Bachelor's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Economics

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EU membership and Economic Growth

Bachelor's thesis in Economics
Supervisor: Hildegunn Ekroll Stokke
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Preface

This paper is dedicated to our Bachelor's degree program at the Department of Economics, at the Norwegian University of Science and Technology. We would like to thank our supervisor, Hildegunn Stokke, for her guidance throughout the writing process.

Abstract

EU membership is a relevant and debated topic nowadays, due to conflicts, unrest and other major challenges in the world. This paper investigates the relationship between EU membership and economic growth, in terms of GDP growth and GDP per capita. In order to study the correlation between the two, two economic models are estimated: a Difference In Differences model used to investigate if countries becoming EU members achieve higher GDP per capita than countries outside EU, as well as a Multiple Linear Regression model used to explore the channels through which EU membership possibly affect GDP growth. The data used for the analysis´s is retrieved from the World Bank. Our theoretical framework is mainly built upon three trade models, namely the Ricardian Model, the Melitz Monopolistic Competition Model and the Free Trade and Efficiency Model, as well as neoclassical theory of economic growth. The results from the regressions are unclear. The coefficients in the MLR have little significance, and there are some surprising (but, insignificant) results, such as foreign direct investment and education having negative effect on GDP growth. Nonetheless, some of the predictions from the analysis align with the theoretical framework, particularly when it comes to trade. The results from the DiD-analysis suggest that EU members have a significantly higher GDP per capita growth compared to countries outside of EU. However, there is no evidence that the higher growth is resulting from membership.

EU-medlemskap er eit relevant og debattert tema no om dagen, grunna konflikt, urolegheit og andre store utfordringar i verda. Denne studien undersøker samanhengen mellom EU-medlemskap og økonomisk vekst, i form av BNP-vekst og BNP per innbyggjar. For å kunne studere korrelasjonen, har det blitt estimert to økonometriske modellar: ein “Difference In Differences”-modell for å kunne sjå på om land som har blitt EU-medlem oppnår høgare BNP per innbyggjar enn land utanfor EU, samt ein “Multiple Linear Regression”-modell, for å finne ut kva potensielle kanalar EU-medlemskap påverkar BNP-vekst gjennom. Dataa som er brukt i analysen er henta frå Verdsbanken. Det teoretiske rammeverket er i hovudsak basert på tre handelsmodellar, nemleg den Ricardianske modellen, Melitz sin monopolistiske konkurransemodell, og frihandels- og effektivitetsmodellen. I tillegg har nyklassisk økonomisk teori om økonomisk vekst blitt nytta. Resultata frå regresjonane er tvetydige. Koeffisientane i MLR-en har lite signifikans, og det er nokre overraskande, men framleis insignifikante, resultat. Dette er til dømes ein estimert negativ effekt på BNP-vekst av utdanning og investering. Nokre av prediksjonane kan likevel bli forklart av teorien, spesielt med omsyn på handel. Når det kjem til DiD-analysen viser det seg at EU-medlem har signifikant høgare BNP per innbyggjar, enn land utanfor EU. Likevel er det ikkje noko bevis for at denne høgare veksten er på grunn av medlemskapet.

Table of content

Introduction

Europe's current economic climate has been rocked by a series of extraordinary shocks, including the pandemic and the energy crisis triggered by the Russian invasion of Ukraine. The US election and Donald Trump's threats that he will reduce the support to European countries has further increased the focus on unity in Europe. Moreover, the continent is struggling to overcome high inflation, while striving to ensure robust and environmentally sustainable long-term growth. Consequently, European economies have experienced a slowdown in recent years, with weak productivity emerging as a central issue. In the light of this context, the potential growth effects the EU can offer through economic integration has piqued our interest, leading us to write an empirical piece on the impact of EU membership on economic growth. Today, the EU has 10 candidate countries for membership, including Ukraine and Georgia (European Commission, n.d.). The EU enlargement in 2004, when 10 new member countries joined (EUR-Lex, 2007), is used as a reference point. The following research question will be discussed: ***What is the relationship between EU membership and economic growth?***

To answer the research question, it is crucial to understand the channels through which the EU can foster economic growth. Our theoretical framework encompasses a presentation of the aggregate production function for economic growth. Furthermore, the role of investment, labor, and productivity in economic growth is put forward, with a particular focus on trade within the latter. The trade theories included in the paper consist of the Ricardian Model, the Melitz Monopolistic competition model, and the model of Free Trade and Efficiency. Lastly, there will be an overview of the EU's economic union, common market, and customs union.

The paper is organized as followed: the initial section provides a presentation of the existing theoretical and empirical framework relevant to our analysis. The next section presents empirical data retrieved for the analysis, a clear and precise description of how the regression was run, and reasoning behind why we selected this procedure. The third section encompasses an explanation of the variables used in the models and descriptive statistics.The following section presents the regression analysis, consisting of a Multiple Regression Analysis (MLR) and a Difference In Differences (DiD) model. Thereafter, the findings from the study will be discussed in the context of the theoretical framework. Lastly we address any shortcomings or areas of critique in the paper, before reaching the conclusion. In closing, a comprehensive list of all sources used in the paper will be presented.

Theory

Economic Growth

Economic growth is defined as an increase in the gross domestic product (GDP), representing the value of everything that is created or produced within a country in a given period, usually a year or a quarter The measurement of GDP is often expressed "per capita" to adjust for variations in population size among different countries, or as the “growth rate” to indicate GDP's change over time (Holden, 2016, p. 45). This paper will use GDP growth as the dependent variable in the Multiple Linear Regression analysis (MLR) and GDP per capita as the dependent variable in the Difference In Differences-analysis (DiD).

According to neoclassical economic theory, economic growth primarily depends on three factors: productivity, physical capital, and human capital per capita. These factors can be illustrated using an aggregate production function for a country, where the production Y in the economy depends on the productivity parameter, A, and the production function F(K,hN). K denotes the quantity of physical capital,while hN represents the quantity of effective labor input, where h is the level of human capital per worker, and N the quantity of labor. The production function essentially shows how much output Y can be produced combining these inputs. The aggregate production function further illustrates how the combination of this function and the economy's productivity, denoted as A, drives economic growth. Mathematically, the relationship between productivity, physical capital, human capital per capita, and economic growth can be expressed as: $Y = AF(K, hN)$. When considering capital per capita, K can be expressed as kN, where k represents capital per worker. Thus, the production function becomes: $Y/N = AF(k, h)$, showing that output per worker depends on the levels of capital per worker and human capital (Holden, 2016, p. 456).

Investment and Physical Capital

As illustrated in the aggregate production function, the output Y typically increases as the input factors increase. As a result, many countries that increase physical capital through savings and investments have been awarded with GDP growth. With better tools and equipment, workers can produce more output per unit of time, leading to higher overall production levels. Additionally, physical capital, including infrastructure such as roads and communication networks, facilitate trade, reduces transportation costs, and connects markets, thereby promoting economic activity. Investment in physical capital also attracts domestic and foreign investment, supports human capital accumulation, and has a multiplier effect on the economy by creating demand for goods and services, creating jobs, and stimulating further consumption and investment.

Moreover, the high productivity and highly qualified workers contribute to the profitability of the investment of physical capital. A very important prerequisite for high investment rates and following economic growth is therefore good and stable framework conditions for the business sector and official facilitation such as required and transportation and qualified workforce (Holden, 2016, p. 457).

Human Capital

Economic growth is also positively influenced by human capital, as highlighted in the aggregate production function. Human capital, in this context, refers to the quality of the labor force (Holden, 2016, p. 458). Education and qualifications play a crucial role in human capital development; better-educated workers tend to be more productive, thus contributing to economic growth (Holden, 2016, p. 460). Additionally, they are often more innovative and adaptable to economic changes, promoting resilience and stability. In countries where there is a significant gap between the skills of job seekers and the requirements of employers, equilibrium unemployment tends to be high because employers struggle to find qualified labor (Holden, 2016, p. 173).

Productivity

Productivity also plays a crucial role in driving economic growth within the aggregate production function. The most significant factor contributing to economic growth is technological advancement, which stimulates productivity, leading to more cost-effective production. Technological advancements improve productivity by allowing businesses to produce more output using the same amount of resources. This increased productivity results in higher GDP, fosters innovation, and creates new opportunities for job creation and market expansion, thus driving sustained economic growth (Holden, 2016, p. 460).

It is evident that economic growth hinges on the availability of production factors: physical capital, human capital, and technology, as well as the effectiveness of these elements within the economy. To gain a deeper understanding of these mechanisms, it is crucial to consider the underlying forces at play. Examples of these are rule of law and property rights, democracy and public institutions, culture, trust, and social capital, as well as issues of growth and inequality. However, this paper will limit its focus to the significance of well-functioning markets, more specifically trade (Holden, 2016, p. 465-469).

Trade

Trade between nations has been instrumental in increasing productivity and allowing for the exchange of goods and services. Additionally, trade facilitates the division of labor and specialization, enabling workers and companies to focus on tasks they excel at, while also benefiting from economies of scale. Furthermore, trade serves as a channel for spreading technological advancements and accessing larger markets, which in turn increases sales and makes large investments more profitable. These factors collectively contribute to higher productivity, creating opportunities for sustained economic growth (Holden, 2016, p. 466).

Several trade theories have been developed to understand the relationship between trade and productivity, including the Ricardian Model, the Melitz Monopolistic Competition Model, and the Free Trade and Efficiency Model. These theories vary in their assumptions, and therefore grasp different aspects of the trade effect.

