Checkmate! Losing with Borders, Winning with Centers. The Case of European Integration

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Abstract

This paper studies two major stages of European integration, the expansion of the European Union (*EU*) in 2004 and the Schengen Area in 2008, and their impacts on economic performance in sub-regions of Central and Eastern European (*CEE*) countries. Using European regional data at the NUTS3 level and disaggregated synthetic control method, I construct counterfactuals for sub-regions of CEE countries. This approach allows me to assess regional treatment effects (*RTEs*) and to study the heterogeneous effects of European integration. I find that the benefits of EU and Schengen memberships to annual GDP per capita are approximately 10% less in border regions, relative to interior areas. The results expose regional economic disparities, as border regions lose relative to interior regions since European integration. Furthermore, integration facilitators in border regions such as fewer geographical barriers, more service employment, and positive attitudes toward the EU did not reduce economic disparities. The results show that the gap persists, regardless of some complementarities. Thus, the main implication of this paper is that sub-regions of CEE countries are far from being fully converged, and that European integration instead seems to have spurred sub-regional divergence.

JEL codes: F15, F16, F20, R12

Keywords: CEE countries, European integration, RTEs, borders, dissagregated synthetic controls

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1 Introduction

Joining the EU in 2004 and the Schengen Area in 2008 were key prerequisites for effective market integration of Central and Eastern European (*CEE*) countries. These were necessary steps in the course of European integration to eliminate barriers that hinder the free movement of goods, services, capital, and labor. One of the central components of the ongoing European integration process is that reduction of international trading costs can influence the economic geography of each integrated country differently. Understanding regional economic inequalities caused by European integration is a complex undertaking. While aggregate disparities slowly disappear and European Union (*EU*) member states converge economically, there are still growing economic inequalities within new member states, with some sub-regions prospering and others struggling to sustain growth. To uncover who benefits and who loses from European integration, it is essential to identify inter-regional economic disparities. To the best of my knowledge, the heterogeneous effects of European integration at sub-regional levels and at different European integration stages, such as the expansion of the EU and Schengen Area, have not yet been studied. One of the main reasons such an analysis has not been performed is the lack of an appropriate methodology, particularly when it comes to finding proper counterfactuals for each sub-region. Using European regional data and disaggregated synthetic control method, this paper contributes to the literature by estimating regional treatment effects (*RTEs*). For inferential analysis, I propose in-space and in-time permutation based methods, and I find that disaggregated RTEs are significant. My results uncover the impact of EU and Schengen Area membership on sub-regional economic performance.

European integration might have varying effects on economic activities in border and interior regions. Based on new economic geography (NEG) models, regions close to borders may be affected differently by integration relative to interior areas, due to a border's proximity to a foreign market (Puga, 1999; Redding, 2010; Redding & Rossi-Hansberg, 2017). Border regions have long been of special interest in the European integration context due to heightened competition, increasing foreign demand, and wider market access. Economic disparities between border and interior regions are of particular interest in the European integration scenario. The empirical literature on European integration has considered border regions as treated and interior regions as control groups (Brakmmann & Vogel, 2011; Brakman et al., 2012; Heider, 2018; Mitze & Breidenbach, 2018). They *a priori* assume that interior areas are much less affected by integration shocks. Those studies tend to bias the effects of European integration on border areas. I argue that interior areas are not a suitable comparison group for border regions in the case of European integration. Because interior regions were also affected by the shocks of joining the EU and the Schengen Area. As a counterfactual, I use sub-regions that were not affected by European integration during the 2004 enlargement of the EU and the 2008 enlargement of the Schengen Area. After synthesizing every NUTS3 region of CEE countries using the disaggregated synthetic control method, I show that, in the course of European integration, annual GDP per capita in border regions lost more relative to interior areas by approximately €300, which is 10% of annual GDP per capita. Furthermore, I find that despite integration facilitators of border regions, such as fewer geographical barriers, more service employment, and positive attitudes toward the EU, border regions have developed less than interior regions as a result of European integration.

In estimating the effects of European integration, I address the following main questions: What would the level of per capita income in each sub-region be if the country it belongs to had not joined the EU and Schengen Area? Do all sub-regions benefit from economic integration, or not? Are there significant regional economic disparities between border and interior regions after European integration? Do different types of integration facilitators reduce internal economic disparities, if any?

This paper contributes to the literature in two ways. This is the first study to examine the effects of reducing international trading costs on economic performance in each sub-region of CEE countries. This paper presents new estimates for the effects of European integration at the sub-regional level. Second, it extends the strand of empirical studies that use European integration as a quasi-natural experiment to analyze the role of wider market access on regional economic performances (i.e., among border and interior regions).

The rest of the paper is organized as follows: Section 2 reviews the literature; Section 3 explains the empirical approach, including the data and the disaggregated synthetic control method; Sections 4 and 5 introduce the results of RTEs and country-specific treatment effects; Section 6 explains estimation results; Section 7 covers the mechanisms and sensitivity analysis; and Section 8 concludes the paper.

2 Literature Review

To date, literature on the effects of European integration on internal economic geography has predominantly pursued two directions (for a detailed description of the related literature, see Table 1). One strand of the literature has estimated structural NEG models using simulation analysis, and explored the effects of European integration on economic activities (Brülhart et al. 2004; Niebuhr, 2008). These simulation studies have found positive integration effects in border regions. For example, Brülhart et al. (2004) found that broadened market access positively affected GDP per capita and manufacturing employment in border regions after the 2004 EU enlargement. In line with this study, Niebuhr (2008) provided a different simulation scenario. The author discovered a substantial positive impact from European integration on market potential and income per capita in European border regions, relative to interior areas. However, the credibility of both studies depends on two main factors: the first is their assumptions in the simulation frameworks; the second is the unit of analysis, which was at the NUTS2 level in both studies. It is worth mentioning here that this level is large and could the pose a problem if the research's primary focus were on inter-regional inequalities. Furthermore, Niebuhr & Stiller (2004) conducted a comprehensive review of the theoretical and empirical literature on the regional effects of European integration, and showed that it was rare for European integration to have a positive effect in border regions. Accordingly, there is no clear-cut conclusion as to whether European integration has benefited border areas close to a foreign market or not.

Another strand of the literature has deemed European integration a quasi-natural experiment to evaluate changes in institutional and economic policies (Brakmmann & Vogel, 2011; Brakman et al., 2012; Heider, 2018; Mitze & Breidenbach, 2018). These studies were inspired mainly by Hanson (2001) and Redding & Sturm (2008), who studied the effects of NAFTA in Mexican-US border cities and German reunification/division in East-West German border cities, respectively. Hanson (2001) studied the regional effects of trade integration on Mexican employment and argued that Mexican economic activities were re-oriented from the hinterlands to cities near the US border. In line with this study, Redding & Sturm (2008) deemed the division of Germany after the Second World War a quasi-natural experiment, and argued that it negatively affected West German population growth in cities near the East-West German border. Inspired by these studies, the European integration literature has considered European integration a quasi-natural experiment, and has studied whether border sub-regions have benefited from the integration process. For example, Brakman et al. (2012) argued that European integration positively affected the population growth rate in European NUTS3 border regions and cities. In line with this study, Heider (2018) examined the effect of the natural experiment of the 2004 EU enlargement on population growth in the border regions within "old" Member States. The results showed that populations increased in German cities along the border with Poland relative to interior regions of Germany after the 2004 EU enlargement. However, no statistically significant effect was found on population growth in the German border cities along the German-Czech border, compared to the German interior areas. These results implied that considerable heterogeneous integration effects were at play. Other recent studies have looked at the economic impact of European integration by focusing on outcomes such as employment, wages, and GDP per capita. For instance, Brülhart et al. (2018) studied the impact of trade liberalization in the 1990s and found a positive effect on employment and wage growth in Austrian border regions compared to interior areas. Furthermore, Mitze & Breidenbach (2018) found a positive effect on regional economic growth in border regions due to the 2004 EU enlargement, using a space-time incremental impact analysis. However, the integration effect can also be negative for border regions. Indeed, cross-border interaction may result in "tunnel or corridor effects" for border regions after European integration (Petrakos & Topaloglou, 2008). In such cases, border areas that locationally facilitate free movement of goods, services, and people to central areas, so the economic activities are ultimately directed towards interior regions. Moreover, Petrakos & Topaloglou (2008) argued that border impediments such as physical and cultural differences were critical factors that undermined the economic benefits of integration in border regions in the course of cross-border interactions.

