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

Job Market Paper

Preliminary version

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Abstract

In this paper, I use the Eastern EU enlargements as a quasi-experiment to assess the impact of integration on the border areas. As such, I compare the growth of night-time light emissions in urban municipalities close to the treated borders to municipalities located in the interior of the same countries applying staggered differences-in-differences approach. I find a positive average treatment effect for urban municipalities that are part of the 2004 EU enlargement and bordering other countries of the 2004 expansion cohort. Moreover, my results indicate the importance of anticipation, as economic activity increased in the 2004 new member states near borders with EU15 before EU accession. The positive impact on the 2004 enlargement also shows the importance of market access. Smaller urban municipalities of the 2007 enlargement display an enhanced economic development in comparison to the hinterland. Also, it seems that proximity to borders made up of mountains or rivers might restrict the positive impact of EU accession for border areas.

Keywords: EU integration, Eastern EU enlargement, nighttime lights, differences-in-differences, regional economics.

JEL Codes: F15, P25, R11.

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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 20$^{\text{th}}$ 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 Petrakos 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

[1] As 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.

areas may also offer firms cheaper production factors and workers more affordable amenities. On the other hand, Crozet and Soubeyran (2004) and Petrakos 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 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 (Brülhart 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

[2]This 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.

[3]The 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.)

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 overglow from urban areas.

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 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); Brülhart 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.

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.[4] 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 1 that the

[4]Even 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.

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 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.[5] 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

[5]For 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 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.

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 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.[6] 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, Petrakos 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.

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.[7] 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 symmetrically on both sides of the borders. However, the unavailability of regular economic data, especially whose definitions are comparable

[6] Historically, 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.

[7] The 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).

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.[8]

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 (Brülhart et al., 2019; Kapanadze, 2022; Bachtrögler-Unger et al., 2023).

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).[9]

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.[10] 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 (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

[8]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).

[9]Note 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.

[10]F10 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.

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 form this pixel is attributed to an area of around 2.7x2.7 km.[11] 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.[12]

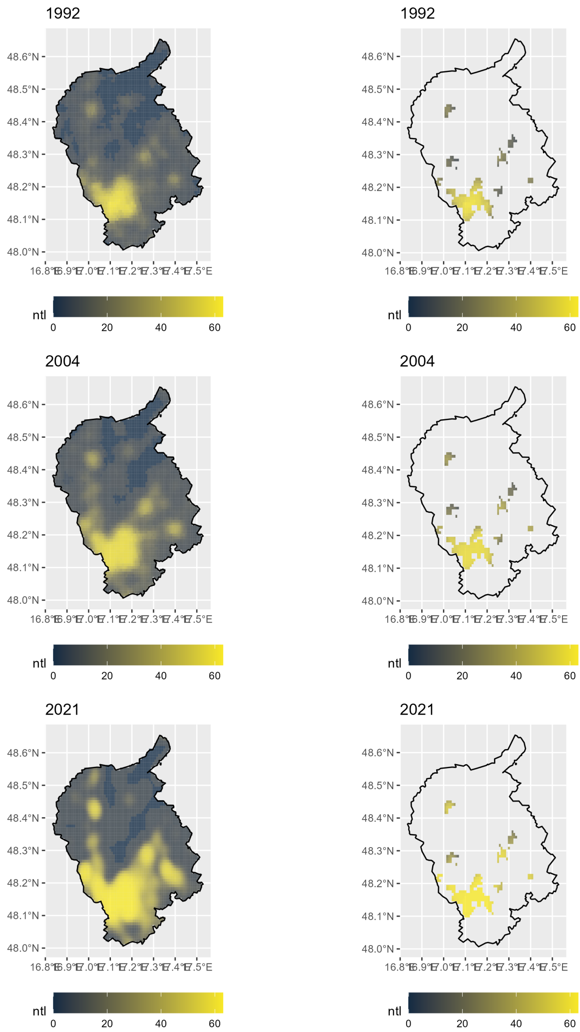
Due to these challenges, NTL are often recommended as a proxy for economic activity when GDP data are unavailable or unreliable. This can result from poor data aggregation and measurement (Chen and Nordhaus, 2011), manipulation of official statistics (Martinez, 2022), or a substantial presence of informal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

[11] 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.

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

Figure 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 8 shows the satellite view of the region for comparison.

provided by Li et al. (2020).[13] 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.

[13] Figure 9 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 8).

I then sum up the of NTL for urban areas of LAU municipalities.[14] 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.[15]

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):

$$rel\_NTL_{ic} = \frac{NTL_{ic}}{NTL_c} \tag{1}$$

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.[16]

Figure 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.[17] Much of the apparent rural luminosity likely reflects urban overglow, especially in the central Bratislava Region where the Malé Karpaty mountains are located (Figure 8). 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 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

[14] The 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.

[15] The definition and data are available here `https://tinyurl.com/bdz59e7p` under the section ”Urban 2018”.

[16] This exclusion affects 20 units in the treatment group and 75 units in the control group. Table 8 includes results where only individual observations are excluded, showing no substantial differences in outcomes.

[17] Luminosity here the 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).

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.[18] 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.[19] That is, the treatment group consists of urban municipalities located within 25 kilometers of a border affected by the EU enlargement. For this threshold, the value for the nearest border is taken into account.[20]

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

[18] For 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.

[19] "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.

