ERASMUS UNIVERSITY ROTTERDAM

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Bachelor Thesis [Financial Economics]

The impact of trade openness on economic growth in European Union countries

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Contents

Abstract

This study examines the effect of trade openness on economic growth in the countries of the European Union in the period 2007–2021. The countries of the European Union differ in the state of economic growth in which they find themselves. According to the theory, trade openness leads to higher economic growth. However, previous studies have found conflicting results. Previous studies have used several variables for trade openness. Therefore, this study examines the effect of trade openness on economic growth in the European Union in the period 2007–2021 and uses multiple variables for trade openness. As a data set, the 27 countries of the European Union were used for the period 2007 to 2021. The effect of trade openness on economic growth was examined using a regression analysis. A pooled ordinary least squares regression, fixed effect regression, and random effect regression were performed. Furthermore, a Hausman test was performed to determine which regression fits the data best. The results show that an increase in trade openness of 1 percent results in an increase in short-term economic growth of between 0.11837 and 0.15855 percent in the EU for the period 2007–2021. The results support the idea of implementing policies that stimulates international trading activities in order to promote economic growth in the short-run. However, the variables were non-stationary. This resulted in the first-order difference being taken out of the variables, and thereby the long-term interpretations were lost. Finally, it is not clear whether there is an endogeneity problem.

1 Introduction

Economic and social developments are important drivers for a country and can be obtained through economic growth. According to the theory, trade openness leads to economic growth. Smith (1996) and Ricardo (1817) suggest in their theories that trade openness leads to economic growth through absolute cost differences and comparative advantage. Schumpeter (1946) argues that innovation is the primary driver of economic growth and that trade openness ensures the diffusion of innovations. Thus, the theory states that trade openness promotes economic growth. However, empirical research shows conflicting results. Some studies have found a negative relationship between trade openness and economic growth (Kinfack & Bonga-Bonga, 2023; Shahbaz, Hye, Tiwari, & Leitao, 2013; Udeagha & Ngepah, 2020; C. Wang, Lim, Zhang, Zha, & Lee, 2020). Conversely, other research has found a positive relationship between trade openness and economic growth (Alexandre, Costa, Portela, & Rodrigues, 2021; Mohsin, Ullah, Iqbal, & Taghizadeh-Hesary, 2021; Qunxi, Dan, Yehui, Xinyue, & Ziqi, 2021; Salman, Long, Dauda, & Mensah, 2019). Consequently, the existing research presents contradictory results, perpetuating an ongoing debate on the relationship between trade openness and economic growth. Previous studies used different measurements to quantify trade openness.Therefore, this study will test multiple measures of trade openness and provide a comprehensive analysis of the effect of trade openness on economic growth in the European Union. The main question of this study is: what is the effect of trade openness on economic growth in the countries of the European Union in the period 2007 to 2021?

This research is socially relevant because the results can contribute to the formulation of strategies for policymakers. It is important to identify the drivers of economic growth in order to implement policies that promote economic growth. The results of this research can provide insight into the effect of trade openness on economic growth for the countries of the European Union, so that these results can provide more insight for new strategies. The results of this research can contribute to policies to combat or implement trade barriers. It is important for policymakers in the member states of the European Union to take into account in their poli-

cies whether it is more productive for these countries to be internationally active or whether it is more productive to produce only for the domestic market. The European Union is a global player in the field of trade. The member states of the European Union actively trade within the European Union but also outside the European Union (Union, 2023b). In 2021, the European Union was the world's second-largest exporter and third-largest importer of goods (Union, 2023a). 14.6 percent of the total global export of goods consisted of the export of goods from the European Union (Union, 2023a). This shows that a better understanding of the effect of trade openness on economic growth in the European Union is important not only for policymakers within the European Union but also for policymakers in the rest of the world.

This research is scientifically relevant because research into the effect of trade openness on economic growth in the European Union is scarce. Vhapi, Sadiku, and Petkovski (2015) conducted research into the effect of trade openness on economic growth in Southeast Europe. Scavia, De la Reguera, Olson, Pezoa, and Kristjanpoller (2021) researched the effect of cultural exports and imports on economic growth in 31 countries in Europe. This study differs from previous studies because it uses a new data set and a variety of trade openness metrics to ensure the robustness of this research. This research uses as a data set all countries of the European Union and all exports and imports. This ensures that this research contributes to the existing empirical literature. Furthermore, this study will add control variables that have been found to be significant in previous studies. This research is scientifically relevant because it investigates the effect of trade openness on economic growth for all countries of the European Union in a recent time period from 2007 to 2021 and uses a data set that has not yet been used in previous research.

