The Cost of Delay: A Synthetic Control Study of Croatia's Missed GDP per Capita Gains from Early EU Accession

By

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AUTHOR'S DECLARATION

I, Ranjan Sapkota, the undersigned candidate for the MA degree in Economic Policy at the Central European University, declare here that the present thesis titled "*The Cost of Delay: A Synthetic Control Study of Croatia's Missed GDP per Capita Gains from Early EU Accession*" is exclusively my own work, based on my research and only such external information as properly credited in notes and bibliography.

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Abstract

This thesis explores the effect of Croatia's hypothetical accession to the European Union in 2004 on GDP per capita, using the Synthetic Control Method (SCM). A counterfactual is constructed to estimate how GDP per capita in Croatia would have evolved in the absence of delayed EU membership. We construct a "Synthetic Croatia" as a weighted average of the ten 2004 accession countries, matching Croatia's GDP per capita and eleven macro-economic predictors (including lagged GDP per capita, FDI, inflation, tax revenue, exchange rate depreciation, employment, exports, labor-force participation, and consumption expenditure) over 1995–2003. To ensure robustness, we conduct a pre-treatment fit validation test: computing weights on 1995–2000 and forecasting into 2001–2003 yields an out-of-sample RMSE of USD 349.15 (under 3.5 % of the average GDP per capita), demonstrating strong predictive accuracy and confirming the credibility of our counterfactual before accession. Comparing actual and synthetic GDP per capita from 2004 to 2012, we find that Croatia underperformed its early-joiner countries by an average of USD 1,466.08 per person—a 10.6 % shortfall. In-space placebo tests, which repeat the SCM for each donor country as if it had joined in 2004, produce no similarly large or persistent post-2004 gaps, underscoring the statistical significance of Croatia's divergence. Our results suggest that Croatia's delayed accession caused a substantial opportunity cost in terms of foregone GDP growth. Analytically, this study contributes to the SCM literature by quantifying the economic penalty of postponed EU membership for a late-joiner economy, offering lessons for future enlargement and integration policies.

Keywords: Synthetic Control Method; EU Accession; Croatia; GDP per capita; Counterfactual, Pre-treatment

Contents

1 Introduction

The process of European Union (EU) enlargement has been one of the most significant geopolitical developments in post-Cold War[1] Europe. For countries in Central and Eastern Europe, EU membership offered not only a symbolic return to the "European family," but also access to economic integration, structural funds, removal of trade barriers and the institutional stability that comes with adopting EU rules and norms. Among the countries of the former Yugoslavia[2], Croatia is one of the only two countries to officially become a member of the European Union, joining on July 1, 2013 as the EU's 28th member (EU, 2013). However, Croatia's path to membership was longer and more complex than that of the ten countries (Czechia, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia) that joined the EU in 2004, raising an important question: *how might Croatia's economy have evolved if it had joined the EU in 2004 alongside its peers?*

Croatia declared independence from Yugoslavia in 1991, and by 1995, the Croatian War of Independence had ended (BBC, 2022). The country officially applied for EU membership in 2003 and received candidate status in 2004, the same year that ten other Central and Eastern European countries—including Hungary, Poland, the Czech Republic, and Slovenia—joined the EU. However, Croatia could not enter the EU immediately after receiving candidate status. Accession negotiations began in 2005, but between 2008 and 2011, the process was delayed due to several issues. One of the main obstacles was a border dispute with Slovenia, an existing EU member (BBC, 2009). Slovenia blocked Croatia's EU accession between late 2008 and 2009, citing unresolved territorial claims. In addition to the border issue, the European Commission raised concerns about judicial reforms, anti-corruption efforts, and Croatia's cooperation with the International Criminal Tribunal for the former Yugoslavia (ICTY)[3]. Only in 2011 did Croatia sign the Accession Treaty, and it finally became a full EU member in mid-2013 (EU, 2013). This long and complex accession path distinguishes Croatia from the earlier wave of EU entrants and raises the possibility that its delayed membership may have affected its economic trajectory.

Understanding the potential impact of Croatia's delayed EU membership is important for several reasons. First, it contributes to the broader literature on the economic consequences

[1]The post-Cold War era is usually known to be a period that started after the beginning of 1991 Soviet Union dissolution.

[2]Bosnia and Herzegovina, Croatia, Macedonia (now North Macedonia), Montenegro, Serbia, and Slovenia

[3]The International Criminal Tribunal for the former Yugoslavia (ICTY) was a United Nations court of law that dealt with war crimes that took place during the conflicts in the Balkans in the 1990s.

of EU accession, particularly for countries that joined later in the process. While much of the research has focused on the 2004 EU entrants, fewer studies explore how the timing of accession influenced countries like Croatia, which joined the EU nearly a decade later. This gap in research is significant, as it allows us to better understand the long-term economic implications of being a late joiner to the EU, especially for countries in Central and Eastern Europe. Second, this analysis offers valuable insights into the costs of delayed institutional integration. The delay in Croatia's membership meant that the country missed out on early access to EU funding, markets, and policy integration, all of which could have accelerated its economic growth. As Croatia navigated its accession, it was also subject to the shifting priorities of the EU, which was increasingly focused on broader integration challenges across Europe. For Croatia, the prolonged accession process likely resulted in missed economic opportunities, which may have slowed its ability to converge economically with more advanced European economies.

This thesis seeks to explore that counterfactual scenario by estimating the potential impact of earlier EU membership on Croatia's GDP per capita, a widely used measure of economic development. Specifically, it examines whether Croatia would have experienced higher levels of GDP per capita, had it joined the EU in 2004 rather than nearly a decade later. To answer this question, we use the Synthetic Control Method (SCM)[4], a statistical technique that allows for the construction of a credible counterfactual by combining data from a group of similar countries that actually received the treatment which in this case is the EU accession in 2004. While it is impossible to observe such difference directly, modern quantitative methods such as SCM provide tools for constructing a reasonable estimate. The SCM approach allows us to create a "Synthetic Croatia"—a weighted combination of the ten 2004 EU accession countries—that closely mirrors Croatia's pre-2004 economic trends and characteristics. By comparing the post-2004 GDP per capita of actual Croatia with that of synthetic Croatia, the thesis estimates the effect that earlier EU accession might have had.

GDP per capita is used as the main outcome variable in this study. It captures the overall performance of an economy and serves as a key economic indicator. For countries in transition, increases in GDP per capita are often associated with successful reforms, access to larger markets, and inflows of foreign investment—all of which can be facilitated by EU membership (Hagemejer et.al, 2021). Thus, analysing GDP per capita allows for a direct

[4]The Synthetic Control Method is a data-driven comparative case study approach that estimates the counterfactual outcome for a treated unit had the intervention not occurred. It constructs a synthetic version of the treated unit from a weighted combination of control units, where the weights are chosen to closely match the treated unit's pre-intervention characteristics.

assessment of whether earlier EU accession could have accelerated Croatia's economic convergence with the rest of the EU.