[20] For example, in the aforementioned Bratislava Region in Figure 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.

bias.[21]

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 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 located within 50 kilometers of the external EU borders, since these could be affected by trade diversion.[22]

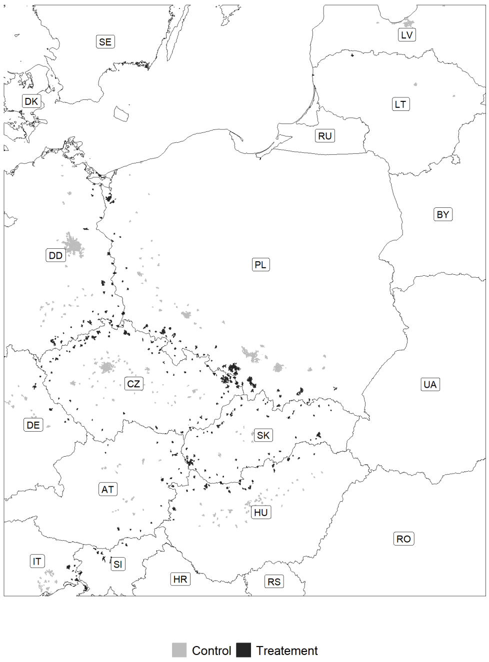
The evaluation of the impact of the Eastern Enlargements on border municipalities assumes that the EU accession shock is exogenous for these areas. As the countries for the Eastern Enlargements were selected based on the pre-treatment similarities with the existing member states as well as geographic 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

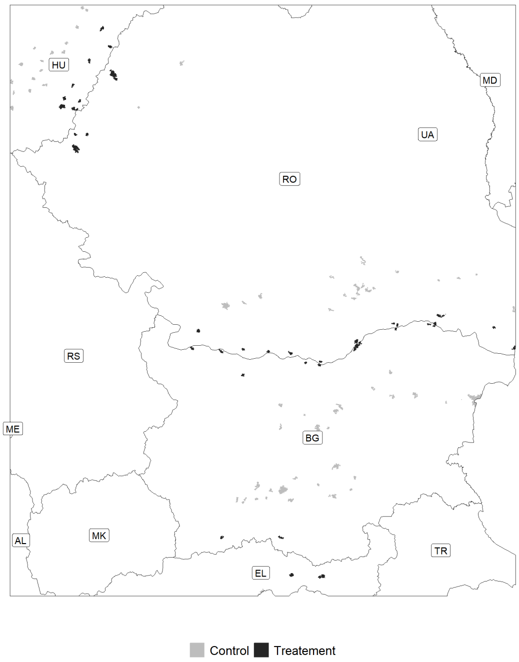
[21] Kapanadze (2021) propose an innovative approach of using regions of countries that acceded later into the EU (Bulgaria, Romania and Croatia) as well as one non-EU country (Norway) in the donor pool to create the synthetic counterfactuals of the 2004 enlargement regions. Yet, this approach creates another problem of being able to compute only the short term effects of the 2004 enlargements as accession of Bulgaria an 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.

[22] Also 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.

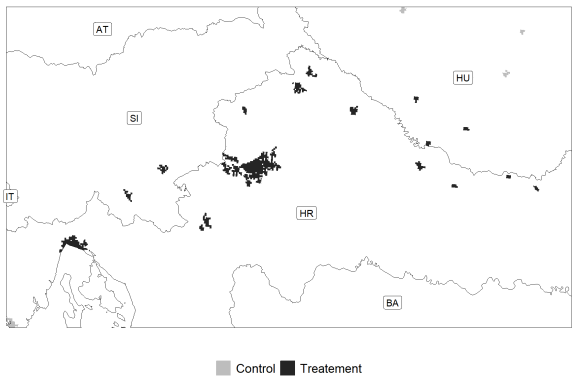
Figure 2: Location of urban municipalities in sample and their distance from border.



(a) 2004 enlargement



(b) 2007 enlargement



(c) 2013 enlargement

Note: Maps show urban municipalities in my sample located in proximity of treated borders of the E8 enlargement (Figure 2a), E2 enlargement (Figure 2b), Croatian enlargement (Figure 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 4 and Table 5 contain cross-sectional counts of observations per country and nearest border, respectively.

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 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.[23]

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*:

[23] When 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

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

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.[24]

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. [25] 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:

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

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

Table 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.[26] 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

[24] Table 8 provides a robustness check of using only never-treated units in the control group.

[25] Mitze and Breidenbach (2024) use the term structural hetrogeneity to denote the differences between enlargement waves as well as between established and new member states.

[26] See **??** for a discussion about the sources and computation of these variables.

Table 2: Descriptive statistics of the main variables.

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

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

Table 3: Baseline results.

	(1)	(2)	(3)	(4)
	All	*EU15*-NMS	EU15-*NMS*	NMS-NMS
	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL
ATT (E8)	0.0269	0.0432	-0.0808*	0.0567*
	(0.0165)	(0.0274)	(0.02)	(0.0172)
ATT (E2)	0.0177	-0.0593	-0.0664	0.033
	(0.0464)	(0.048)	(0.0606)	(0.0581)
ATT (HR)	-0.1126			-0.1126
	(0.0793)			(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 effect ts 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).

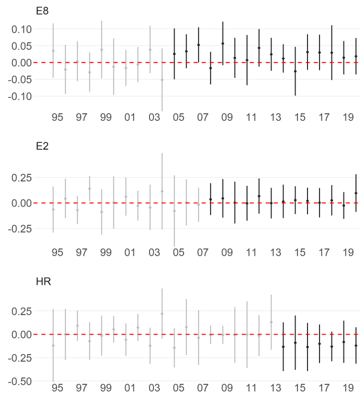
municipalities of the Croatian enlargement. It seems that growth rates were higher in the pre-accession period than in the post-accession period, which may reflect the general economic slowdown in the EU. Lastly, because they are closest to the core economic areas of the EU15, the border urban municipalities affected by the 2004 enlargement exhibit the highest levels of foreign market potential.