The purpose of this research is to answer the central research question: What is the effect of trade openness on economic growth in European Union member countries in the period 2007–2021? The relationship between trade openness and economic growth in the European Union will be tested via a regression analysis. A pooled ordinary least squares regression, fixed effect regression, and random effect regression will be performed. A Hausman test will be performed to test which regression fits

the data best. Multiple variables will be used for trade openness to guarantee the robustness of this study.

The results of this study indicate a significant positive effect of trade openness on short-term economic growth in the countries of the European Union in the time period 2007–2021. According to these results, trade openness will increase short-run economic growth in the countries of the European Union. The results support the idea of implementing policies that stimulates international trading activities in order to promote short-term economic growth.

The structure of the remaining sections is as follows: Section 2 will explain the theory and empirical literature. Section 3 describes the data. Section 4 describes the methodology. Section 5 summarizes the results of this study and the main findings. Section 6 explains the conclusion and some propositions for further research.

2 Theory

2.1 Review of the theory

Over the years, theories regarding trade openness and economic growth have expanded. Smith (1996) was the first economist that wrote a theory about the effect of trade openness. Smith (1996) suggested that trade and competition are good for the efficiency of the economy. Through competition, resources are used most efficiently, and a market functions best. Ricardo (1817) expands on this theory and states that countries also benefit from trade through comparative advantage. Comparative advantage can be created by producing goods in which a country has a comparative advantage in, in order to produce them on a large scale and thereby lower costs. When countries trade these goods with each other, will this provide more economies of scale and therefore more efficiency in the market. Krugman (1992) extends this trade theory even further by saying that even countries that have no comparative advantage can still benefit from trade. When these countries produce on a larger scale, they can create economies of scale. This allows them to produce at a cheaper cost compared to other producers who do not produce on a large scale. Hussain and

Ahmad (2022) describes that factors such as labor and capital are not fairly distributed around the world. The Heckscher-Ohlin (H-O) theory describes that trade can help with this by getting countries to trade in their excess attributing factors, which can lead to equal factor prices. Schumpeter (1946) states that innovations cause a dynamic process of economic development. He states that if a country has a favorable innovation climate, this will cause the credit for the introduction of innovations to expand. Solow (1956) argues that the rate of technological progress, the savings rate, and population growth are the most important components of the growth model. Trade openness ensures the spreading of knowledge and, thereby, innovations and technology, following the endogenous growth theory, which promotes economic growth. It can therefore be argued that the imitation of these innovations by undeveloped countries entails lower costs compared to developed countries, which can contribute to the fact that undeveloped countries grow faster (Agudze & Olarewaju, 2022). However, this is not the case; developed countries have higher costs for the new technologies, but they also grow much faster (Agudze & Olarewaju, 2022). To conclude, the theory suggests that trade openness increases economic growth. Empirical research, however, produces contradictory findings.

2.2 Review of the empirical literature

Some previous research on the effect of trade on economic growth has already been done. Kinfack and Bonga-Bonga (2023) conducted research on the relationship between trade openness and economic growth in African countries. They use panel smooth transition regression with instrumental variables. They use different variables for trade openness. For trade openness, they use the variable trade share, import ratio, and export ratio. Their findings show that for low-income African countries, there is a negative relationship. On the other hand, for high-income African countries, they found a positive relationship (Kinfack & Bonga-Bonga, 2023).Le, Chang, and Park (2016) also uses several trade openness variables in their research. In addition to total exports as a percentage of GDP, they also use the import ratio and the export ratio as metrics for trade openness (Le et al., 2016).Udeagha and Ngepah (2020) investigated the effect of trade openness on economic growth and used countries in South Africa in the period 1960–2016 as their data set. They found that the effect of trade openness on economic growth differs in the short run and the long run. They found that trade openness promotes economic growth in the short term. However, trade openness hampered long-term economic growth in South Africa for the period from 1960 to 2016 (Udeagha & Ngepah, 2020).Qunxi et al. (2021) investigated the effect of trade openness on the quality of China's economic growth from 1994 to 2018. They run an ARDL model as well as a threshold model. They measure variable trade openness by taking the ratio of imports and exports over GDP. Their results show that trade openness and the quality of economic growth co-integrate. Their results show a positive relationship between trade openness and the quality of economic growth in the long run and in the short run. They suggest that trade openness leads to increased productivity, capital formation, and technological advancement (Qunxi et al., 2021).Salman et al. (2019) believes that trade openness drives economic growth. They examined this impact in Indonesia, South Korea, and Thailand, and they used fully modified ordinary least squares and dynamic ordinary least squares models to assess the impact on economic growth. They calculate economic growth as GDP and measure variable trade openness by taking the ratio of