Ricardian model

The Ricardian model predicts that countries will benefit from trade by specializing in the production of goods in which they have a comparative advantage (Roland, 2016, p. 150). A country has a comparative advantage in the production of a certain product when its opportunity cost of producing that product is lower than in other nations, allowing it to produce more efficiently relative to other goods (Krugman et al., 2018, p. 54). The Ricardian model simplifies comparative advantage to differences in labor productivity alone, which clarifies trade patterns by showing how countries specialize in producing goods where they are most efficient, leading to mutually beneficial trade.

In a basic Ricardian model involving two countries, Home and Foreign, and two goods, milk and bread, with labor as the sole factor of production and perfect market competition, the production possibilities illustrate the maximum value an economy can achieve by producing the maximum amount of goods, constrained by available resources (Krugman et al., 2018, p. 55). Mathematically, this relationship can be illustrated by the equation: $L \geq a_{LM}Q_M + a_{LB}Q_B$, where a_{LM} is the labor input needed to produce 1 unit of milk at Home, a_{LB} represents the equivalent for bread. The notation “*” refers to the foreign market. Q represents the quantity produced.

The production possibility frontier illustrates the trade-off between production of the two goods and is represented by the graph with a slope = $a_{LM/}a_{LB}$. The home market is illustrated graphically below.

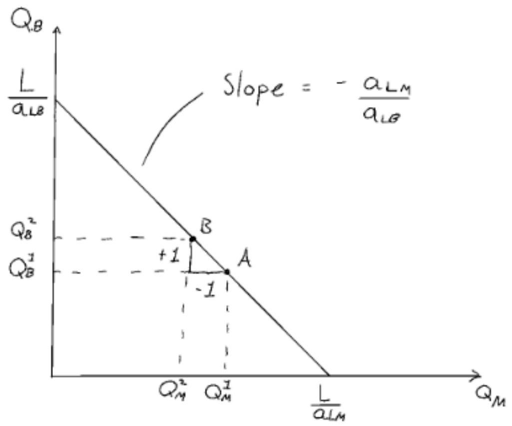

Figure 1: Ricardian model, home market

At point A, milk will be produced at quantity QM1 and bread at quantity QB1. Given a reallocation of one one unit of labor from milk to bread, there will be a new adjustment in point B. The slope of the curve illustrates the opportunity cost of milk in terms of bread.

When foreign market is included, the gains from trade can be illustrated like this:

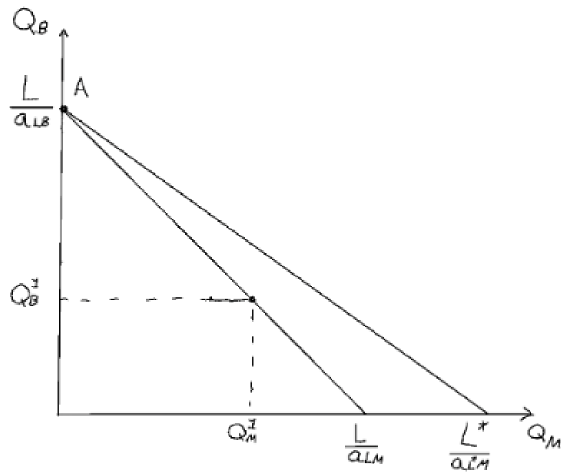

Figure 2: Ricardian model, foreign market

The figure illustrates that the foreign country can produce a larger quantity of milk compared to the home country. Home can produce one unit of milk by producing one unit of bread and trading it with a foreign country. This method is cheaper than producing one unit of milk directly. It's evident that trade has expanded the production possibility frontier. According to the Ricardian model, trade increases production by allowing specialization in goods where countries have a comparative advantage.

Melitz Monopolistic Competition Model

The Melitz Monopolistic Competition Model diverges from the Ricardian Model by suggesting that trade effects are not solely driven by comparative advantage. Instead, this model incorporates the concept of economies of scale, challenging the assumption of perfect competition. Economies of scale occur when the cost per unit decreases as production output increases (Krugman et al., 2018, p. 237).

In industries characterized by monopolistic competition, numerous firms offer differentiated products, behaving similarly to individual monopolies. However, as the industry becomes profitable, more firms enter the market, leading to a reduction in market profits over time. The equilibrium state of the market is influenced by its size. Larger markets can accommodate more firms, each operating at a larger scale of production. Consequently, larger markets experience lower average costs compared to smaller markets (Krugman et al., 2018, p. 237).

This phenomenon highlights the importance of imperfect competition in understanding trade dynamics. Economies of scale play a significant role in shaping market structures and trade patterns, underscoring the complexity beyond comparative advantage alone. The integration of foreign companies in the industry, through international trade, enables the market to grow larger than what would have been possible for just one country. Therefore, it is possible to achieve both higher variety in goods, and a lower price at the same time (Krugman et al., 2018, p. 237).

The Melitz competition model adds another dimension to the model by assuming firm heterogeneity. This explains how reallocations of resources between different types of firms can lead to changes in the overall economy of a country (Melitz, 2003, p. 1718). Essentially, when more productive firms expand and less productive firms exit, it can lead to overall improvements in productivity and economic performance at the aggregate level.

Free Trade and Efficiency

For small countries, particularly developing economies, there are significant benefits to be gained from free trade (Krugman et al., 2018, p.276). One of these is economies of scale. Protected economies restrict the potential economic advantages of economies of scale, as exemplified by the net economic loss incurred by tariffs. This is illustrated in the figure, below, depicting the net loss to the economy due to a tariff on the world price, which distorts economic incentives for producers and consumers. Therefore, it is argued that free trade eliminates these distortions and paves the way for increased national welfare.

In the presence of free trade, domestic markets face competition from foreign markets, encouraging firms to strive for efficiency. Furthermore, free trade fosters an environment that incentivizes entrepreneurs to explore new methods of export and compete with imports, thereby stimulating learning and innovation. Through these mechanisms, free trade stimulates economic growth.

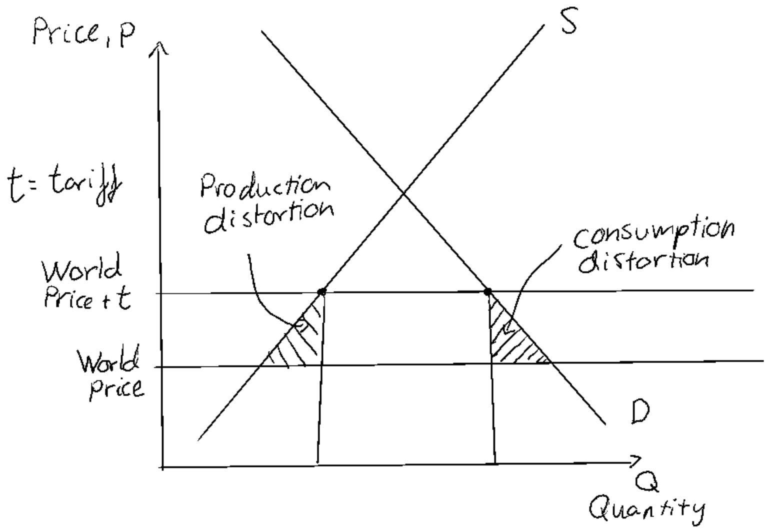

Figure 3: illustration of efficiency case of free trade

The figure illustrates the efficiency case of free trade in a supply-demand graph, with quantity on the first axis and price on the second axis. Initially, the graph depicts the equilibrium where the domestic supply and demand curves intersect at the world price. As the price increases due to a tariff imposed on the world price, there is a corresponding decrease in the quantity demanded. In other words, the imposition of the tariff causes a reduction in imports, which is illustrated by the two blue triangles. This decline in imports represents a loss of consumer surplus, as consumers now pay a higher price for the imported goods. Additionally, domestic producers benefit from the tariff by being able to sell more of their goods at the higher price, leading to an increase in producer surplus. However, the overall welfare of the economy is reduced, as the gains to domestic producers are outweighed by the losses to consumers. This loss of efficiency is represented by the shaded area between the two supply curves and above the world price, which reflects the deadweight loss caused by the tariff. Therefore, free trade eliminates these distortions and maximizes national welfare by allowing for the most efficient allocation of resources.

However, in the present-day scenario, tariff rates are typically minimal, and restrictions on import quantities are less common. Therefore, the sum of the distortions caused by import quotas and tariffs tend to be small. The advantages of free trade are slightly less significant for advanced economies in contrast to developing economies.

The European Union

The European Union, consisting of 27 European countries, is an international organization dedicated to upholding economic and political stability (European Commission, 2022). Today's EU is rooted in treaties signed in the aftermath of the Second World War. The initial aim was to promote economic cooperation, based on the idea that countries that trade with each other become economically interdependent, and as a result, reducing the likelihood of conflict. The initial economic union has since expanded into many more political areas. However, this paper will be restricted to the aspects concerning economic integration.

To effectively address the research question, it is crucial to understand the framework of economic integration within the EU. In this paper, economic integration is defined as consisting of the economic union, common market, and customs union.

Economic Union

The Economic and Monetary Union (EMU) represents a major step in the integration of EU economies. This was launched in 1992 and is based on a coordination of economic and fiscal policies, a common monetary policy and a common currency, that being the euro. According to the EU, economic integration stimulates to an economy of greater size, internal efficiency, and robustness to the EU economy collectively and for its individual member states (European Commission, n.d.).