This thesis aims to make a methodological contribution by applying SCM in the context of EU accession, using publicly available macroeconomic data from the World Bank. The donor pool includes the countries that joined the EU in 2004, all of which experienced similar institutional transitions and shared many characteristics with Croatia in the pre-treatment period. By selecting countries with comparable pre-accession experiences, this study ensures that the synthetic control represents an appropriate and credible counterfactual. In doing so, the study offers an empirical estimate of the effect of EU membership and quantifies the idea behind, *what may have been lost due to delayed entry.*

In the process of examining the impact of earlier EU accession on Croatia's GDP per capita, this thesis contemplates the idea through six main components. First, it reviews the existing literature on similar studies, identifying gaps in the current body of research and explaining how this study contributes to filling those gaps. Second, the thesis will dive deep into the data and methodology, outlining the source of data, variables used for the analysis and a brief note on our estimation strategy. Third, the thesis assesses the pre-treatment validity of the synthetic control model by splitting the pre-treatment period into a training period and a hold-out period. This allows us to check whether the synthetic control's predictions align closely with Croatia's actual economic trajectory before EU membership. Fourth, it turns to the core findings, where the results are presented and interpreted in light of the synthetic control estimates. Fifth, the thesis performs a placebo test to check whether our results are by chance or because of an actual effect. Finally, the thesis concludes with a discussion of the findings, reflecting on their broader implications for Croatia and other countries with delayed EU accession, while offering suggestions for future research in this area.

2 Literature Review

The literature examining the economic impact of European Union (EU) accession has increasingly relied on rigorous counterfactual methods, with the synthetic control method (SCM) emerging as a preferred approach for isolating the causal effects of membership on macroeconomic outcomes, particularly GDP per capita (Marrazzo & Terzi, 2017; Abadie, Diamond, & Hainmueller, 2015; Abadie, 2020). This review synthesizes the state of scholarly knowledge on the subject, highlighting both the consensus and the ongoing debates that shape our understanding of EU accession's economic consequences. It begins by discussing

the growing reliance on counterfactual methods using SCM, in analyzing the economic impacts of EU accession. It explores key studies that have applied SCM to assess the effects of EU membership on GDP per capita and other economic outcomes. The review highlights the methodological challenges and debates within the field, focusing on the heterogeneity of effects across different countries, particularly between early and late EU joiners. Following this, it delves into the mechanisms underlying EU accession's benefits, such as access to larger markets, foreign direct investment, and improved governance. The review concludes by examining how this thesis contributes to the existing literature by focusing on Croatia's delayed EU accession, aiming to quantify the GDP per capita losses resulting from the delay, rather than the post-accession effects, and offering insights into the broader implications of delayed integration for transitioning economies.

Early empirical investigations into the effects of EU accession on member states' economic performance faced significant methodological challenges, most notably the difficulty of constructing credible counterfactuals for what would have happened in the absence of integration. The introduction of the synthetic control method by Abadie and Gardeazabal (2003) and its subsequent refinement by Abadie, Diamond, and Hainmueller (2010, 2015) represented a methodological breakthrough, enabling researchers to construct a weighted combination of unaffected countries that closely mimics the pre-accession path of the treated unit, thereby providing a more plausible counterfactual for post-accession analysis.

One of the most influential applications of SCM to EU accession is the work by Campos, Coricelli, and Moretti (2014, 2019), who estimate the effect of EU membership on per capita income and labor productivity across several accession waves. Their analysis, which focuses on the 1973, 1981, 1986, 1995, and 2004 enlargements, concludes that EU accession produced substantial average gains in GDP per capita, with some estimates suggesting increases as high as 10 percent in the decade following membership.

However, these findings have not gone unchallenged. The magnitude and statistical significance of EU accession effects estimated by the SCM have been shown to vary considerably across studies and countries. For example, Billmeier and Nannicini (2013), in their analysis of economic liberalization episodes using SCM, found that, while some countries experienced substantial gains, in many cases the estimated effects were modest and not always statistically significant, especially in the case of African countries when looking at the most recent liberalization and when subjected to robustness checks and alternative donor pools. Similarly, Hagen and Mühlböck (2022) conducted a systematic SCM assessment of EU inte-

gration's impact on economic growth and reported that, especially for later accession waves, the estimated gains in GDP per capita were often small and indistinguishable from those observed in placebo countries. These findings suggest that while EU membership can have positive economic effects, the size and reliability of these effects depend heavily on country-specific factors and methodological choices, and may be considerably more modest than some earlier studies have suggested. In many cases, estimated effects are statistically indistinguishable from noise, raising questions about the reliability of large positive estimates reported in earlier studies.

Adding on, the heterogeneity in estimated effects is a recurring theme in the literature. While some countries—particularly those joining in the earlier waves—appear to have reaped substantial benefits, the evidence for later entrants, especially those from Central and Eastern Europe, is more mixed. This finding is also consistent with the study by Spruk and Nuno (2023), where they employ SCM to assess the long-run growth and development effects of EU membership and finds that founding member states and some early joiners experienced significant and persistent gains, whereas the benefits for more recent entrants are less pronounced and, in some cases, difficult to distinguish from the counterfactual trajectory. This pattern is echoed in a penalized SCM analysis by El-Shagi and Yamarik (2023), which further highlights the importance of accounting for heterogeneous country characteristics and the potential for both winners and losers from integration.

Despite these caveats, the consensus in the literature is that EU accession has, on average, been economically advantageous for member states, particularly in terms of GDP per capita. A synthetic control analysis of the first 25 years of Austria's EU membership, for example, finds that both GDP per capita and labor productivity grew more rapidly than in the constructed synthetic counterfactual, suggesting a clear accession benefits (Anttonen and Vihriälä 2020). Similar results are reported for other Western and Southern European joiners, though the magnitude of the effect varies (Beyer, Li, & Weber, 2025; Lehtimäki & Sonderma, 2020; Campos, Coricelli, & Moretti, 2019).

The literature also points to the mechanisms underlying these gains. EU membership typically entails access to a much larger single market, increased foreign direct investment, improved institutional quality, and the adoption of common regulatory standards. These channels are thought to drive productivity improvements, facilitate technology transfer, and stimulate export growth, all of which contribute to rising GDP per capita. However, the size and persistence of the accession effect are contingent on domestic factors, including the

absorptive capacity of the economy, the quality of governance, and the extent of complementary reforms undertaken in anticipation of or in response to EU membership (Spruk and Nuno, 2023).

While the bulk of SCM-based research has focused on GDP per capita, a growing body of work has begun to examine other macroeconomic outcomes, such as exports, trade balances, and sectoral shifts (Gunnella et al., 2021; Pochmara & Michałek, 2023; Duque Gabriel & Pessoa, 2024)). These studies generally find that EU accession is associated with increased export activity, particularly to other EU member states, as trade barriers are dismantled and firms are integrated into European value chains. However, the magnitude of these effects is again heterogeneous and often depends on the initial structure of the economy and the degree of pre-existing trade integration.