imports and exports over GDP. Their results show that a 1 percent increase in trade openness increases economic growth by 6.5 percent (Salman et al., 2019).Mohsin et al. (2021) found that trade openness has a positive effect on economic growth in South Asia during their research. The following methods were used: panel ordinary least squares, fixed effect, quantile regression, and robust output regression. They define trade openness as the total import and export of goods and services as a percentage of GDP, and GDP growth is used as a proxy for economic growth. They discovered that increased trade openness leads to increased economic growth because an economy's competitiveness and productivity grow. They discovered a 6-percent relationship between economic growth and trade openness (Mohsin et al., 2021). Alexandre et al. (2021) discovered that trade openness had a positive impact on Portuguese economic growth on a regional scale. They calculate the variable trade openness by taking the ratio of exports to GDP. To calculate the variable regional economic growth, they take the growth rate of real GDP per capita. They employ the system-generalized moment method. They conclude that regional trade openness can provide greater resilience to shocks (Alexandre et al., 2021). C. Wang et al. (2020) found that trade had a negative impact on the economic growth of emerging countries from 2007 to 2016. They discovered that trade openness has a positive effect on economic growth in Eastern and Central Europe. Total exports plus imports of goods are calculated as a percentage of GDP to determine trade openness. GDP per capita is used to calculate economic growth. They argue that trade promotes economic growth by leveraging economies of scale and spreading techniques and knowledge (C. Wang et al., 2020). Shahbaz et al. (2013) studied the dynamic relationship between economic growth and trade openness in Indonesia from 1875 to 2011 using an ARDL bounds test. They found that trade openness had a negative impact on economic growth (Shahbaz et al., 2013). To conclude, the theory suggests that trade openness will improve economic growth. However, empirical research on the effect of trade openness on economic growth has shown contradictory results. This gives us the following hypothesis:

Hypothesis 1 *Trade openness significantly and positively impacts the economic growth of the member countries of the European Union.*

Previous studies have used different samples and different measures of trade openness. This study will test for control variables that have been found significant in previous studies and will use different measures of trade openness to ensure its robustness. There is no earlier empirical research that has examined the effect of trade openness on economic growth in the countries of the European Union in the time period of 2007–2021. Therefore, this research contributes to the literature. Table 1 shows an overview of the trade-growth nexus literature.

Table 1: An overview of the trade-growth nexus literature

Author(s)	**Time coverage**	**Econometric method**	**Openness measure**	**Country coverage**	**Causal relationship**
Kinfack and Bonga-Bonga (2023)	1970-2019	PSTR model	trade share, ratio export to GDP, ratio imports to GDP	38 African countries	- relationship for low-income countries and + significantly for upper-income countries
Qunxi et al. (2021)	1994-2018	ARDL model and a threshold model	exports plus imports as a percentage of GDP	China	+ effect on quality of economic growth in short and long term

Mohsin et al. (2021)	2000-2018	OLS, fixed effect, quantile regression, and robust output regression	exports plus imports as percentage of GDP	South Asian	+ relationship
Alexandre et al. (2021)	2008-2016	GMM	export to GDP ratio	Portugal	+ relationship
Udeagha and Ngepah (2020)	2000-2018	NARDL	Composite trade share	China and US	+ relationship for China and - relationship for US
C. Wang et al. (2020)	2007-2016	Static and dynamic spatial models	exports plus imports as percentage of GDP	Belt and Road Initiative countries	- relationship for emerging countries and + for East-Central Europe
Salman et al. (2019)	1990-2016	FMOLS and DOLS	export plus import as percentage of GDP	East Asian Countries	+ relationship
Shahbaz et al. (2013)	1875-2011	unit root test, ARDL bounds test	export plus import as percentage of GDP	Indonesia	- relationship

Note. PSTR means Panel Smooth Transition Regression model. ARDL means autoregressive distributed lag model. POLS means Pooled Ordinary Least Square model. LSDV means Least Square Dummy Variable model. FMOLS means Fully Modified Ordinary Least Squares model. DOLS means Dynamic Ordinary Least Squares model

3 Data

3.1 The data set

This study uses as a data set the 27 countries of the European Union for the period 2007–2021. Poland, the Czech Republic, Slovakia, Hungary, Estonia, Lithuania, Latvia, and Slovenia joined the European Union in 2004. Romania and Bulgaria joined the European Union in 2007. In 2023, there are 27 countries members of the European Union (Government, 2023). Therefore, these 27 countries are included in the data set, and only data from 2007 to 2021 is used in the study. The 27 countries of the European Union are Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden (Government, 2023). This study gathered the data from the World Development Indicators, which are published by the World Bank. Trade openness will be measured by multiple measurements to guarantee the robustness of this study. Trade share, (total exports plus total imports divided by gross domestic product) is the first measure to represent trade openness (Kinfack & Bonga-Bonga, 2023; Mohsin et al., 2021; Qunxi et al., 2021; Salman et al., 2019; Shahbaz et al., 2013; C. Wang et al., 2020). Export ratio (ratio export to gross domestic product) is the second measure to represent trade openness (Alexandre et al., 2021; Kinfack & Bonga-Bonga, 2023). Import ratio (ratio import to gross domestic product) is the third measure to represent trade openness (Kinfack & Bonga-Bonga, 2023). The dependent variable in this research is economic growth. Previous studies used Gross Domestic Product per capita growth as a calculation of