Results

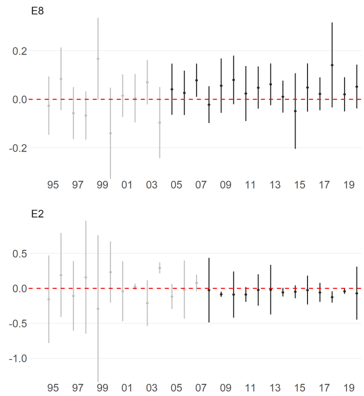
Baseline Results

?? 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 **??** 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

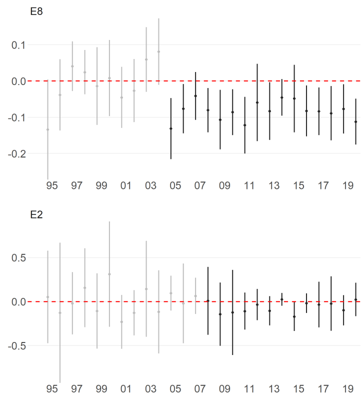
Figure 3: Dynamics of the baseline results.



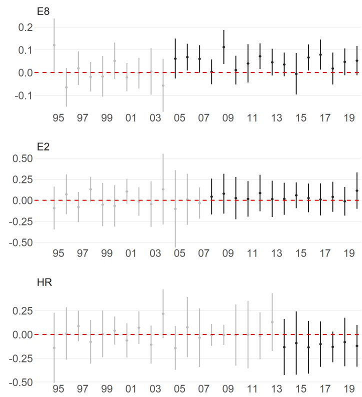
(a) All urban municipalities



(b) Urban municipalities in EU15 near borders with NMS



(c) Urban municipalities in NMS near borders with EU15



(d) Urban municipalities in NMS near borders with NMS

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 3a). In the other subfigures the treatment group is made up of urban municipalities located in EU15 near borders with NMS (Figure 3b), in NMS near borders with EU15 (Figure 3c), in NMS near borders with other NMS (Figure 3d), respectively. Control group is made up of urban municipalities located between 50 and 100 kilometers from the border for all cases.

NMS decreased their share of 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.

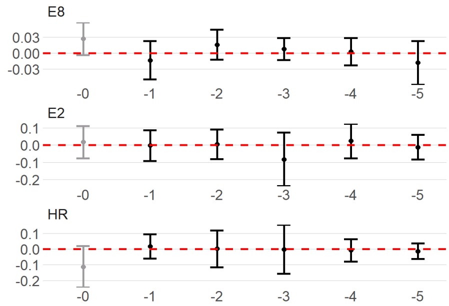
Note that a negative or insignificant impact reported in some columns does not mean that the EU enlargement is not beneficial for these urban municipalities. It only shows that the benefits are smaller or just as big when compared to urban municipalities located in the hinterland. Furthermore, due to 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.

Temporal heterogeneity

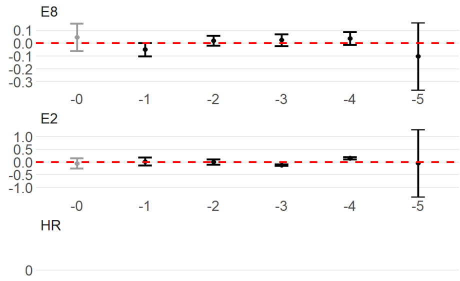
The Eastern Enlargements were a gradual process, with trade liberalization taking place in the pre-accession period and further deepening of the integration after the enlargements happened (Table 1). Looking at the dynamics of the impact presented in **??** , we can observe a potential of anticipation 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 can have two implications for the results, presented in columns (2)-(4) of **??** and **??** . 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 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 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 borer with Austria in the 1990s. As such, this may indicate that, during this period, EU15

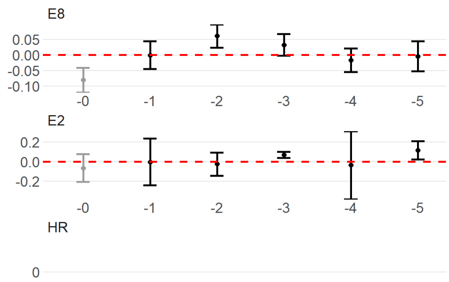
Figure 4: Anticipation effects with $\delta \in [-5, 0]$.



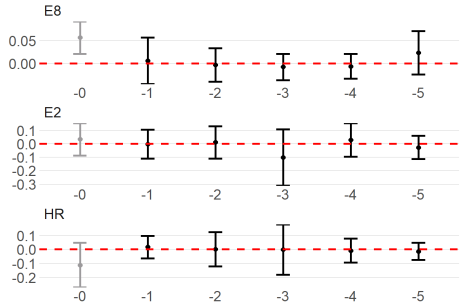
(a) All urban municipalities



(b) Urban municipalities in EU15 near borders with NMS



(c) Urban municipalities in NMS near borders with EU15



(d) Urban municipalities in NMS near borders with NMS

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 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 4b), urban municipalities located in NMS near border with EU15 (Figure 4c) and urban municipalities located in NMS near border with other NMS (Figure 4d). Detailed information on the results is in Table 6.

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.