This study contributes to the growing body of research on the economic effects of EU accession by shifting the focus to Croatia's GDP per capita trajectory and, crucially, by quantifying the foregone gains associated with its delayed accession, rather than merely the post-accession boost. While much of the existing literature has focused on the positive economic effects of EU membership, particularly for early entrants, few studies have rigorously assessed the economic costs of delayed integration. By concentrating on the missed opportunities resulting from Croatia's delayed accession, this thesis provides a novel perspective on the economic consequences of postponed EU membership. Another unique facets of this thesis is that, unlike many SCM applications that draw donor units from any statistically similar countries, this study uniquely confines its donor pool to the ten nations that joined the EU in 2004, ensuring that the counterfactual reflects Croatia's true peer group rather than a broader set of counterparts.

3 Data and Methodology

3.1 Treated Unit and Donor Pool

The treated unit is Croatia[5], under the hypothetical condition that it joined the EU in 2004 rather than in 2013. The donor pool comprises the ten countries that actually acceded to the EU in 2004: Czechia, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, and Slovakia. These countries serve as the basis for constructing the synthetic control. They are selected because they underwent similar transitions from planned to market economies during the 1990s, followed comparable reform paths, and were pretty much subject to the same economic and trade-related shocks upon joining the EU.

Using only the 2004 accession countries as the donor pool helps reduce unobserved heterogeneity that could arise if countries with very different development paths or institutional characteristics were included. Moreover, these countries had similar pre-accession expectations and constraints, which makes them appropriate for constructing a credible synthetic control.

3.2 Time Period

The analysis is split into pre-treatment and post-treatment periods:

- **Pre-treatment period**: 1995–2003
- **Post-treatment period**: 2004–2012

The treatment year is 2004, which corresponds to the EU accession year for the donor countries and the hypothetical accession year for Croatia. The pre-treatment period is used to construct a synthetic Croatia that closely tracks Croatia's actual GDP per capita prior to EU membership. The post-treatment period is used to assess divergence in GDP per capita outcomes between Croatia and the synthetic Croatia, thereby estimating the potential impact of earlier EU accession.

[5]Here, contrary to usual treatment and control concept, we actually interchange but the idea actually remains the same. That is to say that, we only imagine a hypothetical scenario. And that it is not real. In usual case, Croatia would be control unit and donor pool would be treatment unit. But here, we see Croatia as a hypothetical treatment unit and not a control unit and the donor pool as hypothetical control unit and not as a treatment but both purely in a hypothetical sense. While doing the empirical analysis, the analysis would be the same as any other SCM analysis. It is pertinent to not mix up this idea as it is the same as usual SCM logic but just a bit imaginary difference to set up the ideas for this specific scenario.

3.3 Data Sources

The dataset for this analysis is sourced via the World Bank data portal[6]. All data used in this study spans from 1995 to 2012 and is available for both Croatia and all donor pool countries. The dataset used for all variables including predictors is taken from the World Bank itself. Given that Croatia got independence only from 1995, we can only use the dataset from 1995 and given that Croatia joined the EU in 2013, we can only use the dataset till 2012.

3.4 Outcome Variable

The main outcome variable (dependent variable) in this study is GDP per capita, measured in constant 2015 US$. Focusing on GDP per capita allows for a clean interpretation of how economic development might have differed had Croatia joined the EU earlier. This indicator is also well documented, consistently measured across countries, and available for all years in the analysis.

3.5 Predictor Variables

To ensure the validity of the synthetic control, it is essential to match Croatia and the donor countries on relevant predictor variables during the pre-treatment period. These predictors are selected based on their relevance and high correlation with economic performance and their availability in the dataset. The final set of predictors includes:

- **Foreign direct investment:** Generally, a higher GDP per capita indicates a larger market and greater productive capacity, both of which tend to attract foreign investors which usually increases FDI inflows (Bénetrix, Pallan, and Panizza, 2023).
- **Inflation:** Captures price stability, which affects investment and growth. Generally, low and stable inflation (hovering around 2 percent) is known to support economic growth, particularly in advanced economies. But, high or volatile inflation is generally associated with lower GDP per capita, especially in developing countries (Xiong, 2023).
- **Tax Revenue**: A country's ability to raise revenue through taxation is closely tied to its level of economic development, higher-income nations typically collect a larger share of GDP in taxes, reflecting stronger fiscal capacity and public-goods provision. Ho, Tran, & Nguyen (2023), also find that, tax revenue and economic growth have a positive relation.

[6]This dataset is basically a compilation of the datasets from various sources.

- **Exports of goods and services:** This is a key measure for us as generally higher exports often coincide with higher per capita GDP.

- **Employment and Labor Force Participation:** Reflects structural aspects of the labour market. A higher labor force participation rate is typically associated with greater GDP, as a larger working population contributes to higher levels of production and overall economic activity. Bryant et al. 2004, also highlight this in their labor force study on New Zealand.

- **Exchange Rate:** It is generally observed that higher GDP per capita is associated with a stronger currency, meaning that more developed economies often have higher-valued exchange rates (Pramanik 2021). This thesis will use the yearly depreciation rate as a proxy for exchange rate to account for constant changing currency values[7]. The calculation is as below:

$$\textbf{Depreciation Rate} = \log\left(\frac{e_t}{e_{t-1}}\right)$$

  where e_t is the exchange rate for year t, and e_{t-1} is the exchange rate for the previous year $t-1$.

- **Consumption Expenditure:** We include consumption expenditure as one of our predictors as it tells us how much households are spending relative to the size of the economy, and this spending tends to be smoother than overall output, capturing both short-term ups and downs and longer-run trends. Empirical studies by Diacon and Maha (2015) also highlight that consumption and GDP per capita are closely related.

- **Lagged GDP per capita:** GDP values from 1996, 1999, and 2002 are used as lagged predictors to improve pre-treatment match quality.

The values for each predictor are aggregated using their medians over the pre-treatment period (1996–2003), following standard practice in SCM applications as it reduces the influence of outliers and short-term fluctuations.

[7]We concluded to use yearly depreciated rate, largely when we observed a large differences in nominal exchange rates, especially in the case of Hungary.

3.6 Estimation Strategy

The SCM estimation is implemented using the `Synth` package[8] in R (Abadie et.al, 2011). The data is first reshaped to ensure a consistent panel structure, then input into the `dataprep()` function, which organizes the treated and donor units, predictors, and time settings. After fitting the model, a synthetic version of Croatia is created by weighting the donor countries to best match Croatia's pre-treatment GDP per capita and predictor values.

The performance of the synthetic control is evaluated by comparing the pre-treatment match between actual and synthetic Croatia. A good match in the pre-treatment period suggests that the synthetic control provides a credible counterfactual. The post-treatment divergence between Croatia and synthetic Croatia is then interpreted as the estimated effect of EU accession on GDP per capita. The methodology used is as such:

The SCM[9] constructs a synthetic control unit for Croatia by assigning optimal weights w_j to a set of control countries $\mathcal{C}$, minimizing the distance between pre-treatment characteristics of Croatia and the weighted average of predictors. The estimated treatment effect at time t is given by[10]:

$$\hat{\alpha}_{\text{Croatia},t} = Y_{\text{Croatia},t} - \sum_{j \in \mathcal{C}} w_j Y_{jt} \tag{1}$$

which, in a simple manner, can also be written as:

$$\hat{\alpha}_{Croatia,t} = Y_{Croatia,t} - \hat{Y}^{SC}_{Croatia,t} \tag{2}$$

where $\hat{\alpha}_{Croatia,t}$ represents the estimated effect of EU accession on GDP per capita at time t, $Y_{Croatia,t}$ is the actual observed GDP per capita for Croatia, and $\hat{Y}^{SC}_{Croatia,t}$ is the counterfactual outcome estimated from the synthetic control.