economic growth.(Alexandre et al., 2021; Kinfack & Bonga-Bonga, 2023; Mohsin et al., 2021; Qunxi et al., 2021; Salman et al., 2019; Shahbaz et al., 2013; Udeagha & Ngepah, 2020; C. Wang et al., 2020). Following these previous studies, this research will use Gross Domestic Product per capita growth as a calculation of economic growth. Furthermore, this research will include Financial Development, Inflation, Labor Force, and Technology as control variables following Raghutla (2020). Financial development is calculated by the domestic credit given to the private sector by banks as a ratio of GDP. (Raghutla, 2020). Inflation is measured as the Consumer Price Index, and technology is measured by the total sum of patent applications, so residents patent applications and non-residents patent applications (Raghutla, 2020). Table 2 shows the data sources and measurements of the variables that are used in this study.

Table 2: Data sources and measurement

Data	**Variable**	**Definition**	**Source**
Trade share	TO	Total exports plus total imports divided by Gross Domestic Product	Author
Export ratio	EX	Ratio export to Gross Domestic Product	WDI
Import ratio	IM	Ratio import to Gross Domestic Product	WDI
Economic growth	GROWTH	Annual percentage growth rate of GDP per capita	WDI
Financial development	FD	Domestic credit to private sector by banks (percentage of GDP)	WDI
Inflation	INFL	Consumer Price Index	WDI
Labor force	LF	Total labor force	WDI
Technology	TECH	sum of patent applications so residents patent applications and non-residents patent applications	WDI

Note. WDI stands for World Development Indicators

3.2 Cleaning the data

This study depends on the data available. For the years 2022 and 2023 the data was not available or the data had many missing variables. Therefore, this study uses a data set up to 2021. Bulgaria and Romania joined the European Union in 2007 (Government, 2023). Therefore, this study uses data from the period 2007 to 2021. The variables trade share, export ratio, import ratio, financial development, inflation, labor force, and technology are transformed to their natural logarithms to reduce the impact of outliers. The variable economic growth could not be transformed to the natural logarithm as it contains negative values. Transforming a variable to its natural logarithm to clean the data is a commonly used method, and previous research has done the same (Alam & Murad, 2020; Qunxi et al., 2021; Q. Wang & Zhang, 2021).

3.3 Relevant statistics

Table 3 shows the descriptive statistics of the variables used in this study. This research has economic growth dependent variable. The annual percentage growth rate of GDP per capita is used for the variable economic growth. The average of the annual percentage growth rate of GDP per capita equals 1,466 percent in the data set that is used. The standard deviation of economic growth in the sample is 0.481 percent. The labor force has the highest mean of the control variables; namely, it is shown that the average logarithmic form of the labor force is 15.094 people. The spread value of the logarithmic form of the labor force is 2.2863 people. The logarithmic form of technology has the highest standard deviation of the control variables, with a standard deviation of 1.986 patent applications. The logarithmic form of technology has a mean of 6.579 patent applications. Another control variable used in this study is inflation. The mean value of the logarithmic form of inflation is an index of 4.663, and the standard deviation is 1.646. Lastly, financial development is used in this study. The logarithmic form of financial development has an average of 4.356 percent, and a spread value of 0.481 percent. Trade share is calculated as the exports plus imports as a percentage of GDP in this study. The logarithmic form

of trade share has mean of an index of 25.476 and a standard deviation of 1.301. The logarithmic form of the export ratio has mean of an index of -0.553 and a standard deviation of 0.486. The import ratio is expressed as a ratio of GDP. The logarithmic form of the import ratio has mean of an index of 0.578 and a standard deviation of 0.439.

The variables have the same distribution as the normal distribution when the skweness is 0 and the kurtosis is 3 (Tachie et al., 2020). The results in table 3 suggest that this is not the case for all of the variables. The data in table 3 shows that the skewness of growth, inflation, labor force, and technology is negative. This shows on the left side of the distribution of these variables that the tail on this side is flatter compared to the normal distribution. The skewness of the variables trade share, export ratio, import ratio, and financial development is positive. This shows on the right side of this distribution that the tail on this side is flatter compared to the normal distribution. The data in table 3 reveals that the kurtosis of the variables growth, inflation, and technology is higher than 3, and the kurtosis of the variables trade share, export ratio, import ratio, financial development, and labor force is lower than 3. The kurtosis and skewness of these variables show that they are not normally distributed. The Jarque-Bera test rejects the null hypothesis that the variables are normally distributed for the variables trade share, export ratio, import ratio, growth, and inflation ($p<0.05$). Therefore, the Jarque-Bera test also reveals that the variables do not have a normal distribution.