Potential factors

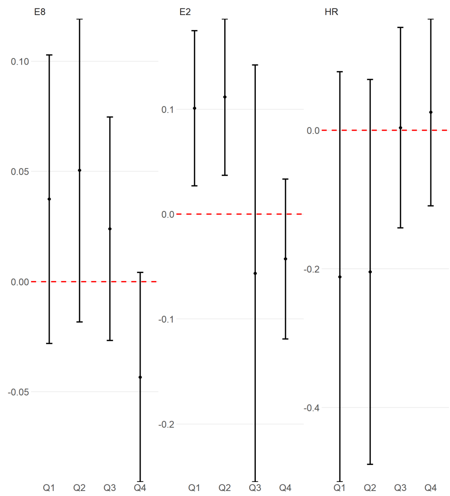
As the treated municipalities as well as the borders they are close to are quite diverse in terms characteristics, I evaluate some of these differences that might influence the extent of the impact of EU enlargement on these urban municipalities. The impact of EU accession on border urban municipalities 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. Brülhart (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 5. The impact of EU accession is significant only 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

Figure 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, [12285.16.59-24547.78) for Q3 and [24547.78-748565) for Q4. Detailed information on the results is in Table 7. Spatial distribution of the quartiles is displayed in Figure 10.

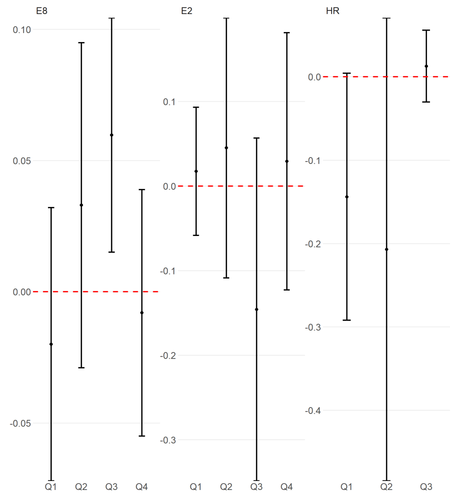
higher number of potential customers on the other side of the border can attract more firms and individuals in the border area Redding and Sturm (2008); Ahlfeldt et al. (2015); Coufalova et al. (2024). To evaluate this mechanism, I use the data from Schiavina et al. (2022) to construct a measure of foreign market potential within 100 kilometers of the border urban municipality, based on Harris (1954):

$$FMP_{i,1990} = \sum_{j \in \mathcal{F}(i)} \mathbf{1}\big(d_{ij} \leq 100\big) \, \frac{P_{j,1990}}{d_{ij}} \tag{2}$$

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 separetely without making changes i the control group.

The results displayed in figure Figure 6 do not indicate much differences of the effects between the quartiles of foreign market potential. With exception being the urban munic-

Figure 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 7. Spatial distribution of the quartiles is displayed in Figure 10.

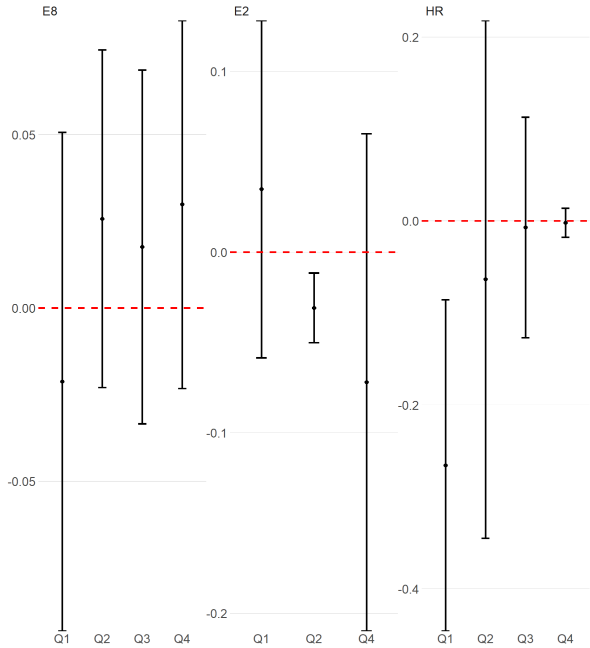
ipalities located close to the 2004 enlargement borders, for which the effect is positive for the third quartile. Interestingly, the impact becomes insignificant for the fourth quartile. A possibility could be that with in localities with a large foreign market potential the increased competition from 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.[27] 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

[27] For 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 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 7. Spatial distribution of the quartiles is displayed in Figure 10.

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 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.

Robustness checks

Methodological changes. To check for robustness of the results, I first consider alterations in the methodological setup (Panel A in Table 8). Another way to include 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 11 suggest greater bias than the baseline results in **??** , 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 municipalies 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 8). 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.[28]

The results, documented in Panel C of Table 8, remain significant for the E8 cohort in NMS, but increase numerically. This may indicate that urban municipalities that 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 8). 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 12). 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

[28]This does not change much the estimated coefficients. For instance, the coefficient for E8 in column (4) of Table 8 would be 0.634 (and significant) with the buffer in place.

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 8, 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 are 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.

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 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) a swell 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.