[8]To check for the coding of the analysis and results, check this github link: *https://github.com/Ranjan681/Thesis.git*

[9]For further understanding of the Mathematics behind SCM with a comparative case example, Check Abadie, A., Diamond, A., and Hainmueller, J. (2010). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. Journal of the American Statistical Association, 105(490), 493–505.

[10]For a full proof or explanation of how we come to this result specific to our study, please check Appendix A.

4 Pre-Treatment Validity Check

A fundamental assumption underpinning the credibility of the Synthetic Control Method (SCM) is that the constructed counterfactual accurately reproduces the treated unit's trajectory before the intervention. In our context, this means that the "synthetic Croatia"—a convex combination of 2004 EU-accession countries—must closely track Croatia's actual GDP per capita prior to accession. While the overall pre-treatment fit (1995–2003) is reassuring, a more stringent test of predictive validity can be obtained by holding out a subset of pre-treatment years as a "test period." By calibrating the synthetic weights on an earlier training window and then forecasting into a subsequent holdout window, we directly assess the model's out-of-sample performance in the pre-treatment phase.

4.1 Training–Test Split within the Pre-Treatment Phase

To implement this internal validation, we partition the 1995–2003 window into:

- **Training period**: 1995–2000
- **Test (holdout) period**: 2001–2003

First, we re-estimate the donor-country weights[11] using only data from 1995 through 2000. This estimation leverages Croatia's observed GDP per capita over those six years (along with any time-invariant covariates), finding the convex combination of donor units that minimizes the mean squared prediction error in the training window. Crucially, the test period data (2001–2003) remain completely concealed during this weight selection.

Next, we apply these fixed weights to generate the synthetic control's GDP per capita in each year of the test window. Because the donor weights were chosen without reference to the test-period realizations, any deviation between actual and synthetic GDP per capita in 2001–2003 constitutes a genuine out-of-sample forecasting error. If the SCM is truly capturing the structural relationship between Croatia and its synthetic counterparts, these prediction errors should remain small and patternless.

4.2 Test-Period Performance Metrics

To quantify the out-of-sample accuracy of our synthetic control over the holdout window, we compute the Root Mean Squared Error (RMSE) as follows:

[11] For a brief detail on the weights contribution, check Appendix C

$$\mathrm{RMSE}_{\mathrm{test}} = \sqrt{\frac{1}{T}\sum_{t=i}^{k}\left(Y_t^{\mathrm{Croatia}} - Y_t^{\mathrm{SC}}\right)^2}$$

In our application,

$$\mathrm{RMSE}_{\mathrm{test}} = 349.15.$$

where, Y_t^{Croatia} and Y_t^{Synth} denote the actual and synthetic GDP per capita, respectively, and

i = first year of test period = 2001, k = last year of test period = 2003, T = total years (test period) =

To put this result in context, the average GDP per capita during 2001–2003 is approximately \$10065.35, so

$$\frac{\mathrm{RMSE}_{\mathrm{test}}}{\overline{Y}^{\mathrm{Croatia}}_{\text{2001–03}}} \approx \frac{349.15}{10065.35} = 3.47\%$$

By SCM standards, an out-of-sample RMSE of less than 5 percent in a holdout window is interpreted as a very strong indication of predictive validity. In our case, the test-period RMSE of 75.23 amounts to much less and under 4 percent of the average GDP per capita in 2001–2003 which implies an exceptionally low forecasting error. This low error confirms that our synthetic Croatia is not merely over-fitting the training data but is genuinely capturing the true economic patterns of Croatia prior to EU accession.

4.3 Graphical Fit

Complementing the numeric test-period RMSE, Figure 1 juxtaposes the actual and synthetic GDP per capita from 1995 through 2003, with the vertical dashed line marking the start of the test period (2001).

- **Training period (1995–2000).** The synthetic series tracks the observed data almost perfectly, with year-by-year deviations barely exceeding \$50 on an \$7,500–\$8,500 base.
- **Test period (2001–2003).** Remarkably, the hold-out performance is tighter as well with not a heavy gap and the largest absolute discrepancy in any test year is noticeably less than the \$350 bound.

This visual evidence and the quantitative findings with out-of-sample RMSE as 349.15, clearly shows that the synthetic control not only fits the in-sample data exceedingly well but also predicts the hold-out years with even greater precision, underscoring the model's robustness.

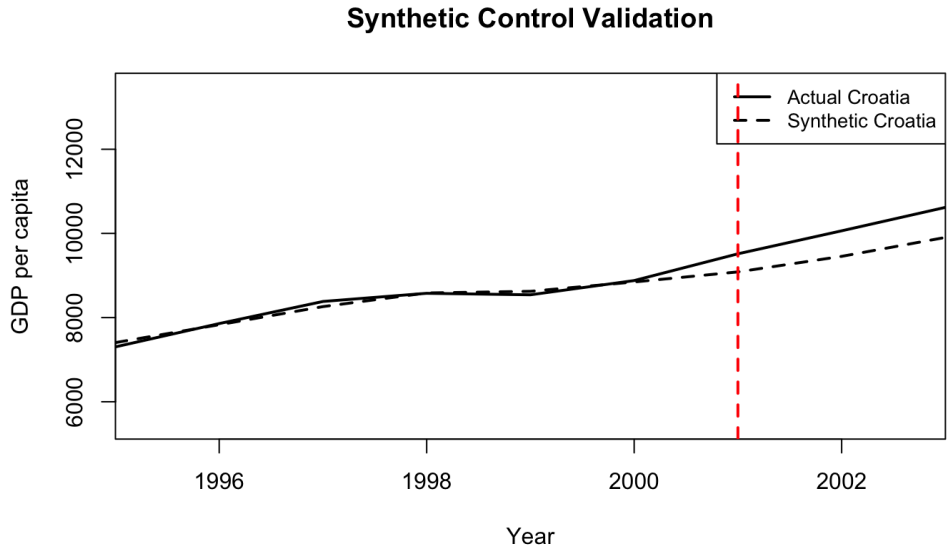

Figure 1: Pre-Treatment Fit: Actual vs. Synthetic Croatia GDP per Capita (1995–2003)

This dual validation, mirroring both in-sample and out-of-sample performance, lends strong support to our SCM's ability to recover a plausible counterfactual trajectory for Croatia's delayed EU accession. Consequently, any post-2004 deviation between actual and synthetic GDP per capita can be interpreted with confidence as the causal effect of joining the European Union.

5 Results

Figure 2 plots the trends in GDP per capita for Croatia and the average of the 2004 EU accession countries. While both followed broadly similar trajectories before 2004, notable differences in levels persisted throughout the pre-treatment period. After 2004, when the donor countries joined the EU and Croatia did not, their economic paths diverged notably. The control group experienced faster and sustained growth, whereas Croatia's progress was not as strong relatively. These differences suggest that the simple average of the 2004 accession countries may not serve as an appropriate comparison group for evaluating the effect of EU accession on Croatia's GDP per capita.

