# UKRAINE'S DCFTA WITH THE EU: TRADE EFFECTS OF ECONOMIC INTEGRATION

by

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Abstract

# TITLE UKRAINE'S DCFTA WITH THE EU: TRADE EFFECTS OF ECONOMIC INTEGRATION

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The thesis provides an ex-post econometric assessment of the Deep and Comprehensive Free Trade Area (DCFTA) between the EU and Ukraine, implemented from 2016, on bilateral trade. Using a panel dataset (2002–2021), two empirical approaches are applied: a gravity model of trade estimated by Poisson Pseudo Maximum Likelihood (PPML) with high-dimensional fixed effects, and Synthetic Counterfactual Methodology (SCM). Gravity model estimates indicate a significant association between the DCFTA and higher Ukraine-EU trade, with an observed increase of 27–29%, which exceeds typical free trade agreements. Even though less robustly, gravity results also suggest a possible asymmetric trade diversion effect, with signatories' imports shifting away from and exports increasing towards non-signatories. The SCM supports these findings, constructing synthetic counterfactuals for Ukraine-EU trade and estimating a consistent 23–24% increase in Ukrainian exports to the EU after the DCFTA. Results for Ukrainian imports from the EU are more sensitive to donor pool specification and are not robust in its magnitude but still indicate a positive effect. Overall, both methods indicate that the DCFTA is associated with substantially higher trade between Ukraine and the EU, aligning with economic theory and suggesting that deep integration measures beyond tariff reduction can yield considerable trade gains.

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LIST OF ABBREVIATIONS

**EU**. European Union.

**DCFTA**. Deep and Comprehensive Free Trade Area.

**CIS**. Commonwealth of Independent States.

**EAEU**. Eurasian Economic Union.

**CU EAEU**. Customs Union of the Eurasian Economic Union.

**CGE**. Computable general equilibrium.

**FTA**. Free trade agreement.

**MRT**. Multilateral resistance terms.

**PPML**. Poisson pseudo-maximum likelihood.

**SCM**. Synthetic counterfactual methodology.

**WTO**. World Trade Organization.

*Chapter 1*

# INTRODUCTION

In the post-WWII reality, the European Community and its adjacent institutions have been founded to be a unifying force for peace in Western Europe, linking the member countries by political and economic institutions. Since 1959, the European Community has expanded with a range of common institutions and policies: a customs union, a single market, common policies in fisheries and agriculture, an economic and monetary union, and a competition policy, among others. Besides institutions for economic cooperation and development, the EU is also integrated via political means which often makes it attractive for other countries striving to join the EU. These include supranational institutions for human rights, security, defense, environmental protection, etc. From a historical perspective, the European Union is considered an unprecedented and successful project to date which has "contributed to the advancement of peace and reconciliation, democracy and human rights in Europe"[1] but also has been a force for development and integration of countries which were a part of the camp aligned with the Soviet Union during the Cold War.

Besides the normative argument for stronger democratic institutions and integration with the family of European nations, there is an argument for deep integration for the substantially improved growth and productivity effects. According to the estimates of Campos, Coricelli and Moretti (2014), countries that joined the EU would, on average, have a per capita income 12 per cent lower than in the counterfactual scenario of not joining the EU.

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[1] NobelPrize.org. "The Nobel Peace Prize 2012." Accessed November 9, 2024. https://www.nobelprize.org/prizes/peace/2012/eu/facts/.

For Ukraine, the choice of pursuing the EU accession has been more than about mere economic calculation. In Ukrainian political reality, for a large part of its post-Soviet history, political discourse has revolved around two dichotomous paths: either the Russia-led Eurasian Economic Union or the European Union. Since the late 1990s, there has been some form of negotiations on accession agreement and free trade agreement between Ukraine and the EU. However, the progress was slow due to a lackluster cooperation from the Ukrainian side and the EU's reservations regarding Ukraine's rule of law. In 2012, the Association Agreement was finalized and initialed but not ratified by the EU leaders because of the cases of selective prosecution of political opponents by the Yanukovych regime.

After President Yanukovych's decision not to sign the European Union—Ukraine Association Agreement in November 2013, followed by Euromaidan protests, deadly clashes, removal of Yanukovych from office, and Russia's annexation of Crimea and occupation of Donbas, the path towards European accession has been defining framework for Ukraine's political and economic development trajectory.

After the Ukrainian Revolution of Dignity, in 2014, the EU—Ukraine Association Agreement was finally signed in 2015 and has been *broadly* applied since. Being a first step towards the EU accession, the Association Agreement allows the signatories to build closer links between each other. Among other things, it establishes the Deep and Comprehensive Free Trade Area (DCFTA) by gradually reducing bilateral tariff duties to zero for most of the product categories. The DCFTA has provisionally entered into force on 1 January 2016 and is effective since 1 January 2017. Right away, the agreement removed 98.1% of tariffs by the EU and 99.1% by Ukraine. While it aims to reduce all the tariff duties to zero, a few product categories in industrial and manufacturing sectors enjoyed transitional periods, tariff rate quotas were imposed on sensitive product categories like agriculture.[2]

Before 2014, Ukraine's main trading block was the Commonwealth of Independent States (CIS), which was established right after the dissolution of the Soviet Union. After the annexation of Crimea by Russia in 2014, and even before the implementation of the DCFTA, the EU has replaced the CIS as Ukraine's main trading partner both as an import origin and export destination (see Figure 1 and Figure 2). The Ukrainian exports to CIS economies have decreased more than imports from the same countries. A large portion of imports from the CIS were iron and steel, inorganic chemicals, and heavy machinery.

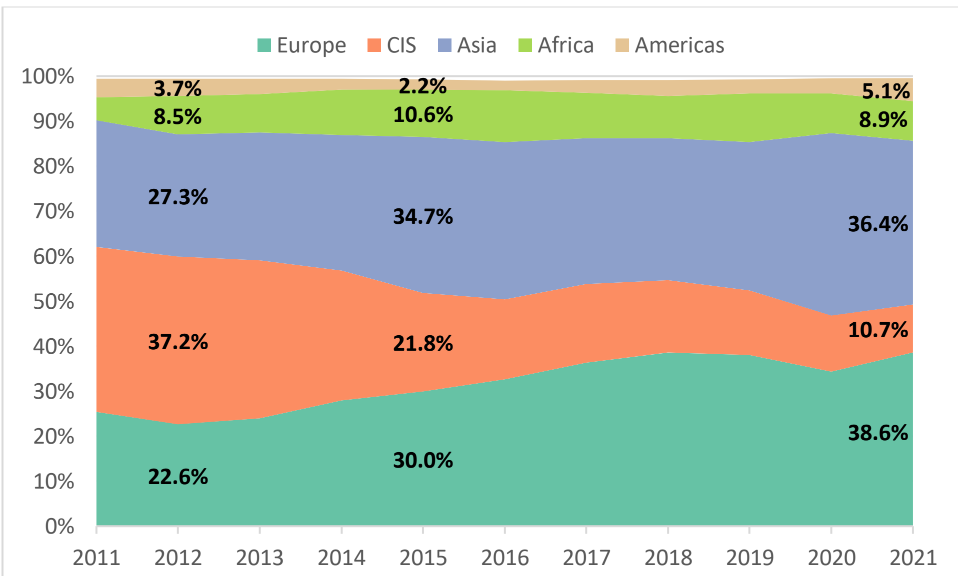


Figure 1. Breakdown of Ukraine's Goods Exports by Geographical Region

Source: Own presentation based on National Bank of Ukraine data.

[2] "EU-Ukraine Deep and Comprehensive Free Trade Area | Access2Markets," European Commission, accessed November 10, 2024, https://trade.ec.europa.eu/access-to-markets/en/content/eu-ukraine-deep-and-comprehensive-free-trade-area.

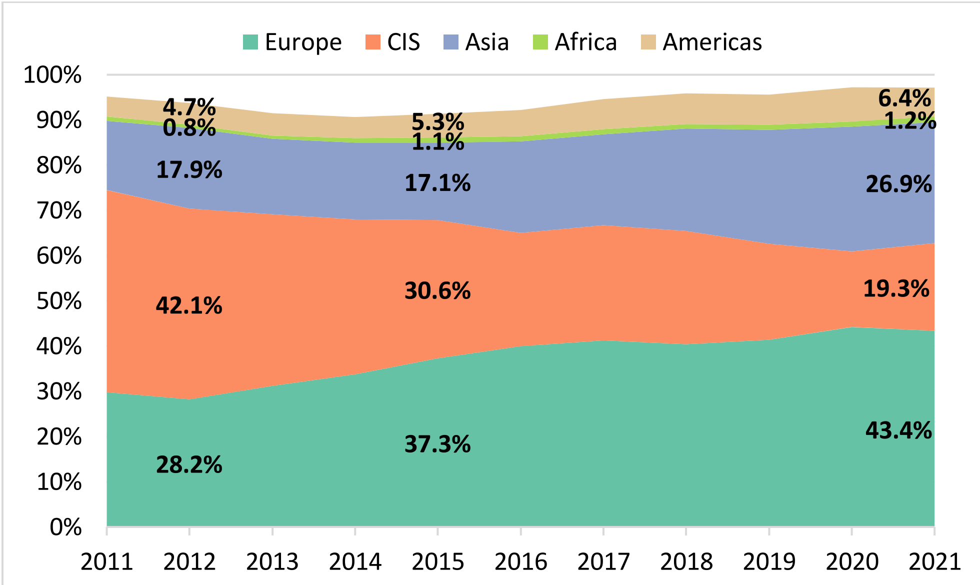


Figure 2. Breakdown of Ukraine's Goods Imports by Geographical Region
Source: Own presentation based on National Bank of Ukraine data.

This paper aims to provide a robust econometric assessment of the impact of the DCFTA implementation on Ukraine's and EU's trade flows. While there is enough literature that tries to estimate the potential effects of DCFTA on Ukraine's trade and welfare ex-ante, the ex-post assessments are limited. Therefore, this thesis tries to fill this gap in the literature using the gravity model of trade and synthetic counterfactual methodology.