References

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. 11

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. 25

Allen, T. (2023). The topography of nations. Technical report, National Bureau of Economic Research. 9

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. 3, 10

Badinger, H. (2005). Growth effects of economic integration: Evidence from the EU member states. *Review of World Economics volume*, 141(1):50–78. 6

Baldwin, R. and Wyplosz, C. (2022). *The Economics of European Integration 7e*. McGraw Hill. 7, 8

Behrens, K. (2024). Casualties of border changes: Evidence from nighttime lights and plant exit. *Economic Policy*, 39(118):359–406. 6

Bluhm, R. and Krause, M. (2022). Top lights: Bright cities and their contribution to economic development. *Journal of Development Economics*, 157:102880. 11

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. 3, 6, 10

Brülhart, M. (2011). The spatial effects of trade openness: A survey. *Review of World Economics*, 147(1):59–83. 24, 31

Brülhart, M., Cadot, O., and Himbert, A. (2019). Let there be light: Trade and the development of border regions. 6, 10

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. 3

Callaway, B. and Sant'Anna, P. H. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2):200–230. 17, 28, 30, 47

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. 6

Campos, N. F., Coricelli, F., and Moretti, L. (2019). Institutional integration and economic growth in Europe. *Journal of Monetary Economics*, 103:88–104. 6, 7

Capello, R., Caragliu, A., and Fratesi, U. (2018). Breaking down the border: Physical, institutional and cultural obstacles. *Economic Geography*, 94(5):485–513. 26

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. 11

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. 9

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. 3, 5

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. 22, 25

Crozet, M. and Soubeyran, P. K. (2004). EU enlargement and the internal geography of countries. *Journal of Comparative Economics*, 32(2):265–279. 3, 8, 9, 26

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. 17

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. 4, 7, 31

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. 11, 13

ESA (2018). Copernicus DEM—Global and European Digital Elevation Model (COP-DEM). 26

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. 28

Frensch, R., Fidrmuc, J., and Rindler, M. (2023). Topography, borders, and trade across europe. *Journal of Comparative Economics*, 51(3):816–832. 26

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. 11

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. 3

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. 9

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. 25

Havranek, T. and Irsova, Z. (2017). Do borders really slash trade? a meta-analysis. *IMF Economic Review*, 65(2):365–396. 5

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. 3, 6, 10

Henderson, J. V., Storeygard, A., and Weil, D. N. (2012). Measuring economic growth from outer space. *American economic review*, 102(2):994–1028. 10

Hoffstadt, M. (2022). The start of Yugoslavia's disintegration: Where borders cut commuting spheres. 5

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. 6

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). 3, 6, 15

Kapanadze, K. (2022). Bring together what belongs together: The case of divided cities in Europe. 3, 6, 10

Kochnev, A. (2019). Dying light: War and trade of the separatist-controlled areas of Ukraine. *Available at SSRN 3579099*. 5

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. 7

Li, X., Zhou, Y., Zhao, M., and Zhao, X. (2020). A harmonized global nighttime light dataset 1992–2018. *Scientific data*, 7(1):168. 11, 12, 13, 29, 30

Martinez, L. R. (2022). How much should we trust the dictator's GDP growth estimates? *Journal of Political Economy*, 130(10):2731–2769. 11

McCallum, J. (1995). National borders matter: Canada-US regional trade patterns. *The American Economic Review*, 85(3):615–623. 5

Mitze, T. and Breidenbach, P. (2018). *Economic integration and growth at the margin: A space-time incremental impact analysis*. Number 775. Ruhr Economic Papers. 3, 6

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. 3, 6, 18, 32

Nagy, D. (2018). Trade and urbanization: Evidence from Hungary. *American Economic Journal: Microeconomics (Revise and resubmit)*. 5

Nakajima, K. (2008). Economic division and spatial relocation: The case of postwar Japan. *Journal of the Japanese and International Economies*, 22(3):383–400. 5

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. 11

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)*. 2, 9

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. 2, 3, 9, 32

Pinkovskiy, M. and Sala-i Martin, X. (2020). Shining a light on purchasing power parities. *American Economic Journal: Macroeconomics*, 12(4):71–108. 29

Poehnlein, M. (2025). Leaky barriers: Labor market effects of EU integration in the Polish border region. *Available at SSRN 5159768*. 3

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. 3, 5, 8, 24, 25, 31

Richter, S. (1998). The CEFTA and the Europe Agreements. *MOST: Economic Policy in Transitional Economies*, 8:91–119. 4, 7

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. 6

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*. 17

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*. 17, 28

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*. 24, 25

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. 9

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. 11

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. 11

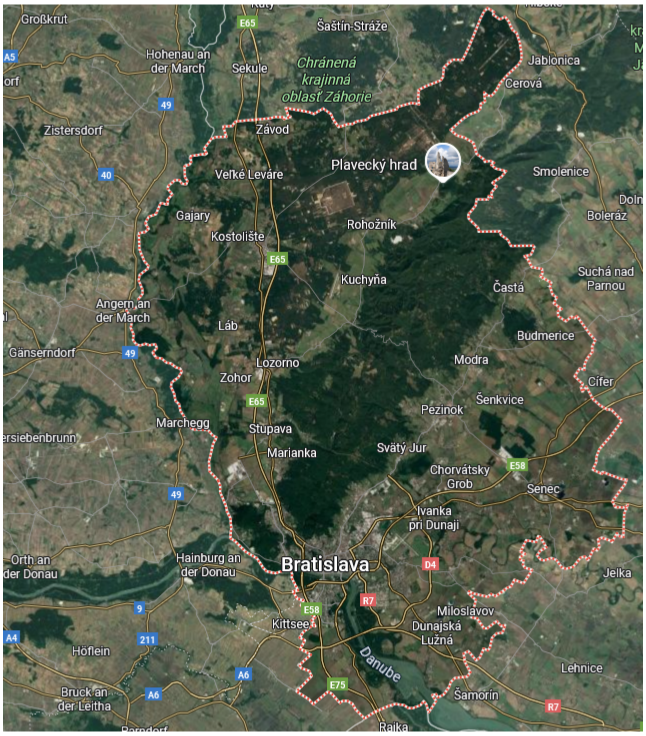
Ulceluse, M. and Kahanec, M. (2023). Eastward enlargements of the European Union, transitional arrangements and self-employment. *Journal of Population Economics*, 36(2):719–742. 7