Overall, previous empirical studies have encountered several methodological challenges, and their results regarding the impact of European integration remain incon-

Table 1: Literature Survey on the Effects of the European Integration in Border Regions

Paper By	Main Results	Treated	Comparision Group	Methods
Simulation Studies				
Brülhart et al. (2004)	(+)	Border regions in EU-15	Interior Regions	Simulation Analysis
Brülhart & Koenig (2006)	(+)	Border regions in NMS-10	Interior Regions	Simulation analysis
Niebuhr (2008)	(+)	Border regions in NMS-10	Interior Regions	Simulation Analysis
Quasi-Experimental Studies				
Brakmmann & Vogel (2011)	(-, NE)	German's Eastern border regions	Interior regions	Difference in Difference
Brakman et al. (2012)	(+)	Border regions in EU	Interior regions	Difference in Difference
Heider (2018)	(+)	German's Eastern border regions	Interior regions	Triple Difference
Mitze & Breidenbach (2018)	(+, NE)	Border regions in EU	Interior regions	Spatial-time incremental difference in difference model
This paper	**Stage I:** (heterogeneous effects)	All sub-regions in CEE countries	Non-EU & Non-Schengen regions	Disaggregated Synthetic Control Method
	Stage II: (-)	Border regions in CEE countries	Interior regions in CEE countries	Cross-sectional OLS

Note: Table 1 represents the primary literature survey on the effects of the European integration. The first column refers to - authors; the second column - main results of the research, (+) denotes the positive effects of European integration in border regions, (-) denotes the negative effects, (NE) denotes the insignificant effect; the third & fourth columns show treated and the control group, respectively (where NMS-15 stands for New Member States); and the last column explains used methodologies.
Source: Author's construction.

clusive. This paper addresses the methodological difficulties, and studies the effects of European integration on economic performance using a disaggregated synthetic control method to uncover the impact of staggered increasing memberships in the EU and Schengen Area at the sub-regional level.

3 Data and Empirical Strategy

My study design and empirical approach are structured in three stages. First, I construct individual synthetic controls for each of the NUTS3 regions and estimate separate RTEs. This approach allows me to create estimated RTEs and to study the heterogeneous consequences of European integration in CEE NUTS3 regions. Second, I observe considerable heterogeneity of RTEs, revealing the winners and losers in European integration. Then, I question if within-country inequalities exist (e.g. between the border and interior regions). Third, I introduce integration facilitators, including fewer geographical barriers, more service employment, and positive attitudes toward the EU, which could trigger positive effects of European integration in border regions and reduce economic inequalities within CEE countries, if any.

3.1 Data

This paper employs a European regional database of 14 European countries and 437 NUTS3 regions from 1990 to 2015 (for detailed descriptive statistics of the main variables, see Appendix A.1.). The European regional data on GDP per capita, sectoral employment, sectoral gross value added (GVA), and population are taken from the Annual Regional Database of the European Commission's Directorate-General for Regional and Urban Policy (ARDECO) platform. The typology and size of NUTS3 regions are collected from the Geographic Information System of the Commission (GISCO) database. European borders at the NUTS3 level and international borders are taken from Eurostat shapefiles. To measure if a region is non-mountainous with fewer geographical barriers, I use the hill-shading procedure and calculate the elevation of hills or mountains using the shade and light of the areas displayed on the terrain maps of the NUTS3 regions of CEE. These terrain maps store illumination values for each cell in raster data, and every single pixel takes a value that ranges between 0 (the lowest-black color) to 255 (the highest-white color). The terrain maps were collected from the European Environment Agency (EEA). In addition, to measure public perceptions of the EU, I use data on EU membership from referendum held one year before countries joined the EU in 2003. Referendum data are at the

NUTS3 level, collected from the European Election and Referendum Database.

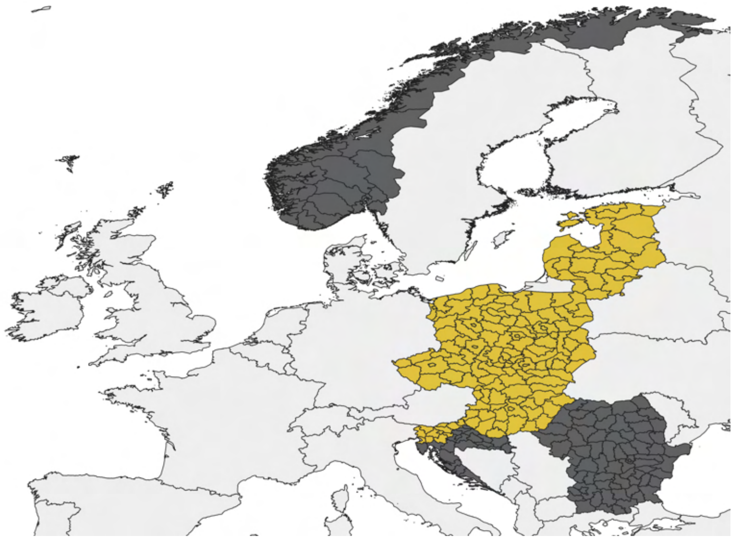
3.2 Disaggregated Synthetic Control Approach

To identify the effects of European integration on regional economic performance, one needs a valid counterfactual (i.e., what would have happened to economic growth in NUTS3 regions had their countries not joined either the EU or the Schengen Area). Measuring these effects requires estimation of the counterfactual outcome from comparably similar sub-regions. In this study, I use the disaggregated synthetic control method to select the most comparable regions (Abadie & Gardeazabal, 2003). Instead of directly comparing the outcomes in regions influenced by European integration and unaffected regions, the synthetic control method constructs a counterfactual group from a weighted average of the non-treated areas, or the so-called "donor pool" (Abadie et al. 2010).

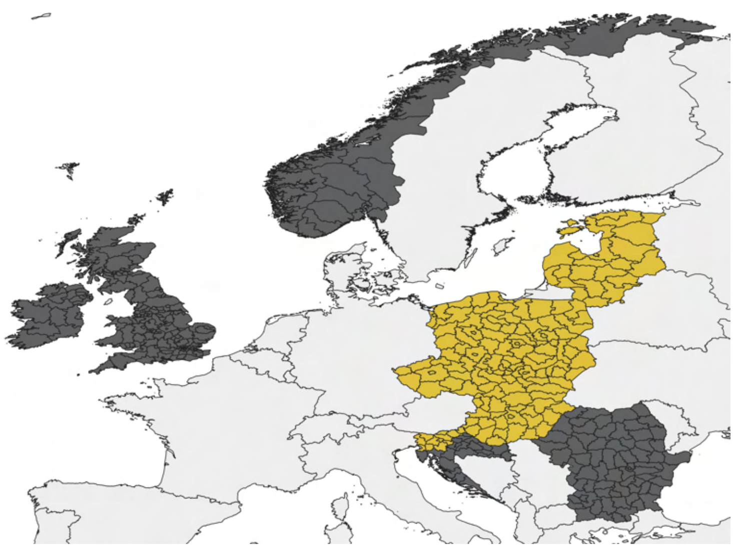
The main advantage of building regional synthetic controls is that the pre-intervention characteristics of the treated sub-regions are accurately approximated by a combination of untreated sub-regions rather than by any single sub-region in Europe. These sub-regions, which were not affected by European integration, are chosen to match as closely as possible in terms of the pre-treatment characteristics of the sub-regions which underwent the integration process (i.e., joining the EU and Schengen Area). As shown in Figure 1, the treated group consists of 146 NUTS3 regions in the Czech Republic, Poland, Hungary, Slovenia, Slovakia, Lithuania, Latvia, and Estonia. To study the effects of two different phases of European integration, joining the EU and joining the Schengen Area, I use two separate control groups. In the case of the 2004 enlargement of the EU, the control group consists of 89 non-EU NUTS3 regions of Bulgaria, Romania, Croatia, and Norway (see Figure 1). Meanwhile, in

Figure 1: Treated and Control NUTS3 regions

(a) European Union



(b) Schengen Area



Notes: Figure 1 (A) represents joining the EU in 2004, treated CEE NUTS3 regions (yellow) and untreated NUTS3 regions in Bulgaria, Romania, Croatia, Norway (gray). Figure 1 (B) represents joining the Schengen Area in 2008, treated CEE NUTS3 regions (yellow) and untreated NUTS3 regions in Bulgaria, Romania, Croatia, Ireland, and the United Kingdom (gray). The rest of the area is out of the sample (white).

Source: Author's elaboration based on GISCO shapefiles.

the case of the 2008 enlargement of the Schengen Area, the control group includes 245 non-Schengen NUTS3 regions of Bulgaria, Romania, Croatia, Ireland, and the United Kingdom (see Figure 1).

Synthetic control estimators were initially introduced for settings in which an aggregate unit was exposed to the intervention, such as a city, a state, or a country (Abadie & Gardeazabal, 2003; Abadie et al., 2010). More recently, synthetic control methods have been used with multiple units (Abadie & L'Hour, 2020; Abadie, 2021). Some relevant studies have used a disaggregated synthetic control method with a large number of units (e.g., 525 firms in Acemoglu et al. (2016), 13 states in Dickert-Conlin et al. (2019), 29 states in Dube & Zipperer (2015), 24 hospitals in Kreif et al., 2016, and 44 German districts in Osikominu et al. (2021)). I use a disaggregated synthetic control approach to estimate the effects of European integration of 146 NUTS3 regions of CEE countries (for detailed illustration of individual 146 synthetic controls, see Appendix B.1. & Appendix C.1.).