The gravity model of trade is used to estimate the trade creation and trade diversion effects of the DCFTA. The gravity model of trade has become a standard framework for empirically estimating the bilateral trade flows and the impact of free trade agreements on trade. The idea initially was borrowed by analogy from Newton's law of universal gravitation which states that the force between two objects (countries) is directly proportional to their masses (GDP) and inversely proportional to the distance between them. While lacking theoretical underpinnings and microfoundations initially, the gravity trade equations have been integrated into theory-consistent modelling frameworks (Head and Mayer 2014).

The model in its simplest estimation form links bilateral trade flows to the GDP of trading partners, the distance between them and other dummy covariates representing determinants of trade frictions and facilitators (e.g., common language, former colonial ties, contiguity, common religion, common legal system, etc.), one of which is free trade agreements. Fixed effects are used to mitigate omitted variable bias. The estimation is used both on an aggregate level as well as to estimate effects industry-wise.

To provide a more robust estimation of the impact of DCFTA implementation on Ukraine's trade flows, the synthetic counterfactual methodology (SCM) is used. The SCM is a quasiexperimental comparative methodology introduced by Abadie and Gardeazebal (2003). It allows to construct a weighted synthetic control unit from a pool of other countries to estimate how the trade flows would have grown had the DCFTA not been implemented. In this thesis, I largely follow the novel approach used by Adarov (2023) to study the effects of European trade integration with Ukraine. The analysis both on aggregate and sectoral levels allows to identify temporal effects and heterogeneity between different industries. While Adarov (2023) focuses on trade between Belarus, Kazakhstan, and Russia, my analysis is a case study of Ukraine-EU integration which implies a focus on all trade flows between Ukraine and 28 EU members as units treated under the DCFTA.

That is, the use of two methodologies — the gravity model of trade and the SCM — is complementary. The former measures the average effects of the DCFTA for all relevant countries at once. The latter allows for more explicit capturing of trade effects over time and between pairs of countries.

The whole analysis in this thesis employs panel data on trade flows between countries. Both gravity regressions and synthetic counterfactuals are based on the same dataset that describes the year, a trade pair, volume of trade, and other relevant gravity variables which serve as covariates in the regression analysis and as predictors in the SCM analysis. The covariates include variables such as distance between trade partners, the GDP of exporter and importer, dummy variables for common language, common border, common legal system, etc.

Overall, the findings of trade effects estimated by gravity regressions and the synthetic counterfactual methodology yield similar results which are consistent with each other, with economic theory, and with ex-ante literature. A significant, positive, and internally robust trade creation effect is found as a result of the DCFTA between Ukraine and the EU.

The rest of the thesis is structured as follows. Chapter 2 presents an overview of the literature. Chapter 3 describes the gravity model of trade and the synthetic control method used in estimation. Data is described in Chapter 4. Chapter 5 presents the results of the estimation and provides a discussion of the findings. Chapter 6 concludes.

*Chapter 2*

# LITERATURE REVIEW

In this chapter, I provide a review of the existing literature with a focus on three areas relevant to the thesis: i) studies estimating the impact of Ukraine joining a free trade agreement, ii) the applications of gravity models of trade, and iii) synthetic counterfactual method applied to a similar context.

## 2.1. Prior Research on Ukraine-EU Trade Integration

There have been multiple endeavors to analyze the impact of Ukraine joining certain trading blocs. Since there was still a political discussion regarding which trade project Ukraine should join, the European Union or the Eurasian Economic Union, the relevant studies predating 2014 were largely focused on exploring the potential benefits from these two alternatives and different levels of integration.

One of the earliest attempts to quantify the possible economic effects of entering the EU was conducted using the computable general equilibrium (CGE) modeling in 2009, which was long before the political consensus on European integration in Ukraine was formed. The study by Maliszewska, Orlova, and Taran (2009) finds that deep integration with the EU would have resulted in 5.8% GDP gains which were expected to materialize over 10 to 15 years. The expected welfare gains, growth of real wages and expansion of international trade were also expected to be significant for Ukraine and much larger than for Armenia, Russia, Azerbaijan and Georgia. Of course, the results of any of the simulations and estimates depend on the assumptions made, and the authors acknowledge this. Specifically, it is difficult to estimate the effects of institutional harmonization with the EU, in which the integration of legal and business environments can have broader externalities on the level of trade which can be difficult to account for ex-ante.

Two studies compare the potential effects from integrating with the EU via DCFTA or joining the EAEU Customs Union with Russia, Belarus and Kazakhstan using CGE model based on the social accounting matrix (Movchan and Giucci 2011; Movchan and Shportyuk 2011). Regarding the DCFTA with the EU, their estimates are broadly aligned with the findings of Maliszewska, Orlova, and Taran (2009): the EU DCFTA is found to be preferred to the Customs Union with Russia, Belarus, and Kazakhstan as the aggregate welfare effects for the DCFTA are positive while for the Customs Union, they are negative. The same goes for trade. The DCFTA scenario showed that trade creation 8eginnts dominated while the Customs Union scenario showed the dominance of trade diversion over trade creation due to the need to increase Ukrainian tariff duties to the level of the Customs Union.

Pre-2014, Shepotylo (2010) studies the same question using gravity models of trade analyzing the period of 2001-2007. Based on historical data, the paper estimates the potential outcomes had Ukraine joined the EU in the 2004 EU enlargement wave. The results indicated that Ukraine would have benefited both from deeper integration with the EU and the Commonwealth of Independent States (CIS), which was before the Eurasian Economic Union was established in 2010. CIS then included Armenia, Azerbaijan, Kyrgyzstan, Moldova, Tajikistan, and Uzbekistan in addition to Belarus, Kazakhstan, and Russia. However, the estimated benefits from EU integration would have been higher.

Shepotylo (2013) extends this research given the updated reality of the newly established Customs Union of the Eurasian Economic Union in 2010. The paper suggests that the expected long-run gains in exports from Ukraine would have been 18% under the CU EAEU scenario, 36% under the EU DCFTA scenario, and 46% under the full EU accession scenario.

To summarize, all the ex-ante literature – while applying different methodologies, different sets of integration assumptions as well as studying different time frames – agrees on the dominance of trade creation effects from the DCFTA and on the fact that EU trade and economic integration scenario was strictly preferred over Russia-led Eurasian Economic Union. At the same time, there are acknowledged limits to these estimates since in reality the trade is conducted by specific businesses which make decisions to export/import based not only on tariffs but also on specific details of FTA implementation, standard harmonization, institutional and legal alignment and even cultural proximity. That is, the real effect of the DCFTA can be estimated only after it is implemented, and the gains are fully or partially realized.

### 2.2. Applications of Gravity Models in Trade Analysis

The gravity model of trade is a popular and established toolkit for analyzing the impacts of free trade agreements and other trade policy effects of geography, tariffs, subsidies, sanctions, immigration, etc. The model borrows its name from the analogy with Newton's universal gravitation law of gravitation which states that every two objects are attracted to each other with the force directly proportional to the product of their masses and inversely proportional to the square of the distance between them. A similar idea is applied to the trade flow, suggesting that the trade flows between two countries are directly proportional to the economic size (e.g., by GDP) of the two countries and inversely proportional to the distance between them. This empirical observation was first proposed by Tinbergen (1962). However, the initial applications were atheoretical. The first theoretical foundations for gravity equations were proposed by Anderson (1979) under the assumptions of product differentiation by place of origin and constant elasticity of substitution (CES) expenditures.

Later it was shown that the gravity model can arise from a wide range of theoretical frameworks. A more in-depth overview is provided by Yotov et al. (2016) which also outlines the main challenges in estimating the structural gravity model:

1) Multilateral resistance terms (MRTs). MRTs are theoretical constructs initially introduced by Anderson and Van Wincoop (2003), which are not observed directly in the data. The concept captures the idea that the resistance to trade depends not only on the trade barriers between two trade partners but also on barriers with all other countries. The modern consensus has been reached by using exporter-time and importer-time fixed effects to account for MRTs (Olivero and Yotov 2012).

2) Zero trade flows and heteroscedasticity of trade data. While both of these problems had proposed solutions like the Tobit or two-stage models for addressing the zero values in the trade flow data, or size-adjustment of the dependent variable – these approaches have their strong drawbacks. A more comprehensive approach of applying the Poisson Pseudo Maximum Likelihood (PPML) estimator to estimate the gravity model which addresses both problems at the same time, performs well, and has become an industry standard (Silva and Tenreyro 2006; Yotov et al. 2016).

3) Bilateral trade costs. The standard practice is to include a number of observable variables pertaining to relations between two countries which influence the ease of trade: distance, the existence of a common border, common language, colonial ties, trade agreements, etc.

Providing a popular and useful toolkit, gravity models of trade are actively used to estimate the effects of ex-post events. Korkmaz and Karacan (2024) analyze the regional impact of the Russian aggression against Georgia in 2008 and Western sanctions against Russia following the 2014 annexation of Crimea. Using trade gravity framework, they find a strong negative effect of 2014 sanctions, leading to a considerable decline in bilateral trade not only in the post-Soviet region but in trade with other regional trade partners such as the EU, China, Iran, and Turkey. These findings highlight the negative trade externalities of the Russian aggression on a broader region.

In a recent policy report commissioned by the National Board of Trade of Sweden, Söderlund (2024) investigates the trade effects of the DCFTA on Ukrainian trade with the EU using a gravity trade model. The report's estimates suggest that the DCFTA has more than doubled the EU-Ukraine trade flows which is an unusually strong effect compared to other free trade agreements which might require additional scrutiny due to the following methodological limitations. The author uses a dynamic difference-in-differences regression with coarsened exact matching for weighting. I, on the other hand, use a more conventional trade gravity model with relevant covariates (GDPs, distance, cultural proximity, etc.) included in the regression itself which serves a similar purpose in controlling for trade determinants. Moreover, my work expands on the report by analyzing trade on a more disaggregated level of industries (grouped HS2 codes) to get a nuanced understanding as the DCFTA rollout and tariff reduction was uneven in time for different sectors. Finally, the author of the report uses 2012 (when the AA treaty was initialed) as the11eginningg of a treatment period which has a danger of conflating the effect of the DCFTA with other fundamental factors affecting trade. Since the DCFTA was neither de jure nor de facto implemented until 2016, I will be using 2016 as a treatment period. Still, the report can be a useful reference to compare the estimated effects.