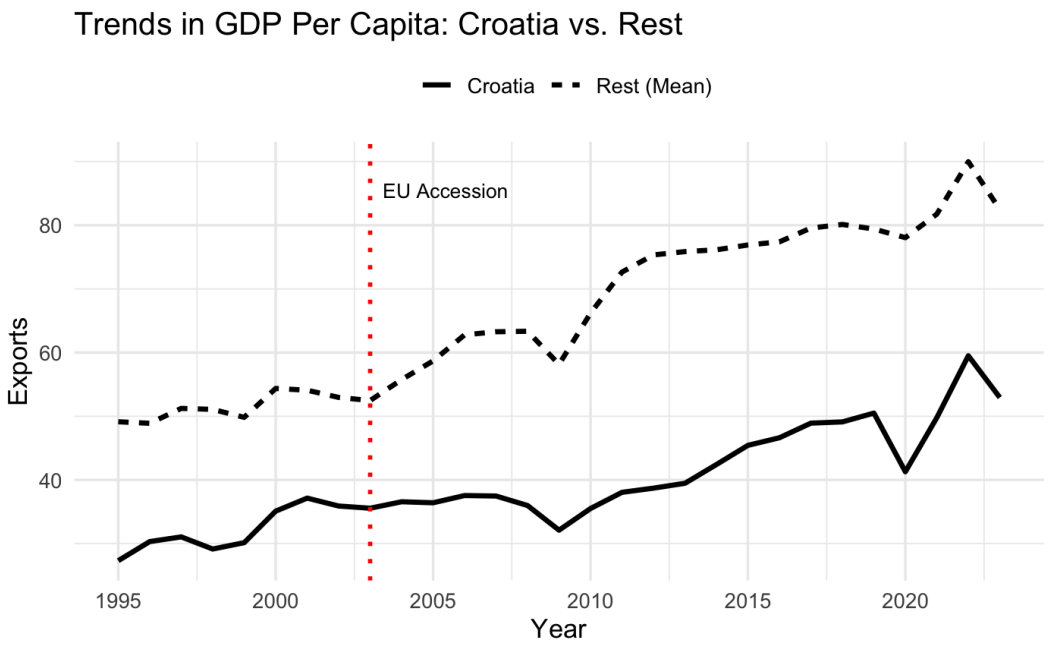

Figure 2: Trends in GDP per capita: Croatia vs. Rest (mean)

As mentioned earlier as well, to evaluate the impact of earlier EU accession on Croatia's GDP per capita, the central question would be to see how Croatia's economy would have evolved had it joined the EU in 2004. A simple comparison with the average of the donor pool countries is unlikely to yield a credible answer, as it does not adequately account for various differences that affect economic outcomes.

Hence, we construct the synthetic Croatia as the convex combination of countries that joined EU in 2004 in the donor pool that most closely resembled Croatia. The results are highlighted in Table 1. The synthetic Croatia closely reproduces the values observed for actual Croatia across nearly all predictors. For instance, the synthetic unit matches Croatia's GDP per capita in 1996, 1999, and 2002 with minimal deviation, and aligns closely on employment, FDI, Inflation and exchange rate. While the average of the donor pool differs substantially—particularly in larbor force, and exports—the synthetic version substantially narrows these gaps. This close alignment supports the credibility of the synthetic Croatia as a valid counterfactual for assessing the impact of EU accession timing.

Table 2.1 shows the weights assigned to countries in the donor pool for constructing synthetic Croatia. The results indicate that Lithuania (0.7), Czechia (0.15), and Cyprus (0.10) contribute almost entirely to the synthetic control, while all other countries receive negligible or zero weights. This suggests that Croatia's pre-2004 economic profile is best approximated by

Table 1: Predictor Means: Croatia, Synthetic, and Donor Pool Mean

Variable	**Croatia**	**Synthetic**	**Donor Pool Mean**
Lagged GDP per capita (1996)	7,857.72	7,755.08	9,731.52
Lagged GDP per capita (1999)	8,541.24	8,654.28	10,913.67
Lagged GDP per capita (2002)	10,061.69	9,971.12	12,458.88
FDI inflows (% of GDP)	4.06	4.49	5.27
Inflation rate (%)	4.89	4.29	5.86
Tax revenue (% of GDP)	22.70	20.70	23.89
Exchange rate depreciation (log points)	0.03	-0.02	0.03
Employment rate (%)	29.54	29.49	32.60
Exports (% of GDP)	33.04	44.23	51.86
Labor force (% total population ages 15-64))	63.46	71.14	67.44
Consumption expenditure (% of GDP)	85.62	82.79	78.42

a convex combination of these three countries, with Lithuania playing the dominant role[12]. The low or zero weights for the remaining countries reflect weaker alignment with Croatia's pre-treatment characteristics.

Table 2.2 reports the weights assigned to each predictor. The results indicate that inflation (0.35) employment (0.3), and GDP in 1996 (0.13) were the most influential predictors in constructing synthetic Croatia. These variables contributed most to matching Croatia's pre-accession economic profile, suggesting they were particularly important in predicting GDP per capita during the pre-treatment period. In contrast, variables such as labor force exports and exchange rates, among others received little to almost no weights, indicating limited predictive power in this context.

[12]Given that Lithuania contributes an alarmingly high weight, for cross-checking potential biases, we have also shown how it works without Lithuania and we find that, while the Synthetic and Actual Croatia's distance (as shown in Table 1) of variable changes a bit, it however, does not make a significant difference that could impact our overall analysis. In the absence of Lithuania, Poland and Latvia contribute the majority of the weights. We have highlighted the weight distribution and Predictor Means in the absence of Lithuania in Appendix B.

Table 2: Donor Country Weights and Predictor Weights

Table 2.1: Country Weights

Country	Weight
Cyprus	0.100
Czechia	0.157
Estonia	0.002
Hungary	0.002
Latvia	0.001
Lithuania	0.705
Malta	0.000
Poland	0.027
Slovak Republic	0.001
Slovenia	0.005

Table 2.2: Predictor Weights

Predictor	Weight
Lagged GDP per capita (1996)	0.132
Lagged GDP per capita (1999)	0.119
Lagged GDP per capita (2002)	0.083
FDI inflows (% GDP)	0.003
Inflation rate	0.350
Tax revenue (% GDP)	0.001
Exchange rate depreciation	0.000
Employment rate	0.307
Exports (% GDP)	0.004
Labor force participation rate	0.000
Consumption expenditure (% GDP)	0.001

As highlighted by Figure 3, prior to 2004—the year when donor countries joined the EU, synthetic Croatia closely tracks actual Croatia, indicating a strong pre-treatment fit. The tight alignment of both series during the pre-accession period suggests that the synthetic control effectively replicates Croatia's economic trajectory in the absence of EU membership, providing a credible counterfactual.