A synthetic control method relies on a weighted combination of control units. Weights are chosen to minimize the distance between synthetic and treated units in the pre-treatment period. In Equation 1, multiple treated NUTS3 regions are represented by i and control NUTS3 regions by j, whole sample size by m, and total number of treated units by n (i.e., 146 NUTS3 regions of CEE countries). Let X_i be a matrix that collects pre-treatment predictors of economic performance for the treated NUTS3 regions $[X_1....X_n]$. Predictors of regional economic performance are GDP per capita in pre-treatment periods, GVA share in the industrial sector, GVA share in the agriculture sector, employment share in the industrial sector, population (log) and the size of NUTS3 regions (log) (for more details, see Table 2). A matrix of predictors of the same variables for all possible control NUTS3 regions in the pre-treatment period is X_0 and in the post-treatment, is represented by $[X_{n+1}....X_m]$. Weights are

Table 2: Predictors of Regional Economic Performance (Disaggregated synthetic control method)

Treatment	Years	Treated Group (NUTS3)	Donor Pool (NUTS3)	Predictors
2004 EU	1996-2006	Czech Republic (14), Estonia (5), Hungary (20), Latvia (6), Lithuania (10), Poland (72), Slovakia (8), Slovenia (12)	Romania (42), Bulgaria (28), Croatia (21), Norway (12)	GDP per capita dummies in pre-treatment periods , GVA share in industry sector , GVA share in agriculture sector, Employment share in industrial sector, Population (log), NUTS3 size (log)
2008 Schengen Area	1996-2013	Czech Republic (14), Estonia (5), Hungary (20), Latvia (6), Lithuania (10), Poland (72), Slovakia (8), Slovenia (12)	Romania (42), Bulgaria (28), Croatia (21), Ireland (8), United Kingdom (173)	GDP per capita dummies in pre-treatment periods , GVA share in industrial sector, GVA share in agriculture sector, Employment share in industrial sector, Population (log), NUTS3 size (log)

Note: Table 2 represents two phases of European integration, expansion of the EU and the Schengen Area. Treated groups include 146 NUTS3 regions in eight CEE countries. The donor pool includes 89 NUT3 regions of non-EU countries and 245 NUTS3 regions of non-Schengen countries. The last column presents predictors of regional economic performance. They are used to measure RTEs using disaggregated synthetic control method.
Source: Author's construction.

displayed by $W_{i,j} = w_{i,n+1}, ..., w_{i,m}$ where $w_{i,n+1}$ is the weight of untreated $n+1$ in the synthetic control of unit i. Individual weights are non-negative and the total weight is added to one to avoid extrapolation problems:

$$min_w (X_i - X_0 W_i)'(X_i - X_0 W_i) \tag{1}$$

$$w_i \geq 0$$

$$w_{i,n+1} + ... + w_{i,m} = 1 \quad \forall i = 1, 2, ..., n$$

Once the synthetic control model optimally chooses a set of weights, I estimate the effects of European integration on the economic performance in each NUTS3 region of CEE countries, denoted as $\hat{\alpha}_i$, over the period $t \in T_0 + 1, \ldots, T_1$ for an intervention that occurred in the time T_0. The estimated treatment effect is the difference between the observed value of the treated and simulated synthetic units. Equation 2 represents estimated RTEs, $\hat{\alpha}_i$:

$$\hat{\alpha}_i = Y_i - \sum_{j=n+1}^{m} w_{i,j} * Y_j \tag{2}$$

The estimated effect in Equation 2 measures the post-treatment difference between the outcome of the treated units, Y_i, and the synthesized control units as an optimal average of all control units in the donor pool, $\sum_{j=n+1}^{m} w_{i,j} * Y_j$. Selection of pre-treatment characteristics has a significant impact on the weights and composition of the synthetic control (i.e., on $w_{i,j}$). To find the optimal weight distribution, I select the specification for which the pre-treatment characteristics generate the smallest mean squared prediction error (Abadie & Gardeazabal, 2003).

4 Results of Regional Treatment Effects

After estimating all individual treatment effects for each of the 146 NUTS3 regions of CEE countries, Figure 2 shows how European integration has affected GDP per capita at constant prices in sub-regions. The results indicate that joining the EU and Schengen Area brought about uneven regional effects. The most positive regional treatment effect is presented by a green color and the most negative by a red color. Further, Figure 2 illustrates some level of clustering of RTEs: negative integration effects are more clustered after the 2004 enlargement of the EU than after the Schengen expansion in 2008 [1].

[1] Appendix A.1. shows that, on average, RTEs as a result of EU enlargement in 2004 are negative in border regions and positive in interior regions. On average, RTEs are positive in both border and interior regions after the expansion of the Schengen Area in 2008, however, the magnitude of the mean effects in the interior regions is higher.

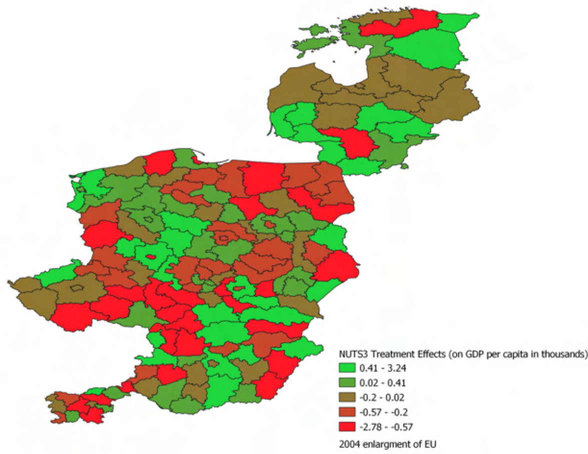
Next, I pool the RTEs from each of the 146 NUTS3 regions; in Figure 3, the dashed grey lines represent the individual treatment effects. These are the gaps between treated and synthetic controls for each NUTS3 region. Figure 3 shows that the gap in the pre-treatment period is close to zero; in other words, I have synthetic controls with perfect pre-treatment fit where $\hat{\alpha}_{it}$ before T_0 intervention is close to zero. In the post-treatment period, some areas have positive and others have negative RTEs. Both Figures 2 and 3 illustrate considerable heterogeneity of the effects of European integration in NUTS3 regions following the enlargement of the EU in 2004 and the Schengen Area in 2008.

4.1 Inference Framework: In-Space and In-Time Permutations

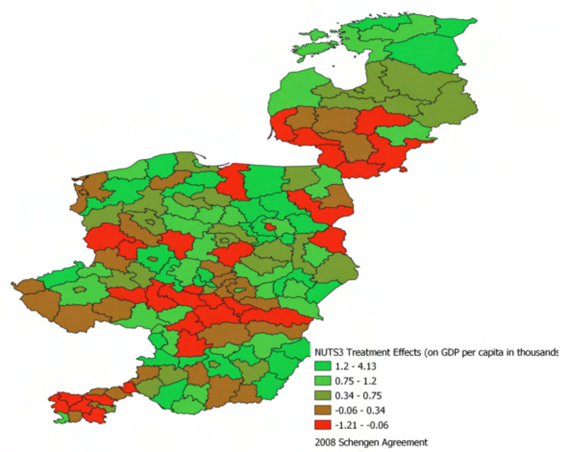
I propose two different permutation-based methods of the inference analyses for the disaggregated synthetic control method. These are in-time and in-space permutation methods suggested in Abadie et al. (2010), Abadie & L'Hour (2020), and Abadie (2021). I permute the treatment status across space and across time to generate the placebo distribution of treatment effects under the null hypothesis, $H_0 = 0$*: no effects of European integration.* If the distribution function of treatment effects computed by permutations and the distribution of actual RTEs differ, then it is

Figure 2: Regional Treatment Effects in CEE Countries

(A) European Union

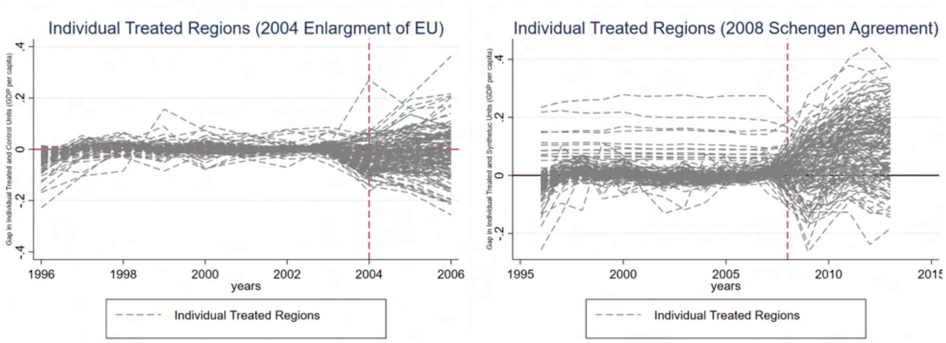


(B) Schengen Area



Notes: *The left* side of the Figure 2 shows the effects of the 2004 EU Enlargement on GDP per capita (at constant prices in thousands €) in 146 CEE NUTS3 regions. *The right* side of Figure 2 shows the effects of the 2008 Schengen Agreement on GDP per capita (in thousands) in 146 CEE NUTS3 regions.
Source: Author's elaboration.