The detailed specification of the gravity model of trade estimated in this thesis is provided in Chapter 3.

## 2.3. Applications of Synthetic Counterfactual Method

Synthetic Counterfactual Methodology (SCM) is a quasiexperimental strategy for estimating the causal impact of certain historical events or policy interventions. The original paper by Abadie and Gardeazabal (2003) investigates the impact of political terrorism in the 1970s in the Basque Country on its GDP per capita. Building on the same idea, papers by Abadie, Diamond, and Hainmueller (2010) and by Abadie, Diamond, and Hainmueller (2015) investigate the causal impact of California's tobacco control program on tobacco consumption and the economic impact of the 1990 German reunification on Western Germany. These papers demonstrate the causal inference power of the SCM in different comparative settings.

In a typical case, we have a time series for a treated unit and a number of untreated units (donor pool). In the classic examples above, the units are either Spain's region, of which the Basque Country is a treated unit, the US states, of which California is a treated unit, or countries similar to Germany, of which Western Germany is a treated unit. The authors then obtain a weighted average of untreated units such that its time series closely corresponds to the pre-treatment period of the treated unit. In Abadie, Diamond, and Hainmueller (2010), authors construct a synthetic California as a weighted average of 5 states which were chosen from the donor pool of 38 states which did not introduce any major tobacco regulation in the period of interest. Thus, synthetic California closely replicates the smoking prevalence values of real California before the regulation was introduced. After the tobacco regulation is introduced, the synthetic control and observed California diverge. The difference between them reflects the estimated effect of regulation akin to a difference-in-differences approach. The

SCM is useful in the case of a small number of observations when other matching methods have limited applicability.

Since the methodology is relatively new, its application in international trade literature is limited. Billmeier and Nannicini (2013), for example, employ the SCM to identify the causal link between trade liberalization episodes and economic growth. The method allowed the authors to address the persistent challenge of endogeneity by accounting for the time-varying unobservable confounders. In this paper, the authors find that there is indeed a link between economic liberalization and its impact on the trajectory of real income per capita. At the same time, the benefits of liberalization are found to be higher for countries which liberalized before the 1990s.

The paper by Adarov (2023) uses the methodology on which this thesis relies. In the paper, the author uses a two-stage approach to quantify the impact of economic integration of Belarus, Kazakhstan and Russia within the Eurasian Economic Union (EAEU). The first step is trade gravity equation estimation which estimates the impact on both aggregate and sector levels. The second step uses the SCM to identify the effect of integration on trade over time. This, for instance, allows not only to identify the average effect for the post-treatment period, but also to identify the change in trade creation/diversion effects over time. This is particularly useful when the treatment is on a rolling basis, i.e. dependent on specific implementation and harmonization of legal and regulatory standards.

The specifics of the SCM approach to estimate dynamic trade effects of the DCFTA used in this thesis are laid out in Chapter 3.

*Chapter 3*

# METHODOLOGY

The methodological approach is twofold. First, we estimate the gravity model of trade, using which I will analyze the bilateral trade flows as a function of relevant determinants of trade such as economic size, distance between trading partners, cultural, linguistic, geographical commonalities, political commonalities, etc. The model will include a binary variable taking value 1 for the trading partners belonging to the DCFTA and will capture the effect associated with Ukraine and the EU bilaterally lowering tariff duties and harmonizing standards.

The second step employs synthetic counterfactual methodology. The SCM as a quasiexperimental tool helps to assess the causal effect of an intervention, an intervention being the introduction of the DCFTA. The SCM is applied on both aggregate and industry levels making it possible to estimate possible industry specific heterogeneity as well as impact over time. Both steps in the estimation strategy allow for robustness checks.

## 3.1. Gravity Model of Trade

The gravity of trade methodology takes its roots since the early 1960s when Tinbergen noticed a stylized fact that larger economies which are closely located tend to trade with each other more (Tinbergen 1962). Since his naïve and atheoretical application, the gravity of trade has developed and found its solid theoretical foundation which emerges from a multitude of theoretical frameworks as demonstrated by Arkolakis, Costinot, and Rodríguez-Clare (2012). They showed that many international trade theories can deliver basically the same gravity equation: Armington-CES (Anderson 1979; Bergstrand 1985; Anderson and Van Wincoop 2003), Heckscher-Ohlin (Bergstrand 1989, 1998; Deardorff 1998), monopolistic competition model (Krugman 1980; Bergstrand 1989), heterogeneous firms frameworks (Helpman, Melitz, and Rubinstein 2008; Chaney 2008; Melitz and Redding 2014), and others. That is, the gravity of trade paradigm became both theoretical and gained microfoundations.

The estimation methods have also evolved in this context. As first shown by Feenstra (2004) and Redding and Venables (2004), the importer and exporter fixed effects can be used to capture the multilateral resistance terms which are present in theoretical models of trade. Its rapid adoption and becoming a state-of-the-art approach have coined it as "the MR/fixed effects revolution" (Head and Mayer 2014). Use of country-year and country-pair (dyadic) fixed effects allows us to capture time-invariant as well as time-variant attributes associated with each trade flow.

Time-invariant attributes include each country's relative position in the global trading network, including barriers of trade, trade attractiveness, systemic features like infrastructure, remoteness and other potentially unobserved relative trade barriers.

Time-variant fixed effects would capture other time-specific changes like global shocks, terms-of-trade shocks, including some changes that are not included explicitly in the estimation. Such changes could be accession to certain international organizations like the WTO or a specific place in the business cycle, which impacts the volume of trade. Therefore, inclusion of fixed effects reduces the omitted variable bias and captures the multilateral resistance terms.

The trade gravity literature also discusses the potential challenges associated with trade flow data and estimation of gravity equations (Yotov et al. 2016). Main challenges include zero-trade flows as a large share of countries often does not trade with each other and heteroskedasticity of trade data. As Silva and Tenreyro (2006) demonstrate using Monte Carlo simulations, the log-linearized OLS in the presence of heteroskedasticity delivers highly misleading results. Instead, they propose the use of Poisson Pseudo Maximum Likelihood (PPML) estimator and show that it results in correct and theoretically consistent estimates. Also, the authors showed that the specification test suggests that PPML is the only adequate estimator for estimating structural gravity equations. Since then, the PPML estimator has become a standard in the gravity of trade literature. Therefore, unlike Poisson regression, PPML relaxes assumption on equidispersion (variance equaling to the mean), naturally handles zero observations, unbiased under heteroskedasticity, and can be applied to continuous data.

In this thesis, the gravity of trade equation to be estimated takes the following form:

$$\mathrm{T_{ijt}} = \beta_0 + \beta_1 \mathrm{BothDCFTA_{ijt}} + \beta_2 \mathrm{ImpDCFTA_{ijt}} + \beta_3 \mathrm{ExpDCFTA_{ijt}} + \beta_4 \mathrm{GDP_{it}} + \beta_5 \mathrm{GDP_{jt}} + \mathrm{BX_{ijt}} + \alpha + \varepsilon_{\mathrm{ijt}}, \quad (1)$$

where $\mathrm{T_{ijt}}$ is the trade flow from country $i$ to country $\mathrm{j}$ in period $\mathrm{t}$.

**BothDCFTA** is a dummy variable, =1 if both countries are signatories of the DCFTA (i.e. if one of the countries is Ukraine and the other is an EU member), =0 otherwise. That is, one country must be Ukraine and the other must be an EU member. The dummy is equal to zero if at least one of the countries is not part of the DCFTA or two countries are the EU members. This way, the dummy would capture the trade creation effect between Ukraine and the EU.

**ImpDCFTA** is a dummy variable, =1 if importer is a DCFTA signatory (i.e. either Ukraine or EU member), =0 otherwise. This variable would capture a potential change in aggregate export volume of the EU and Ukraine to the rest of the world. If the coefficient on this variable would be negative, it would imply the existence of trade diversion effect associated with the DCFTA which is often the case with FTAs.

**ExpDCFTA** is a dummy variable, =1 if exporter is a DCFTA signatory (i.e. either Ukraine or EU member), =0 otherwise. Thus, this variable would capture the change in import of the EU and Ukraine from the rest of the world associated with the DCFTA.

Since the DCFTA came into force provisionally since 2016, these three dummies are in play only for the years 2016-2021 and are always zero for the years before 2016.

$\mathbf{GDP_{it}}$ and $\mathbf{GDP_{jt}}$ are GDPs (in current thousands USD) of exporting and importing countries, respectively, at period $\mathrm{t}$.

$\mathbf{X_{ijt}}$ is a vector of other relevant canonical gravity dummy covariates: common border dummy, common language, common legal system, historical colonial relationship, free trade agreement between two countries. $\mathrm{B}$ is a corresponding vector of coefficients.

$\boldsymbol{\alpha}$ is a set of high-dimensional fixed-effects: exporter-time, importer-time, and exporter-importer FEs, which would – in line with the literature – capture both time-variant and time-invariant unobserved variation.

$\boldsymbol{\varepsilon_{ijt}}$ is an iid zero-mean error term.

The standard practice is to estimate the clustered errors by the trading pair (exporter-importer clustering).

To ensure robustness, it is a standard practice to provide multiple variations of model specifications. All three estimated models use the following combination of fixed effects: Exporter-Year FE, Importer-Year FE, and Exporter-Importer FE.

First, the parsimonious model is estimated which includes the dummy variables related to the effects associated with the DCFTA ($BothDCFTA_{ijt}$, $ImpDCFTA_{ijt}$, $ExpDCFTA_{ijt}$) and capture the trade creation and trade diversion effects as well as dummy for all free trade agreements registered in the WTO ($FTA_{ij}$) and the log of distance between trading country pair.

Then, two additional extended model specifications are estimated. The second one adds relevant controlling standard gravity covariates to the model: logs of GDP of each country in a trading pair, dummy variables for common border, language and colonial history.

The third model extends the first parsimonious model by adding also sectoral fixed effects which control for unobserved variation associated with trade by sectors.

