS * Human Health	0.015 (0.049)	0.996 (2.744)		
EU15-NMS * Sports and Recreation	0.075 (0.047)	3.006 (2.827)		
NMS-EU15 * Agriculture			-0.009 (0.006)	-0.505+ (0.255)
NMS-NMS * Agriculture			0.006	0.002

	(0.006)	(0.248)
NMS-EXT * Agriculture	0.012	0.882
	(0.008)	(0.534)
NMS-EU15 * Mining	-0.052*	0.427
	(0.022)	(0.360)
NMS-NMS * Mining	-0.046*	-0.277
	(0.020)	(0.574)
NMS-EXT * Mining	-0.058+	-3.121*
	(0.033)	(1.243)
NMS-EU15 * Manufacturing	0.009	0.628*
	(0.007)	(0.289)
NMS-NMS * Manufacturing	-0.012	-0.048
	(0.007)	(0.247)
NMS-EXT * Manufacturing	-0.009	-0.992+
	(0.011)	(0.577)
NMS-EU15 * Electricity	0.011	0.875
	(0.015)	(0.568)
NMS-NMS * Electricity	0.006	0.335
	(0.014)	(0.501)
NMS-EXT * Electricity	-0.014	-1.944
	(0.039)	(1.330)
NMS-EU15 * Water management	0.000	0.370
	(0.010)	(0.374)
NMS-NMS * Water management	-0.000	0.058
	(0.011)	(0.333)
NMS-EXT * Water management	-0.074***	-1.388*
	(0.019)	(0.622)
NMS-EU15 * Construction	0.020**	0.822**
	(0.007)	(0.286)
NMS-NMS * Construction	-0.006	0.084
	(0.008)	(0.298)
NMS-EXT * Construction	-0.020	-0.559
	(0.021)	(0.464)
NMS-EU15 * Retail	-0.008	0.294
	(0.007)	(0.302)
NMS-NMS * Retail	-0.014*	-0.039
	(0.006)	(0.297)
NMS-EXT * Retail	-0.014	-1.297*
	(0.014)	(0.585)
NMS-EU15 * Transportation	0.011	0.396
	(0.008)	(0.288)
NMS-NMS * Transportation	-0.004	-0.014
	(0.009)	(0.290)
NMS-EXT * Transportation	-0.035***	-0.707
	(0.010)	(0.679)
NMS-EU15 * Accommodation	-0.000	1.372*
	(0.010)	(0.650)

NMS-NMS * Accommodation	-0.024*	-0.237
	(0.010)	(0.434)
NMS-EXT * Accommodation	-0.001	-0.563
	(0.022)	(1.033)
NMS-EU15 * Publishing	-0.006	0.304
	(0.018)	(0.481)
NMS-NMS * Publishing	-0.014	-0.161
	(0.009)	(0.309)
NMS-EXT * Publishing	-0.021	-0.418
	(0.023)	(0.893)
NMS-EU15 * Telecommunication	-0.025	0.407
	(0.021)	(0.627)
NMS-NMS * Telecommunication	-0.026	-0.609
	(0.016)	(0.689)
NMS-EXT * Telecommunication	0.037	-0.613
	(0.027)	(0.975)
NMS-EU15 * Financial	-0.004	1.527*
	(0.009)	(0.615)
NMS-NMS * Financial	-0.011	0.984
	(0.011)	(0.598)
NMS-EXT * Financial	-0.014	0.068
	(0.020)	(0.771)
NMS-EU15 * Real Estate	-0.006	0.495
	(0.009)	(0.406)
NMS-NMS * Real Estate	-0.008	-0.089
	(0.008)	(0.340)
NMS-EXT * Real Estate	0.011	-1.141+
	(0.016)	(0.661)
NMS-EU15 * Scientific	-0.001	0.751*
	(0.011)	(0.357)
NMS-NMS * Scientific	-0.012	0.088
	(0.011)	(0.305)
NMS-EXT * Scientific	-0.026	-0.187
	(0.023)	(0.871)
NMS-EU15 * Administrative	0.051	0.759
	(0.088)	(0.853)
NMS-NMS * Administrative	0.128***	0.318
	(0.036)	(0.766)
NMS-EXT * Administrative	-0.123***	-0.308
	(0.030)	(0.770)
NMS-EU15 * Public administration	-0.008	0.380
	(0.024)	(0.589)
NMS-NMS * Public administration	0.016	-0.256
	(0.014)	(0.506)
NMS-EXT * Public administration	0.025	0.342
	(0.042)	(0.647)
NMS-EU15 * Education	0.001	0.395

			(0.011)	(0.286)
NMS-NMS * Education			0.011	0.120
			(0.009)	(0.291)
NMS-EXT * Education			0.022	-0.735
			(0.014)	(0.644)
NMS-EU15 * Human Health			-0.037	1.343+
			(0.023)	(0.703)
NMS-NMS * Human Health			-0.019	0.490
			(0.018)	(0.551)
NMS-EXT * Human Health			-0.058**	-1.048
			(0.021)	(1.499)
NMS-EU15 * Sports and Recreation			0.001	0.979*
			(0.011)	(0.494)
NMS-NMS * Sports and Recreation			0.011	0.412
			(0.016)	(0.391)
NMS-EXT * Sports and Recreation			-0.034	-0.713
			(0.033)	(0.812)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.047	0.039	0.034	0.095
R2 Adj.	0.045	0.038	0.034	0.095
RMSE	0.33	3.36	0.36	4.71
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
Firm level controls	Yes	Yes	Yes	Yes
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

Note: The impact of firm location on growth and profitability (EBITDA per employee). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new member states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively.