Figure 3: Regional Treatment Effects 1996-2013



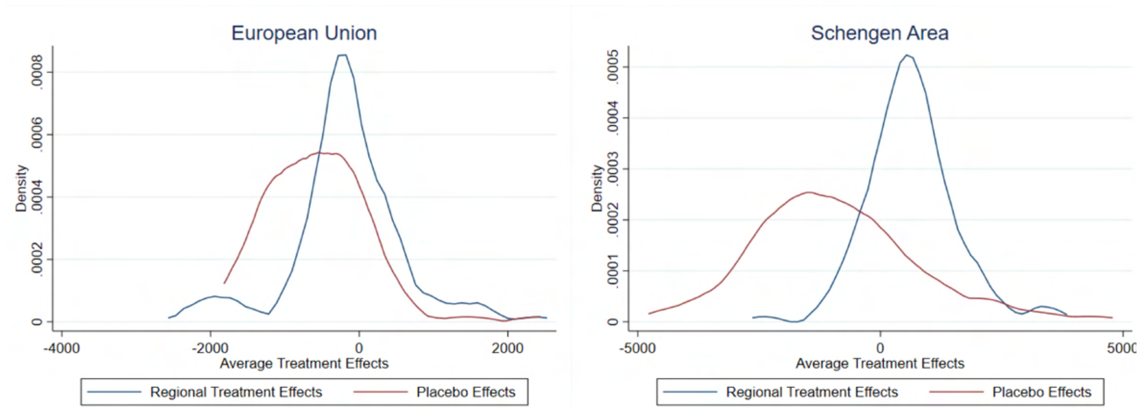
Notes: *The left* side of Figure 3 represents a gap in treated and synthetic controls as a result of joining the EU in 2004, and the *the Right* side of Figure 3 represents a gap in treated and synthetic controls as a result of joining the Schengen Area in 2008.
Source: Author's elaboration.

against the null hypothesis, and disaggregated RTEs are deemed significant.

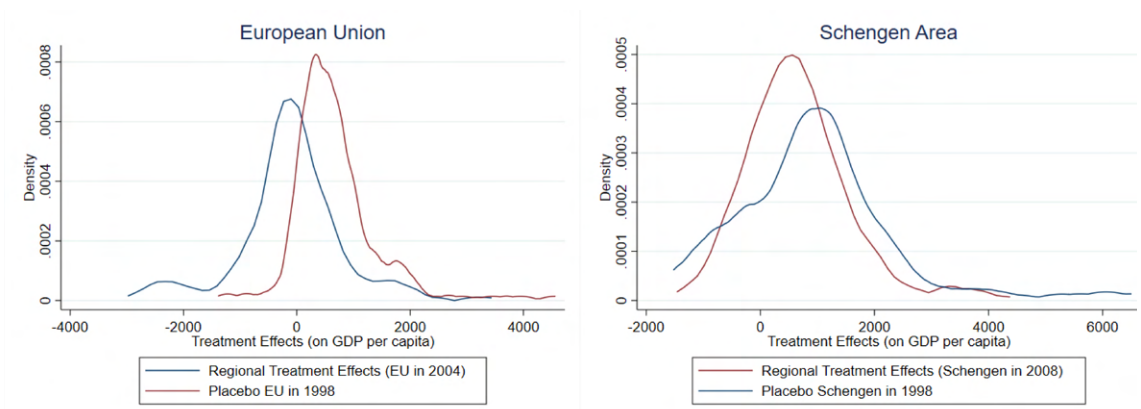
My inferential framework is based on two permutation methods. First, regarding the in-time permutations, I permute the treatment status for all NUTS3 regions of CEE in the pre-treatment period. To generate the placebo distribution of treatment effects, I compute the synthetic control estimates in the pre-treatment year - 1998. The European agreements came into force in 1998, which may mean that there was an anticipation effect; membership negotiations had already begun, leading to some level of integration even before these countries joined the EU in 2004 (Campos et al., 2019). Under the placebo scenario in 1998, CEE countries received pre-integration aid during the pre-accession period, so as to facilitate their integration into the EU. Hence, I permute intervention time so that the 146 NUTS3 regions received treatment in 1998; thus, I generate placebo treatment effects as if the CEE countries joined the EU and Schengen Area in 1998.

Figure 4: Distributions of Regional Treatment and Placebo Effects

(A) Permutations in Space



(B) Permutations in Time



Note: Permutations in space and in time.
The left side of Figure 4 (A) and (B) displays kernel density function of regional treatment effects as a result of joining the EU in 2004 (blue line) and kernel density function of placebo effects when I generated in space and in time permutations of treatment assignments (red line), respectively. *The right* sides of Figure 4 (A) and (B) display kernel density function of regional treatment effects as a result of joining the Schengen Area in 2008 (blue line) and kernel density function of placebo effects when I generated in-space and in-time permutations of treatment assignment (red line), respectively.
Source: Author's elaborations.

Second, regarding in-space permutations, I construct permutation distributions by reassigning the treatment status (i.e., joining the EU and Schengen Area), to each

Table 3: Inference on the Distribution of Regional Treatment Effects

(A) Permutations in Space

heightEU	Differences	P_value
K-S Test in 2004	0.1858	0.042
K-S Test in 2005	0.4195	0.000
K-S Test in 2006	0.3782	0.000
Schengen Area	Differences	P_value
K-S Test in 2008	0.5065	0.000
K-S Test in 2009	0.4709	0.000
K-S Test in 2010	0.5603	0.000
K-S Test in 2011	0.7063	0.000
K-S Test in 2012	0.6159	0.000
K-S Test in 2013	0.5545	0.000

(B) Permutations in Time

EU	Differences	P_value
K-S test in 1998 vs. in 2004	0.5616	0.000
Schengen Area	Differences	P_value
K-S test in 1998 vs. in 2004	0.2082	0.003

Note: Table 3 (A) and (B) reports results of Kolmogorov-Smirnov tests of permutation in space and in time, respectively. The columns labeled *Differences* refer to the most significant differences between placebo and actual treatment effect distribution. The column labeled *P-value* refers to the asymptotic p-value, which is computed to the equality of placebo and actual treatment effect distribution.
Source: Author's calculations.

NUTS3 region in the donor pool and estimating placebo effects in every iteration. Then, I compare in-space permutation distribution to the distribution of estimated RTEs. If the distributions of in-space permutations and actual RTEs differ, then the integration effect in the given NUTS3 region is considered significant.

I conduct a series of placebo estimations by applying a synthetic control method to estimate the effect of joining the EU in 2004 and the Schengen Area in 2008 on every NUTS3 region in the donor pool. In each iteration, I reassign the treatment to one of the 89 NUTS3 regions in Bulgaria, Romania, Croatia, Norway, and the 245 NUTS3 regions in Bulgaria, Romania, Croatia, Ireland, and the United Kingdom. All treated NUTS3 regions are shifted to the donor pool. Then, I proceed as if one of the countries to which one of the NUTS3 regions belongs in the donor pool became a member of the EU in 2004 and the Schengen Area in 2008, instead of the Czech Republic, Hungary, Poland, Slovenia, Slovakia, Latvia, Lithuania, and Estonia. Then, I compute the estimated placebo treatment effects associated with each placebo iteration.

The distribution of treatment effects can be compared to the in-space and in-time permutations distribution, as shown in Figure 4 (A) and (B). These figures provide a visual illustration of in-space, in-time permutations and actual RTE distributions. For both interventions, joining the EU and the Schengen Area, the treatment effect distribution lies on both sides of the tail; it has a bell-shaped curve. The effects of European integration are positively and negatively skewed, suggesting that there are winners and losers among NUTS3 regions.

Further, I compute Kolmogorov-Smirnov statistics to test for the equality of the placebo treatment effects and RTE distributions. Table 3 (A) and (B) presents the Kolmogorov-Smirnov test, a non-parametric test of the equality of two sample distributions. The test indicates that actual and placebo distributions of treatment effects have a p-value of zero, confirming non-equality of the distributions of actual and placebo treatment effects in every post-treatment year.