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). 3, 6

Wooldridge, J. M. (2021). Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators. *Available at SSRN 3906345*. 17, 28, 47

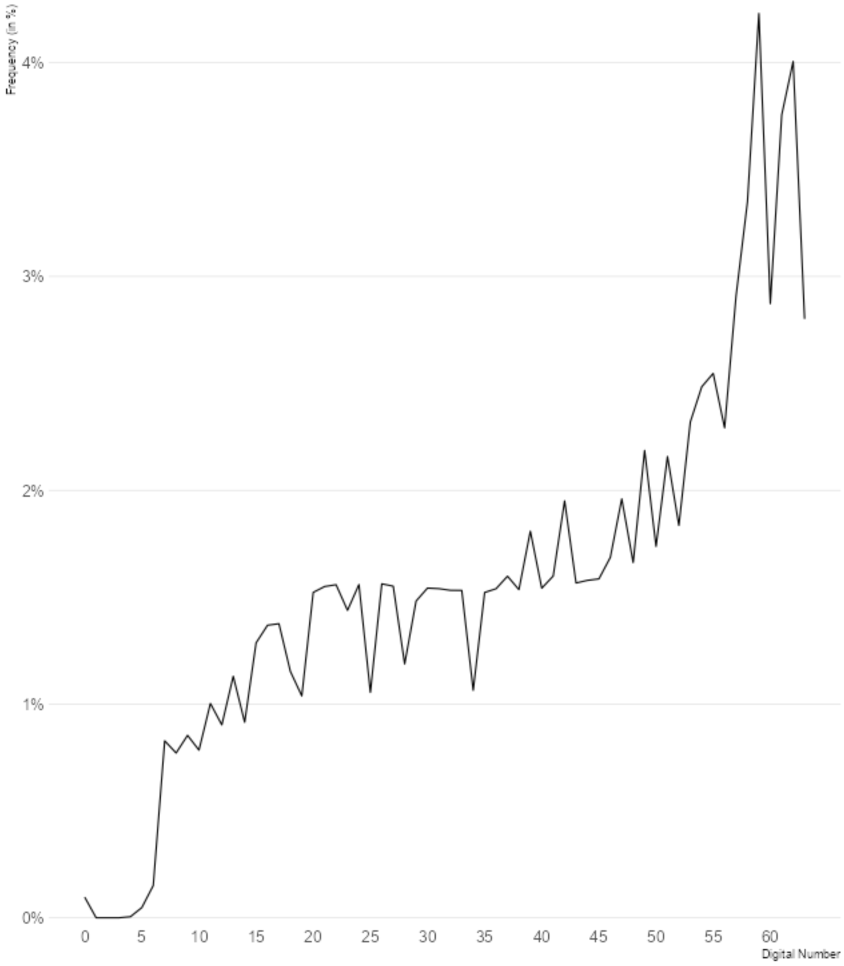
Appendix

Figure 8: 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 1. Source: Google Maps.

Figure 9: 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 4: 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 5: 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

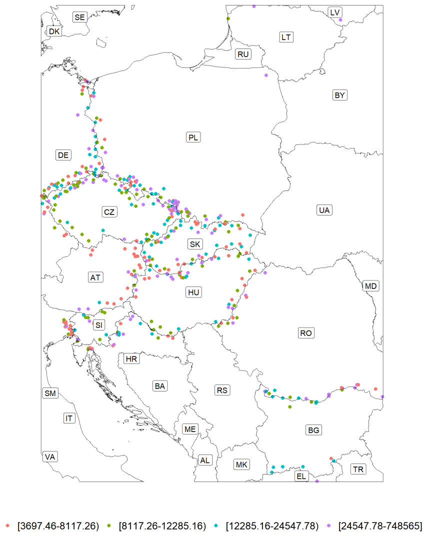
Notes: The table reports cross-sectional count of observations by nearest border, denoted by the ISO 31
the countries separated by the border. DD further denotes the former German Democratic Republic.

Table 6: Anticipation effects with $\delta \in [-5, 0]$.

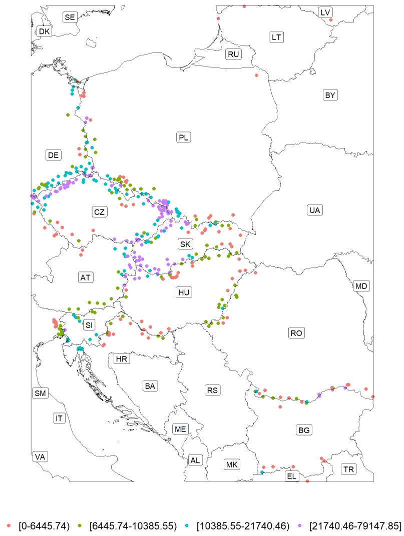
	(1) All Δ rel_NTL	(2) *EU15*-NMS Δ rel_NTL	(3) EU15-*NMS* Δ rel_NTL	(4) NMS-NMS Δ rel_NTL	(5) All Δ rel_NTL	(6) *EU15*-NMS Δ rel_NTL	(7) EU15-*NMS* Δ rel_NTL	(8) NMS-NMS Δ rel_NTL
ATT (E8)	-0.0135	-0.0521	-0.0011	0.0055	0.0158	0.0171	0.0605*	-0.0038
	(0.016)	(0.0286)	(0.0206)	(0.0267)	(0.0132)	(0.0194)	(0.0218)	(0.0173)
ATT (E2)	-0.0018	0.0171	-0.0032	-0.0028	0.0054	-0.0033	-0.0251	0.0101
	(0.0459)	(0.0337)	(0.1215)	(0.0537)	(0.0435)	(0.0527)	(0.0618)	(0.0553)
ATT (HR)	0.0166			0.0166	0.0016			0.0016
	(0.0425)			(0.0426)	(0.0593)			(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	0.0211	0.0318	-0.0081	0.0028	0.0352	-0.0174	-0.0068
	(0.0111)	(0.0219)	(0.015)	(0.0142)	(0.0125)	(0.0231)	(0.0193)	(0.0132)
ATT (E2)	-0.0824	-0.1223*	0.0687*	-0.1019	0.0247	0.15*	-0.0369	0.0276
	(0.0907)	(0.012)	(0.0146)	(0.1047)	(0.0516)	(0.0217)	(0.1526)	(0.0537)
ATT (HR)	-0.0018			-0.0018	-0.0083			-0.0083
	(0.0864)			(0.0872)	(0.0377)		(0.0397)	
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	-0.1042*	-0.0045	0.0236				
	(0.021)	(0.0457)	(0.0234)	(0.02)				
ATT (E2)	-0.0112	-0.0496	0.1156*	-0.0271				
	(0.0381)	(0.1294)	(0.0482)	(0.0387)				
ATT (HR)	-0.0141			-0.0141				
	(0.0286)			(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)).