Table C2: Baseline results with profit per asset

	(1)	(2)	(3)	(4)
	$\Delta profit_asset$	$profit_asset$	$\Delta profit_asset$	$profit_asset$
EU15-NMS	-0.002 (0.029)	0.022 (0.016)		
NMS-EU15			-0.001 (0.003)	0.004 (0.007)
NMS-NMS			-0.003 (0.002)	0.005 (0.005)
NMS-EXT			0.002 (0.003)	0.004 (0.005)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.016	0.040	0.012	0.043
R2 Adj.	0.014	0.039	0.012	0.043
RMSE	0.30	0.10	0.32	0.22
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
Firm level controls	Yes	Yes	Yes	Yes
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

Note: The impact of firm location on growth and profitability (EBITDA per asset). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. Comparison group contains firms located 50-100 kilometers from treated borders.

Table C3: Results by sector group with profit per asset

	(1)	(2)	(3)	(4)
	$\Delta profit_assets$	$profit_assets$	$\Delta profit_assets$	$profit_assets$
EU15-NMS*Agriculture	0.646 (0.823)	-0.006 (0.337)		
EU15-NMS*Construction	-0.803 (0.833)	0.122 (0.342)		
EU15-NMS*Production	-0.684 (0.814)	0.113 (0.345)		
EU15-NMS*Services	-0.733 (0.813)	0.108 (0.311)		
NMS-EU15*Agriculture			-0.112 (0.088)	-0.129 (0.108)
NMS-EU15*Construction			0.214 (0.136)	0.070 (0.117)
NMS-EU15*Production			0.049 (0.137)	0.044 (0.107)
NMS-EU15*Services			0.147 (0.090)	0.089 (0.124)
NMS-NMS*Agriculture			-0.141+ (0.080)	-0.278** (0.102)
NMS-NMS*Construction			0.114 (0.090)	0.256* (0.101)
NMS-NMS*Production			0.010 (0.128)	0.223* (0.095)
NMS-NMS*Services			0.151+ (0.088)	0.220* (0.105)
NMS-EXT*Agriculture			-0.094 (0.081)	-0.008 (0.110)
NMS-EXT*Construction			0.449 (0.296)	-0.010 (0.127)
NMS-EXT*Production			-0.001 (0.135)	-0.095 (0.122)
NMS-EXT*Services			0.128 (0.090)	0.012 (0.134)
Sample	EU15	EU15	NMS	NMS
N	56759	57087	476633	479283
R2	0.003	0.676	0.000	0.707
R2 Adj.	0.002	0.675	0.000	0.707
RMSE	2.18	0.98	9.19	1.13
Firm level controls	Yes	Yes	Yes	Yes
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

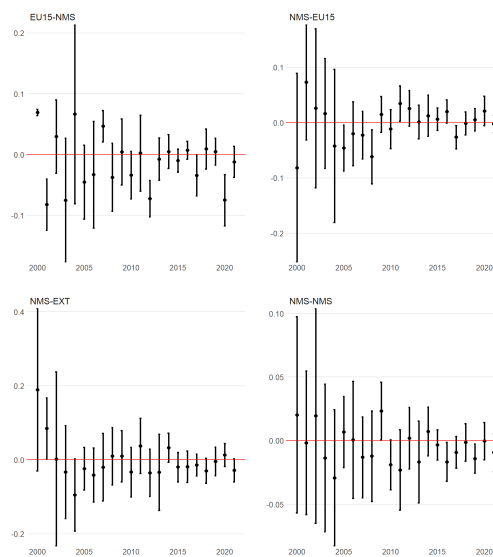
Note: The impact of firm location on growth and profitability (EBITDA per asset). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new members states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. Comparison group contains firms located 50-100 kilometers from treated borders. Agriculture corresponds to NACE A sector; production sectors comprise NACE sectors B, C, D and E; construction corresponds to NACE F sector and services are NACE G, H, I, J, K, L, M, N, O, P, Q, R, S and T sectors.

Table C4: Results by firm size with profit per asset

	(1)	(2)	(3)	(4)
	$\Delta profit_assets$	$profit_assets$	$\Delta profit_assets$	$profit_assets$
EU15-NMS*Small	0.004 (0.029)	0.021 (0.016)		
EU15-NMS*Medium	-0.002 (0.004)	0.000 (0.004)		
EU15-NMS*Large	-0.010* (0.005)	0.003 (0.006)		
EU15-NMS*Very Large	0.010 (0.017)	-0.006 (0.014)		
NMS-EU15*Small			0.003 (0.003)	0.026* (0.011)
NMS-EU15*Medium			-0.007* (0.003)	-0.038** (0.011)
NMS-EU15*Large			-0.011* (0.005)	-0.042* (0.019)
NMS-EU15*Very Large			-0.009 (0.016)	-0.073** (0.023)
NMS-NMS*Small			-0.001 (0.003)	0.012 (0.008)
NMS-NMS*Medium			-0.003 (0.004)	-0.014 (0.010)
NMS-NMS*Large			-0.007+ (0.004)	-0.012 (0.020)
NMS-NMS*Very Large			-0.005 (0.009)	-0.004 (0.024)
NMS-EXT*Small			0.006 (0.004)	0.012+ (0.007)
NMS-EXT*Medium			-0.008 (0.008)	-0.020+ (0.011)
NMS-EXT*Large			-0.020+ (0.011)	-0.034* (0.017)
NMS-EXT*Very Large			0.045 (0.086)	-0.097** (0.030)
Sample	EU15	EU15	NMS	NMS
N	60532	60532	505641	505641
R2	0.016	0.040	0.012	0.044
R2 Adj.	0.014	0.039	0.012	0.044
RMSE	0.30	0.10	0.32	0.22
Cluster	NUTS3	NUTS3	NUTS3	NUTS3
Firm level controls	Yes	Yes	Yes	Yes
NUTS3 FEs	X	X	X	X
Yearly FEs	X	X	X	X