Common/Single Market

The EU single market ensures free movement of goods, services, capital and persons in a single EU internal market (European Union, u.d.). The EU facilitates free trade and business activities by eliminating technical, legal, and bureaucratic obstacles. The European Parliament believes that free movement of goods, capital, services and people still offer untapped potential for citizens and business, in terms of efficiency, growth and job creation (European Parliament, 2017, s. 1). Within the single market is the The Capital Markets Union (CMU), the European Union's effort to establish a unified marketplace for capital among its member states. Its goal is to facilitate the movement of investment and savings across all EU countries, benefiting citizens, businesses, and investors alike (European Council and Council of the European Union, 2024). The EU is striving to create a unified capital market across its member states to unlock funding, boost growth, and provide citizens with greater investment opportunities, all while ensuring robust investor protection measures are in place (European Council and Council of the European Union, 2024).

The Custom Union

The Custom Union includes a standardized customs duty tariff applied to imports from outside the EU (European Commission, n.d.)**.** Meanwhile, there are no customs duties imposed at the borders between EU member states. Typically, customs duties on goods from outside the EU are settled upon their initial entry into the EU. Afterward, there are no further customs duties to be paid, and no additional customs checks are required - all goods move unrestrictedly within the EU Customs Union. The EU promotes this as simultaneously modernized customs operations, making them more adaptable and efficient in facilitating trade.

The coordination of economic and fiscal policies, along with a common monetary policy and currency within the economic union, facilitation of free movement of goods, services, capital, and persons in a single EU internal market, and the absence of customs duties at borders between EU member states serves as channels through which the EU can stimulate economic growth.

In addition, the EU has several requirements for countries wanting to be approved as members. The criteria is to comply with all the EU´s standard and rules, having the consent of the EU institutions and member states, as well as having the consent of the countries own citizens. The latter is expressed through approval in their national parliaments or by referendum. These requirements are more clearly expressed in the Copenhagen criteria, which states that, among other, membership requires stability of institutions guaranteeing democracy and human rights, a functioning market economy, and capacity to cope with the competitiveness and market forces within the Union (EU Commission, n.d.).

Empiricism

Existing literature has explored the effects of EU membership on economic growth, highlighting various dimensions such as trade, investment, and human capital. This section provides empirical insights from selected studies to provide a comprehensive understanding of how EU integration influences economic growth across different sectors and countries.

EU and Economic Growth

The paper *The EU, a Growth Engine? The Impact of European Integration on Economic Growth in Central Eastern Europe* investigates how the European integration process, particularly in Central Eastern European countries, has affected GDP growth. The analysis conducted in this paper finds that there is a small but yet significant medium term growth bonus from the integration. In other words, EU membership has had a positive impact on growth in these countries (Mann, 2015, p.1).

Trade and Economic Growth

Another aspect explored in the literature is how trade fosters economic growth. In *The economic benefits of the EU Single Market in goods and services,* it is estimated how the single market of European Union (EU) has significantly boosted trade flows within the EU by removing trade tariffs and reducing non-tariff barriers, leading to increased output and domestic demand. This has resulted in an average long-term GDP rise of 8–9%. The impact exceeds previous estimates, possibly due to stronger effects on investment and competition. Additionally, trade openness can stimulate innovation, although there's no consensus on this. While some argue that increased import competition may reduce innovation, others find a positive impact (Veld, 2019, p. 817).

Investment

According to the literature explored, Foreign Direct Investments (FDIs) have varying effects on economic growth depending on the sector invested in. *Foreign Direct Investment and Growth: Does the Sector Matter* stresses that investments in the primary sector tended to have a negative effect on economic growth. Conversely, investments in the manufacturing sector had a positive effect, while inflows in the service sector had an ambiguous effect on growth (Alfaro, 2003, p.2).

Human Capital

Another pattern identified in the research is the correlation between human capital and Foreign Direct Investments (FDI´s). Blomström and Kokko (2001) states that there is a correlation, though the direction of the correlation remains uncertain. The study showed that FDI´s create potential for spillover to the local labor force, by increasing knowledge in production, new production methods, or more capital, making the production more effective. This effect depends on the initial level of human capital among the labor force; higher human capital makes the labor force and firms more able to absorb the spillover. Conversely, higher human capital could work as a factor attracting more FDI´s (Blomström & Kokko, 2001).

The findings from the article *Who Benefits from the EU's Free Movement of Labour,* published by Euractiv explores the attitudes and behaviors of EU citizens regarding labor mobility. It underscores that citizens view the ability to move freely between labor markets as beneficial (Packroff, 2023). Individuals with higher levels of education are more inclined to live and work abroad compared to those with lower levels of education. Cinzia Alcidi, research director at the Centre for European Policy Studies, notes that "Having the possibility to work abroad increases the possibility of finding a job or a better or more suitable job". However, Alcidi also highlights drawbacks, such as the brain drain effect, where highly educated citizens leave their home countries, leading to a loss of human capital. Moreover, there are differences between larger and smaller member states, according to Alcidi. She states, "Usually, people coming from small countries are more mobile than people from larger countries." This trend is notable within the EU.

Empirical insights from various studies highlight the multifaceted nature of the relationship between EU integration and economic growth. While some sectors and countries experience positive effects, others show mixed or negative outcomes. Understanding these dynamics is crucial for policymakers in leveraging the benefits of EU membership and fostering sustainable economic growth across the region.

Method

In the following section, our methods used for the analysis will be presented in a comprehensive way, including the assumptions each method takes.

Multiple Regression Analysis (MLR)

Multiple regression allows us to explore how multiple independent variables (x_1, x_2, …, x_k) are related to a dependent variable (y). Subscript k indicates the number of variables, and n indicates the sample size. The general multiple regression model with k independent variables could be written as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u$$

The population parameter β_k estimates the change in y when x_k changes by one unit, while β_0 is the estimated value of y when all else equals null. u is an unobserved random error, which is other factors than x_i, $i = 1, ..., k$ affecting y (Wooldridge, 2012, p. 71).

In our case, the dependent variable is economic growth in terms of GDP (y), and we have several independent variables (x_k). EU membership is one of the independent variables, together with the control variables, which is used to control for other factors than EU membership that could affect economic growth. This is also the reason that MLR is a more favorable way of finding ceteris paribus analysis than Single Regression Analysis (SLR), where there is only one independent variable. Ceteris paribus means "all else equal", and by controlling for other factors affecting the dependent variable through MLR, there is more certainty in the causality. Looking at a change in x_1 while holding

$x_2, ..., x_k$ fixed, is called controlling for the variables $x_2, ..., x_k$. More variables added to the analysis leads to more explanation of the variation in the dependent variable (Wooldridge, 2012, p. 68 & p. 76).

Ordinary Least Square (OLS) is used to estimate the parameters of the different variables, i.e., β_k. This method gives us the marginal effect of a variable, isolated from the effect of other variables. The estimates found by OLS are the ones minimizing the sum of squared residuals (Wooldridge, 2012, p. 73). The residual of an observation i could be understood as the difference between the observed data point and the value predicted from the model (Wooldridge, 2012, p. 77). The OLS regression line is:

$$\hat{y} = \widehat{\beta_0} + \widehat{\beta_1} x_1 + \widehat{\beta_1} x_2 + ... + \widehat{\beta_k} x_k$$

where $\widehat{\beta_0}$ is called the OLS intercept estimate, and $\widehat{\beta_1}, \ldots, \widehat{\beta_k}$ is the estimation of the population parameters corresponding to the independent variables in the model, called the OLS slope estimates (Wooldridge, 2012, s. 74). Note that these values are only estimates, having a correlated margin of error. There is no way of obtaining the real regression line, it is unknown.

MLR assumptions

There are several assumptions that have to be fulfilled, in order to have unbiased population parameters.

MLR1 - Linearity

The model we are using can be written as $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u$, where all the population parameters ($\beta_0, \beta_1, \beta_2, \ldots, \beta_k$) is unknown and linear, and a random error u is included. The variables ($x_1, x_2, \ldots, x_k$) could be non-linear.

MLR2 - Random sampling

The observations in the sample should have been drawn random from the population, $\{(x_{i1}, x_{i2}, ..., x_{ik}, y_i): i = 1, 2, ..., n\}$, which implies that each i have had the same probability of being selected. This assumption reduces bias and increases representativeness.

MLR3 - No perfect collinearity

The third assumption states that there has to be enough variation, $V(x_i) \neq 0$, and no perfect collinearity. No perfect collinearity means that no x should be able to be written as a linear combination of other $x´s$. If this is the case, it would not be possible to separately estimate the impact of the given $x´s$ on y. Note that we do not require that there are no correlation between the regressors, only no *perfect* collinearity.

Another property of MLR3 is that the sample size n should be big enough, so that $n \geq k + 1$. $k + 1$ is the number of population parameters, and to estimate such number of parameters, we need at least $k + 1$ observations (Wooldridge, 2012, p. 86).

MLR4 - Zero conditional mean

$E(u|x_1, ..., x_k) = 0$. The average value of error does not change across different parts of the population, i.e., x-values. We then say that the $x's$ are exogenous. If they are correlated with u, we say endogenous. This assumptions says that there should be no correlation between the error term u and the $x's$. Violation of the assumption happens for example if an important factor correlated with any of the variables is omitted (Wooldridge, 2012, p. 86).

Under the assumptions MLR 1-4, OLS is unbiased: $E(\widehat{\beta_j}) = \beta_j$, $j = 0, 1, ..., k$, for any values of the population parameter β_j. The estimators of β_j obtained by OLS, are in other words unbiased estimators of the population parameters (Wooldridge, 2012, p. 87).