5 Results of Country-Specific Treatment Effects

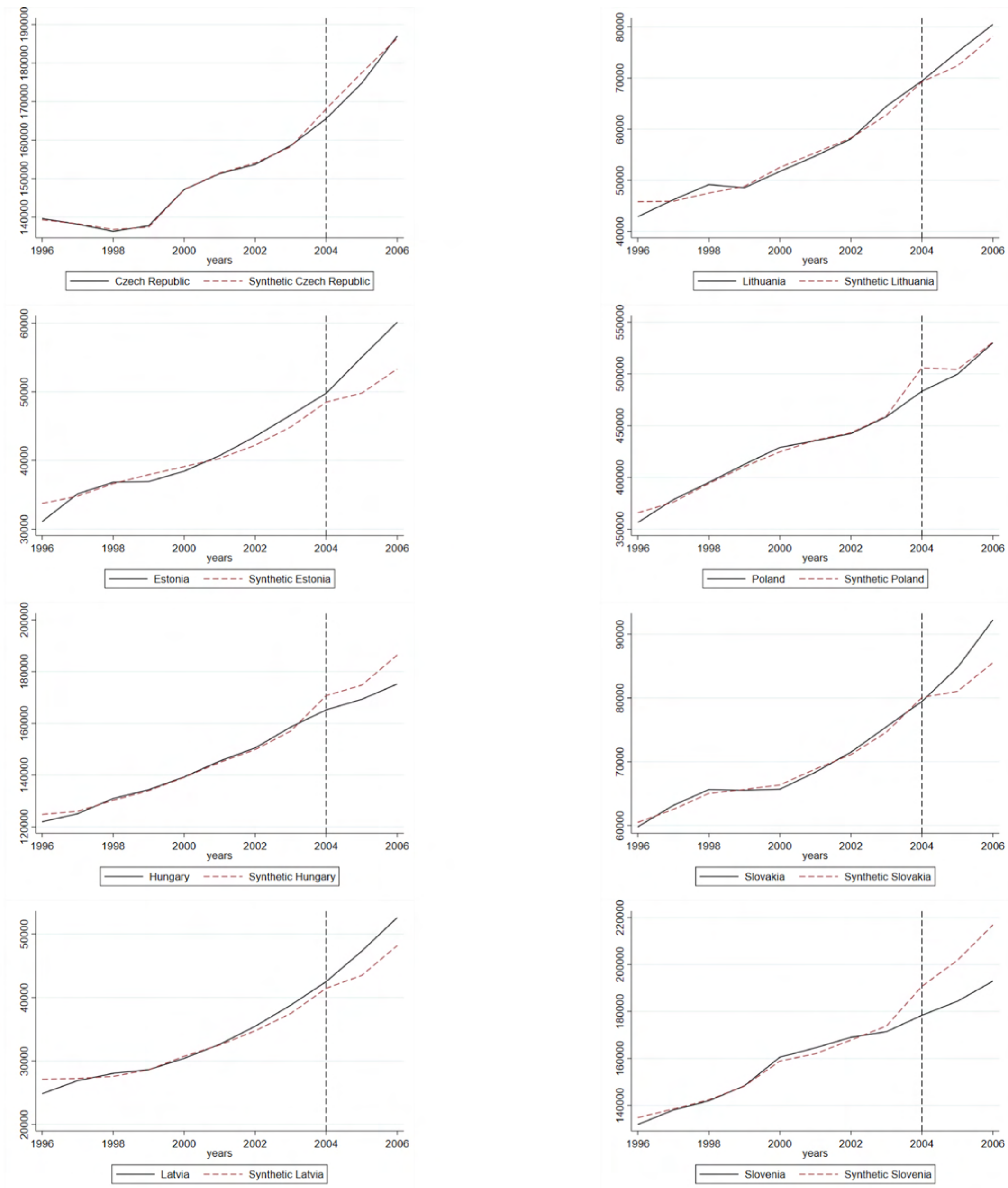
In this section, I aggregate RTEs at the country level. Figure 5 presents the effects of CEE joining the EU. After aggregating individual treatment effects, I find that joining the EU had a positive effect with respect to the 2008 global financial crisis in Estonia, Lithuania, Latvia, and Slovakia. Insignificant effects are found for the Czech Republic, and an adverse effect was detected for Poland, Hungary, and Slovenia.

Figure 6 illustrates the effects of joining the Schengen Area, which are almost entirely positive among CEE countries. However, for Baltic states, slightly adverse or insignificant effects are detected until 2009, with positive impacts thereafter. This could be attributable to the global financial crisis, which lasted from mid-2007 to early 2009; these countries' membership in the Schengen Area in 2008 co-occurred with a global recession. In Europe, the Baltic states were the most negatively impacted by the global financial crisis (Staehr, 2013).

Aggregate estimations are in line with the findings of Campos et al. (2019), who studied the effects of European integration on GDP per capita using a synthetic control method at the country level. My results are consistent with their findings, confirming the significance of estimated individual/regional treatment effects. Campos et al. (2019) found that GDP per capita increased with EU membership in Estonia, Hungary, Latvia, and Lithuania. However, the effects tended to be slightly negative for Poland and Hungary, and insignificant for Slovenia[2].

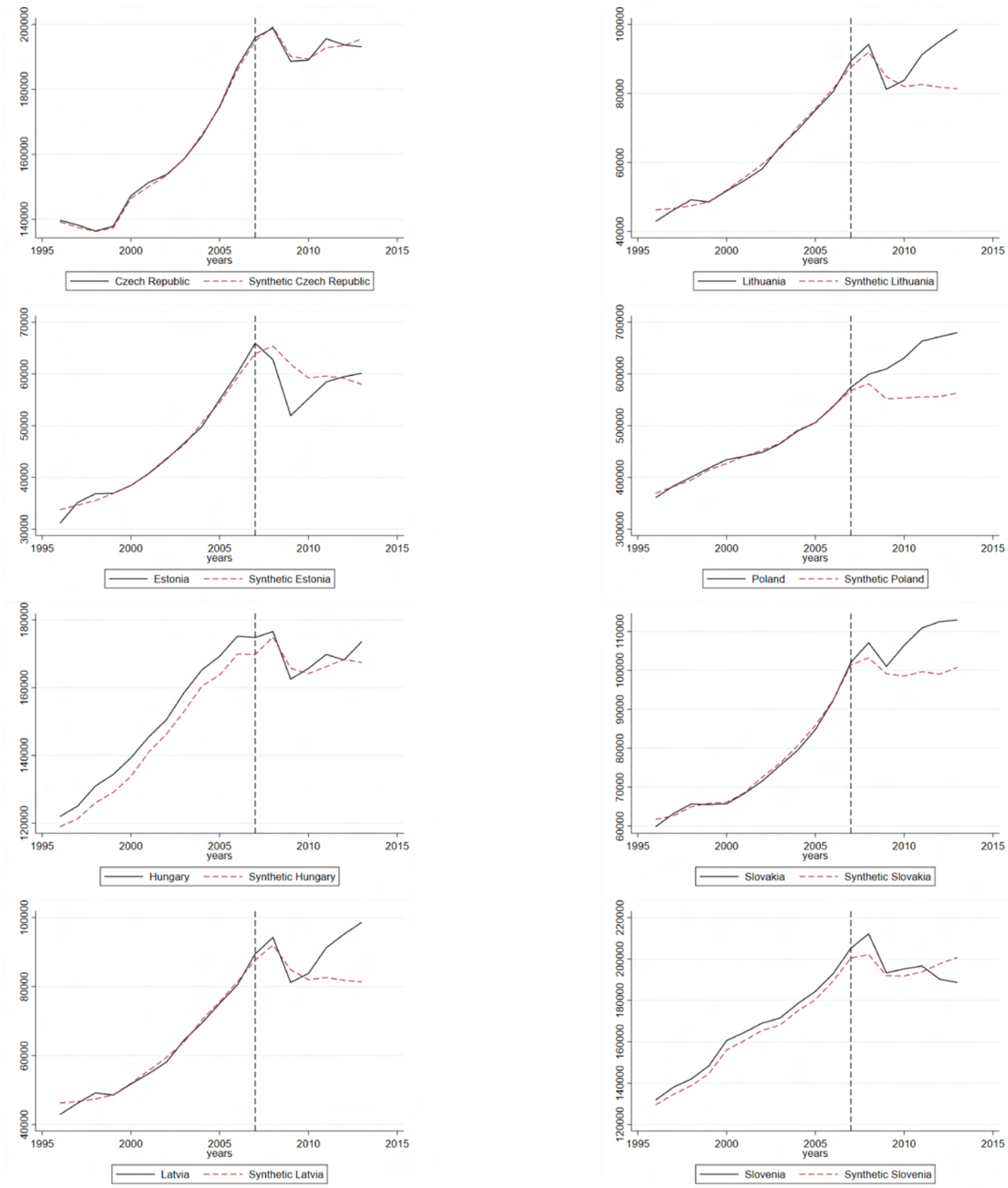
[2] The main reason for these differences in the case of Slovenia might be the chosen donor pool in Campos et al. (2019). It is worth noting that the relative weights in the donor pool for Slovenia are

Figure 5: EU - Actual and Synthetic CEE Countries. Country-Specific Treatment Effects



Note: Figure 5 shows the effects of CEE countries joining the EU. The solid line denotes actual GDP per capita (2005 constant prices, €), in the Czech Republic, Hungary, Poland, Slovenia, Slovakia, Lithuania, Latvia, and Estonia. The dashed line represents the synthetic country - GDP per capita in CEE. The gap after 2004 shows the dynamic effects of the EU in CEE countries.
Source: Author's elaborations.

Figure 6: Schengen Area - Actual and Synthetic CEE countries. Country-Specific Treatment Effects



Note: Figure 6 shows the effects of CEE countries joining the Schengen Area. The solid line denotes actual GDP per capita (2005 constant prices, €), in the Czech Republic, Hungary, Poland, Slovenia, Slovakia, Lithuania, Latvia, and Estonia. The dashed line represents the synthetic country - GDP per capita in CEE. The gap after 2008 shows the dynamic effects of the Schengen Area in CEE countries.

Source: Author's elaborations.

6 Estimation Results: Border vs. Interior Regions

The disaggregated synthetic control methodology with multiple treatment units resulted in 146 NUTS3-level treatment effects. To understand the cause of treatment heterogeneities across integrated regions, I examine whether local characteristics of the NUTS3 regions influence the RTEs in the post-treatment period (e.g., the key determinant is if a region is close to an international border, or not). Using cross-sectional ordinary least square (OLS) regression, I exploit European integration set-up for the following estimation model:

$$RTE_i^{2004} = \alpha_{eu} Border_i + X_i + D_c + \epsilon_i \tag{3}$$

$$RTE_i^{2008} = \alpha_{sch} Border_i + X_i + D_c + \epsilon_i \tag{4}$$

where RTE_i^{2004} and RTE_i^{2004} are the effects of the 2004 enlargement of the EU and 2008 Schengen expansion in NUTS3 region i, respectively; $Border_i$ is a dummy variable and equals one if it is a NUTS3 region with a land border, or is a region where more than half of the population lives within 25 kilometers of such a border; α_{eu} and α_{sch} show how the EU and Schengen Area outcomes differ in border versus interior regions; X_i denotes a set of observable characteristics including geographical factors, sectoral structure, and public perceptions about the EU; in order to capture unobserved country heterogeneity, I include country fixed effects represented by D_c,

43.4%, South Korea, 24.5% Chile, 20.9% Canada, 11.1% Colombia, and 0.1% Thailand in Campos et al. (2019). However, all regions in the donor pool I use are European sub-regions, which are comparable controls. The synthetic control method should use control units that are similar to the treated unit (Abadie, 2021), because, in the case of a poor donor pool, high weights may be allocated to units with better fits, which results over-fitting of the model.

and ϵ_i is an error term estimated using heteroscedasticity-consistent robust standard errors.