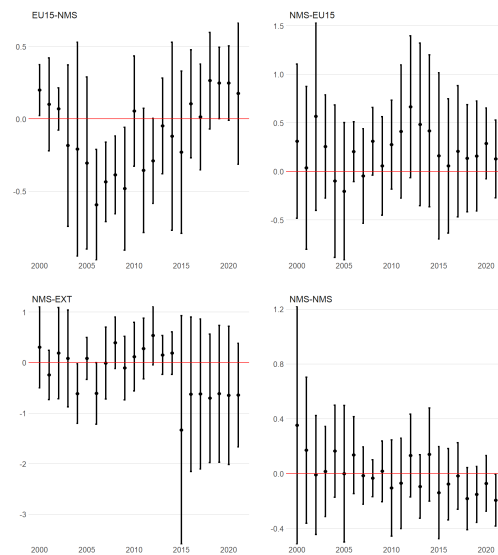
Note: The impact of firm location on growth and profitability (EBITDA per employee). Significance levels: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Clustered standard errors in parenthesis. EU15-NMS denotes firms located in EU15 countries within 25 kilometers of borders with new member states, while NMS-EU15, NMS-NMS and NMS-EXT are firms located in new member states within 25 kilometers of borders with EU15, other new member states and non-EU countries respectively. The comparison group contains firms located 50-100 kilometers from treated borders. Very large companies are those with an operating revenue above 100 million EUR, total assets above 200 million EUR and at least 1000 employees. Large companies have an operating revenue between 10 and 100 million EUR, total assets between 20 and 200 million EUR and a number of employees between 150 and 1000. Medium sized companies have an operating revenue between 1 and 10 million EUR, total assets between 2 and 20 million EUR and a number of employees between 15 and 150. The rest of the companies are classified as small firms

Figure C1: Yearly estimation using propensity score matching for each year for growth of profit per employee.



Notes: The figure presents regression results based on propensity score matching, where all covariates from (3.1) are used in both the matching procedure and the subsequent regression. The regressions are estimated separately for each year.

Figure C2: Yearly estimation using propensity score matching for each year for level of profit per employee.



Notes: The figure presents regression results based on propensity score matching, where all covariates from (3.1) are used in both the matching procedure and the subsequent regression. The regressions are estimated separately for each year.

General Conclusion

In this thesis, I evaluate different aspects of European integration and their connection to regional development. The first chapter assesses the impact of EU funds on regional GDP, while the second and third chapters focus on the economic development of border regions following recent EU enlargements. The results show that EU funds foster regional growth, sometimes generating spillover effects that surpass the direct impacts. The second chapter examines the development of border municipalities in Eastern Europe, and the third compares the performance of firms located near different types of borders with those in the interior. Together, these two chapters highlight heterogeneity in economic development across border areas and provide a more granular understanding of regional dynamics.

The analyses conducted in this thesis can provide insights for policy recommendations as well as ideas for future research that can provide more answers:

Availability of granular data. My thesis is a journey from using data on a more aggregate level to employing more granular data in conducting research. It is still easier to find a larger amount of data for evaluation of economic policies on the level of NUTS regions than on granular level. However, the rapid technological progress is making vast improvements in this area, with constant improvements in NTL data (Li et al., 2020) or provision of new data on a finer scale (Rossi-Hansberg and Zhang, 2025; Kummu et al., 2025; Desmet et al., 2025). These can help in the future to provide further improvements in explaining various aspects of EU enlargement. Hence, provision of more data on a finer scale by EU institutions, in spatial and temporal sense, could provide more accurate information about the needs of regions for a more

effective allocation of EU funds on as well as in the evaluation of the use of EU funds.

Improvements in causal inference methodology. The use of [Callaway and Sant'Anna \(2021\)](#) method in the evaluation of the effect of EU accession on border urban municipalities is one of my contributions to the literature on this topic. Further advancements in causal inference, for instance integration of the new difference-in-differences estimators with spatial econometrics, might help to further improve these estimates in the future.

Natura 2000. In [Chapter 1](#), we employ the presence of nature-protected areas belonging to the Natura 2000 framework as an instrumental variable in evaluating the impact of EU funds. Although we argue that the regulations connected with Natura 2000 may increase the demand for EU-funded projects—thereby raising their costs—we do not explore this issue in sufficient depth. More broadly, [Blicharska et al. \(2016\)](#) highlight the lack of research on the impact and effectiveness of Natura 2000 sites themselves. In light of the growing importance of nature protection for mitigating the effects of climate change, further analysis of the role and effectiveness of the Natura 2000 framework would be highly valuable.

Border regions. The analyses in [Chapter 2](#) and [Chapter 3](#) provide insight into the border areas of the Eastern enlargements. Upon further improvements, [Chapter 3](#) can be helpful in identifying weak spots of the 2004 border regions, which could help with policies helping these border areas. Firm level data can be further employed to analyze the border areas of the EU in general, especially in the context of cross-border projects.