MLR5 - Homoscidasticity

Assumption 5 states that the error term u has the same variance given any of the $x's$: $Var(u|x_1, ..., x_k) = \sigma^2$. In other words, the variance of the error term is not dependant of any of the $x's$. If this is not the case, the model suffers from heteroscedasticity.

Under assumptions MLR 1-5, the estimated population parameters $\widehat{\beta_0}, \widehat{\beta_1}, \ldots, \widehat{\beta_k}$ obtained from OLS, are the best linear unbiased estimators (BLUEs) of the real population parameters $\beta_0, \beta_1, \ldots, \beta_k$. This is called the Gauss-Markov Theorem, and implies $E(\widehat{\sigma^2}) = \sigma^2$ (Wooldridge, 2012, p. 93 & p. 102).

MLR6 - Normality

The random error u is not correlated to any of the variables in the model ($x_1, ..., x_k$), and is normally distributed with a mean of zero and variance σ^2: $u \sim N(0, \sigma^2)$ (Wooldridge, 2012, p. 118).

MLR 1-6 are known as the classical linear model (CLM) assumptions, and the model under these assumptions is therefore called the classical linear model. Adding the sixt assumption, is making the OLS estimators ($\widehat{\beta_0}, \widehat{\beta_1}, \ldots, \widehat{\beta_k}$) in CLM stronger than under the Gauss-Markov assumptions. In this case, OLS has the smallest variance among unbiased estimators (Wooldridge, 2012, p.119).

Goodness of fit

The model´s goodness of fit is estimated through the R^2, where:

$$R^2 = SSE/SST = 1 - SSR/SST$$

SSE is the explained sum of squares, SST is the total sum of squares, and SSR is the residual sum of squares, which gives us $SST = SSE + SSR$. SST measures the total variation in the dependent variable, in other words, how spread the y_i are in the sample. SSE measures the sample variance of $\widehat{y_i}$, and SSR the sample variance of $\widehat{u_i}$ (Wooldridge, 2012, p. 37). From the formula of R^2, we can see that it is the ratio between the explained variation and the total variation in the model, i.e., the fraction of the sample variance in y that is explained by x. This number is always between 0 and 1, and usually multiplied by 100, so that it shows the percentage of the sample variance in y that is explained by x. Higher number indicates better fit of the OLS line, that is, a number of 1 means that all data points lie on the same line - a perfect fit. A property of R^2 is that the value never decreases, and usually increases when adding another variable to the regression (Wooldridge, 2012, p. 38). Therefore, the adjusted R^2 is applied in most works, and also the one we are using in this paper.

The adjusted R^2 takes the degrees of freedom and the sample size into consideration, and penalizes adding a new independent variable into the regression. The adjusted R^2 could therefore both increase and decrease when adding a new variable, because the degrees of freedom fall. The value of the adjusted R^2 is only increasing when the added variable is increasing the model´s explanatory power (Wooldridge, 2012, p. 202).

Difference In Difference (DiD)

Difference In Difference is a method used to estimate the causal effect of a treatment or intervention, by comparing the changes in outcomes over time between a group receiving the intervention, and a group not receiving the treatment. In our case, we are using a DiD-model with two periods and two groups, which gives the general formulation:

$$y = \beta_0 + \delta_0 d2 + \beta_1 dT + \delta_1 d2 * dT + other\, factors + \varepsilon$$

where $dT = 1$ for the treatment group and $dT = 0$ for control group, as well as $d2 = 1$ for post-intervention and $d2 = 0$ otherwise. Without other factors in the model, we have:

$$\widehat{\delta_1} = (Y^1(2) - Y^1(1)) - (Y^0(2) - Y^0(1))$$

where $Y^a(t)$ is the potential outcome given treatment $A = a$ at time t. In this case, $A = 1$ represents treatment and $A = 0$ represents no treatment, while $t = 2$ is the time period after treatment. δ_1 is the DiD-estimator, that could be interpreted as the difference in the estimated trend for the treatment and control groups. δ_0 captures changes in both groups (Wooldridge, 2012, p. 457) (Zeldow & Hatfield, 2019).

Assumptions

Consistency

$$Y(t) = (1 - A) * Y^0(t) + A * Y^1(t)$$

Recall that $A = 0$ represents treated groups, while $A = 1$ represent groups without treatment. This particular assumption links the potential outcome $Y^a(t)$ at time t with treatment $A = a$ to the observed outcomes $Y(t)$. The treated group do only receive treatment when $t \leq T_0$.

We only observe the outcome related to the treatment status of the given group. In theory, each of the two groups have two potential outcomes: one outcome with, and one without, treatment. However, if the given group is getting treatment, the outcome is the potential outcome with treatment: $Y(t) = Y^1(t)$. If the group is not getting treatment, $Y(t) = Y^0(t)$.

Also, we assume that the outcomes are not affected by future treatment. Therefore, in this period, a group getting future treatment and a group not getting future treatment, should have the same potential outcome.

$$Y(t) = Y^0(t) = Y^1(t),\ for\ t \leq T_0$$

(Zeldow & Hatfield, 2019).

Counterfactual assumption (parallel trends)

$$E[Y^0(2) - Y^0(1)|A = 1] = E[Y^0(2) - Y^0(1)]$$

The difference between the potential outcome before ($t = 1$) and after ($t = 2$) treatment between the two groups should be the same, meaning that if none of the groups is getting treatment, the trends should be equal. In other words, in the absence of treatment, the difference between the two groups should remain the same over time. This is a crucial assumption, but it is not possible testable following from the consistency assumption since $Y^0(2)$ for $A = 1$ is unobserved. What could be done is to investigate whether the assumption holds in previous periods, if having enough data (Zeldow & Hatfield, 2019).

Positivity assumption

$$0 < P(A = 1|X) < 1\ for\ all\ X$$

This assumption states that the treatment is not determinant for specific values of X, i.e., for any $X = x$, the probability of being treated lies between 0 and 1, inclusive. If there is a guarantee that some values of X leads to either the probability 0 or 1 of getting treated, the study population should be reconsidered (Zeldow & Hatfield, 2019).

No spillover effects

No spillover effects means that the effects the treated group is getting from the treatment should have no spillover effect to the non-treated group.

Identification

We could now see that there is a non-observable outcome in the ATT which was presented at the beginning of the chapter, namely $Y^0(2)$ for $A = 1$. Using the assumptions, we could rewrite this equation to a form only dependent on observed factors, a process called identification. Using the consistency and the counterfactual assumption, we derive:

$$ATT \equiv E[Y^1(2) - Y^0(2)|A = 1]$$
$$= \{E[Y(2)|A = 1] - E[Y(1)|A = 1]\} - \{E[Y(2)|A = 0] - E[Y(1)|A = 0]\}$$

ATT could be estimated by using the post-intervention average of the treated group $E[Y(2)|A = 1]$, pre-intervention average of the treated group $E[Y(1)|A = 1]$, post-intervention average of the non-treated group $E[Y(2)|A = 0]$, and the pre-intervention average of the non-treated group $E[Y(1)|A = 0]$ (Zeldow & Hatfield, 2019).

Data

This part of the paper is dedicated to explaining the variables used in the two models, as well as some descriptive statistics. The data of the variables is retrieved from the World Bank, and Python is used as a tool in order to obtain the descriptive statistics and the correlation matrix.

Dataset 1: MLR-analysis

For the Multiple Regression Model, cross-sectional data is used, meaning there is a sample of units taken at a given point in time (Woolridge, 2012, p. 5). In our case, the unit is European countries, where we have included 39. The model is based on one dependent and seven independent variables. The dependent variable is economic growth in terms of GDP growth, while the independent explanatory variable is EU membership. In addition, there are six independent control variables, namely export, import, foreign direct investment, public expenditures, education, and GDP per capita in year 2008.

Most of the variables are the mean of a ten year period, spanning from and including 2008 to and including 2017. We have chosen to use the average value of this period, as GDP growth could be varying a lot from year to year. A MLR regression of a single year would most probably not give us the trends we are looking for. The particular period is chosen because we want to compare EU members with countries that are not members, and in this period, Croatia is the only country in Europe that became a member. This way, we have been able to have the maximum number of countries in our dataset. However, Croatia had to be omitted as the EU membership variable took two different values over the period. Other omitted countries are Andorra, Armenia, Bosnia and Herzegovina, Faroe Islands, Greenland, Kosovo, Latvia, Liechtenstein, Malta, and Monaco, as a result of missing values. As these countries are mostly relatively small, we believe this factor will have minimal influence on our analysis.

Our main goal with the MLR analysis is not to see if EU membership in total isolation affects GDP growth, but rather which channels that could have an impact on GDP growth, through EU membership. In other words, the benefits from being an EU member, regarding GDP growth. By adding extra control variables in the MLR regression, we could extract overlapping effects between the EU membership variable and other variables, and extract which advantages EU membership give, when it comes to GDP growth

Dependent variable

Economic growth is a wide term which can be measured in several different ways. One of the most common measures is GDP growth, which is the one we have chosen to use as a measure and therefore as our dependent variable. In the dataset, GDP growth is measured as the percentage change in GDP each year. GDP is calculated by summarizing the gross value added by resident producers in the economy, incorporating any taxes on products and excluding subsidies not included in product values (World Bank, n.d.). Data are in percentage, and measured as the average of the ten year period. Using GDP growth instead of level of GDP makes comparison between countries easier, and as we are interested in how much EU membership contributes to economic growth, measuring the growth instead of level is more beneficial.