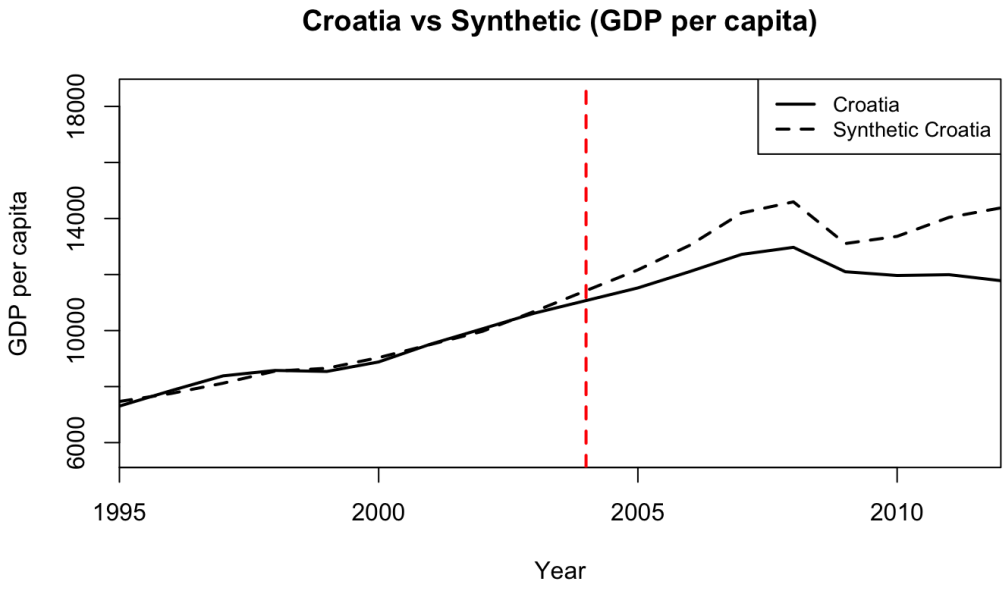

Figure 3: Synthetic Vs Real Croatia per capita GDP comparison (between 1995 and 2012)

Following the treatment year, when the synthetic Croatia is assumed to join the EU, the gap turns consistently negative, suggesting that actual Croatia underperformed relative to its synthetic version. As we can see from the Figure 3 as well, the divergence becomes more pronounced after 2008 and persists through 2012, with the gap widening to over $2,500 in the final years of the sample. On average, GDP per capita in actual Croatia was $1,466.08 lower than in synthetic Croatia during the post-treatment period, corresponding to a 10.6 percent shortfall.

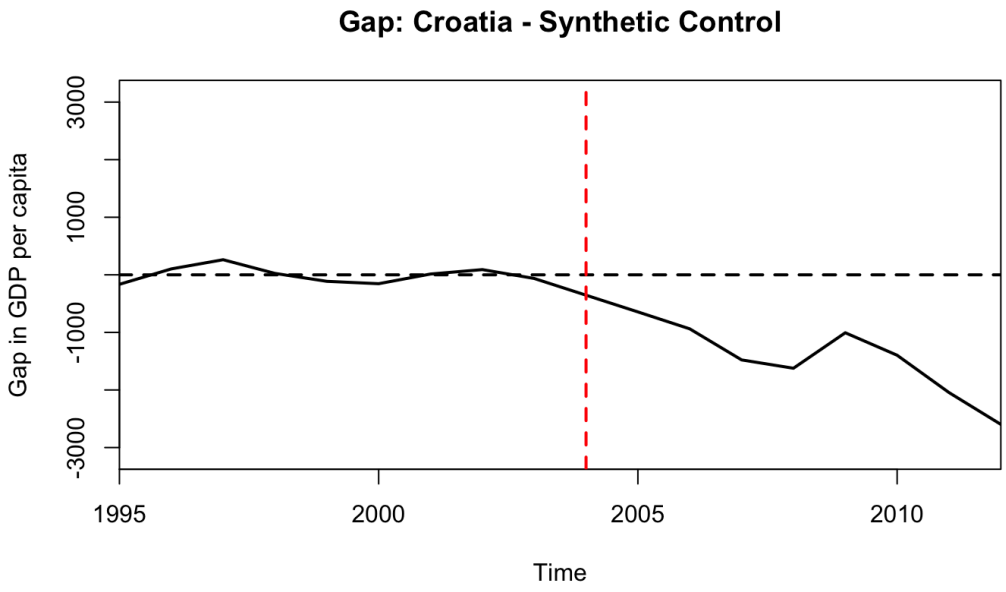

Figure 4: Synthetic Vs Real Croatia per capita GDP Gap

This sustained and economically significant gap suggests that delayed EU accession have hindered Croatia's GDP per capita, holding back convergence with its regional peers. Given the strong pre-treatment fit and the sustained divergence observed after 2004, the evidence is consistent with our causal interpretation; had Croatia joined EU in 2004, Croatia would have had on average 10.6 percent more GDP per capita then what they actually had.

6 Placebo Analysis: Assessing the Significance of the Estimated Effect

Following Abadie et al. (2010), Abadie and Cattaneo (2018), and Firpo and Possebom (2018), to evaluate whether the estimated effect of delayed EU accession on Croatia's GDP per capita

could be attributed to chance, we conduct an in-space placebo test[13] using the synthetic control method on each country in the donor pool. In each iteration, we reassign the hypothetical treatment—EU accession in 2004—to a country other than Croatia and compute the gap between actual and synthetic GDP per capita for that country. This generates a distribution of placebo effects under the assumption that no true intervention occurred.

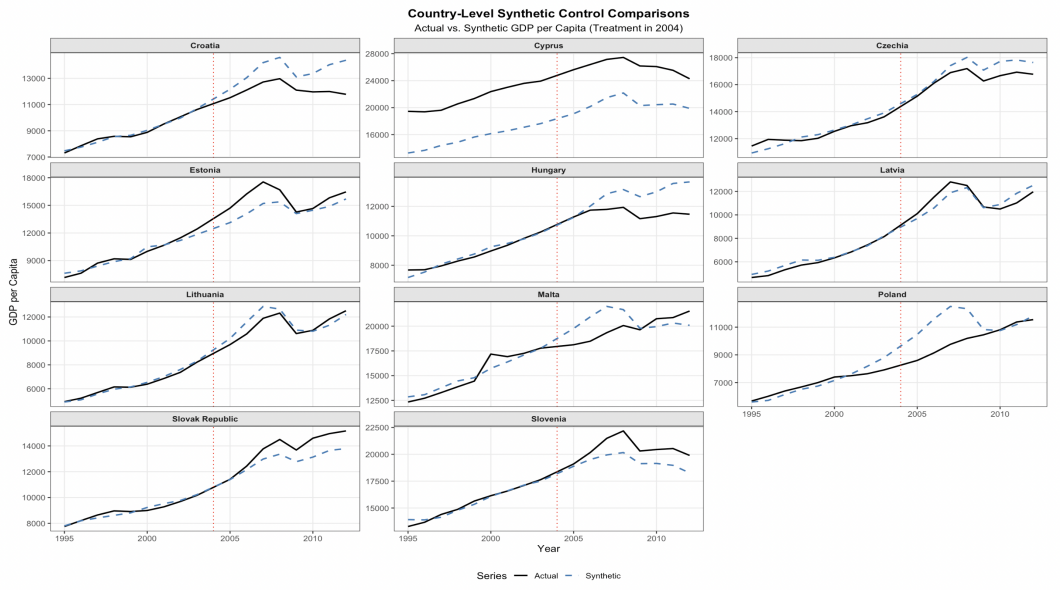

Figure 5: Country-Level Synthetic Control Comparisons (EU Accession in 2004). Each of the twelve small panels shows a country's actual GDP per capita (solid black) alongside its synthetic-control estimate (dashed blue). The vertical red dotted line marks the "treatment" year of 2004.