### 3.2. Synthetic Counterfactual Methodology

The synthetic counterfactual methodology (SCM) developed by Abadie and Gardeazabal (2003), Abadie et al. (2010), and Abadie et al. (2015) is applied for further analysis of the impact of the DCFTA on EU-Ukraine trade. The general idea of the method is to compare the observed outcome of a treated unit with the hypothetical (synthetic) counterfactual unit. In our study, unit is represented by each trade flow, so the treated units are Ukraine-EU and EU-Ukraine trade flows. The synthetic counterfactual outcome is calculated as a weighted average of non-treated trade flows such that its pre-treatment outcome and predictors closely follow observed treated outcome. This way, the post-treatment divergence between observed (treated) and synthetic (untreated) outcomes would signify the effect of the DCFTA (treatment).

The SCM description below is largely based on the paper on the SCM implementation as an R package, Synth (Abadie, Diamond, and Hainmueller 2011) and Adarov (2023).

### 3.2.1. Nested Optimization Problem

The SCM constructs a synthetic control by optimally weighting multiple control units (trade flows) unaffected by the DCFTA. These control units, when weighted, together mimic the pre-DCFTA characteristics of the treated trade flows (Ukraine-to-EU and EU-to-Ukraine trade flows). Formally, consider a set of J+1 trade flows in our dataset, where trade flow 1 represents the treated unit (i.e., Ukraine-EU trade flow). The units 2 to J+1 together constitute a "donor pool" of non-treated trade flows which is used to construct a synthetic control by weighting them optimally. Thus, the counterfactual trade flow $Y_{1t}^{C}$ is estimated as a weighted combination of the control units:

$$Y_{1t}^{C} = \sum_{j=2}^{J+1} w_j Y_{jt} \,, \tag{2}$$

where $Y_{1t}^{C}$ is an unobserved counterfactual trade flow for the treated unit in the absence of the DCFTA; $Y_{jt}$ is the trade flow for control unit $j$ at time $t$. The weights $w_j$ are non-negative and sum up to one:

$$\sum_{j=2}^{J+1} w_j = 1 \tag{3}$$

The weights are chosen to minimize the distance between the synthetic unit and the treated unit in terms of pre-treatment (2002-2015) trade flows and other relevant predictors (gravity variables).

Simply put, we want to find such a synthetic weighted unit which would minimize a) the distance between the treated unit and the synthetic control in terms of predictors, and b) the mean squared prediction error (MSPE) between the treated unit and its synthetic counterpart in the pre-treatment period. This forms a nested optimization problem which is solved computationally using the Synth package in R (Abadie, Diamond, and Hainmueller 2011).

That being said, the nested optimization is comprised of inner and outer optimization subproblems.

1) In **inner optimization**, for a given weighting scheme $V$ over predictor variables, we find the vector of donor weights $W^*(V)$ that minimizes the distance between the treated unit and the synthetic control in terms of predictors:

$$W^*(V) = \arg\min_{W}(X_1 - X_0W)'V(X_1 - X_0W)\,, \tag{4}$$

where $X_1$ is the vector of pre-treatment predictor values for the observed (treated) trade flow;

$X_0$ is the matrix of the predictor values for the donor pool trade flows;

$V$ is a diagonal positive semidefinite matrix which assigns importance to each predictor values. In *Synth* package, it is by default chosen using data-driven procedure (see outer optimization below) which minimizes the mean squared prediction error (MSPE) of the outcome variable (volume of trade flow) over the pre-intervention period. Positive semidefiniteness ensures that the weights are non-negative.

2) In **outer optimization**, we choose the predictor weight matrix $V^*$ which minimizes MSPE between the treated (observed) trade flow and the synthetic (unobserved and untreated) trade flow in the pre-treatment period (2002-2015):

$$V^* = \arg\min_{V} \sum_{t\in[2002,2015]} \left( Y_{1t} - \sum_{j=2}^{J+1} w_j^*(V) Y_{jt} \right)^2 \qquad (5)$$

or as it is often presented in matrix form:

$$V^* = \arg\min_{V\in\mathcal{V}} \big(Z_1 - Z_0 W^*(V)\big)' \big(Z_1 - Z_0 W^*(V)\big), \qquad (6)$$

where $\mathcal{V}$ is a set of all positive semi-definite matrices; $Z_1$ is a vector of outcome variables for treated (observed) trade flow in pre-treatment period; $Z_0$ is a matrix of outcome values for donor units in pre-treatment period. $W^*(V)$ is chosen in inner optimization step in expression (4).

After the numerical optimization finds optimal weights $W^*$ and $V^*$, the impact of the treatment (DCFTA) can be found as a difference between the synthetic counterfactual outcome and observed treated outcome in the post-treatment period: $\alpha_t = \mathrm{Y}_{1t}^C - Y_{1t}$.

### 3.2.2. Donor Pool Formation

In the context of SCM, the donor pool is the collection of units (trade flows) which were not affected by the treatment (DCFTA). When forming a donor pool, there are considerations which need to be considered:

- *Contamination of donor pool.* The critical assumption of SCM is that donor units are not affected by the intervention. Therefore, I exclude units which have been influenced by the EU trade liberalization policy. This removes trade flows of most of the European countries, including the EU countries and Ukraine.
- *Similarity of donor pool to the treated unit*. Since synthetic control will serve as a hypothetical untreated unit, the donor pool should be similar to the treated unit in terms of pre-intervention characteristics. This is partly achieved by the inner optimization subproblem described above, which minimizes pre-treatment predictor values, see Equation (4).
- *Donor pool size*. Abadie and Gardeazabal (2003) warn against a possible interpolation bias as a form of overfitting. Simply put, "it is technically possible to get the closest fit with a large number of donor units each having a very small weight" (Adarov 2023). To alleviate this problem, Abadie and Gardeazabal suggest to limit the donor pool to a subset of units which are sufficiently similar to the treated unit. At the same time, the donor pool should not become too small.

This being said, I follow the following steps to form a donor pool:

1) To ensure that the synthetic control is constructed from the trade flows unaffected by the DCFTA, I remove all the dyads (country pairs) which involve either EU or Ukraine. These trade flows are likely directly or indirectly to have been affected by the DCFTA between EU and Ukraine.

2) Then, once direct trade flows involving the EU and/or Ukraine are excluded, I limit the donor pool by geography close to Ukraine. Namely, I include all European non-EU countries, former Soviet Union countries (except Ukraine), and EU candidate countries.
3) Finally, to prevent interpolation bias (overfitting), I restrict the donor pool further by selecting only those units whose mean average pre-treatment trade volume is within two standard deviations of the treated unit's pre-treatment average. This step is aimed at excluding trade flows which are too economically dissimilar to EU-Ukraine trade flows.

For the robustness check, I also run an alternative specification, in which the donor pool is limited only by step 1 (removal of the dyads involving the EU countries and/or Ukraine) and step 3 (restriction by the mean average pre-treatment trade).

### 3.2.3. Predictors

The gravity of trade framework offers a natural choice of predictor variables. As in the gravity equations, the following set of predictors is used in the synthetic control specification: GDP of the origin country, GDP of the destination country, distance between trading partners, dummies for common border, common language, and common legal system. When there is not enough of variation in dummies (particularly, in the specification with geographical restrictions), the dummy variables are dropped from predictors.

*Chapter 4*

# DATA

The data for analysis in this thesis is sourced from CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) which provides data on yearly bilateral trade flows as well as a gravity dataset which includes important trade covariates. The dataset spans for the period 2002-2021 which provides enough coverage for both pre-treatment and post-treatment periods.

The trade flow dataset is based on data from BACI dataset provided by CEPII. BACI dataset in turn is based on the UN Comtrade data. While, in principle, trade flow from country $i$ to country $j$ should be the same when reported by either $i$ or $j$, often it is not the case for two main reasons: 1) according to the Incoterms, import values must be reported as CIF (cost, insurance and freight) while export values should be reported as FOB (free on board); 2) discrepancies in data can be caused by mistakes or shadow underreporting. CEPII estimates transport and insurance rates, removes them from import values. Then, authors estimate the reliability of reported data using weighted variance analysis and adjust values by giving higher weight to a more reliable reporter (Gaulier and Zignago 2010).

This period is chosen since it, on the one hand, provides enough observations for reliable coefficient estimation in the regression and, on the other hand, the chosen period provides a manageable size of dataset maintaining computational feasibility. Gravity regressions rely on heavy datasets and often take a lot of time to compute so this is a significant point of consideration. Also, the trade dataset used in this thesis provides trade data in a standard nomenclature of the Harmonized System (HS). However, there have been multiple revisions of this standard over the last thirty years: each version introduces or removes certain goods categories, sometimes uniting them. To maintain the product classification consistency, the data for the whole period must be in the same edition of the HS. One of such revisions was conducted in 2002 (HS02). Thus, CEPII provides the trade flow dataset for the period 2002-2023 in HS02 goods nomenclature.

At the same time, I do not include years which cover the post-2022 Russian invasion. This has been an extensive external shock to the trade due to logistic and production disruptions and damage alongside with changed terms of trade between Ukraine and the EU. Since the direct and indirect effects of the Russian full-scale invasion as well as other additional wartime policy interventions could mislead the results, they are excluded from the estimation, leaving 20 years of observations (2001-2022), six of which are post-treatment periods (2016-2021).

Over the period covered in this thesis, the EU-Ukraine trade flows have experienced significant fluctuations, driven by economic shocks and influences of different nature (Figure 3 and Figure 4). Both Ukrainian imports from and exports to the EU historically peaked in 2008, after almost a decade of strong economic growth and development. In late 2008-2009, the global financial crisis hit Ukraine's economy exceptionally hard. The world commodity prices and world demand plummeted, Ukrainian commodity-centered exports have almost halved. Similarly, Ukrainian domestic demand entered a recession which was much deeper compared to most neighboring countries due to macroeconomic imbalances, weak banking system and currency crash.