Disadvantages regarding using GDP as a measure of growth, is that it does not say anything about the distribution of the growth or values. There could be a small part of the country or the population that is having very high growth or is very rich, while most inhabitants are not a part of this and living in poverty. Nor will voluntary work, work at home, or black work be included, and one should be careful in using GDP as a measure of wealth or affluence. The reason is that distribution of values is not included, so that there might be a very rich elite while most of the population is living in poverty, as well as factors such as health, education, and happiness are omitted. In our analysis, the variable is called gdpgrowth.

Explanatory variable

Our explanatory variable, i.e. the variable we want to explain economic growth by, is EU membership. This is a dummy variable, having the value 1 if the country is a EU member on the data collection time, and 0 otherwise. The variable is named eu.

Control variables

In addition to the explanatory variable, we have included six control variables, affecting GDP growth. This way, the model are able to separate the effect of the control variables on the dependent variable, and isolate the relationship between EU membership and GDP growth, so that we could see what economic advantages the EU has.

Export

Export is the value of what the country is selling of goods and services to other countries. Our variable is measuring export in percentage of GDP, and employment compensation, and investment income and transfer payments are excluded (World bank, n.d.), and is included due to several articles finding a positive effect of export on GDP growth (Feder, 1882, p. 59) (Balassa, 1977, p. 188). In the analysis, the variable is named export. Export is also measured as the average of the given time period.

Import

Import is the value of what the country is buying of goods and services from other countries, also measured in percentage of GDP and as the mean of the ten years. As with export, employment compensation, and investment income and transfer payments are excluded (World Bank, n.d.). The variable is called import. The reason we are controlling for import in our analysis, is that there are implications from research that import and economic growth interact with each other, which makes it an interesting factor (Taghavi et al., 2012, p. 12787) (Centina & Barisik, 2008, p.636).

Foreign direct investment (FDI)

Foreign direct investment (FDI) is direct equity cash flows, which will be the sum of equity capital, reinvestments of earnings, and long-term and short-term capital in the country. Our data is based on net FDI, which will say, the outflows minus the inflows, measured in percentage of GDP, and as the average over ten years. Outflow is the amount of foreign investment that is withdrawn from the country in the time period, while inflow is the foreign investment that is introduced to the given country in the time period (World Bank, n.d.). As mentioned in the theory part, investments are affecting economic growth in a positive manner, which is the reason it is included. The variable name is fdi.

Public expenditures (PE)

Public expenditures (PE) is measured in percentage of GDP, and refers to payments taken by the government to deliver goods and services. In this case, compensation of employees, interests and subsidies, grants, social benefits, and other expenses are included, but some military expenditures are excluded (World Bank, n.d.). The variable is called pe, and as the other variables, it is the average value of the chosen time period. There is evidence that there is a positive relationship between government spending and economic growth (Barro, 1990), as well as evidence for a negative relationship (Fölster & Henrekson, 1998, p.337). Either way, public expenditures is a variable might affecting economic growth, that we would like to control for in our analysis.

Education

Education is measured as enrollment in tertiary education, expressed as the percentage of the total population of the five-year age group following on from secondary school leaving (World Bank, n.d.). In the analysis, the variable is named educ. Education could be used as a measure of human capital which could lead to increased economic growth as presented in the theory. Also, there are studies that have found a positive effect between education and economic growth (Barro, 2013). We have included the variable in order to have the opportunity to partial out the effect of education, in view of the theory presented.

Since enrollment rates usually are relatively stable over time, education is not measured as the average value, but rather as the percentage value in 2008. There were a couple of missing 2008-values for some countries, which means that Germany´s value is from 2013, Greece's from 2010, and Turkiye from 2017. We believe that this will not have a significant effect on the results in our analysis.

GDP per capita in year 2008

Our final explanatory variable is GDP per capita in 2008. We include GDP per capita from the first year in the dataset to capture income convergence or divergence between countries. If an increase in initial GDP per capita leads to higher GDP growth, it indicates divergence. Conversely, if an increase in initial GDP per capita leads to lower GDP growth, it indicates convergence. Additionally, adjusting GDP for population is essential because GDP might rise simply due to population growth, resulting in more people working and producing. Therefore, GDP per capita is a more suitable measure for comparing countries, as it reflects the average income per person rather than the country's total economic size. This variable is shortened to gdppc2008 in our analysis, and is included as the log value, to obtain to growth rate instead of the level rate.

Descriptive statistics

The table below shows the descriptive statistics for the dataset used in the MLR model.

Table 1: descriptive statistics MLR

Variables	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
gdpgrowth	39	1.646	1.699	-2.898	5.074

gdppc2008	39	38061.982	38460.634	3324.754	204097.114
eu	39	0.641	0.486	0.0	1.0
export	39	56.312	32.369	23.814	174.768
impor	39	56.369	27.423	20.717	148.283
fdi	39	-1.504	4.877	-15.461	17.621
pe	39	19.736	6.064	10.890	45.852
educ	39	61.726	20.749	10.607	113.217

The variable gdpgrowth, which is the average growth rate of GDP during 2008-2017, has a mean of 1.65%. Standard deviation tells us something about the spread in the data, and in this case, the standard deviation is 1.7, meaning that growth rate usually vary +/- 1.7 percentage points. Spain has the highest with a growth rate at 5.07%, and Georgia the lowest with -2.9%.

gdppc2008 is the numerical value of GDP per capita in 2008, and has a mean value of 38061.98 dollars per capita. Standard deviation is 38460.63, while minimum and maximum value is 3324.75 and 204097.11 dollars per capita, measured in Georgia and Moldova, respectively.

EU is a dummy variable, which is the reason why minimum value is 0 and maximum value is 1. The mean tells us that 64% of the countries in the data set are EU members.

Export has a mean of 56.31% of GDP, with a minimum value of 23.81% and a maximum value of 174.77%, for respectively Ukraine and Luxembourg. Moldova has the highest share of imports, with 148.28%. The minimum value is found in Russia, with 20.72%, and the mean is 56.37% of GDP. Export has a slightly higher standard deviation, meaning that there is more variance in share of exports than imports for the countries.

When it comes to FDI, the mean is -1.5% of GDP. Montenegro has the minimum value of -15.46% of GDP, meaning that there is more outflows of investment from Montenegro, than outflows - more capital is coming into the country for investment than capital floating out. The maximum value is 17.62%, that is Cyprus. There is a relatively low spread in the investments between the countries, which the standard deviation of 4.88% shows. The reason the value is negative, is that the value of the outflow of investment from a country exceeds the inflow of investment, which could be due to for example capital flight.

Public expenditures (pe) have a mean of 19.74% of GDP, and a standard deviation of 6.06%, saying the variance in expenditures on average is around 6%. The minimum and maximum value is 10.89% and 45.85%, Albania and Germany respectively.

Lastly, the mean value of education (educ) is 61.73%, meaning that around 62% of the given age group enrolled in tertiary education. The standard deviation is relatively high, with 20.75%, while the maximum and minimum value is 10.61% and 113.22%. These values are for Luxembourg and Turkey. In Turkey, the value is over 100%, which may seem odd. However, if a student is quitting its education and beginning over again, (s)he would be counted in the numerator, but not the denominator, making the percentage bigger.

Table 2 beneath shows the correlation matrix for the MLR analysis, which indicates the correlation between the different variables used in the dataset. The values are ranging from -1 to 1, including both, where -1 indicates perfect negative collinearity, 1 indicates perfect positive collinearity, and 0 no collinearity.

The matrix table shows that the general correlation in the model is low. The EU variable has a slightly positive correlation with GDP growth, which indicates that a positive change in GDP will be higher for EU-members. However, the effect would be marginal, as the correlation is not particularly high. GDP growth correlates positively with EU, GDP per capita in 2008, export, FDI and education. The clearest positive relationship is of 0.41 with export, and on the other hand, GDP growth has barely any relationship with FDI. In addition, it correlates negatively with import and public expenditures. Looking at the EU variable, it correlates positively with education, FDI, public expenditures and import, and have a negative relationship with export and GDP per capita in 2008. We can see that the FDI is the variable that is mostly affected by the country being an EU member, with a correlation of 0.36. The value indicates that FDI is a larger part of the GDP for EU members.

The matrix indicates that we do not have a problem with multicollinearity. However, we see that some correlations are close to 0. For example, the correlation between EU membership and export is -0.0038 which could indicate that the two variables do not have a significant relationship. In other words, being an EU-member can only explain an extremely small part of the change in the export. Nonetheless, it is important to specify that the relationship could be non-linear and therefore not captured by the correlation coefficient.

Table 2: correlation matrix MLR

gdppgrowth	1	0.12	0.11	0.41	-0.14	-0.054	0.055	0.2
eu	0.12	1	-0.1	-0.0038	0.26	0.18	0.36	0.22
gdppc2008	0.11	-0.1	1	-0.12	0.24	0.098	-0.015	-0.22
export	0.41	-0.0038	-0.12	1	0.0091	-0.092	-0.0047	0.22
impor	-0.14	0.26	0.24	0.0091	1	-0.014	-0.22	-0.43
pe	-0.054	0.18	0.098	-0.092	-0.014	1	0.24	-0.023
fdi	0.055	0.36	-0.015	-0.0047	-0.22	0.24	1	0.2

educ	0.2	0.22	-0.22	0.22	-0.43	-0.023	0.2	1
	gdpgrowth	*eu*	*gdppc2008*	*export*	*impor*	*pe*	*fdi*	*educ*

Dataset 2: Difference in Differences-analysis

The Difference In Differences Model is built upon the dependent variable GDP per capita. GDP per capita is also retrieved from the data set from the World Bank - the same data set as used in the MLR. The explanation of the variable is therefore the same. The reason to use GDP per capita instead of GDP level is, as written, to correct for population growth when measuring GDP. In our analysis, we have used to log value of GDP per capita, in order to have an easier interpretation.