EU (dis-)integration). The EU integration is an ongoing process, with possible future enlargements taking place in the Western Balkans and Eastern Europe. The results from [Chapter 2](#) indicate that trade liberalization can be helpful for the candidate countries in the pre-accession process, although there is the uniqueness of the 2004 enlargement countries directly neighboring the EU15. However, the firm-level data could be used to provide granular information about the border regions of the

candidate countries and help with developing cooperation projects to facilitate their accession into the EU. Furthermore, the withdrawal of the UK from the EU provides another understudied topic in the context of economic development of border regions, this time also taking maritime borders into consideration.

Bibliography

- Abrahams, A., Oram, C., and Lozano-Gracia, N. (2018). Deblurring DMSP nighttime lights: A new method using Gaussian filters and frequencies of illumination. *Remote Sensing of Environment*, 210:242–258.
- Ahlfeldt, G. M., Redding, S. J., Sturm, D. M., and Wolf, N. (2015). The economics of density: Evidence from the Berlin wall. *Econometrica*, 83(6):2127–2189.
- Allen, T. (2023). The topography of nations. Technical report, National Bureau of Economic Research.
- Altomonte, C. et al. (2016). *Measuring competitiveness in Europe: resource allocation, granularity and trade*. Bruegel.
- Bachtrögler, J., Fratesi, U., and Perucca, G. (2020). The influence of the local context on the implementation and impact of EU Cohesion Policy. *Regional Studies*, 54(1):21–34.
- Bachtrögler, J., Hammer, C., Reuter, W. H., and Schwendinger, F. (2017). Spotlight on the beneficiaries of EU regional funds: A new firm-level dataset.
- Bachtrögler-Unger, J., Dolls, M., Krolage, C., Schüle, P., Taubenböck, H., and Weigand, M. (2022). EU Cohesion Policy on the ground: Analyzing small-scale effects using satellite data. *WIFO Working Papers*, (653).
- Bachtrögler-Unger, J., Dolls, M., Krolage, C., Schüle, P., Taubenböck, H., and Weigand, M. (2023). EU Cohesion Policy on the ground: Analyzing small-scale effects using satellite data. *Regional Science and Urban Economics*, 103:103954.

- Bachtrögler, J. and Hammer, C. (2018). Who are the beneficiaries of the structural funds and the Cohesion Fund and how does the Cohesion Policy impact firm-level performance? *OECD Economics Department Working Papers*, (1499).
- Badinger, H. (2005). Growth effects of economic integration: Evidence from the EU member states. *Review of World Economics volume*, 141(1):50–78.
- Bähr, C. (2008). How does sub-national autonomy affect the effectiveness of Structural Funds? *Kyklos*, 61(1):3–18.
- Baldwin, R. and Wyplosz, C. (2022). *The Economics of European Integration 7e*. McGraw Hill.
- Bańkowski, K., Bouabdallah, O., Semeano, J. D., Dorrucchi, E., Freier, M., Jacquinet, P., Modery, W., Rodríguez Vives, M., Valenta, V., and Zorell, N. (2022). The economic impact of Next Generation EU: A Euro Area perspective. *ECB Occasional Paper*, (2022/291).
- Barca, F. (2009). An agenda for a reformed Cohesion Policy: A place-based approach to meeting European Union challenges and expectations. *European Commission, Brussels*.
- Barone, G., David, F., and De Blasio, G. (2016). Boulevard of broken dreams: The end of EU funding (1997: Abruzzi, Italy). *Regional Science and Urban Economics*, 60:31–38.
- Becker, S. O., Egger, P. H., and Von Ehrlich, M. (2010). Going NUTS: The effect of EU Structural Funds on regional performance. *Journal of Public Economics*, 94(9-10):578–590.
- Becker, S. O., Egger, P. H., and Von Ehrlich, M. (2012). Too much of a good thing? On the growth effects of the EU's regional policy. *European Economic Review*, 56(4):648–668.

- Becker, S. O., Egger, P. H., and Von Ehrlich, M. (2013). Absorptive capacity and the growth and investment effects of regional transfers: A regression discontinuity design with heterogeneous treatment effects. *American Economic Journal: Economic Policy*, 5(4):29–77.
- Becker, S. O., Egger, P. H., and von Ehrlich, M. (2018). Effects of EU regional policy: 1989-2013. *Regional Science and Urban Economics*, 69:143–152.
- Beer, C. and Riedl, A. (2012). Modelling spatial externalities in panel data: The Spatial Durbin Model revisited. *Papers in Regional Science*, 91(2):299–318.
- Behrens, K. (2024). Casualties of border changes: Evidence from nighttime lights and plant exit. *Economic Policy*, 39(118):359–406.
- Belotti, F., Di Porto, E., and Santoni, G. (2018). Spatial differencing: Estimation and inference. *CESifo Economic Studies*, 64(2):241–254.
- Berkowitz, P., Monfort, P., and Pieńkowski, J. (2020). Unpacking the growth impacts of European Union Cohesion Policy: transmission channels from Cohesion Policy into economic growth. *Regional Studies*, 54(1):60–71.
- Beugelsdijk, M. and Eijffinger, S. C. (2005). The effectiveness of structural policy in the European Union: An empirical analysis for the EU-15 in 1995–2001*. *JCMS: Journal of Common Market Studies*, 43(1):37–51.
- Blicharska, M., Orlikowska, E. H., Roberge, J.-M., and Grodzinska-Jurczak, M. (2016). Contribution of social science to large scale biodiversity conservation: A review of research about the Natura 2000 network. *Biological Conservation*, 199:110–122.
- Bluhm, R. and Krause, M. (2022). Top lights: Bright cities and their contribution to economic development. *Journal of Development Economics*, 157:102880.