In every panel in Figure 4, the pre-treatment fit is remarkably tight: from 1995 up to 2003, each dashed-blue synthetic line almost exactly tracks its solid-black actual counterpart with an exception to Cyprus and Poland, demonstrating that the synthetic control algorithm faithfully reproduces each country's counterfactual path when "hypothetically joining" the EU in 2004. This close pre-2004 alignment confirms that the observed post-2004 deviations cannot be attributed to a poor pre-treatment match.

Also, most placebo countries exhibit relatively small or transitory deviations from their synthetic controls following 2004. In contrast, the gap for Croatia becomes increasingly negative

[13]Here, if one particular country were "really" treated in 2004, we'd expect its plot to display a clear, sustained gap between the black and blue lines after that date. However, for placebo cases, there should be no dramatic breaks. By stacking all these charts together, we can quickly see that none of the non-treated countries suddenly deviate in a meaningful way after 2004, reinforcing the idea that any big gap in the actual treated country is not simply a coincidence.

over time, with a sustained divergence that is visibly distinct from the majority of placebo lines. This suggests that the magnitude and persistence of Croatia's post-treatment gap is not commonly observed among untreated countries and that the gap we see for the true treated case is less likely to be a random blip.

Taken together, the placebo test supports the interpretation that the delayed accession of Croatia to the European Union had a negative and economically meaningful impact on its GDP per capita. Since the estimated gap for Croatia is among the largest in the donor pool and exhibits a consistent post-treatment trajectory, the findings reinforce the credibility of a causal link between delayed EU accession and a GDP per capita shortfall. This result is further strengthened by the close pre-treatment fit, which ensures that post-2004 deviations are unlikely to be driven by poor model match rather than the absence of earlier EU membership.

7 Conclusion

By constructing a "Synthetic Croatia" from a weighted combination of the ten 2004 accession countries, and validating its fit both in-sample (1995–2000) and out-of-sample (2001–2003), we demonstrate that the counterfactual closely tracks Croatia's pre-2004 GDP per capita, achieving a test-period RMSE of just 349 (under 4 percent away from the actual mean of the test period). Following the hypothetical treatment year of 2004, actual Croatia's GDP per capita falls persistently below that of its synthetic counterpart. Between 2004 and 2012, Croatia's GDP per capita averages $1,466 lower than the synthetic control—a shortfall of approximately 10.6 percent. The gap widens steadily after 2008, reaching over $2,500 by 2012. Placebo tests, which apply the same procedure to each donor country in turn, confirm that Croatia's divergence is unusually large and statistically significant relative to the distribution of other placebo countries.

Taken together, these findings suggest that Croatia's prolonged accession negotiations and political disputes imposed a sizeable opportunity cost on its economic convergence. Had Croatia joined the EU in 2004, its GDP per capita trajectory would very likely have aligned more closely with its regional peers—resulting in higher GDP per capita .

These findings carry important lessons for both researchers and policymakers. First, they underscore that the timing of institutional integration matters: beyond the symbolic and regulatory advantages of membership, joining earlier appears to have accelerated convergence

toward higher per-capita GDP. For late-joining economies, delayed negotiations or domestic political disputes can translate into millions—or even billions—of dollars in forgone output. Second, the post-2008 widening of the gap suggests that early access to EU-wide safety nets, cohesion funding, and integrated financial markets may bolster resilience during downturns. Had Croatia been able to tap these supports in 2008, it might have limited the depth of its downturn and narrowed its divergence from peers.

At the same time, our analysis invites several avenues for further investigation. One promising extension would be to examine sectoral outcomes, such as sectoral exports such as manufacturing exports or labor market dynamics, to see how accession timing shaped structural change. Finally, applying this framework to other late joiners—Bulgaria, Romania, among others- could reveal whether Croatia's experience is typical or exceptional among transition economies.

In sum, this thesis quantifies the tangible opportunity cost of Croatia's delayed EU accession: a persistent, double-digit shortfall in per-person GDP per capita. For countries contemplating future enlargement or grappling with the pace of domestic reform, our results provide concrete evidence that postponement carries real consequences for economic standards.

Appendix A: Methodology for Synthetic Control (Croatia)

1. Structural Explanation[14]

We model each country's counterfactual outcome $Y_{c,t}^N$ as:

$$Y_{c,t}^N = \underbrace{\delta_t}_{\text{common time effect}} + \underbrace{\theta_t' Z_c}_{\substack{\text{observed covariates} \\ \text{(e.g. lagged GDP etc)}}} + \underbrace{\lambda_t' \mu_c}_{\substack{\text{latent common} \\ \text{factors}}} + \underbrace{\varepsilon_{c,t}}_{\substack{\text{country-specific} \\ \text{temporary shock}}}.$$

- δ_t: Year-t shock shared by all countries (e.g. global recession or boom).
- Z_c: Vector of observed pre-treatment covariates for country c (e.g. lagged GDP, exchange rate, tax revenue, among others).
- θ_t: Time-varying weights on each element of Z_c.
- μ_c: Country-specific loadings on hidden common factors.
- λ_t: Unobserved common factors in year t (e.g. global technology trend).
- $\varepsilon_{c,t}$: Transitory, country-specific noise in year t.

2. Structure Specific to the Croatian Synthetic Control

Having introduced the general factor-model representation, we next explain how to construct the synthetic control for Croatia specifically. Lets, denote Croatia's country index by $c = 1$, and let $j = 2, 3, \ldots, 11$ index the ten donor countries (all EU peers except Croatia). And, we define a vector of nonnegative weights:

$$W = (w_2, w_3, \ldots, w_{11}), \qquad w_j \geq 0, \quad \sum_{j=2}^{11} w_j = 1.$$

These weights w_j will be chosen so that a weighted average of the donors' pre-treatment characteristics and outcomes closely matches those of Croatia.