The dummy variables used in the regression are EU membership and time. The time variable is 1 for the time period after 2004, and 0 for the time period prior to and including 2004. The EU membership variable is 1 if the country is a becoming an EU member in 2004, and 0 otherwise. In other words, all the countries in the treatment group have value 1, and all countries in the control group have value 0.

Regarding the time variable, we chose to have our periods prior to and after 2004, due to ten countries gaining EU membership this year, as written. 2004 is included in the first period, as the countries got their membership status May the 1st. Assuming that the implementing process takes time, it is reasonable to use 2005 as the first period, when trying to evaluate the effect of EU membership. The countries who became members were the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia, and Slovenia. It was the biggest enlargement of the EU both measured in countries and people at the point, and it still is (European Commission, n.d.). We therefore considered this to be a suitable separation of the time periods.

Descriptive statistics

The dataset used for the DiD model consists of the ten countries that became members of the EU in 2004, which is the treatment group, and a control group of nine countries that were not EU members in the given period 2000-2009. The whole dataset consists of 190 observations.

Table 3: descriptive statistics DiD

Variables	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
gdppc	190	8144.8	7087.714	440.5	35397.4
eu	190	0.526	0.464	0.0	1.0
time	190	0.5	0.501	0.0	1.0
interac	190	0.263	0.442	0.0	1.0

From the table, we can see that the mean of GDP per capita is 8144.8 dollars, while the standard deviation is 7087.7, meaning the data points in average is spread ca. +/- 7000 dollars from the mean.

This indicates that there is a huge variation in the different countries´ GDP pc, with some countries having a high value and some having a low. The minimum value was found in Moldova in 2000 with 440.5 dollars, while the maximum was 35397.4 dollars, found in Cyprus in 2008, showing some of the difference in the GDP per capita value.

The interpretation of the three other rows is not that useful. Both the EU and the time variable is a dummy, meaning that the mean is showing the percentage of observations that takes the value “1” for respectively EU, Time, and interaction term (interac). Further, the standard deviation is measuring the average spread of data points, while minimum and maximum values naturally are 0 and 1, respectively.

Regression Analysis

This section presents findings of the Multiple Linear Regression-analysis and Difference in Difference-analysis.

MLR-analysis and results

The MLR was performed using the OLS method in R. This regression model aims at determining if there exists a correlation between EU membership and GDP growth, when controlling for a number of variables. We have used R to assess the MLR, and R-studio to analyze the DiD model. This is purely based on preference and does not affect the result. The following models have been estimated:

(1) $gdpgrowth = \beta_0 + \beta_1 eu$

(2) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008$

(3) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008 + \beta_3 export$

(4) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008 + \beta_3 export + \beta_4 import$

(5) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008 + \beta_3 export + \beta_4 impor + \beta_4 fdi$

(6) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008 + \beta_3 export + \beta_4 impor + \beta_4 fdi + \beta_5 pe$

(7) $gdpgrowth = \beta_0 + \beta_1 eu + \beta_2 gdppc2008 + \beta_3 export + \beta_4 impor + \beta_4 fdi + \beta_5 pe + \beta_6 educ$

Table 4: regression table MLR

Variables	(1) *gdpgrowth*	(2) *gdpgrowth*	(3) *gdpgrowth*	(4) *gdpgrowth*	(5) *gdpgrowth*	(6) *gdpgrowth*	(7) *gdpgrowth*
constant	1.370** (0.457)	-1.756 (2.719)	-3.758 (2.564)	-3.432 (2.535)	-3.637 (2.582)	-3.435 (2.616)	-3.205 (2.832)
eu	0.431 (0.571)	0.337 (0.574)	0.325 (0.521)	0.516 (0.530)	0.672 (0.595)	0.707 (0.602)	0.767 (0.663)
gdppc2008		0.316 (0.217)	0.375 (0.247)	0.416 (0.245)	0.434 (0.249)	0.480 (0.259)	0.484 (0.263)
export			0.026** (0.009)	0.027** (0.009)	0.027** (0.009)	0.026** (0.009)	0.027** (0.010)
import				-0.016 (0.011)	-0.019 (0.012)	-0.019 (0.012)	-0.021 (0.014)
fdi					-0.035 (0.059)	-0.028 (0.060)	-0.029 (0.061)
pe						-0.032 (0.044)	-0.033 (0.045)

educ							-0.004 (0.015)
Observations	39	39	39	39	39	39	39
R^2	0.015	0.051	0.238	0.282	0.290	0.301	0.303
Adjusted R^2	-0.011	-0.002	0.173	0.198	0.182	0.170	0.145
Residual std. error	1.709 (df = 37)	1.701 (df = 36)	1.546 (df = 35)	1.522 (df = 34)	1.537 (df = 33)	1.548 (df = 32)	1.571 (df = 31)
F-statistic	0.570 (df = 1; 37)	0.968 (df = 2; 36)	3.641* (df = 3; 35)	3.345* (df = 4; 34)	2.696* (df = 5; 33)	2.300 (df = 6; 32)	1.921 (df = 7; 31)

Significance codes: 0 ´***´ 0.001 ´**´ 0.01 ´**´ 0.05 ´.´ 0.1 ´ ´ 1

The regression table (table 4) shows the estimation of model 1 to 7. The values in each column shows the estimated regression coefficients $(\widehat{\beta}_j)$ with their corresponding standard deviation in parentheses behind. Some of the coefficients are marked with stars (*), indicating the level of significance the coefficients could be interpreted with. The significance codes are written beneath the table.

Number of observations, R^2, adjusted R^2, residual standard error and F-statistic is presented at the bottom of the table. In model 7, the value of the adjusted R^2 is 0.145, meaning that our model is explaining 14.5% of the variation of our dependent variable, GDP growth. This explanatory power do also increase from -0.011 to 0.145, namely by 15.6 percentage points, by adding the control variables. However, the adjusted R^2 is at its highest in model 4, explaining 19.8% of GDP growth in the chosen countries, and then decreases to 0.145 in the last model. The reason the adjusted R^2 is falling, is that the newly added variables are improving the model less than expected, meaning the inclusion of foreign direct investment, public expenditures and education did not increase the explanatory power of the model with a sufficient amount.

Columns 1 to 6 shows a positive correlation between EU membership and GDP growth, but to varying extent of how much the membership contributes to growth. All else equal, model 1 to 5 is predicting that being EU member should increase GDP growth by between 0.325 and 0.707 percentage points. However, these values are not statistically significant, meaning that there is not enough evidence in our dataset to draw this conclusion. Another property of the EU membership coefficient, is that decreases when controlling for GDP per capita in 2008 and export, the value is falling, meaning EU membership have less impact on GDP growth. A possible explanation is that some of the effect membership has in model 1 and 2 is functioning through GDP per capita and export, and this effect is isolated when the variables are no longer included in the error term u. The export coefficient is significant, however, the coefficient of EU membership is not, meaning that we could not be sure that this is the relationship.

The only significant variable in the models is export, which is significant under a 1% significance level. Our model is in other words expecting GDP growth to increase by 0.026 or 0.027 percentage points (depending on the particular model), when export as share of GDP is increasing by one percentage point.

On the other hand, including import, FDI, public expenditures and education increases the coefficient of EU membership, which could be explained by the control variables not capturing correlation of other variables included in the error term u, that could be correlation with both the particular variable and GDP growth. Again, none of the variables are significant, meaning that the effects are highly uncertain.

Another value that is significant at some point, is the F-statistic, that is measuring the overall fit of the regression model to the data. Higher F-statistic indicates a better fit, meaning that the model explains a larger proportion of the variability in the dependent variable. The F-statistic is significant in model 3 to 5, with a value of between 3.641 and 2.696, highest for model 3. A decreasing value indicates that the regression model fits worse with our data set, which is the case from model 3 to model 7.

Our final model could be written as:

$$(7)\ gdpgrowth = -\ 3.205 + 0.767eu + 0.484gdppc2008 + 0.027export - 0.021impor - 0.029fdi - 0.033pe - 0.004educ$$

-3.205 is the intercept, which says that if we have the unlikely assumption that all other variables equals zero, the country will have a GDP growth of -3.205%. The intercept is not statistically significant under a 0.1%, 1%, 5% or 10% significance level, meaning that there is not strong evidence for this particular relationship. Further, the model shows a positive relationship between GDP growth and respectively EU membership, GDP per capita in 2008 and export. Being an EU member is expected to increase GDP growth by 0.767 percentage points, while one percentage increase in GDP per capita in 2008 is expected to increase growth by 0.484 percentage points, all else equal. The intuition between the export coefficient is already interpreted, and it is statistically significant under a 1% significance level, but GDP per capita and EU membership are not significant.

The last four variables added; import, foreign direct investment, public expenditures and education, have a negative relationship with GDP growth. GDP growth is expected to decrease by 0.021, 0.029, 0.033 and 0.004 percentage points by a one unit increase in import, investment, expenditures and education respectively. Regarding import, foreign direct investment and public expenditures, one unit increase means a one percent increase in the variables share of GDP, while a one unit increase in education means a one percent increase in tertiary school enrollment. The negative correlation between the variables and GDP growth is surprising given the theory, in which an increase in growth would have been the expected outcome. Nevertheless, the values are not statistically significant.