- Boldrin, M., Canova, F., Pischke, J.-S., and Puga, D. (2001). Inequality and convergence in Europe's regions: Reconsidering European regional policies. *Economic policy*, pages 207–253.
- Braakmann, N. and Vogel, A. (2010). The impact of the 2004 EU enlargement on the performance of service enterprises in Germany's eastern border region. *Review of World Economics*, 146:75–89.
- Bradley, J., Morgenroth, E., Gács, J., and Untiedt, G. (2004). A study of the macroeconomic impact of the reform of EU Cohesion Policy. *ESRI, Dublin, Ireland*.
- Bradley, J. and Untiedt, G. (2007). Do economic models tell us anything useful about Cohesion Policy impacts. *Münster (GEFRA Working Paper: Juli 2007–Nr. 3)*.
- Brakman, S., Garretsen, H., van Marrewijk, C., and Oumer, A. (2012). The border population effects of eu integration. *Journal of Regional Science*, 52(1):40–59.
- Breidenbach, P., Mitze, T., and Schmidt, C. M. (2019). EU regional policy and the neighbour's curse: Analyzing the income convergence effects of ESIF funding in the presence of spatial spillovers. *JCMS: Journal of Common Market Studies*, 57(2):388–405.
- Brülhart, M. (2011). The spatial effects of trade openness: A survey. *Review of World Economics*, 147(1):59–83.
- Brülhart, M., Cadot, O., and Himbert, A. (2019). Let there be light: Trade and the development of border regions.
- Brülhart, M., Carrère, C., and Robert-Nicoud, F. (2018). Trade and towns: Heterogeneous adjustment to a border shock. *Journal of Urban Economics*, 105:162–175.
- Burbidge, J. B., Magee, L., and Robb, L. A. (1988). Alternative transformations to handle extreme values of the dependent variable. *Journal of the American Statistical Association*, 83:123–127. tex.owner: Nicolas tex.timestamp: 2014.05.30.

- Callaway, B. and Sant'Anna, P. H. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230.
- Camagni, R., Capello, R., Cerisola, S., and Fratesi, U. (2020). Fighting gravity: Institutional changes and regional disparities in the EU. *Economic Geography*, 96(2):108–136.
- Campos, N. F., Coricelli, F., and Moretti, L. (2019). Institutional integration and economic growth in Europe. *Journal of Monetary Economics*, 103:88–104.
- Capello, R., Caragliu, A., and Fratesi, U. (2018). Breaking down the border: Physical, institutional and cultural obstacles. *Economic Geography*, 94(5):485–513.
- Cappelen, A., Castellacci, F., Fagerberg, J., and Verspagen, B. (2003). The impact of EU regional support on growth and convergence in the European Union. *JCMS: Journal of Common Market Studies*, 41(4):621–644.
- Casula, M. (2021). Under which conditions is Cohesion Policy effective: Proposing an Hirschmanian approach to EU Structural Funds. *Regional & Federal Studies*, 31(4):541–567.
- Cerqua, A. and Pellegrini, G. (2018). Are we spending too much to grow? The case of Structural Funds. *Journal of Regional Science*, 58(3):535–563.
- Chen, X. and Nordhaus, W. D. (2011). Using luminosity data as a proxy for economic statistics. *Proceedings of the National Academy of Sciences*, 108(21):8589–8594.
- Commission, E.-E. et al. (2020). Statistical regions in the european union and partner countries: Nuts and statistical regions 2021: 2020 edition. *Publications Office doi*, 10:72829.
- Coufalová, L., Dellinger, F., Huber, P., and Mikula, S. (2024). Borders and population growth: Evidence from a century of border regime changes on the Austrian-Czech border. Technical report, WIFO Working Papers.

- Coufalova, L., Huberb, P., and Mikulad, M. K. S. (2024). The impact of of market potential and competition on regional enterprise creation? Evidence from the fall of the Iron Curtain.
- Crescenzi, R., Fratesi, U., and Monastiriotis, V. (2017). The EU Cohesion Policy and the factors conditioning success and failure: Evidence from 15 regions. *Regions Magazine*, 305(1):4–7.
- Crescenzi, R. and Giua, M. (2020). One or many Cohesion Policies of the European Union? On the differential economic impacts of Cohesion Policy across member states. *Regional Studies*, 54(1):10–20.
- Crozet, M. and Soubeyran, P. K. (2004). EU enlargement and the internal geography of countries. *Journal of Comparative Economics*, 32(2):265–279.
- Dall’Erba, S. and Le Gallo, J. (2008). Regional convergence and the impact of European Structural Funds over 1989–1999: A spatial econometric analysis. *Papers in Regional Science*, 87(2):219–244.
- Dall’erba, S. and Fang, F. (2017). A meta-analysis of the estimated impact of Structural Funds on regional growth. *Regional Studies*, 51.
- De Chaisemartin, C. and d’Haultfoeuille, X. (2023). Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: A survey. *The Econometrics Journal*, 26(3):C1–C30.
- De Dominicis, L. (2014). Inequality and growth in European regions: Towards a place-based approach. *Spatial Economic Analysis*, 9(2):120–141.
- De Matteis, F., Striani, F., and Bianchi, P. (2021). The role of local governments in managing EU Structural Funds for entrepreneurial development. *EDITORIAL BOARD*, page 165.