Table 3: Relevant statistics

Statistic	**TO**	**EX**	**IM**	**GROWTH**	**FD**	**INFL**	**LF**	**TECH**
Min	23.049	-1.661	-1.468	-14.464	3.203	4.416	12.029	1.097
Mean	25.476	-0.553	0.578	1.466	4.356	4.663	15.094	6.579
Max	28.326	0.748	0.569	23.201	5.534	4.894	17.609	11.126
Std.dev	1.301	0.486	0.439	4.219	0.481	0.073	1.341	1.986
Skewness	0.067	0.385	0.396	-0.191	0.009	-0.005	-0.162	-0.151
Kurtosis	2.106	2.831	2.74	6.045	2.593	3.618	2.625	3.257
Jarque-Bera	0.0000	0.0094	0.0056	0.0000	0.1502	0.0425	0.0866	0.2726
Obs.	405	405	405	405	405	405	405	405

Note. This table shows the main characteristics of the variables and the probability of the Jarque-Bera test. Trade share is a proportions. Financial Development is a percentage. Inflation is an index. Labor Force is in persons. Technology is in pieces. Growth is in percentage. Trade share, export ratio, import ratio, financial development, labor force, and technology are in their natural logarithm

3.4 Correlation and no perfect multicollinearity

Table 5 shows the correlation matrix between the different explanatory variables, the tolerance, and VIF values. The data in table 5 show that trade share is positively correlated with financial development, labor force, technology, and inflation. This means that the variables move in the same direction visually. When one variable rises, the other variable rises as well. Furthermore, technology appears to be negatively correlated with inflation, and positively correlated with financial development. Lastly, labor force participation, and inflation are negatively correlated with financial development. Table 5 also shows the tolerance and VIF values of the different variables. These values indicate if there is a collinearity or multicollinearity problem between the variables. Tachie et al. (2020) states that variables with a VIF value between 0.2 and 5 do not have a problem with multicollinearity. The variables trade share, financial development, labor force, and inflation have a VIF value between 0.2 and 5 and do not have a problem with multicollinearity. VIF values that are above

10 imply that there is considerable multicollinearity and that a correction is required (CFI, 2022). A tolerance less than 0.1 indicates that substantial multicollinearity exists and must be corrected (CFI, 2022). Therefore, the VIF and tolerance findings indicate that there are no issues with multicollinearity or collinearity.

Table 4: Correlation matrix and multicollinearity test

Statistic	**TO**	**FD**	**LF**	**TECH**	**INFL**
Correlation matrix					
TO	1.0000				
FD	0.1366	1.0000			
LF	0.7906	-0.0308	1.0000		
TECH	0.8676	0.0855	0.8787	1.0000	
INFL	0.0683	-0.2518	-0.0136	-0.0314	1.0000
Multicollinearity					
Tolerance	0.224018	0.843354	0.210643	0.144402	0.881827
VIF	4.46	1.19	4.75	6.93	1.13

Note. This table shows a correlation matrix and the results of the Tolerance and VIF test. Trade share, export ratio, and import ratio are proportions. Economic growth is in us dollars. Financial Development is a percentage. Inflation is an index. Labor Force is in persons. Technology is in pieces.

3.5 Non-stationarity

This study will test for the non-stationarity of the variables. When there is non-stationarity, will this result in a shock in the past staying in the process and being permanent. This will result in the expectation of what the process is going to look like in the future changing and the fundamental assumption about time series being violated (Quaedvlieg, 2022c). The consequence of non-stationarity is spurious regression (Quaedvlieg, 2022c). This study will test for non-stationarity using a unit root test. If it is non-stationary, then this study will change the data to make it stationary. This study performed a Fisher-type unit root test on panel data (Choi,

2001). The null hypothesis states that all panels contain unit roots. For the variables trade share, export ratio, import ratio, financial development, inflation, labor force, and technology, the null hypothesis could not be rejected, which stated that these variables were non-stationary. After taking the first-order difference of these variables, they became stationary. However, by differencing the data, the cross-sectional variables that differ cross-sectionally but not over time lose their value, which results in losing long-run interpretations (Quaedvlieg, 2022c).

Table 5: Fisher-type unit-root test results

	At level		**At first difference**	
Variables	**Statistic**	**P-value**	**Statistic**	**P-value**
Augmented dickey fuller test				
TO	39.8511	0.9246	501.128***	0.0000
EX	68.38	0.0901	447.181***	0.0000
IM	77.9634	0.1181	529.554***	0.0000
FD	30.5467	0.9958	179.854***	0.0000
INFL	11.5768	1.0000	91.6269***	0.0011
LF	38.7608	0.9414	184.499***	0.0000
TECH	44.9692	0.8045	196.202***	0.0000
GROWTH	284.182***	0.0000	-	-

Note. ***, **,* indicate statistically significant at 1 percent level, 5 percent level, and 10 percent level.