Overall, each model indicates that there is interplay and overlapping between various of the variables included in the model. The inclusion of export improved the model, and is the only significant relationship our model has indicated. Further investigation and inclusion of variables would be beneficial for understanding the effect of the other variables.

Difference in Differences-analysis and results

Regarding the Difference in Differences analysis, the following model has been estimated:

$$(8)\ lngdppc = \beta_0 + \beta_1 eu + \beta_2 time + \beta_3 interac$$

The model presents the result of a linear regression model predicting the natural logarithm of GDP growth and the effect of a EU membership.

Table 5: regression table DiD

Residuals:				
Min	1Q	Median	3Q	Max
-1.297	-0.344	-0.019	0.353	1.350

Coefficients:

	Estimate	Std. error	T value	Pr(>|t|)
intercept	7.354	0.077	95.243	<2e-16***
eu	1.582	0.106	14.858	<2e-16***
time	0.884	0.109	8.092	7.42e-14***.
interac	-0.166	0.151	-1.102	0.272
Residual standard error	0.518 (df = 186)			
Multiple R-squared	0.733			
Adjusted R-squared	0.728			
F-statistic	170 (df = 3; 186)			
p-value	< 2.2e-16			

Significance codes: 0 ´***´ 0.001 ´**´ 0.01 ´**´ 0.05 ´.´ 0.1 ´ ´ 1

The range of the residuals is relatively small, -1.2965 to 1.3504, indicating that the model's predictions are not far off from the actual values, but there is some spread. The model´s median is -0.0185, meaning that there is a relatively good fit, but a slight tendency of underpredicting the GDP per capita. The interquartile range is from -0.344 to 0.353.

Firstly, the intercept has a value of 7.354. This particular value is not possible to interpret in a sensible way, but by doing some mathematical magic, we can obtain a interpretable value. By raising e to the power of the coefficient value, we get $e^{7.354} = 1562.43$. In other words, the countries becoming EU members have an estimated GDP per capita equal to 1562.43 dollars on average.

The coefficient of the EU variable is 1.5832. Interpretation of this value, is that the countries in the treatment group have a 1.58 percentage point higher GDP per capita than the countries in the control group in period 0. The p-value (<2e-16) indicates that the coefficient is significant, and that the probability of the estimate to fall within the degrees of freedom is high. Further, the time coefficient of 0.884 indicates a GDP per capita of 0.88 percentage points higher in the period after 2004 compared to before 2004, regardless of the country receiving treatment or not. This effect is also statistically significant.
Last, the coefficient of the interaction term is -0.166, meaning that GDP per capita from the pre-2004 period to the post-2004 period is 0.166 percentage points lower for the treatment group than the control group. Our model is then estimating a lower value after 2004 for the countries that became members, than the countries who did not become EU members. In other words, there is no sign that EU membership has a positive impact on GDP per capita, rather the opposite. However, the coefficient is not significant, which indicates that the model is lacking evidence trying to predict the effect of being an EU member in the post treatment period.

The quality of the model is represented by the high value of R-squared, and the small residual. The F-statistic is highly significant (p-value < 2.2e-16), which means the model as a whole is statistically significant. However, the insignificance of the interaction term indicates that the model lacks the ability to prove that EU membership has an effect on GDP growth in the post-treatment period - there is no correlation between EU-membership and growth. The fact that the model falls short in trying to prove this effect indicates that further investigation would be advantageous.

Discussion

DiD

The negative value of the interaction term suggests that upon joining the EU countries in the treatment group experienced lower economic growth than the control group in period 1. This contradicts the findings from the paper by Mann, suggesting that EU membership has contributed to economic growth. Some of this effect can be explained EU's economic criteria have implications for several of the assumptions. In the theory part, the criteria for joining the EU were shortly presented. Some of these requirements target economic aspects, while others focus on laws and regulations. Countries applying for EU membership, are often using a couple of years before actually gaining status as a member, precisely because they need to work on fulfilling the criteria. A couple of examples are Greece who needed six years, Hungary who needed eight years, and Finland who took three years. In other words, the countries are in the process over a certain period, when they are aiming to do economic and political changes demanded for membership. The result of the interaction term could therefore indicate that the incentive to invest in economic growth factors are reduced once the country has become a part of the union.

The coefficient for EU membership could further support this view. This particular coefficient suggests higher GDP per capita for countries joining the EU compared to those not joining, in period 0. Assuming that the countries took measures meeting the criteria, it is natural that those had higher GDP per capita than the other group. In addition, the model estimates an increase in GDP per capita from the first to the second period, regardless of being granted EU membership or not. The value creation has thus been higher than the population growth in sum. This is an indication that the control group have had an increase in GDP per capita, due to the interaction term indicating a decrease in the EU members´ GDP per capita.

Despite a highly significant F-statistic for the overall model, the insignificance of the interaction term suggests a lack of evidence to support the effect of EU membership on GDP per capita in the post-treatment period. These findings challenge traditional economic theories, which emphasize the role of factors such as physical capital, human capital, and productivity in driving economic growth, and suggest the need for further investigation into the complexities of EU integration and its effects on economic performance.

However, in order to gain a deeper understanding of the role of different variables in economic growth, it is important to look into the results from the MLR analysis.

MLR

Before beginning to discuss our findings from the MLR, it is important to emphasize the fact that we do not know the direction of the estimated correlations. Increased GDP growth could also potentially have positive (or negative) effects on the variables of choice, such as increased trade, investment and education. Note also that the only significant estimates we obtained were export, so keep in mind that the discussion of the other estimates are highly uncertain.

EU membership on Economic growth

The analysis indicates that EU membership potentially has a positive impact on GDP growth, although further evidence is necessary to confirm this relationship definitively. This aligns with the findings from the paper by Mann, suggesting that EU membership has contributed to growth in Central Eastern European countries through a notable medium-term bonus resulting from integration. This prompts an inquiry into whether the effect on EU membership on economic growth varies among countries, particularly between Western and Central Eastern countries. For example, the model of free trade and efficiency suggests that the benefits from free trade primarily regards developing economies. This could explain why Eastern European countries experience more growth from integration compared to Western countries, as they are generally considered less wealthy. However, it is important to note that our regression analysis has not quantified this pattern.

Export and import

The significant and positive effect of exports on GDP growth, as indicated by the MLR analysis, suggests that higher levels of exports lead to increased GDP. These results aligns with the findings of Veld, predicting a average long term GDP growth from trade within the single market, highlighting the positive effect of removal of trade-tariffs. The findings can also be contextualized within the Free Trade and Efficiency Model, which highlights the role of trade in fostering economic growth. In the context of EU membership, the economic growth resulting from exports can be attributed to the EU's Customs Union, which promotes free trade among its member states. Under this union, standardized customs duties are imposed on imports from outside the EU, while no duties are applied at borders between EU member states. This fosters unrestricted movement of goods within the EU, enhancing efficiency and trade. The elimination of customs duties between member states reduces distortions in economic incentives for producers and consumers, as shown by the net loss resulting from tariffs. This suggests that EU membership facilitates increased trade and contributes to economic growth through the export channel.

Furthermore, free trade within the EU encourages economies of scale, competition, and innovation, thus enhancing overall efficiency and welfare. Therefore, it can be argued that free trade eliminates these distortions. By reducing trade barriers, such as tariffs and quotas, countries can specialize in producing goods and services where they have a comparative advantage. This specialization leads to higher productivity and efficiency in resource allocation, driving economic growth. Thus, the results also align with the assumptions from the Ricardian model.

The significance of export on economic growth, can also be seen in the light of the Melitz model, which emphasizes the importance of exporting for firms to survive in a competitive market. EU membership provides firms with access to a large internal market as well as preferential trade agreements with non-EU countries. This access to a wider range of export markets allows firms to increase their exports, expand their customer base, and potentially achieve higher profits, contributing to economic growth. The model suggests that increased competition leads to greater efficiency and innovation among firms. EU membership exposes domestic firms to a larger pool of competitors from other member states, which can spur them to improve their products and production processes to remain competitive. This competition-driven innovation can boost productivity and ultimately contribute to economic growth.

Import on the other hand, indicates a negative effect on GDP growth. The general expectation is that both export and import increases due to EU membership, due to the accommodation for trade. However, the negative import effect can simply be interpreted as a trade deficit, meaning that countries import more than they export, generating a negative economic growth. If the analysis showed a significant result for import, meaning that import has a negative effect on economic growth, this would align with the assumption that EU membership leads to increased import, and contributes to negative economic growth. Hence, the economic growth would depend on exports being larger than imports.

Investment

Public expenditures suggest a positive effect on GDP growth. The lack of significance in the public expenditure coefficient in the multiple linear regression (MLR) analysis challenges the theory of the aggregate production function, which suggests that increased investment leads to economic growth. Furthermore, the results also contradict the idea that the single market facilitates economic growth through the investment channel. Therefore, the insignificance of public expenditure challenges the economic rationale that economic growth can be achieved through EU membership.

The results show that foreign direct investment (FDI) has a negative effect on GDP growth, although not statistically significant. This contradicts Melitz's prediction of positive effects of foreign investment on economic growth. The model suggests that increased competition leads to greater efficiency and innovation among firms. EU membership exposes domestic firms to a larger pool of competitors from other member states, which can spur them to improve their products and production processes to remain competitive. This competition-driven innovation can boost productivity and ultimately contribute to economic growth. The model can be used to explain how EU membership enlarges the market size for member countries' goods and services.