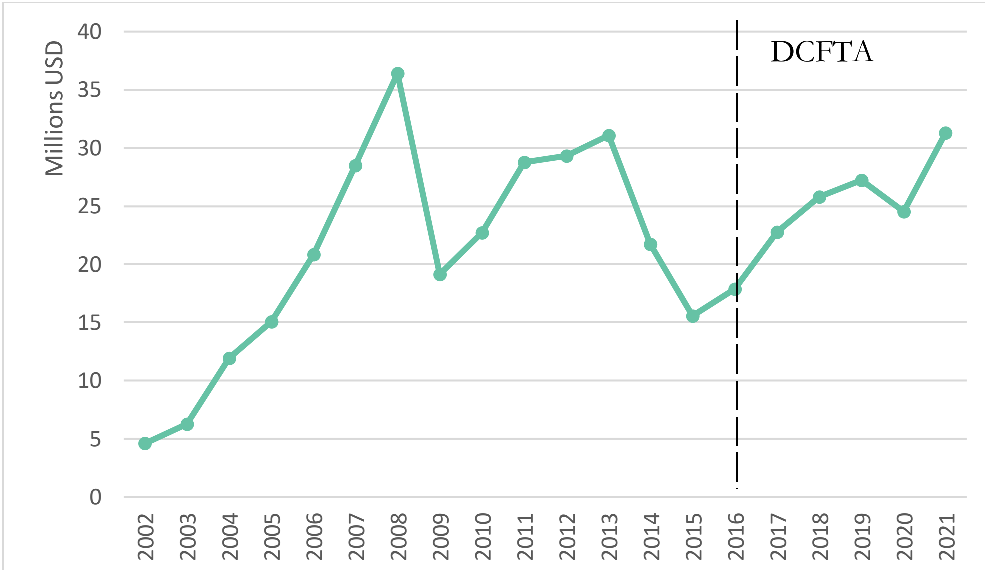


Figure 3. Trade flows from the EU to Ukraine, millions of current USD.
Source: own calculations based on CEPII data.

Before being hit by another 2014-2015 recession as a result of the Russia's invasion of Ukraine's East and annexation of Crimea, Ukrainian international trade flows stagnated largely due to weak domestic economic performance as well as weaker global demand which had trouble recovering after the global financial recession.

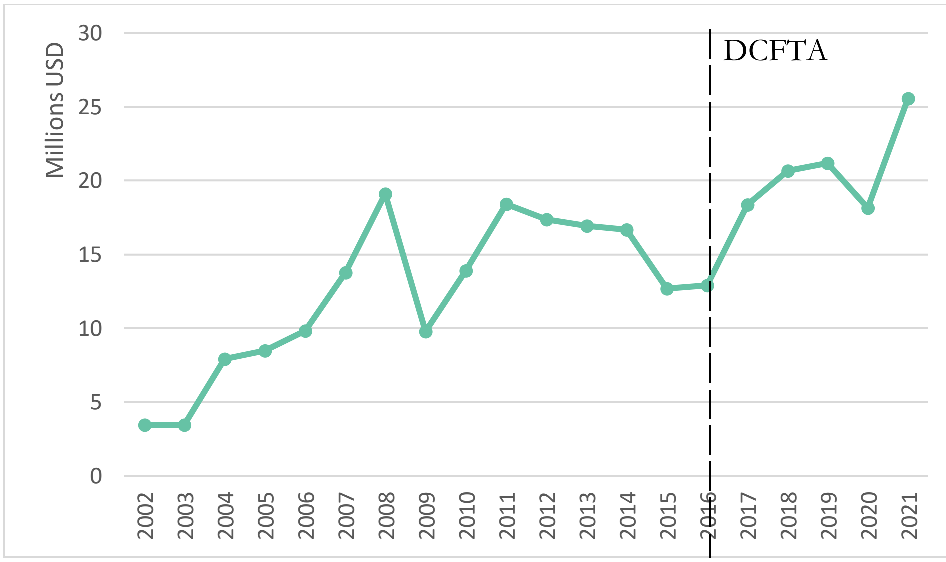


Figure 4. Trade flows from Ukraine to the EU, millions of current USD.
Source: own calculations based on CEPII data.

After years of stagnation, Ukraine's trade with the EU grew significantly following the entry into force of the DCFTA in 2016, with notable increases in both imports from and exports to the European Union between 2016 and 2021.

After cleaning the dataset and removing the countries/territories for which GDP statistics is not available in the gravity dataset (such as Syria, Iran, North Korea and some microstates), the dataset contains the trade flows between 188 countries and territories.

By attaching gravity variables to the trade flow data, I obtain a panel data for years 2002-2021, descriptive statistics for which are presented in Table 1 for continuous variables and in Table 2 for dummy variables.

Table 1. Descriptive statistics of continuous variables in the trade gravity dataset (pooled)

| | count | mean | std | min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| **volume (‘000 current USD)** | 3984799 | 43.6 | 531 | 0 | 0.009 | 0.170 | 2.905 | 116254 |
| **distance (km)** | 3984799 | 6826.17 | 4484 | 8.0 | 3035 | 6294 | 9690 | 19819 |
| **gdp_o (mln current USD)** | 3984799 | 517.558 | 1317.592 | 0.015 | 21.830 | 110.205 | 386.428 | 17734 |
| **gdp_d (mln current USD)** | 3984799 | 426.991 | 1212.967 | 0.015 | 13.148 | 58.539 | 306.143 | 17734 |

Table 2. Descriptive statistics of binary (dummy) variables in the trade gravity dataset

| | count | mean | std |
|---|---|---|---|
| **contiguity** | 3984799 | 0.034 | 0.181 |
| **comlang** | 3984799 | 0.156 | 0.363 |
| **comlegal** | 3984799 | 0.265 | 0.441 |
| **col_depend** | 3984799 | 0.017 | 0.131 |
| **eu_o** | 3984799 | 0.254 | 0.435 |
| **eu_d** | 3984799 | 0.207 | 0.405 |
| **fta_wto** | 3984799 | 0.219 | 0.413 |
| **both_dcfta** | 3984799 | 0.004 | 0.060 |
| **exporter_dcfta** | 3984799 | 0.260 | 0.438 |
| **importer_dcfta** | 3984799 | 0.210 | 0.407 |

Data includes trade flows in thousands of US dollars (***volume***), standard binary variables for common border (***contiguity***), common language (***comlang***), common legal system (**comlegal**), historical colonial relationship (***col_depend***), GDPs (***gdp_o*** and ***gdp_d*** for origin and destination countries, respectively), EU membership (***eu_o*** and ***eu_d***), existence of FTA between two trading partners as registered by the WTO (***fta_wto***).

Three binary variables are added to the dataset for the purpose of this study:

- ***both_dcfta*** is equal to 1 if two trading partners are part of the DCFTA agreement. That is, one country must be Ukraine and the other must be an EU member. The dummy is equal to zero if at least one of the countries is not part of the DCFTA or two countries are the EU members. This way, the dummy would capture the trade creation effect between Ukraine and the EU.
- ***exporter_dcfta*** is equal to 1 if only the exporter is a signatory to the DCFTA, otherwise the dummy variable is equal to 0. This variable would capture a potential change in aggregate export volume of the EU and Ukraine to the rest of the world. If the coefficient on this variable would be negative, it would imply the existence of trade diversion effect associated with the DCFTA which is often the case with FTAs.
- Similarly, ***importer_dcfta*** is equal to 1 if only the importer is a part of the DCFTA agreement. Otherwise, it is equal to 0. Thus, this variable would capture the change in import of the EU and Ukraine from the rest of the world associated with the DCFTA.

Since the DCFTA came into force provisionally in 2016, these three dummies are in play only for the years 2016-2021, and are always zero for the years before 2016.

Table 3 reports the decomposition of total variance in continuous variables into variation between trade pairs and variation within trade pairs over time. The dominance of within-variation (77.2%) in the dependent variable, trade volume, supports the use of fixed effects. This suggests that most of the variation in the volume of trade comes from the variation within each dyad (trade pair) rather than across different trade flows. The employment of exporter-time, importer-time, and dyad (exporter-importer) fixed effects, which together help to control for both time-varying, country-specific shocks (like policy changes, crises, GDP changes, etc.) as well as time-invariant dyad-specific factors. Such an approach helps to absorb both observable and unobservable confounders, allowing for a more credible estimation of the trade effects of the DCFTA.

Other explanatory variables in the table include distance between trade partners and GDPs of exporters and importers. As expected, distance shows virtually no within-dyad variation because distance between trade partners mostly doesn't change in our time frame. For GDPs, the between variation dominates as there is a large dispersion of countries by economic size but the national GDPs do not vary so much from period to period – economically smaller countries generally remain small, and economically larger countries remain large.

Table 3. Panel variance decomposition of continuous variables in the trade gravity dataset

| | Total variation | Between variation | Within Variation | Share of between variation | Share of within variation |
|---|---|---|---|---|---|
| **volume ('000 current USD)** | 281474 | 64140 | 217334 | 22.8% | 77.2% |
| **distance (km)** | 20109958 | 20109410 | 549 | 100% | 0% |
| **gdp_o (current USD)** | 1736049 | 1393213 | 342835 | 80.3% | 19.7% |
| **gdp_d (current USD)** | 1471290 | 1210600 | 260690 | 82.3% | 17.7% |

*Chapter 5*

# ESTIMATION RESULTS

## 5.1. Gravity Model of Trade

In this section, I present the estimation results for the gravity model of trade. For a robust estimation of trade creation and trade diversion effect, Table 4 provides multiple versions of the estimated gravity model of trade. All model specifications are estimated via PPML with the exporter-importer, importer-year, and exporter-year fixed effects and dyadic trade pair clustering, which controls for multilateral resistance terms and variation in standard errors along different trade flows between countries.

The first column provides the results for a parsimonious model. The second column provides estimates for a model extended with more gravity covariate variables like common border, language, and historical colonial relationship. The third column also augments the aggregate country-level gravity equation by including – and thus controlling for – sector-specific fixed effects.

The overall estimated coefficients are found to be as expected. In particular, I find a large positive and statistically significant trade creation effect (captured by $BothDCFTA$ variable) which is around threefold higher than an average trade creation effect of free-trade agreements (captured by the $FTA$ variable). In other words, the Deep and Comprehensive Free Trade Agreement is found to be associated with the increase in trade between Ukraine and the aggregate EU by 26-29% over 2016-2021. At the same time, the associated effect estimated based on a variable capturing the free trade agreements registered in the WTO is an additional 9% of trade creation between FTA signatories.