4 Methodology

4.1 Regression

This research examines the effects of trade openness on economic growth and covers 27 countries from the European Union over a period of 2007 to 2021. The data for this study consists of different countries and different years. As a result, the data include a cross-sectional part and a time-dimension part, which are also called panel data. Following Mohsin et al. (2021), this study will perform a Pooled Ordinary Least Squares, Fixed Effect regression, and Random Effect regression as the data consists of panel data. First, a Pooled Ordinary Least Squares regression will be performed. This study conducted multiple measures of trade openness to examine the robustness of the results. The Pooled Ordinary Least Squares regression with trade share as a measure of trade openness is shown in equation 1. Additionally, equation 2 shows the Pooled Ordinary Least Squares regression with the export ratio as a measure of trade openness. The Pooled Ordinary Least Squares regression with the import ratio as a measure of trade openness is shown in equation 3.The variables trade share, export ratio, import ratio, financial development, inflation, and technology were transformed to their natural logarithms for the convenience of the parameters. Logarithmic transformation of the variables is a commonly recognized method, and several studies have done so (Alam & Murad, 2020; Qunxi et al., 2021; Q. Wang & Zhang, 2021). The first-order difference is taken from trade share, export ratio, import ratio, financial development, inflation, labor force, and technology to make it stationary. This study will also perform a fixed effect regression and a random effect regression in addition to the Pooled Ordinary Least Squares regression.

$$GROWTH_{i,t} = \alpha_0 + \alpha_1 \Delta lnTO_{i,t} + \alpha_2 \Delta lnFD_{i,t} + \alpha_3 \Delta lnINFL_{i,t} + \alpha_4 \Delta lnLF_{i,t} + \alpha_5 \Delta lnTECH_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$GROWTH_{i,t} = \beta_0 + \beta_1 \Delta lnEX_{i,t} + \beta_2 \Delta lnFD_{i,t} + \beta_3 \Delta lnINFL_{i,t} + \beta_4 \Delta lnLF_{i,t} + \beta_5 \Delta lnTECH_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$GROWTH_{i,t} = \lambda_0 + \lambda_1 \Delta lnIM_{i,t} + \lambda_2 \Delta lnFD_{i,t} + \lambda_3 \Delta lnINFL_{i,t} + \lambda_4 \Delta lnLF_{i,t} + \lambda_5 \Delta lnTECH_{i,t} + \varepsilon_{i,t} \quad (3)$$

In the regression 1, 2, and 3 correspond Δ to the differential operator of first order. Additionally, GROWTH corresponds to economic growth. Furthermore, i implies the different countries (i=1,2 ... ,27) and t implies the different years (t=2007, 2008,..., 2021). $\alpha_0, \beta_0, \lambda_0$ implies the constant terms. $\alpha_i, \beta_i, \lambda_i$ indicates the coefficients of the variables for trade openness, where TO, EX, and IM stand for the different measurements for trade openness, and for the control variables, Financial Development, Inflation, Labor Force, and Technology. $\varepsilon_{i,t}$ correspond to the error term.

4.2 Heteroskedacity

The White-test will be performed in this study to test if there is a problem with heteroskedacity (White, 1980). When there is heteroskedacity, the default standard errors are not valid anymore (Quaedvlieg, 2022e). The White standard errors could solve this problem and give better estimations when there is heteroskedacity (Quaedvlieg, 2022e). The White test compares the null hypothesis of homoskedacity versus the alternative hypothesis of heteroskedacity (Quaedvlieg, 2022e).

The null and alternative assumptions are described as:

$$H_0 : \sigma_i^2 = \sigma^2$$

$$vs$$

$$H_1 : \sigma_i^2 \neq \sigma^2$$

4.3 Autocorrelation

A Wooldridge test will be performed in this study to test for autocorrelation in panel data (Woolridge, 1994). The coefficients are still consistent if the errors are correlated (Quaedvlieg, 2022a). However, there is a small sample bias, and the default standard errors are no longer valid (Quaedvlieg, 2022a). The Wooldridge test tests the null hypothesis of no first-order autocorrelation (Woolridge, 1994).