However, the regression analysis does not provide details on the specific projects invested in. If these projects primarily involve capital-intensive endeavors and do not foster spillover effects, such as technology transfer or skill development within the domestic workforce, as introduced by Blomström and Kokko, their overall impact on productivity may be limited. This limitation can constrain the economy's long-term growth potential. This momentum is however challenged by the work of Alfaro in the literature previously presented, which suggests that investments in the manufacturing sector have a positive effect on economic growth. The manufacturing sector typically involves more capital-intensive production rather than labor-intensive processes.

Human Capital

The negative effect of the education variable on GDP growth may indicate the brain drain effect discussed by Alcidi. This suggests that EU membership, which facilitates freedom of movement, allows highly educated citizens to leave their home countries, resulting in a loss of human capital that could otherwise contribute significantly to economic growth. The importance of human capital, as expressed by the aggregate production function, suggests that an increase in human capital should lead to higher output, thereby boosting production and economic growth. However, the negative effect is insignificant, and lacks sufficient evidence.

On the other hand, if the result is considered in light of the aggregate production function alone, it contradicts the theory. Within the EU's single market, the four freedoms ensure that citizens can seek employment across borders more easily, enhancing labor market efficiency. Consequently, increased mobility could potentially reduce the equilibrium unemployment rate, as workers relocate to countries where their skills are in demand, ultimately boosting productivity. Thus, EU membership would in theory increase economic growth through the human capital channel.

Criticism and robustness

Our analysis contains weaknesses and constraints that have to be presented and accounted for. Both regressions is dependent on a series of assumptions that needs to be fulfilled in order to be precise, objective and without biases, that were not compiled with. Following, there is a review of the limitations of the econometric analysis and method, and comments on the robustness.

Omitted variables

Firstly, there are several variables that are omitted in the analysis, that could have contributed in explaining the variation in GDP growth. Due to MLR 4, variables correlated with both the dependent and independent variable (in our case, GDP growth and EU membership), should be included in the model. Else, the particular variables will be included in the error term, and the zero conditional mean will not be obtained. Such variables could be variables regarding capital market or institutional measures such as corruption or rule of law. Missing variables could have effects on the estimated impact other control variables have on GDP growth, biasing the value of the coefficients and thus our interpretation.

In addition, the EEA Agreement makes Norway, Iceland, and Liechtenstein part of the EU's internal market. As they are not fully worthy members, the two former nations are included as non-EU members in the MLR analysis. Liechtenstein is omitted due to missing values. However, one could argue that the EEA countries are enjoying many of the economic benefits of EU membership, without being formal members. Thus, this could lead to a omitted variable bias.

Sample

As previously stated, we have used cross-sectional data in our analysis. However, when making the data set, time series data was used in order to obtain the mean values of the specific variables in the MLR. The time series data were observations in chronological order, which breaks the assumption of random sampling (MLR 2). Thus, the use of time series data in the data processing part can be identified as a limitation in our analysis. Generally, when using time series data in multiple regression analysis, additional methods are required to ensure unbiasedness.

Another limitation to our data set is that the sample used for the MLR consists of only 39 observations, representing different countries. One can argue that this is not a sufficient amount of sample points to obtain a completely unbiased and strong analysis. When trying to increase the long-term relevance, we used the 10 year average instead of only one year. However, it is debatable, if this is enough in order to actually identify the long term pattern. Seen in retrospective, we could have used a larger pool of countries from the whole world, as non EU members, instead of only European countries. It could have provided us more significant values by having more to base the analysis on.

In addition, we had to omit some smaller European countries, such as Andorra and Malta, due to missing values. The exclusion of smaller countries might skew the results towards the characteristics of larger countries, which can lead to over- or underestimation of effects if the relationships between variables differ by country size.

Limited sample is also criticism we can direct towards the DID-analysis, due to the inclusion of only ten countries in the treatment group, and nine in the control group. As mentioned discussing the MLR, we could have chosen to include more countries in the control group. Also, the randomness in the DiD sample could be criticized. All the countries in the control group are East-European countries. It could be argued that all these countries have similar characteristics and therefore might have similar trends, which could lead to wrong estimation of the coefficients and limit our analysis.

No spillover effects

Regarding the DiD-analysis to discuss, the assumption of no spillover effects from the treated group to the control group is possible to discuss. The assumption states that the effect the countries get from becoming EU members should not affect the GDP growth in the countries not being EU members in our dataset. One can imagine that there could be certain impacts on other countries, by oneself joining EU. Increased export from being an EU member could also benefit countries outside the EU, and contribute to changes in their GDP growth. Also, changes in legislatures, i.e. requirements of defense budget or aid, could also be beneficial across borders.

EU criteria / certain countries

The fact that there might be differences between applying countries and countries not applying for EU membership, is something not accounted for in the analysis, and challenges the assumptions of especially the DiD analysis. Firstly, the consistency assumption requires that the treated group only receives treatment when $t \leq T_0$. In our case, there should be no treatment before period 1, that is 2004. Earlier, we assumed that it could be reasonable to start period 1 in 2005, as the implementation period takes time, and the countries were granted membership five months into 2004. On the other hand, this means that there could be some treatment before period 1, as the countries became members during 2004, which is in period 0. Furthermore, it may be contained that the EU members are getting treatment before they are officially becoming EU members in the sense that they are working to fulfill the requirements, which could have pretty big impacts on growth rate. In our DiD-analysis, the result was that the country in the treatment group in period 0 (before becoming members) had approximately 1.5% higher growth rate than the countries in the control group, which could indicate effects of fulfilling the criteria.

Also, in our control group, Turkey applied to join in 1987 and North Macedonia in 2004 (Hackett, 2024), meaning that these two countries could have gotten some kind of treatment, even though they shouldn't have. Montenegro filed its application in 2008, and Serbia and Albania in 2009, which also could have had an affection on their growth in advance. In other words, our control group is not necessarily totally untreated.

Furthermore, it is possible to argue that only certain types of country are becoming members, because they need a certain type of political and economic characteristics. If some countries are not obtaining these traits, they won´t gain membership. This could be a violation of the positivity assumption of the DiD, which states that all individuals have the same chance of getting treatment. Countries having the specific characteristics or being close obtaining them, will therefore have a higher probability of becoming a member of the EU.

The counterfactual assumption, or the parallel trend assumption, is also challenged by the thinking that there is a certain type of country gaining status as a member. The particular assumption requires that the trend of the two groups would have been the same if the treatment group were not getting treatment. In our case, the growth rate trend of the treated and control group should have been equal if the treatment group had not become EU members. Given the assumption that the two groups of countries differ in certain characteristics affecting growth, in sense that the treatment group for example is more politically stable or having less inflation, there could also be different trends in the GDP growth of the countries regardless of the membership. If so, the counterfactual analysis is broken, and our analysis is limited.

Goodness of fit

As previously explained, the model´s goodness of fit is found using the adjusted R^2. The adjusted R^2 in our complete model (model 7 from table 4) is 0.145. This number is not satisfying, given that our model only explains 14.5% of the variation in the dependent variable, GDP growth. It is not necessary important for the results, but it could be worth mentioning, also correlated to the discussion of omitted variables that might explain a bigger share of the variance.

The F-statistic in the MLR is, as presented, significant, even though the variables are not. There are several possible explanations, one being the possibility of multicollinearity. If this is the case, MLR3 is broken, which will bias the analysis. However, the correlation matrix provided in table 2 shows that there is no perfect correlation between the variables, meaning that multicollinearity most likely shouldn't be a problem. Another explanation could be that there are missing variables that should have been included, or non-linear terms not taken into account. Omitted variables is, as mentioned, a possible way of breaking the assumptions, namely MLR4. Also, small sample size could be a contributor to the given situation, as a small sample makes it difficult to obtain significant coefficients of each variable, but in total, the model could be significant. Again, we are seeing that limitations in our sample size could have an effect on the analysis.

Conclusion

This paper has aimed to provide insights into the relationship between EU membership and economic growth, seeking to determine whether the correlation is positive or negative and to identify the factors driving this correlation.

Initially, several theories and empirical studies were presented, chosen based on the EU's goals and its areas of influence within the member countries' economies. A DiD Model was used in order to obtain the differences in GDP per capita growth between EU members and non-members. Furthermore, a Multiple Regression Model was estimated, aiming to find the reasons behind possible growth for EU-members. The DiD analysis found significant evidence that EU members initially had a higher GDP per capita, but after joining, their GDP per capita was lower compared to non-members.

However, the latter was not statistically significant. The MLR-analysis provided mostly insignificant estimates of the different variables impact on GDP growth, with only the positive effect from export being significant. Some of the estimates were also surprisingly, contradicting the theory.

In light of our results, we conclude that there is insufficient evidence to draw definitive conclusions due to a lack of significance. The reasons for this insignificance could be numerous and complex, including potential omitted variables, a limited data sample, and the fact that countries might experience positive effects from EU membership even before officially joining, through the application process. We suggest that additional research is needed to further investigate the relationship between EU membership and economic growth, and if a relationship exists, to understand the underlying reasons. Future studies could benefit from a larger sample size, a longer time period, and adjustments for potential pre-membership effects.

Given our results, it's important to acknowledge that the goals of the EU and its economic integration may not prioritize economic growth as the primary objective. The EU's primary aims may include promoting peace, stability, and cooperation among member states, which could be equally, if not more, significant than economic outcomes. Nonetheless, the EU and the debate surrounding it will continue to be significant topics in public discourse in the coming years.

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