The trade diversion effects (captured by the $ImpDCFTA$ and $ExpDCFTA$) are less robust to the model specification as they are statistically significant only in the second specification. Still, the trade diversion effect is found to be asymmetrical along import versus export dimensions. The model estimates suggest a decrease in imports to Ukraine and the EU from the rest of the world and the increase in exports from Ukraine and EU to the rest of the world.

Table 4. Estimation results for gravity regressions

| | PPML country-level | PPML country-level | PPML pooled sectoral |
|---|---|---|---|
| $BothDCFTA_{ij}$ | 0.267* | 0.287· | 0.267* |
| | (0.128) | (0.170) | (0.129) |
| $ImpDCFTA_{ij}$ | -0.214 | -0.388*** | -0.215 |
| | (0.145) | (0.106) | (0.145) |
| $ExpDCFTA_{ij}$ | 0.054 | 0.291** | 0.055 |
| | (0.147) | (0.107) | (0.146) |
| $FTA_{ij}$ | 0.087*** | 0.091*** | 0.088*** |
| | (0.023) | (0.028) | (0.023) |
| $GDP_{ij}, log$[3] | | 7.882 | |
| | | (30192) | |
| $GDP_{ij}, log$ | | 14.387 | |
| | | (122590) | |
| $Distance_{ij}, log$ | -6.314*** | -1.167*** | -6.292*** |
| | (1.477) | (0.061) | (1.476) |
| $Border_{ij}$ | | -0.240 | |
| | | (0.192) | |
| $Language_{ij}$ | | 0.480** | |
| | | (0.148) | |
| $Colonial_{ij}$ | | 1.097*** | |
| | | (0.264) | |
| Exporter-Year FE | Yes | Yes | Yes |
| Importer-Year FE | Yes | Yes | Yes |
| Exporter-Importer FE | Yes | Yes | Yes |
| Sector FE | | | Yes |
| Adj. Pseudo-$R^2$ | 0.99 | 0.972 | 0.99 |
| Observations | 464,060 | 464,060 | 464,060 |
| Clustering | Yes | Yes | Yes |

Note: Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '·' 0.1 ' ' 1

[3] The standard errors for GDP variables are large due to high collinearity with the exporter-year and importer-year fixed effects, rendering the coefficients uninformative. However, since they have not reached a required threshold to be automatically dropped by the estimation software, I included them in the table for transparency.

Other included gravity covariates exhibit an expected behavior: larger distance between trade partners is associated with less trade, common language and common colonial relationship facilitate trade.

From the economic perspective, the DCFTA is found to be a very beneficial free trade agreement which boosts the trade between Ukraine and the EU much more than a generic conventional free trade agreement usually does. This is particularly noteworthy in light of the additional non-tariff measures which accompanied the Ukraine-EU Association Agreement. These included standard harmonization, reduction of non-tariff barriers, alignment of the Ukrainian laws and institutions with the EU acquis as well as deepening of cultural and social links between Ukraine and EU after 2014.

The asymmetry in trade diversion effects between imports and exports can imply an important effect of the DCFTA. The decrease in imports from the rest of the world can imply a shift towards intra-DCFTA trade while the increase in exports to non-DCFTA countries can suggest improved productivity of firms within DCFTA countries. For example, firm productivity can be driven by inputs which became cheaper because of the DCFTA. However, the productivity effects of the DCFTA on firms need further research. Such results would align with desirable theoretical outcomes of a deep trade agreement which would improve technology transfer, market access and productive performance.

From a policy perspective, the results suggest that deeper economic integration via regulatory harmonization and institutional alignment (as they were prescribed by the integration measures in AA/DCFTA) can yield substantial trade gains.

### 5.2. Synthetic Counterfactual Analysis

In this section, I provide the results of Synthetic Counterfactual Methodology (SCM) application to the aggregate trade flows between the EU and Ukraine. The SCM is used to identify effect of the DCFTA on Ukrainian imports from and Ukrainian exports to the EU.

To establish internal validity of an approach and provide better robustness of the effect estimates, I apply the SCM with two donor pool specifications: the first donor pool specification has a restriction on countries by geographical location similar to the Ukrainian one (Figure 5 and Figure 7); the second donor pool relaxes geographical restriction to include all countries in the dataset (Figure 6 and Figure 8). Other donor pool selection rules described in section 3.2.2. still apply — avoiding donor pool contamination by excluding all trade flows involving either Ukraine or EU member states, and restricting the pool by having mean average pre-treatment trade volume within two standard deviations of the treated unit's pre-treatment average. The figures below show actual treated outcome (solid line) and synthetic counterfactual trade flows (dashed line). The treatment year is 2016, denoted by a vertical line.

The constituents of each synthetic counterfactual and their corresponding weights are presented in tables in the Annex.

For further robustness check, I conduct the placebo tests results of which are presented in the Annex. The SCM procedure is applied on all the units in the donor pool and the gaps between the observed trade flows and synthetic counterfactuals are compared. The idea is to see that, in principle, all gaps for untreated (non-DCFTA) trade flows should follow a normal distribution centered around zero in the post-treatment period. If the synthetic counterfactual for the unit in question (trade flows between Ukraine and EU) lies on the outskirts of the distribution, it would suggest that the estimated effect is identified and not due chance.

### 5.2.1. Ukrainian exports to the EU

For Ukrainian exports to the EU, the SCM analysis shows a consistent and robust increase in trade volumes over the post-treatment period of 2016-2021. For a donor pool restricted to European and post-Soviet countries (Figure 5), the increase in trade volume is +23%.[4] For an unrestricted donor pool (Figure 6), the trade volume increases by 24%.

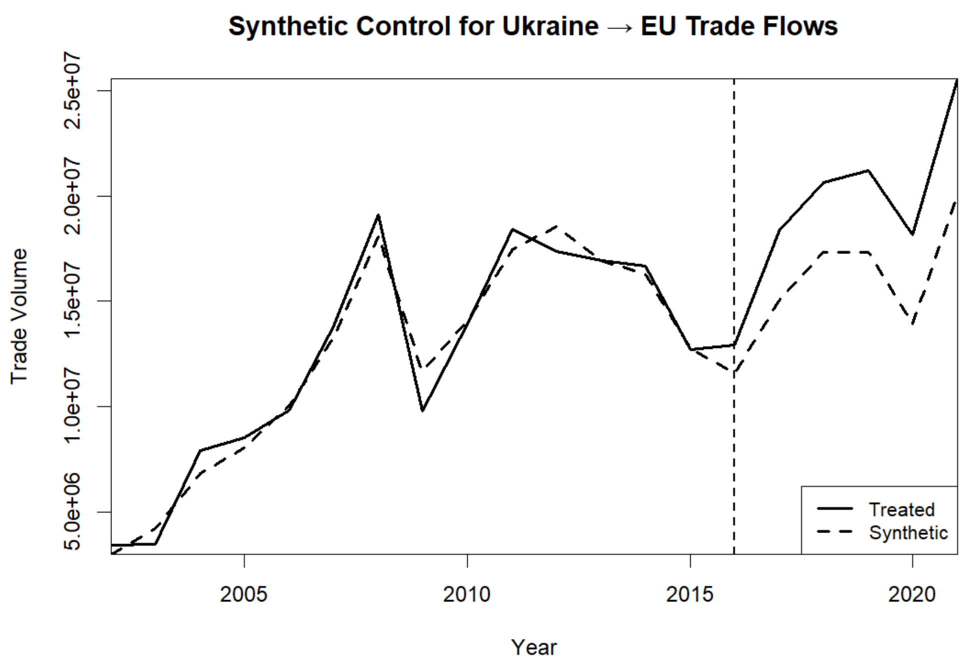


Figure 5. Synthetic counterfactual results for Ukrainian exports to the EU (with geographic restriction on donor pool)

[4] When referring to changes in trade volume, I refer to the percentage by how much the treated (observed) trade volume over the post-treatement period (2016-2021) is higher than a synthetic counterfactual over the same period. The change in trade corresponds to the area between two lines (treated and synthetic) for period 2016 to 2021.

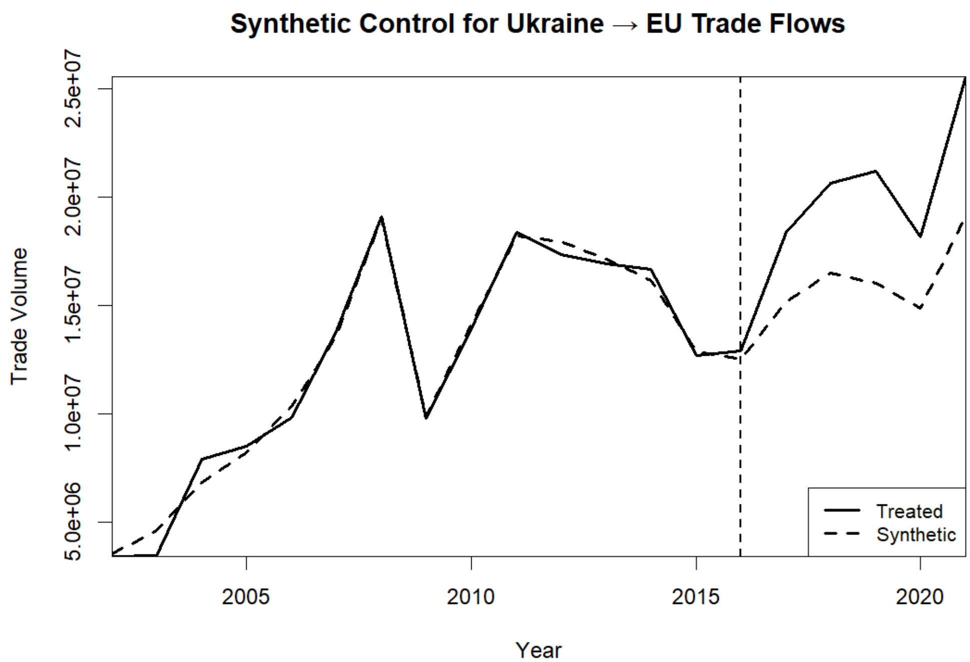


Figure 6. Synthetic counterfactual results for Ukrainian exports to the EU (without geographic restriction on donor pool)

These results suggest a strong trade creation effect caused by the implementation of the DCFTA between Ukraine and the EU.