4.4 Hausman-test

With a fixed effect regression and a random effect regression, time-invariant features can be extracted from data without first recognizing the previous causes (Quaedvlieg, 2022d). As a result, the coefficient is not influenced by time-invariant properties (Quaedvlieg, 2022d). Therefore, in addition to the Pooled Ordinary Least Squares regression, this study will also perform a fixed effect regression and a random effect regression. The Hausman-test will be performed in this study to decide if the Fixed Effects regression or the Random Effects regression is more effective (Hausman, 1978). When the cross-section-specific error term and the explanatory variable are correlated with each other, the fixed effects regression is suitable (Quaedvlieg, 2022d). On the contrary, if the cross-section-specific error term and the explanatory variable are not correlated with each other, then the Random Effects regression is more effective (Quaedvlieg, 2022d). Under the null hypothesis are the fixed effects regression and the random effects regression consistent (Quaedvlieg, 2022d). However, the null hypothesis of the Hausman test states that the Random Effects regression is more efficient compared to the Fixed Effects regression (Quaedvlieg, 2022d). Under the alternative hypothesis, the Fixed Effects regression is still consistent, whereas the Random Effects regression is inconsistent (Quaedvlieg, 2022d).

4.5 Control variables and expected signs of the variables

Financial Development, Inflation, Labor force, and Technology are included as control variables in the models. According to the theory, labor is very important and

indispensable in production. The labor force is an important driver of economic growth because, without labor, an economy cannot produce anything (Islam, Alsaif, & Alsaif, 2022; Omri & Kahouli, 2014). In addition, the neoclassic growth theory argues that when there is a low labor force, this ensures that there is also a shortage of labor, which nevertheless slows down economic growth (Islam et al., 2022; Omri & Kahouli, 2014). As a result, it is expected that the labor force will have a positive coefficient. Udeagha and Ngepah (2020) states that financial development may affect growth in two main ways, namely through capital accumulation and technical innovation. Therefore, financial development can promote the development of new products and processes, which in turn results in economic growth (Udeagha & Ngepah, 2020). Additionally, the economic growth theory states that more financial development leads to more savings mobilization, more innovation in technologies, which in turn result in economic growth (Udeagha & Ngepah, 2020). Therefore, it is expected that financial development will have a positive coefficient. Modern society is unable to function without technology (Udeagha & Ngepah, 2020). New technologies could increase the productivity of employees, and higher productivity ultimately leads to economic growth (Udeagha & Ngepah, 2020). Economic growth theory suggests a positive effect of technology on economic growth (Udeagha & Ngepah, 2020). Therefore, it is expected that technology will have a positive coefficient. Higher inflation will cause less investment, and if there is less investment, this will decrease economic growth (Omri & Kahouli, 2014; Tenzin, 2019). As a result, the expected sign for inflation is positive. Trade openness is measured based on trade share, import ratio, and export ratio. Previous research has found different relationships between trade openness and economic growth. Some researchers have found a positive relationship (Alexandre et al., 2021; Mohsin et al., 2021; Qunxi et al., 2021; Salman et al., 2019), while others find a negative relationship or no robust evidence (Kinfack & Bonga-Bonga, 2023; Shahbaz et al., 2013; C. Wang et al., 2020).

4.6 Endogeneity

A big problem that might exist is endogeneity. Endogeneity can be caused by a variety of factors. Omitted variable bias is one factor contributing to endogeneity. When associated and explanatory factors are left out, omitted variable bias results, rendering the Ordinary Least Squares inconclusive (Quaedvlieg, 2022b). The second type of endogeneity is attenuation bias. Attenuation bias occurs when explanatory variables are measured incorrectly, and this is included in the residual (Quaedvlieg, 2022b). The final cause of endogeneity is simultaneity bias. Simultaneity bias occurs when there is an effect of trade openness on economic growth, but at the same time there is also an effect of economic growth on trade openness (Quaedvlieg, 2022b). Endogeneity is a significant issue that should be addressed when computing regression critical values (Quaedvlieg, 2022b). However, it is not possible to test for endogeneity (Quaedvlieg, 2022b).

5 Results

5.1 Pooled Ordinary Least Squares regression

This study performed a White-test and a Pooled Ordinary Least Squares regression. Table 6 shows the findings of the White-test and Pooled Ordinary Least Squares regression. The dependent variable in this research is economic growth, which is calculated by the annual percentage growth rate of GDP per capita. Model 1 included as measure for trade openness the trade share variable; these results are shown in column 2 in table 6. Model 2 included as measure for trade openness the export ratio variable; these results are shown in column 3 in table 6. Model 3 included as measure for trade openness the import ratio variable; these results are shown in column 4 in table 6. All the models included financial development, inflation, the labor force, and technology as control variables. The logarithm and first difference are taken from the variables trade share, export ratio, import ratio, financial development, inflation, labor force, and technology. The results in table 6 reveal that the null

of the White-test is rejected for all three models ($p<0.05$). This suggests that the default standard errors are not valid anymore, as there could be a problem with heterokedacity (Quaedvlieg, 2022a). Therefore, robust standard errors are used in the regressions to account for heteroskedasticity.