A. Weighted Average of Donors' Outcomes: Consider the weighted average of the donor

[14]For the core mathematical explanation or logic behind the weight calculation for all cases, please check the Section 2 of Abadie, A., Diamond, A., Hainmueller, J. (2010). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program.

countries' no-treatment outcomes in a given year t:

$$\sum_{j=2}^{11} w_j\, Y_{j,t}^{N} \;=\; \sum_{j=2}^{11} w_j \Big[\; \underbrace{\delta_t}_{\text{common to all}} \;+\; \underbrace{\theta_t' \, Z_j}_{\substack{\text{observed covariates,}\\ \text{weighted by } \theta_t}} \;+\; \underbrace{\lambda_t' \, \mu_j}_{\substack{\text{unobserved common}\\ \text{factors}\times\text{loadings}}} \;+\; \underbrace{\varepsilon_{j,t}}_{\text{idiosyncratic shocks}} \;\Big]$$

Because δ_t, θ_t, and λ_t do not depend on country index j, we can pull them outside the weighted sum:

$$\sum_{j=2}^{11} w_j\, Y_{j,t}^{N} \;=\; \underbrace{\delta_t}_{\substack{\text{common to}\\ \text{all countries}}} \;+\; \underbrace{\theta_t'\Big(\sum_{j=2}^{11} w_j\, Z_j\Big)}_{\substack{\text{weighted average of}\\ \text{observed covariates}}} \;+\; \underbrace{\lambda_t'\Big(\sum_{j=2}^{11} w_j\, \mu_j\Big)}_{\substack{\text{weighted average of}\\ \text{donors' latent}}} \;+\; \underbrace{\sum_{j=2}^{11} w_j\, \varepsilon_{j,t}}_{\substack{\text{weighted}\\ \text{idiosyncratic shocks}}}$$

B. Choosing the Weights W: We select the weight vector W by solving an optimization problem that minimizes the distance between

- the weighted donors' covariate vector $\sum_{j=2}^{11} w_j\, Z_j$ and Croatia's covariate vector Z_{Croatia}, and
- the weighted donors' pre-treatment outcomes $\sum_{j=2}^{11} w_j\, Y_{j,t}$ and Croatia's pre-treatment outcomes $Y_{\text{Croatia},\,t}$ for $t < t^*$.

Concretely, we enforce

$$\sum_{j=2}^{11} w_j\, Z_j \;\approx\; Z_{\text{Croatia}}, \qquad \sum_{j=2}^{11} w_j\, \mu_j \;\approx\; \mu_{\text{Croatia}}.$$

By this construction, for each $t < t^*$ (the year Croatia joins the EU), the synthetic control $\sum_{j=2}^{11} w_j\, Y_{j,t}$ will closely replicate Croatia's own counterfactual $Y_{\text{Croatia},\,t}^{N}$. In other words, pre-treatment,

$$\sum_{j=2}^{11} w_j\, Y_{j,t} \;\approx\; Y_{\text{Croatia},\,t}.$$

C. Estimating the Treatment Effect: Once the optimal weights W are determined, we define the estimated "gap" or treatment effect for Croatia in year $t \geq t^*$ which leads us back to our equation 1, as:

$$\hat{\alpha}_{\text{Croatia},\,t} \;=\; \underbrace{Y_{\text{Croatia},\,t}}_{\substack{\text{actual observed}\\ \text{GDP per capita}}} \;-\; \underbrace{\sum_{j=2}^{11} w_j\, Y_{j,t}}_{\substack{\text{synthetic control's}\\ \text{GDP per capita}}} \quad .$$

Equivalently, writing $\hat{Y}^{\text{SC}}_{\text{Croatia},\,t} = \sum_{j=2}^{11} w_j\, Y_{j,t}$, leads us back to our equation 2:

$$\hat{\alpha}_{\text{Croatia},\,t} \;=\; Y_{\text{Croatia},\,t} \;-\; \hat{Y}^{\text{SC}}_{\text{Croatia},\,t}.$$

This difference captures the *causal effect of early EU accession* on Croatia's GDP per capita in each post-treatment year.

Appendix B: How does the Synthetic perform in the absence of Lithuania

As we saw from our analysis, when constructing Synthetic Croatia, Lithuania initially receives the largest weight—raising concerns about over-reliance on a single donor. However, to test robustness, we drop Lithuania and re-estimate the synthetic control. We find that the pre-treatment trends remain nearly unchanged, and Poland and Latvia take on larger weights (Table 4.1). Also, we see that, although the predictor-mean values (Table 3) shift slightly, the overall distance between Croatia and its synthetic counterpart for each covariate stays virtually identical, confirming that our results do not hinge on Lithuania alone.

Table 3: Predictor Means: Croatia, Synthetic, and Donor Pool Mean

Variable	**Croatia**	**Synthetic**	**Donor Pool Mean**
Lagged GDP per capita (1996)	7,857.72	7,654.29	10,233.79
Lagged GDP per capita (1999)	8,541.24	8,773.98	11,445.19
Lagged GDP per capita (2002)	10,061.69	9,985.28	13,023.85
FDI inflows (% of GDP)	4.06	4.35	5.42
Inflation rate (%)	4.89	5.74	6.06
Tax revenue (% of GDP)	22.70	22.27	24.29
Exchange rate depreciation (log points)	0.03	0.03	0.03
Employment rate (%)	29.54	29.35	33.15
Exports (% of GDP)	33.04	37.86	52.99
Labor force (% total population ages 15–64)	63.46	66.60	66.97
Consumption expenditure (% of GDP)	85.62	81.78	77.53

Table 4: Donor Country Weights and Predictor Weights

Table 4.1: Country Weights

Country	Weight
Cyprus	0.105
Czechia	0.047
Estonia	0.000
Hungary	0.000
Latvia	0.312
Malta	0.047
Poland	0.487
Slovak Republic	0.000
Slovenia	0.001

Table 4.2: Predictor Weights

Predictor	Weight
Lagged GDP per capita (1996)	0.188
Lagged GDP per capita (1999)	0.029
Lagged GDP per capita (2002)	0.027
FDI inflows (% GDP)	0.114
Inflation rate	0.081
Tax revenue (% GDP)	0.222
Exchange rate depreciation	0.067
Employment rate	0.184
Exports (% GDP)	0.086
Labor force participation rate	0.000
Consumption expenditure (% GDP)	0.000

Appendix C: Weights while checking Pre-tretment Fit

Table 5: Predictor Means: Croatia, Synthetic, and Donor Pool Mean

Variable	Croatia	Synthetic	Donor Pool Mean
Lagged GDP per capita (1997)	8,383.18	8,260.84	10,191.87
Lagged GDP per capita (1999)	8,541.24	8,624.37	10,913.67
FDI inflows (% of GDP)	3.82	3.08	5.26
Inflation rate (%)	5.35	6.90	7.00
Tax revenue (% of GDP)	23.16	20.66	23.82
Exchange rate depreciation (log points)	0.09	0.09	0.08
Employment rate (%)	29.30	37.00	33.05
Exports (% of GDP)	31.14	45.51	51.07
Labor force (% total population ages 15–64)	63.66	68.16	67.52
Consumption expenditure (% of GDP)	86.31	77.04	78.64

Table 6: Donor Country Weights and Predictor Weights

Table 5.1: Country Weights

Country	Weight
Cyprus	0.000
Czechia	0.000
Estonia	0.000
Hungary	0.000
Latvia	0.032
Lithuania	0.000
Malta	0.027
Poland	0.179
Slovak Republic	0.761
Slovenia	0.000

Table 5.2: Predictor Weights

Predictor	Weight
Lagged GDP per capita (1997)	0.063
Lagged GDP per capita (1999)	0.841
FDI inflows (% of GDP)	0.019
Inflation rate (%)	0.034
Tax revenue (% of GDP)	0.000
Exchange rate depreciation (log points)	0.033
Employment rate (%)	0.000
Exports (% of GDP)	0.008
Labor force (% total population ages 15–64)	0.001
Consumption expenditure (% of GDP)	0.000

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