The results in Table 4 column 1 indicate that, on average, joining the EU and Schengen Area negatively influenced border regions, compared to interior regions. The unconditional gap between border and interior regions is significantly negative. If the region has land borders, the economic benefit of joining the EU declines by €277, and the benefit from entering the Schengen Area reduces by €354 per capita, annually (i.e., approximately 10% of annual GDP per capita) [3].

I divide land borders into two categories: internal EU borders - (i.e., borders on neighboring fellow EU member sub-regions); and external EU borders (i.e., borders on neighboring non-EU member sub-regions). The unconditional gap between internal borders and interior regions due to the 2004 EU enlargement and the 2008 Schengen expansion is negative. So, internal border regions lose from European integration. Similarly, there is significant inequality between external EU border regions and interior regions, but the magnitude is higher when I compare internal EU border regions and interior regions. In Table 4, the regional economic disparity between external border regions and interior regions is approximately 50% higher than the regional economic inequality between internal border regions and interior regions.

Heterogeneous effects in CEE sub-regions show that there are indeed winners and losers as a result of European integration. On average, border regions lose more from integration than interior regions. To analyze this more deeply, I investigate if border regions become "winners" when European integration is complemented by different types of integration facilitators.

[3] It is worth noting that after dropping interior NUTS3 regions where the largest capital cities, Prague and Budapest are located (e.g., 25 km from the land border), the baseline results are moderately robust (see Appendix A.2).

Table 4: Regional Effects of Joining the EU and Schengen Area

	(1)	(2)	(3)
EU	RTE	RTE	RTE
Land Border	-0.277***		
	(0.060)		
Internal Border		-0.240**	
		(0.072)	
External Border			-0.364**
			(0.104)
Country Fixed Effects	YES	YES	YES
Observations	146	130	68
Adjusted R^2	0.412	0.330	0.470

	(1)	(2)	(3)
Schengen Area	RTE	RTE	RTE
Land Border	-0.354*		
	(0.151)		
Internal Border		-0.283*	
		(0.120)	
External Border			-0.592*
			(0.279)
Country Fixed Effects	YES	YES	YES
Observations	146	130	68
Adjusted R^2	0.381	0.392	0.350

Note: Cross-sectional regional data consisting of eight CEE countries and 146 NUTS3 regions. *Estimation method:* OLS. *Dependent variable:* estimated RTE - regional effects of joining the EU and Schengen Area on GDP per capita. *Standard errors:* Robust standard errors in parentheses. (*) (**) (***) denotes statistical significance at the (10) (5) (1) percent level. *Source:* Author's calculations.

7 Mechanisms and Sensitivity Analysis

This study shows that, on average, joining the EU and Schengen Area had a lower effect on GDP per capita in border sub-regions, compared to interior regions. However, where border regions interact with integration facilitators, existing regional economic disparity within CEE countries may be reduced. Different types of proximities have important roles in cross-border cooperation, because they can serve as impediments to, or facilitators of, social interactions (Boschma, 2005; Torre, 2008). Related literature has introduced three main categories of proximity: physical, relational, and sectoral (Boschma, 2005; Torre & Gilly, 2000; Torre, 2008).

First, physical proximity is related to the geographical dimension, particularly to road conditions, time-distance, transaction types, and transportation costs. It may be challenging to trade and to enjoy free mobility in mountainous border areas. A lack of good roads in high-altitude regions complicates market access and hinders the free movement of goods, services, and people. Several studies have emphasized the importance of addressing tangible barriers in border regions to accelerate the economic integration process (Petrakos & Topaloglou, 2008; Capello et al., 2018). Second, relational proximity concerns the non-tangible dimension. It covers social and cultural proximities that have a bearing on social decisions and public opinions (Torre, 2008). One intangible barrier, negative attitudes toward the EU, can stem from cultural and historical dissimilarities between local and neighboring foreign sub-regions in the EU. Crucially, residents in sub-regions of CEE countries may support integration into the EU for economic and cultural reasons. Public opinion plays a salient role in determining whether countries integrate into the EU or not, so public perceptions about the EU are essential; they can hinder or accelerate the integration process (Bølstad, 2015, Brack & Startin, 2015). A great example of the importance of voters was a referendum in June 2016, in which residents of the United Kingdom voted to leave the EU (Brexit). So, where there is a lack of positive attitudes towards the EU in border regions, trade faces an invisible frontier. In general, the concept of European integration refers to the importance of removing barriers, particularly to cross-border services. With this in mind, the third facilitator is sectoral proximity. Service industries include transport, legal, accommodation, food, health, and tourism services, they requiring face-to-face interactions between buyers and sellers. Proximity to services is related to trading in the service sector across borders, while free movement of wholesale, retail, transport, accommodation, food, information, and communication is important in cross-border interactions. European integration guarantees free movement of services; that is why the service sector is a salient factor in the integration process, and enables direct intercommunication between locals and foreigners. In cross-border relations, it is important to have well-developed services along borders, so that nationals and foreigners in border regions can benefit from opportunities accessible on both sides of the given border. For this reason, physical proximity, relational proximity, and sectoral proximity may shape the economic advantages gleaned in border regions relative to interior areas.

My findings in Section 4 indicate that a higher degree of integration, such as through joining the EU and the Schengen Area, leads to greater inter-regional inequalities. Thus, it triggers a divergence among RTEs in NUTS3 regions. The heterogeneity of RTEs suggests the importance of local characteristics and tangible and intangible factors, specifically geography and pre-integration conditions. These are important dimensions that shape economic outcomes together with economic integration. In the modified model in Equation 5, I introduce integration facilitators that may enhance the positive effect of European integration in border regions and reduce the economic gap between border regions and interior regions. I estimate the following modified model:

$$RTE_i = \beta_1 Border_i + \beta_2 Border_i \times Facilitator_i^k + \beta_3 Facilitator_i^k + D_c + \epsilon_i \qquad k \in 1,2,3 \tag{5}$$

where RTE_i represents the effects of joining the EU and Schengen Area in NUTS3 region i; $Border_i$ is a dummy variable and equals one if the NUTS3 region is a land border. And, interactions between $Facilitator_i^k$ and $Border_i$ represent integration facilitators in border regions. The first is a physical or geographical facilitator ($k = 1$): these areas have fewer physical barriers (e.g., they are low-altitude border regions). The second is a sectoral facilitator ($k = 2$), referring to border regions with a high share of service employment before they joined the EU and the Schengen Area, in wholesale, retail, transport, accommodation, food services, information, and communication. The third is a relational facilitator ($k = 3$), referring to areas with border regions where the public voted to join the EU in a referendum.

In addition to baseline results, Table 5 shows the conditional means, where I control for different local characteristics, including the altitude of the region, public perceptions about the EU, and the employment share in the service sector before the country joined the EU. I find that the gap after European integration becomes significantly negative between border regions and interior regions in CEE countries, *ceteris paribus*. Similarly, the gap is negative between internal borders and interior areas. The results in Table 5, column 2 match the findings in Table 4 column 2. This implies that the differences between the border regions and interior regions result purely from the locational border effect. However, if I compare results from Table 4, column 3 to those in Table 5 column 3, the gap is insignificant between external borders and interior regions, *ceteris paribus*. This suggests that the inequality is not

Table 5: Conditional Regional Effects of Joining the EU and Schengen Area

	EU			Schengen Area		
	(1)	(2)	(3)	(1)	(2)	(3)
	RTE	RTE	RTE	RTE	RTE	RTE
Average Hill Shades (from high to low)	-0.007	-0.006	-0.018**	0.018**	0.020**	0.002
	(0.015)	(0.015)	(0.006)	(0.005)	(0.007)	(0.009)
Employment in Service Sector (2003)	4.344**	3.743*	4.863*	4.555***	5.005***	7.431**
	(1.828)	(1.694)	(2.072)	(1.274)	(1.054)	(2.844)
Pro-EU Attitudes (2003)	-0.002	0.001	0.000	-0.002	-0.004	0.003
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)
Land Border	-0.189**			-0.312*		
	(0.066)			(0.146)		
Internal Border		-0.222**			-0.292*	
		(0.065)			(0.143)	
External Border			-0.087			-0.165
			(0.109)			(0.241)
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	140	125	66	140	125	66
Adjusted R^2	0.327	0.245	0.404	0.435	0.466	0.478

Note: Cross-sectional regional data consisting of eight CEE countries and 146 NUTS3 regions. *Estimation method:* OLS. *Dependent variable:* estimated RTE - regional effects joining the EU and Schengen Area on GDP per capita. *Standard errors:* Robust standard errors in parentheses. (*) (**) (***) denotes statistical significance at the (10) (5) (1) percent level. *Source:* Author's calculations.

determined by geographical location or the border effect, and could be explained by regional or economic characteristics.