- Desmet, K., Nagy, D. K., and Rossi-Hansberg, E. (2025). Human capital accumulation across space.
- Di Cataldo, M. (2017). The impact of EU Objective 1 funds on regional development: Evidence from the UK and the prospect of Brexit. *Journal of Regional Science*, 57(5):814–839.
- Di Cataldo, M. and Monastiriotis, V. (2020). Regional needs, regional targeting and regional growth: An assessment of EU Cohesion Policy in UK regions. *Regional Studies*, 54(1):35–47.
- Dicharry, B. (2020). Impact of European Cohesion Policy on regional growth: When time isn't money. *unpublished manuscript*.
- Egger, P. and Larch, M. (2011). An assessment of the europe agreements' effects on bilateral trade, GDP, and welfare. *European Economic Review*, 55(2):263–279.
- Eggert, W., Von Ehrlich, M., Fenge, R., and König, G. (2007). Konvergenz- und Wachstumseffekte der europäischen Regionalpolitik in Deutschland. *Perspektiven der Wirtschaftspolitik*, 8(2):130–146.
- Elvidge, C. D., Baugh, K. E., Kihn, E. A., Kroehl, H. W., and Davis, E. R. (1997). Mapping city lights with nighttime data from the dmsp operational linescan system. *Photogrammetric Engineering and Remote Sensing*, 63(6):727–734.
- Ertur, C. and Koch, W. (2007). Growth, technological interdependence and spatial externalities: Theory and evidence. *Journal of applied econometrics*, 22(6):1033–1062.
- ESA (2018). Copernicus DEM—Global and European Digital Elevation Model (COP-DEM).
- European Commission (2021). EU border regions: Living labs of european integration. Report COM(2021) 393 final, Directorate-General for Regional and Urban Policy,

- Brussels. Accessed: 2025-05-05.
- Fagerberg, J. and Verspagen, B. (1996). Heading for divergence? Regional growth in Europe reconsidered. *JCMS: Journal of Common Market Studies*, 34(3):431–448.
- Fantechi, F. and Fratesi, U. (2022). Measuring competitiveness differentials inside the same region: A propensity-score matching approach. *Social Indicators Research*, 173(1):109–135.
- Fantechi, F. and Fratesi, U. (2023). Border effects on firm’s productivity: The role of peripherality and territorial capital. *Papers in Regional Science*, 102(3):483–507.
- Ferrara, A. R., McCann, P., Pellegrini, G., Stelder, D., and Terribile, F. (2017). Assessing the impacts of Cohesion Policy on EU regions: A non-parametric analysis on interventions promoting research and innovation and transport accessibility. *Papers in Regional Science*, 96(4):817–841.
- Fiaschi, D., Lavezzi, A. M., and Parenti, A. (2018). Does EU Cohesion Policy work? Theory and evidence. *Journal of Regional Science*, 58(2):386–423.
- Fidrmuc, J., Hulényi, M., and Zajkowska, O. (2024). The long and winding road to find the impact of EU funds on regional growth: IV and spatial analyses. *Regional Studies*, 58(3):583–600.
- Frensch, R., Fidrmuc, J., and Rindler, M. (2023). Topography, borders, and trade across europe. *Journal of Comparative Economics*, 51(3):816–832.
- Gagliardi, L. and Percoco, M. (2017). The impact of European Cohesion Policy in urban and rural regions. *Regional Studies*, 51(6):857–868.
- Gantioler, S., Rayment, M., Ten Brink, P., McConville, A., Kettunen, M., and Bassi, S. (2014). The costs and socio-economic benefits associated with the Natura 2000 network. *International Journal of Sustainable Society*, 6(1-2):135–157.

- Gibbons, S. and Overman, H. G. (2012). Mostly pointless spatial econometrics? *Journal of Regional Science*, 52(2):172–191.
- Gibson, J., Olivia, S., and Boe-Gibson, G. (2020). Night lights in economics: Sources and uses ¹. *Journal of Economic Surveys*, 34(5):955–980.
- Giua, M. (2017). Spatial discontinuity for the impact assessment of the EU regional policy: The case of Italian Objective 1 regions. *Journal of Regional Science*, 57(1):109–131.
- Gouveia, S., Correia, L., and Martins, P. (2020). European integration and its effects on population in border and peripheral regions. *Eastern Journal of European Studies*, 11.
- Grasland, C., Madelin, M., Mathian, H., Sanders, L., Lambert, N., Rebah, M. B., Charlton, M., Cheng, J., Fotheringham, S., Holm, E., et al. (2006). *The modifiable areas unit problem*. PhD thesis, ESPON| Inspire Policy Making with Territorial Evidence.
- Hagen, T. and Mohl, P. (2011). Econometric evaluation of EU Cohesion Policy: A survey. *International Handbook on the Economics of Integration: Factor Mobility, Agriculture, Environment and Quantitative Studies*, 3:343.
- Haltiwanger, J., Jarmin, R. S., and Miranda, J. (2011). Who creates jobs? small vs. large vs. young. *NBER working paper*, 16300:02138.
- Harris, C. D. (1954). The market as a factor in the localization of industry in the united states. *Annals of the association of American geographers*, 44(4):315–348.
- Havranek, T. and Irsova, Z. (2017). Do borders really slash trade? a meta-analysis. *IMF Economic Review*, 65(2):365–396.
- Heider, B. (2019). The impact of EU Eastern enlargement on urban growth and decline: New insights from Germany’s eastern border. *Papers in Regional Science*,