### 5.2.2. Ukrainian imports from the EU

When the same SCM procedure is applied to Ukrainian imports from the EU, the algorithm fails to converge and find a synthetic counterfactual under the donor pool geographic restriction, as can be seen in Figure 7.

As discussed in Chapter 4, the volume of Ukrainian imports has been historically highly volatile and idiosyncratic. This can explain why strictly limited donor pool can fail in producing a synthetic counterfactual which captures the pre-treatment observed trade flow dynamics well. In other words, countries in a smaller donor pool do not sufficiently resemble Ukraine to construct a reliable counterfactual.

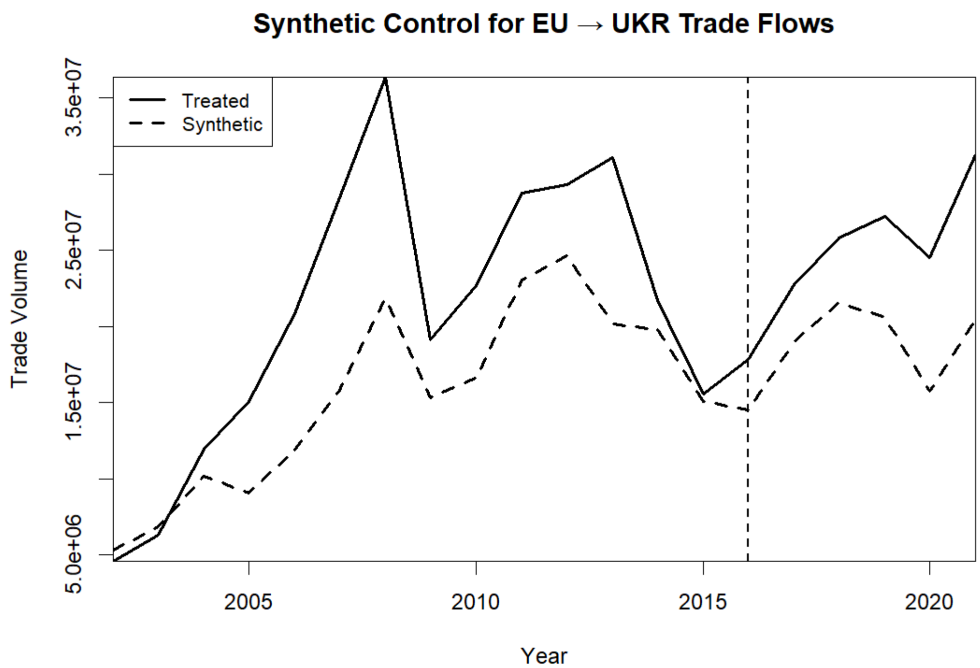


Figure 7. Synthetic counterfactual results for Ukrainian imports from the EU (with geographic restriction on donor pool)

However, when the donor pool restriction is relaxed, the SCM algorithm results in a much better pre-treatment fit of a synthetic counterfactual (Figure 8). The resulting estimate suggests an increase in trade flows of +71%. These results should be interpreted with caution due to the risk of an overfitting bias. While I confirm the robustness of a trade creation effect with respect to Ukrainian imports from the EU, the directionality of the effect in all specifications is positive, consistent with prior estimates and economic expectations.

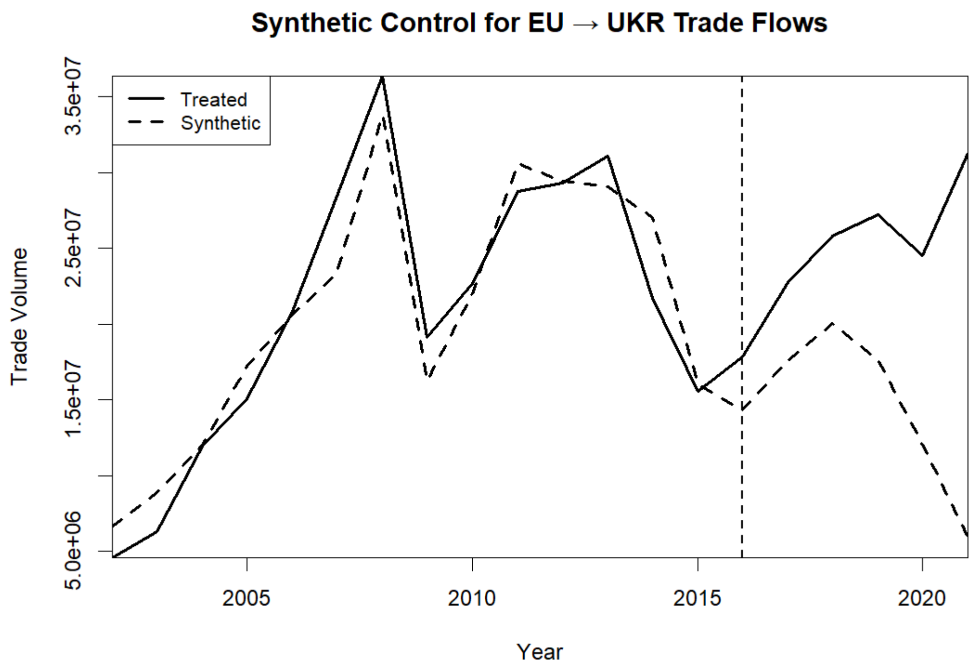


Figure 8. Synthetic counterfactual results for Ukrainian imports from the EU (without geographic restriction on donor pool)

*Chapter 6*

# CONCLUSIONS

This thesis analyzes the trade effects associated with Ukraine's trade integration with the EU in form of the Deep and Comprehensive Free Trade Area (DCFTA) which has been rolled out since 2016. To this end, the study relies on a set of two empirical methodologies – gravity of trade regressions and the synthetic counterfactual methodology. Both approaches link the implementation of the DCFTA with a significant increase in trade between Ukraine and the European Union.

The results of the gravity estimation provide robust evidence of the trade creation effect of 27-29% associated with the DCFTA. This is almost three times higher than the associated average trade creation effect of other free trade agreements registered in the WTO. The gravity of trade results are broadly aligned with the ex-ante literature: for example, the paper of Shepotylo (2013), which also relied on gravity framework, estimated the expected long-run gains in Ukrainian exports of 36%.

The gravity model also suggests an asymmetric trade diversion effect. While the significance of the results is inconclusive across different model specifications, their directionality is consistently asymmetric. The DCFTA is associated with a decrease in imports of the DCFTA signatories (i.e. EU members and Ukraine) from the rest of the world. At the same time, DCFTA is statistically linked to the increase in exports from the DCFTA signatories to the rest of the world. This can be explained by a potential shift towards intra-DCFTA trade and increased firm productivity because of DCFTA. However, the effect of DCFTA on firm productivity can be a matter of further research.

The quasi-experimental nature of the synthetic counterfactual methodology (SCM) allows not only to corroborate the gravity estimates but also to identify causal effects (i.e. controlling for general equilibrium effects). For Ukrainian exports to the EU, the synthetic control approach estimates a consistent and robust post-treatment increase in trade volume by 23-24%. For Ukrainian imports from the EU, results were more sensitive to donor pool composition: no valid synthetic control could be constructed under restricted donor pool conditions due to highly idiosyncratic volatility in volume of pre-treatment import flows. Under a relaxed donor pool, the SCM finds imports increased by approximately 71%, although this estimate should be interpreted with caution due to potential overfitting.

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APPENDIX

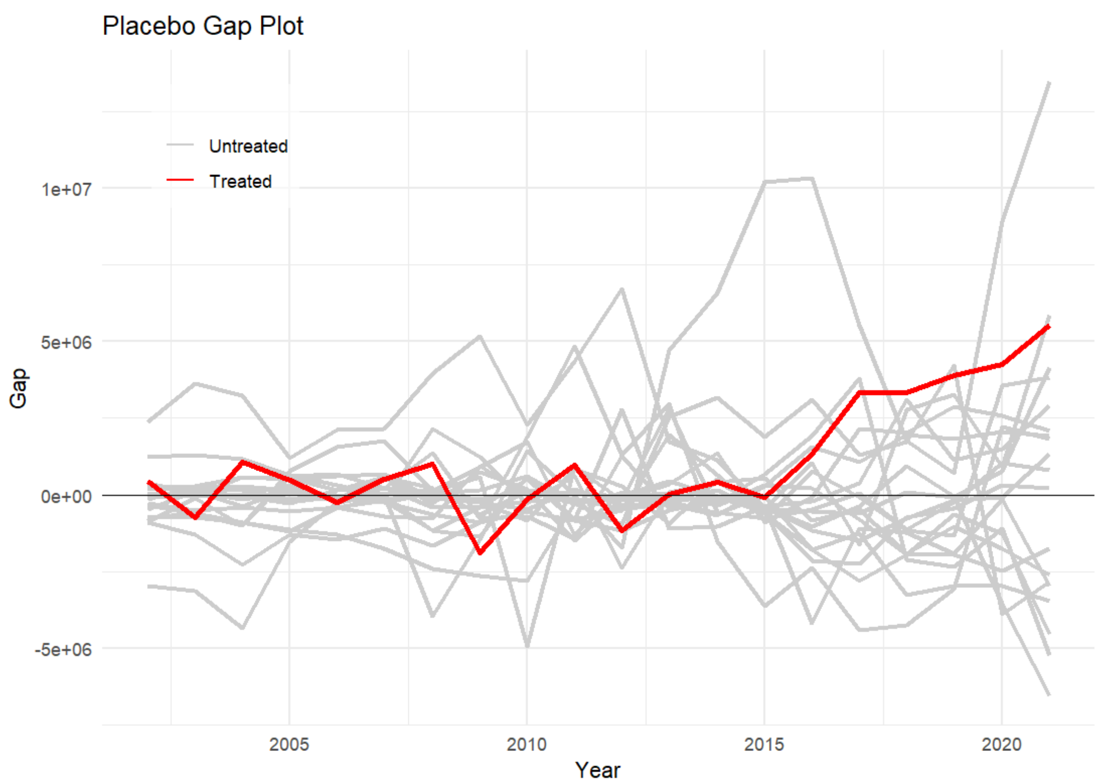


Figure 9. Placebo test for a synthetic counterfactual of Ukrainian exports to the EU (donor pool limited by European and post-Soviet countries only)