As European integration has affected border regions less than interior regions, I question whether there are any variations between various boundary locations and if some facilitators can offset the negative effect. Interestingly, the negative integration effect in border regions versus that in their interior counterparts is so strong that the negative border effect persists even when I apply integration facilitators. There is no significant relationship between the interaction terms in Table 6.

Table 6: The Effect of European Integration Complemented with Facilitators in Internal EU Borders

	European Union			Schengen Area		
European Union	(1)	(2)	(3)	(1)	(2)	(3)
	RTE	RTE	RTE	RTE	RTE	RTE
Internal Border	-0.276	0.080	-0.306	0.267	1.383*	1.609
	(1.150)	(0.489)	(0.794)	(1.317)	(0.720)	(0.872)
Average Hill Shades (from high to low)	-0.006	-0.006	-0.006	0.023***	0.021**	0.021**
	(0.013)	(0.015)	(0.015)	(0.003)	(0.007)	(0.006)
Employment in Service Sector (2003)	3.739*	4.262**	3.750*	5.043***	7.882***	4.844***
	(1.743)	(1.452)	(1.751)	(1.018)	(2.107)	(0.993)
Pro-EU Attitudes (2003)	0.001	0.001	0.001	-0.004	-0.007	0.002
	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.005)
Internal Border × Average Hill Shades	0.000			-0.003		
	(0.006)			(0.007)		
Internal Border× Employment in Service Sector		-1.407			-7.799	
		(2.457)			(4.304)	
Internal Border × Pro-EU Attitudes			0.001			-0.025
			(0.011)			(0.014)
Constant	0.121	-0.006	0.100	-4.189***	-4.241***	-4.221***
	(2.158)	(2.297)	(2.214)	(0.394)	(1.101)	(1.036)
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Observations	125	125	125	125	125	125
Adjusted R^2	0.239	0.240	0.239	0.461	0.500	0.475

Note: Cross-sectional regional data consisting of eight CEE countries and 146 NUTS3 regions. *Estimation method:* OLS. *Dependent variable:* estimated RTE - regional effects of joining the Schengen Area on GDP per capita. *Standard errors:* Robust standard errors in parentheses. (*) (**) (***) denotes statistical significance at the (10) (5) (1) percent level. *Source:* Author's calculations.

This paper has three main findings. First, I construct RTEs through the use of a disaggregated synthetic control methodology. The results indicate the heterogeneity of the effects of European integration. As illustrated in Figure 2, in the RTEs map, some regions have been positively affected by European integration, while others have not. Second, this study shows significant evidence of inequality between border regions and interior regions within CEE countries after integration. Border regions, on average, lose out from integration compared to interior regions. Specifically, internal border regions that directly neighbor former EU sub-regions lose relative to interior regions. In contrast, external border regions, that directly neighbor non-EU sub-regions, lose not because of their location but due to economic conditions. Third, I introduce different types of trade facilitators, but even with such complementarities, the gap between border regions and interior regions within CEE countries persists.

I can conclude that the positive effects of European integration are found more in interior regions rather than in border regions, and that such economic integration has has exacerbated significant within-country inequalities.

8 Conclusion

There is a heated debate about a growing spatial disconnect of economic performance in CEE countries, with some regions growing and others lagging in the aftermath of their European integration. This study adds to the growing body of research that indicates there are "winners and losers" of European integration. Using European regional data and disaggregated synthetic control method, this paper is one of the first to attempt to thoroughly examine the effects of joining the European Union in 2004 and the Schengen Area in 2008 at the sub-regional level. I obtain precise estimates for every RTEs as a result of European integration. I find that the positive effects from European integration on annual GDP per capita are approximately 10% less in border regions relative to interior regions. Perhaps the main reason previous studies on European integration reached inconclusive results was that these studies treat interior regions as a counterfactual. In this paper, I address these concerns and contribute to the literature by proposing a refined counterfactual scenario. This strategy allows me to derive new evidence on economic disparities between border and interior regions.

The main results show that becoming a member of the EU or Schengen Area has a unequal impact on economic performance in sub-regions of CEE countries. Using RTEs, I find that border regions are losers from their countries joining the EU and the Schengen Area relative to interior regions. The results are consistent when I drop from the sample interior sub-regions where the largest capital cities, such as Prague and Budapest, are located. Further, this paper provides additional evidence that integration facilitators, including fewer geographical obstacles, more service employment, and positive public perceptions about the EU, do not obviate the loss in border regions. Further research is needed to fully understand why border regions have relatively negative outcomes from EU accession and expansion of the Schengen Area. Future work will focus on case-studies of border regions at a granular level to uncover specific mechanisms and channels through which European integration affects the internal structure of border regions.

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Appendix

A.1: Descriptive Statistics

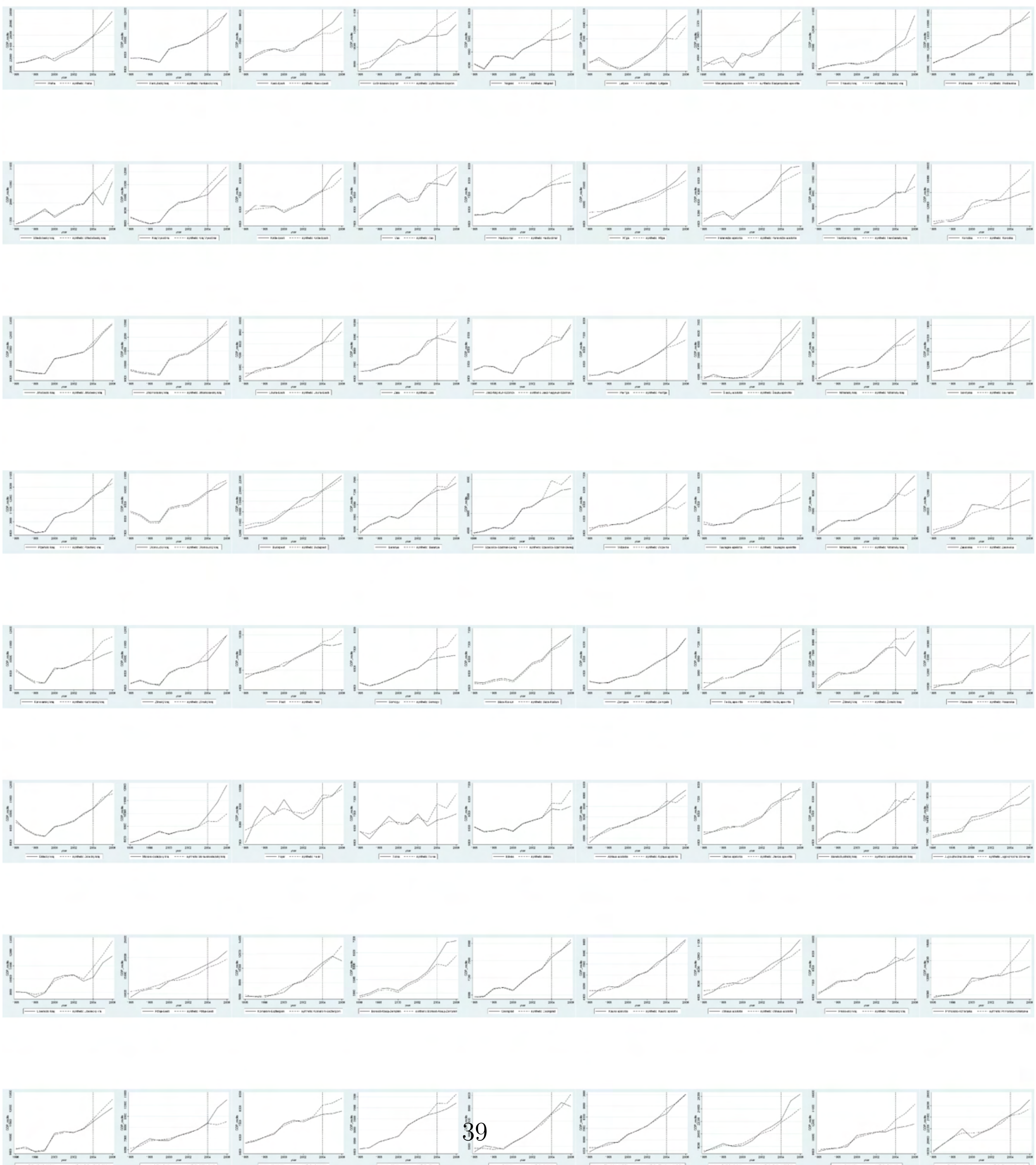
Variable	Mean	Std. Dev.	Min	Max
GDP per capita in constant prices R	10103.105	11012.156	1628.120	96850.422
Industry Share of GVA at constant prices	0.278	0.106	0.046	0.774
Agriculture share of GVA at constant prices	0.072	0.060	0.000	0.562
Employment in industry (share of total employment)	0.249	0.088	0.041	0.576
Population (log)	12.781	0.652	10.777	14.594
Regions size (log) (in km2)	8.712	0.834	5.886	10.872
Distance to the nearest border (from nuts3 centroid) (in km)	92.006	76.913	6.049	333.495
Road Distance to nearest foreign region's centroid (in km)	196.239	129.906	15.110	780.530
Share of population voted in favor in referendum (2003)	55.671	28.272	10.919	96.090
Employment share in the service sector (2003) wholesale, retail, transport, accommodation, food, information, and communication	0.208	0.052	0.101	0.359
Average hill shades	174.350	11.736	110.964	183.496
Land border (dummy)	-	-	0	1
Estimated Regional Treatment Effects on GDP per capita in thousands (European Union)				
Border (N=94)	-0.218	0.934	-2.782	2.326
Interior (N=52)	0.109	0.847	-2.042	3.236
Estimated Regional Treatment Effects on GDP per capita in thousands (Schengen Area)				
Border (N=94)	0.4045	0.748	-1.21	3.614
Interior (N=52)	1.099	1.017	-1.117	4.125