- 98(3):1443–1468.
- Henderson, J. V., Storeygard, A., and Weil, D. N. (2012). Measuring economic growth from outer space. *American economic review*, 102(2):994–1028.
- Hoffstadt, M. (2022). The start of Yugoslavia’s disintegration: Where borders cut commuting spheres.
- Islam, N. (1995). Growth empirics: A panel data approach. *The Quarterly Journal of Economics*, 110(4):1127–1170.
- Jakubowski, A. and Wójcik, P. (2024). Towards cohesion at the interface between the european union states? Cross-border asymmetry and convergence. *Regional Studies*, 58(1):194–207.
- Jones, J., Serwicka, I., and Wren, C. (2020). Motives for foreign direct investment location in europe and eu enlargement. *Environment and Planning A: Economy and Space*, 52(8):1681–1699.
- Kalemli-Özcan, Ş., Sørensen, B. E., Villegas-Sanchez, C., Volosovych, V., and Yeşiltaş, S. (2024). How to construct nationally representative firm-level data from the Orbis global database: New facts on SMEs and aggregate implications for industry concentration. *American Economic Journal: Macroeconomics*, 16(2):353–374.
- Kapanadze, K. (2021). Checkmate! Losing with borders, winning with centers. The case of European integration. *Losing with Borders, Winning with Centers. The Case of European Integration (December 1, 2021). CERGE-EI Working Paper Series*, (716).
- Kapanadze, K. (2022). Bring together what belongs together: The case of divided cities in Europe.
- Kaufmann, D., Kraay, A., and Mastruzzi, M. (2011). The Worldwide Governance Indicators: Methodology and analytical issues. *Hague Journal on the Rule of Law*,

3(02):220–246.

Kochnev, A. (2019). Dying light: War and trade of the separatist-controlled areas of Ukraine. *Available at SSRN 3579099*.

Kopczewska, K., Kudła, J., and Walczyk, K. (2017). Strategy of spatial panel estimation: Spatial spillovers between taxation and economic growth. *Applied Spatial Analysis and Policy*, 10(1):77–102.

Kosma, M. T., Adam, A., and McHugh, M. J. (2003). *Trade Liberalization Strategies: What Could South Eastern Europe Learn From CEFTA and BFTA?* International Monetary Fund.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of political economy*, 99(3):483–499.

Kummu, M., Kosonen, M., and Masoumzadeh Sayyar, S. (2025). Downscaled gridded global dataset for gross domestic product (GDP) per capita PPP over 1990–2022. *Scientific Data*, 12(1):178.

Lahti, L., Huovari, J., Kainu, M., and Biecek, P. (2017). Retrieval and analysis of eurostat open data with the eurostat package.

Le Gallo, J., Dall’Erba, S., and Guillain, R. (2011). The local versus global dilemma of the effects of Structural Funds. *Growth and Change*, 42(4):466–490.

Li, X., Zhou, Y., Zhao, M., and Zhao, X. (2020). A harmonized global nighttime light dataset 1992–2018. *Scientific data*, 7(1):168.

Lösch, A. (1944). *Die räumliche ordnung der wirtschaft*. G. Fischer.

Mankiw, N. G., Romer, D., and Weil, D. N. (1992). A contribution to the empirics of economic growth. *The quarterly journal of economics*, 107(2):407–437.

- Martinez, L. R. (2022). How much should we trust the dictator's GDP growth estimates? *Journal of Political Economy*, 130(10):2731–2769.
- Marzinotto, B. (2012). The growth effects of EU Cohesion Policy: A meta-analysis. Bruegel working paper.
- Maynou, L., Saez, M., Kyriacou, A., and Bacaria, J. (2014). The impact of Structural and Cohesion Funds on Eurozone convergence, 1990–2010. *Regional Studies*, 50(7):1–13.
- McCallum, J. (1995). National borders matter: Canada-US regional trade patterns. *The American Economic Review*, 85(3):615–623.
- Merlevede, B. and Purice, V. (2019). Border regimes and indirect productivity effects from foreign direct investment. *Available at SSRN 3357499*.
- Mitze, T. and Breidenbach, P. (2018). *Economic integration and growth at the margin: A space-time incremental impact analysis*. Number 775. Ruhr Economic Papers.
- Mitze, T. and Breidenbach, P. (2024). The complex regional effects of macro-institutional change: Evidence from EU enlargement over three decades. *Review of World Economics*, pages 1–33.
- Mohl, P., Hagen, T., et al. (2008). Does EU Cohesion Policy promote growth? Evidence from regional data and alternative econometric approaches. Technical report, ZEW-Zentrum für Europäische Wirtschaftsforschung/Center for European Economic Research.
- Nagy, D. (2018). Trade and urbanization: Evidence from Hungary. *American Economic Journal: Microeconomics (Revise and resubmit)*.
- Nakajima, K. (2008). Economic division and spatial relocation: The case of postwar Japan. *Journal of the Japanese and International Economies*, 22(3):383–400.