Table 5. Constituents of the synthetic counterfactual of Ukrainian exports to the EU (donor pool limited by European and post-Soviet countries only)

| Exporter-Importer | Weights |
|---|---|
| Russia – Türkiye | 0.633 |
| Russia – Belarus | 0.275 |
| Russia – Kazakhstan | 0.4092 |

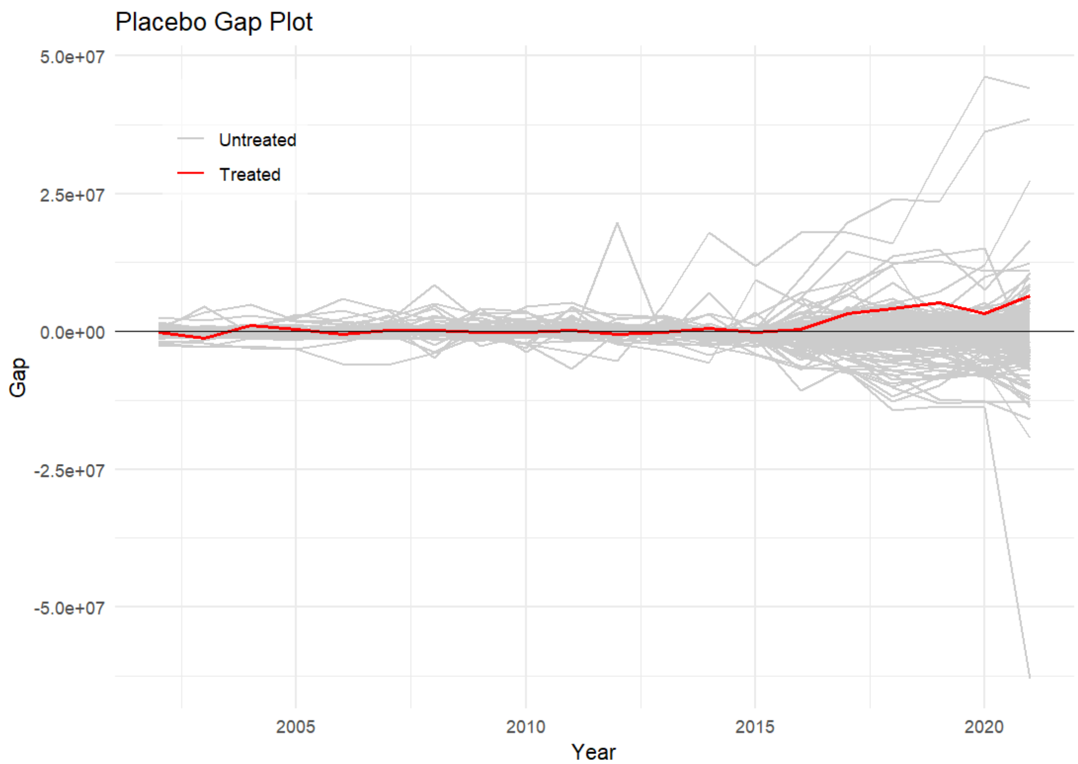


Figure 10. Placebo test for a synthetic counterfactual of Ukrainian exports to the EU (donor pool geographically unrestricted)

Table 6. Constituents of the synthetic counterfactual of Ukrainian exports to the EU (donor pool geographically unrestricted)

| Exporter-Importer | Weights |
|---|---|
| Japan – Russia | 0.426 |
| Japan – Singapore | 0.133 |
| Thailand – China, Hong Kong | 0.133 |
| Russia – Türkiye | 0.112 |
| Russia – Belarus | 0.086 |
| China – Vietnam | 0.052 |
| Saudi Arabia – Bahrain | 0.030 |
| Russia – Kazakhstan | 0.026 |
| Philippines – China | 0.001 |

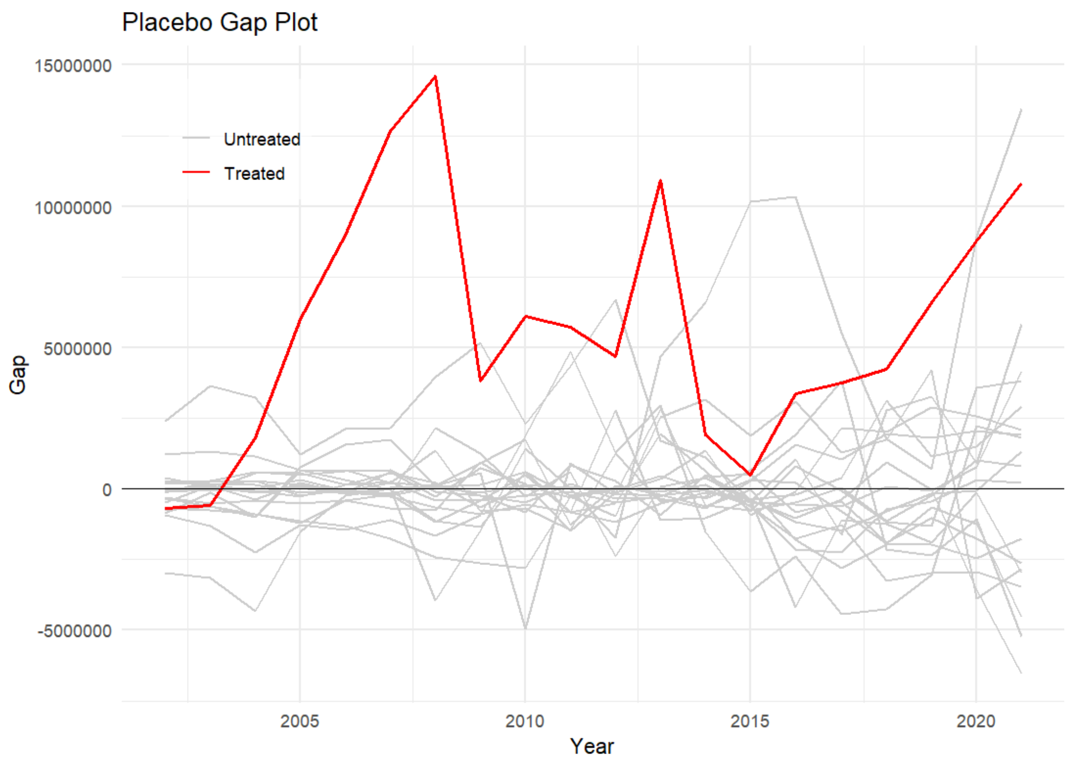


Figure 11. Placebo test for a synthetic counterfactual of Ukrainian imports from the EU (donor pool limited by European and post-Soviet countries only)

Table 7. Constituents of the synthetic counterfactual of Ukrainian imports from the EU (donor pool limited by European and post-Soviet countries only)

| Exporter-Importer | Weights |
|---|---|
| Belarus – Russia | 1.000 |

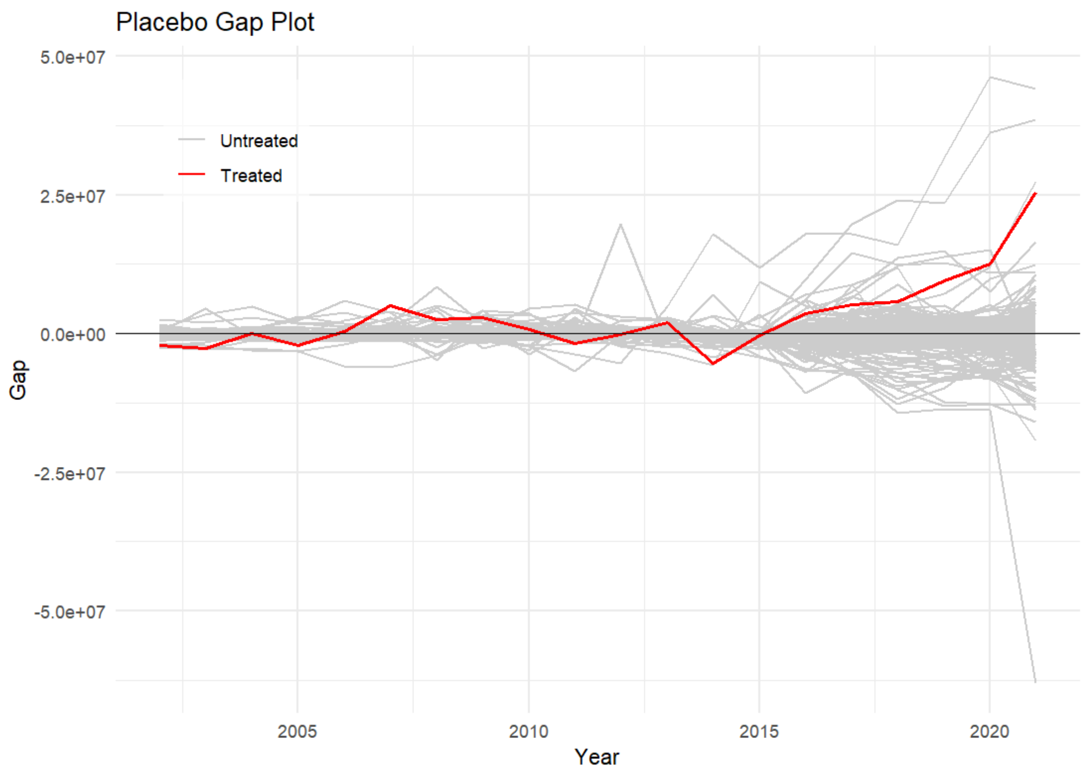


Figure 12. Placebo test for a synthetic counterfactual of Ukrainian imports from the EU (donor pool geographically unrestricted)

Table 8. Constituents of the synthetic counterfactual of Ukrainian imports from the EU (donor pool geographically unrestricted)

| Exporter-Importer | Weights |
|---|---|
| United Arab Emirates – Japan | 0.515 |
| Thailand – Australia | 0.361 |
| Japan – Russia | 0.090 |
| Saudi Arabia – Jordan | 0.035 |