A.2: Regional Effects of Joining the EU and Schengen Area (excluding NUTS3 Interior Regions of Prague and Budapest)

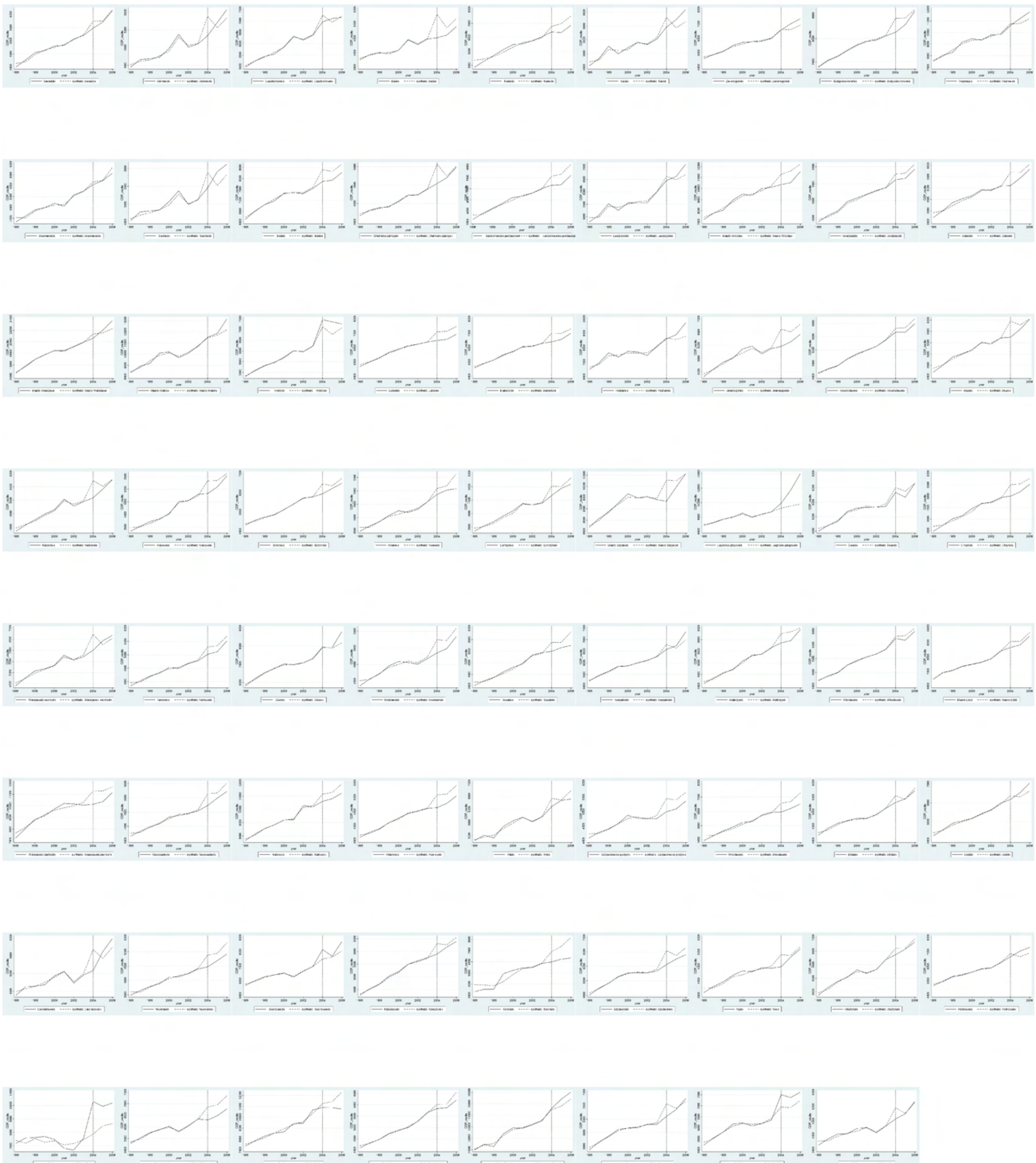
	(1)	(2)
	RTE (EU 2004)	RTE (Schengen 2008)
Land Border	-0.200**	-0.344*
	(0.078)	(0.086)
Country Fixed Effects	YES	YES
Observations	144	144
Adjusted R^2	0.451	0.417

Note: *Estimation method:* OLS. *Dependent variable:* estimated RTE - regional effects of joining the EU and Schengen Area on GDP per capita. *Standard errors:* Robust standard errors in parentheses. (*) (**) (***) denotes statistical significance at the (10) (5) (1) percent level. *Source:* Author's calculations.

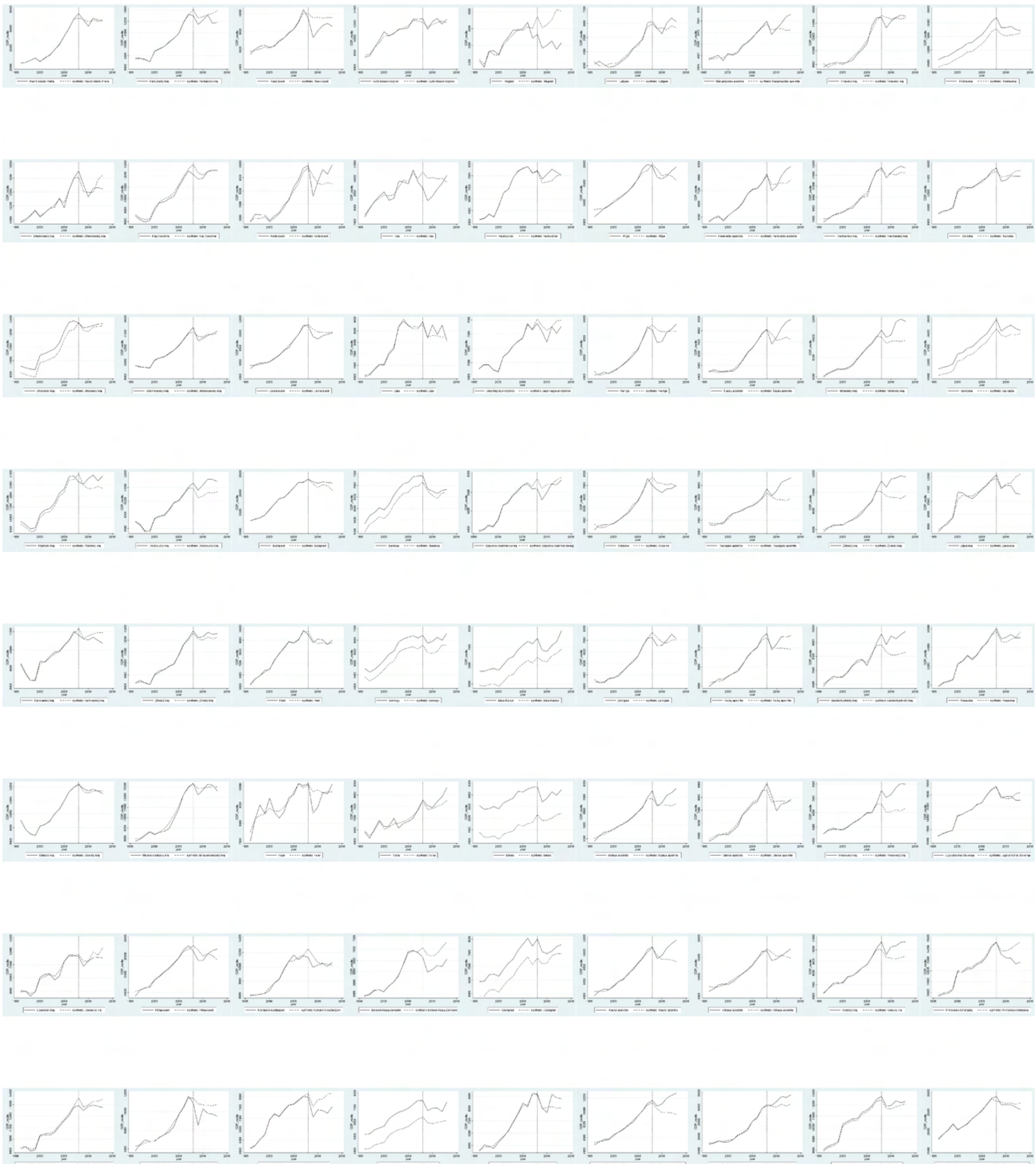
B.1. Disaggregated Synthetic Controls of EU



cont. B.1. Disaggregated Synthetic Controls of EU



C.1. Disaggregated Synthetic Controls of Schengen Area



cont. C.1. Disaggregated Synthetic Controls of Schengen Area