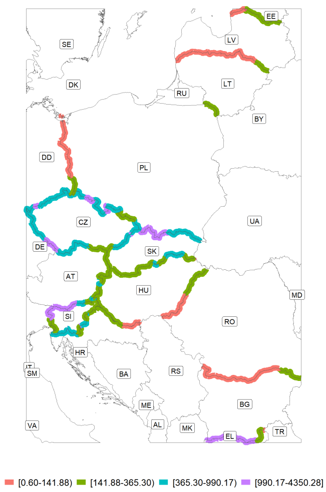
Figure 10: Average elevation of border segments.



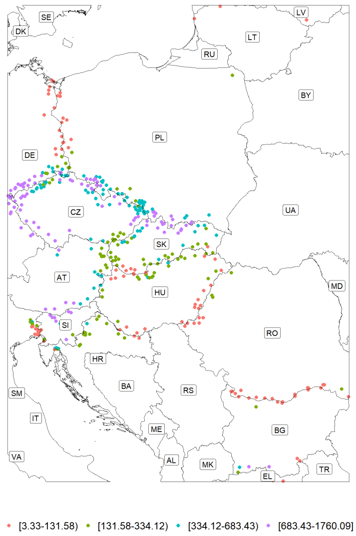
(a) Quartiles of urban municipality populations



(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 7: 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	0.0354	0.0415	-0.0392	0.0044	0.0319	0.0562*	-0.0045
	(0.0368)	(0.0363)	(0.0267)	(0.0255)	(0.033)	(0.0364)	(0.0295)	(0.0291)
ATT (E2)	0.1115*	0.1009*	-0.0565	-0.0427	0.0234	0.0431	-0.1459	0.0293
	(0.0375)	(0.0484)	(0.1187)	(0.0393)	(0.0358)	(0.1108)	(0.1204)	(0.0925)
ATT (HR)	-0.2041	-0.2113	0.0038	-0.1438*	-0.2069	0.0128		
	(0.148)	(0.1571)	(0.096)	(0.0811)	(0.0846)	(0.1674)	(0.0261)	
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	0.017	0.0405	0.0314
	(0.0458)	(0.0245)	(0.0301)	(0.027)
ATT (E2)	0.0349	-0.0309*	-0.0072	-0.0722
	(0.052)	(0.0098)	(0.07)	(0.0707)
ATT (HR)	-0.2659*	-0.0636		-0.0021
	(0.1051)	(0.1303)		(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 8: Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	*EU15*-NMS	EU15-*NMS*	NMS-NMS	All	*EU15*-NMS	EU15-*NMS*	NMS-NMS
	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				
Panel D: Sample restrictions								