- Nguyen, C. and Noy, I. (2018). Measuring the impact of insurance on urban recovery with light: The 2010-2011 New Zealand earthquakes. Technical report, CESifo Working Paper.
- Niebuhr, A., Stiller, S., Niebuhr, A., and Stiller, S. (2002). Integration effects in border regions - A survey of economic theory and empirical studies. *Hamburg Institute of International Economics (HWWA)*.
- Oberfield, E., Rossi-Hansberg, E., Sarte, P.-D., and Trachter, N. (2024). Plants in space. *Journal of Political Economy*, 132(3):867–909.
- Pellegrini, G., Terribile, F., Tarola, O., Muccigrosso, T., and Busillo, F. (2013). Measuring the effects of European regional policy on economic growth: A regression discontinuity approach. *Papers in Regional Science*, 92(1):217–233.
- Percoco, M. (2017). Impact of European Cohesion Policy on regional growth: Does local economic structure matter? *Regional Studies*, 51(6):833–843.
- Petrakos, G., Topaloglou, L., et al. (2008). Economic geography and European integration: the effects on the EU's external border regions. *International Journal of Public Policy*, 3(3/4):146.
- Pinkovskiy, M. and Sala-i Martin, X. (2020). Shining a light on purchasing power parities. *American Economic Journal: Macroeconomics*, 12(4):71–108.
- Poehnlein, M. (2025). Leaky barriers: Labor market effects of EU integration in the Polish border region. *Available at SSRN 5159768*.
- Radvansky, M., Lichner, I., and Miklosovic, T. (2015). Using regional Hermin model at NUTS 3 level for CSF ex-post assessment in Slovakia. EcoMod2015 8466, EcoMod.
- Ramey, V. A. (2011). Can government purchases stimulate the economy? *Journal of Economic Literature*, 49(3):673–85.

- Redding, S. J. and Sturm, D. M. (2008). The costs of remoteness: Evidence from German division and reunification. *American Economic Review*, 98(5):1766–97.
- Richter, S. (1998). The CEFTA and the Europe Agreements. *MOST: Economic Policy in Transitional Economies*, 8:91–119.
- Rodríguez-Pose, A. (2022). The rise of populism and the revenge of the places that don't matter. *Origins and Alternative Policy Responses*, 79.
- Rodríguez-Pose, A., Bartalucci, F., Lozano-Gracia, N., and Dávalos, M. (2024). Overcoming left-behindedness. moving beyond the efficiency versus equity debate in territorial development. *Regional Science Policy & Practice*, 16(12):100144.
- Rodríguez-Pose, A. and Fratesi, U. (2004). Between development and social policies: The impact of European Structural Funds in Objective 1 regions. *Regional Studies*, 38(1):97–113.
- Rodríguez-Pose, A. and Garcilazo, E. (2015). Quality of government and the returns of investment: Examining the impact of cohesion expenditure in European regions. *Regional Studies*, 49(8):1274–1290.
- Rodríguez-Pose, A. and Ketterer, T. (2020). Institutional change and the development of lagging regions in Europe. *Regional studies*, 54(7):974–986.
- Roemisch, R. (2017). Establishment of consolidated financial data 1989–2013. *Directorate-General for Regional and Urban Policy, European Commission*.
- Rossi-Hansberg, E. and Zhang, J. (2025). Local GDP estimates around the world. Technical report, National Bureau of Economic Research.
- Roth, J., Sant'Anna, P. H., Bilinski, A., and Poe, J. (2023). What's trending in difference-in-differences? a synthesis of the recent econometrics literature. *Journal of Econometrics*.

- Rüttenauer, T. and Aksoy, O. (2024). When can we use two-way fixed-effects (twfe): A comparison of twfe and novel dynamic difference-in-differences estimators. *arXiv preprint arXiv:2402.09928*.
- Schiavina, M., Melchiorri, M., Pesaresi, M., Politis, P., Freire, S., Maffenini, L., Florio, P., Ehrlich, D., Goch, K., Tommasi, P., et al. (2022). GHSL data package 2022. *Publications Office of the European Union: Luxembourg*.
- Serwicka, I. E., Jones, J., and Wren, C. (2024). Economic integration and FDI location: Is there a border effect within the enlarged EU? *The Annals of Regional Science*, 72(1):85–106.
- Simonovska, R. and Tafenau, E. (2024). Varying size and shape of spatial units: Analysing the maup through agglomeration economies in the case of germany. *Region: the journal of ERSA*, 11(2):63–97.
- Tanaka, K. and Keola, S. (2017). Shedding light on the shadow economy: A nighttime light approach. *The Journal of Development Studies*, 53(1):32–48.
- Tuttle, B. T., Anderson, S. J., Sutton, P. C., Elvidge, C. D., and Baugh, K. (2013). It used to be dark here. *Photogrammetric Engineering & Remote Sensing*, 79(3):287–297.
- Ulceluse, M. and Kahanec, M. (2023). Eastward enlargements of the European Union, transitional arrangements and self-employment. *Journal of Population Economics*, 36(2):719–742.
- van Dijk, B. (2011). *Orbis User Guide*. Brussels, Belgium. Accessed from Bureau van Dijk’s Orbis database documentation.
- Van Houtum, H. (2000). III european perspectives on borderlands: An overview of European geographical research on borders and border regions. *Journal of Borderlands studies*, 15(1):56–83.

- Védrine, L. (2020). Allocation of European Structural Funds, decentralization and strategic spatial interactions. *Regional Studies*, 54(1):72–82.
- Venables, A. and Gasiorek, M. (1999). The socio-economic impact of projects financed by the Cohesion Fund: A modeling approach. *Luxembourg: European Commission*.
- Wassmann, P. (2016). The economic effects of the EU Eastern enlargement on border regions in the old member states. Technical report, Hannover Economic Papers (HEP).
- Wooldridge, J. M. (2021). Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators. *Available at SSRN 3906345*.
- Wostner, P. and Šlander, S. (2009). *The effectiveness of EU Cohesion Policy revisited: are EU Funds really additional?* European Policies Research Centre.