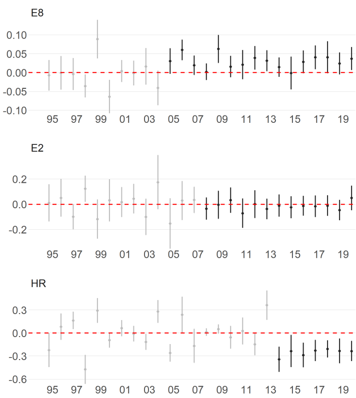
Continued on next page

Table 8 – continued from previous page

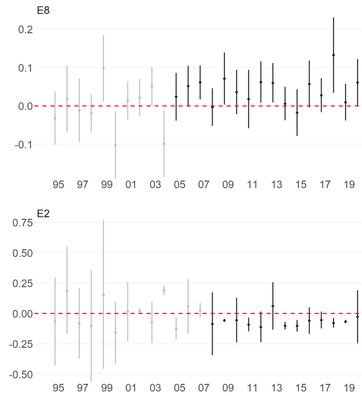
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	*EU15*-NMS	EU15-*NMS*	NMS-NMS	All	*EU15*-NMS	EU15-*NMS*	NMS-NMS
	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL	Δ rel_NTL
ATT (E8)	0.0241	0.0417	-0.089*	0.0541*	0.0268*	0.0423	-0.0797*	0.0559*
	(0.0157)	(0.0289)	(0.02)	(0.0166)	(0.0161)	(0.0284)	(0.0215)	(0.018)
ATT (E2)	0.0162	-0.0639	-0.071	0.0305	-0.06	-0.0672	0.0322	
	(0.0471)	(0.0532)	(0.0766)	(0.0537)	(0.0452)	(0.0614)	(0.061)	(0.0626)
ATT (HR)	-0.1099			-0.1099	-0.1185*			-0.1185
	(0.07)			(0.0666)	(0.0687)			(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	0.0385	-0.0786*	0.0588*	0.0377*	0.0229	-0.0592*	0.0789*
	(0.0164)	(0.0273)	(0.0205)	(0.0166)	(0.0161)	(0.0274)	(0.0227)	(0.0163)
ATT (E2)	0.0213	-0.0556	-0.0628	0.0366	0.027	-0.0793	-0.0704	0.0456
	(0.0457)	(0.0464)	(0.0627)	(0.0614)	(0.0501)	(0.088)	(0.0825)	(0.0584)
ATT (HR)	-0.1139			-0.1139	-0.1328*			-0.1328
	(0.0751)			(0.0769)	(0.0654)			(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	0.0402	-0.0833*	0.0608*				
	(0.0172)	(0.0276)	(0.0199)	(0.0174)				
ATT (E2)	0.0225	-0.0568	-0.0696	0.039				
	(0.051)	(0.044)	(0.095)	(0.0623)				
ATT (HR)	-0.1327			-0.1327				
	(0.0955)			(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-terated 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 cpaitals excludes capital cities, and index, weighted and until 2013 denote various alternatives of relative NTL used.

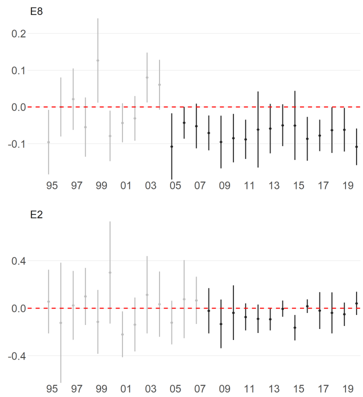
Figure 11: Dynamics of the matching results.



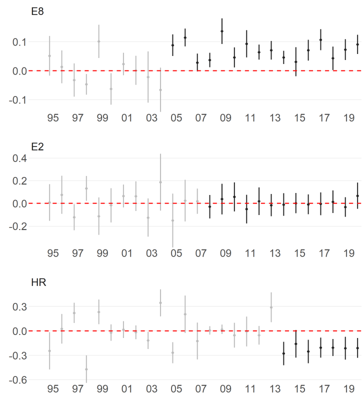
(a) All urban municipalities



(b) Urban municipalities in EU15 near borders with NMS



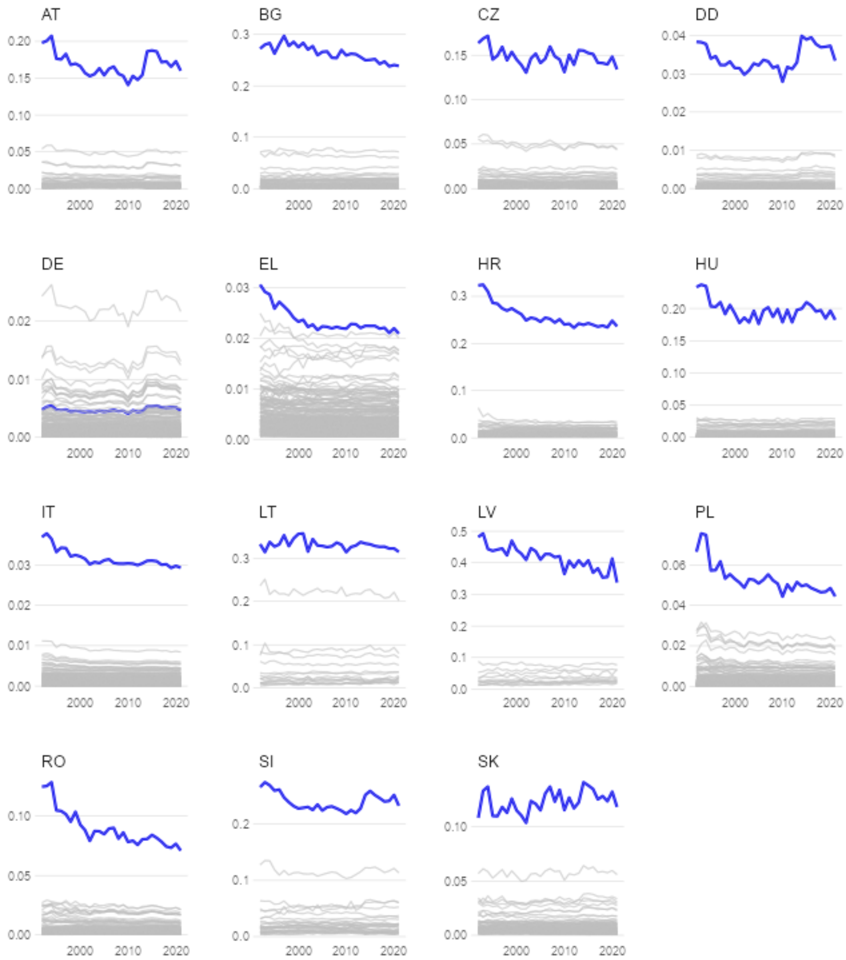
(c) Urban municipalities in NMS near borders with EU15



(d) Urban municipalities in NMS near borders with NMS

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 11a). In the other subfigures the treatment group is made up of urban municipalities located in EU15 near borders with NMS (Figure 11b), in NMS near borders with EU15 (Figure 11c), in NMS near borders with other NMS (Figure 11d), respectively. Control group is made up of urban municipalities located between 50 and 100 kilometers from the border for all cases.

Figure 12: 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).