Table 6: Results Pooled OLS regression with the different measures for trade openness

Dependent variable: **Economic growth**	**Model 1 (Trade share)**	**Model 2 (Export ratio)**	**Model 3 (Import ratio)**
$\Delta ln(Tradeshare)$	14.946^{***}		
	(1.573)		
$\Delta ln(Exportratio)$		11.837^{***}	
		(3.242)	
$\Delta ln(Importratio)$			14.505^{***}
			(0.138)
$\Delta ln(Financial-$	-23.961^{***}	-28.414^{***}	-27.654^{***}
development)	(3.076)	(3.814)	(3.637)
$\Delta ln(Inflation)$	-6.057	28.582^{*}	26.875^{*}
	(14.121)	(16.171)	(15.556)
$\Delta ln(Laborforce)$	19.786^{*}	28.027^{**}	24.058^{*}
	(11.552)	(13.101)	(13.204)
$\Delta ln(Technology)$	0.596	0.612	0.843
	(0.822)	(0.827)	(0.795)

Constant	0.438	0.027	0.15
	(0.259)	(0.289)	(0.286)
White-test	0.000	0.000	0.000

Note. ***, **,* indicate statistically significant at 1 percent level, 5 percent level, and 10 percent level. Standard errors are in the parentheses. Model 1 use trade share as a measure for trade openness. Model 2 use the export ratio as a measure for trade openness. Model 3 use import ratio as a measure for trade openness. Δ correspond to the differential operator of first order. Robust standard errors are used.

The results of model 1 in table 6 show that a one percent increase of trade share leads to an increase in short-run economic growth of 0.14946 percent. Model 2 in table 6 shows that an increase in the export ratio of 1 percent leads to an increase in short-run economic growth of 0.11837 percent. The results of model 3 in table 6 show that when the import ratio increases by 1 percent, this increases short-run economic growth by 0.14505 percent. The conclusion that could be drawn from the presented results in table 6 with respect to the hypotheses is the following: the findings of the Pooled Ordinary Least Squares regressions with the multiple measurements for trade openness all have a significant and positive effect on the economic growth of countries from the European Union in short terms. This is in line with previous studies (Alexandre et al., 2021; Mohsin et al., 2021; Qunxi et al., 2021; Salman et al., 2019). The results of the effect of the various measures of trade openness on economic growth suggest that trade openness promotes economic growth in the short term. The results support the idea of implementing a policy that encourages trading activity. However, the first-order difference of the variables were taken due to non-stationarity, which resulted in losing long-term interpretations. The results show that when trade openness increases by 1 percent, economic growth increases by between 0.11837 and 0.14946 percent by using different measures of trade openness. This effect is lower than the effect found by Salman et al. (2019) and Mohsin et al. (2021). Salman et al. (2019) found a 6.5 percent relationship between trade openness and economic growth, and Mohsin et al. (2021) found a 6 percent relationship between trade openness and economic growth. Vhapi et al. (2015) also found a positive relationship between

trade openness and economic growth in southern and eastern Europe. However, the effect they found was not significant. The results of in table 6 show a positive significant relationship between trade openness and economic growth in the short run. Additionally, the findings of the effect of financial development, inflation, labor force, and technology on economic growth are shown in table 6. The results show that a one percent increase in financial development results in a 0.23961 significant decrease in the short-run economic growth in model 1. The findings of model 2 show that in the short run, a one percent increase in financial development results in a 0.28414 percent decrease in economic growth. In model 3, a 1 percent increase in financial development results in a decrease in short-run economic growth of 0.27654 percent. In all three models, financial development has a significant negative effect on short-term economic growth. This is in contrast with Li and Wei (2021). Li and Wei (2021) states that a higher level of financial development could result in a lower corporate borrowing cost because of a higher level of investment and a higher factor productivity, which will result in higher economic growth. The effect of labor force is also significant in all 3 models. The results in table 6 show that a 1 percent increase in the labor force in model 1 results in a 0.19785 percent increase in short-term economic growth. In model 3, this effect is 0.24058 percent, and in model 2, this effect is 0.28027 percent. This is in line with the results of Omri and Kahouli (2014). Omri and Kahouli (2014) found a positive and significant effect of the labor force on economic growth. The effect of technology on economic growth is positive in all three models. However, the effect of technology on economic growth is not significant in all three models. The coefficient of inflation in models 2 and in model 3 is positive and significant. However, the coefficient of inflation became insignificant in model 1. Furthermore, the sign shifts when the measure of trade openness changes. The sign of the coefficient of inflation shifts from model 1 to the inverse in models 2 and 3. These findings indicate that the sign of the coefficients of inflation is dependent on the measure of trade openness. The sign of the coefficient of inflation is inverse when trade share is used as a measure for trade openness, compared to when the export ratio or import ratio is used as a measure for trade openness. This change in the sign of the coefficient of inflation when changing the measurement of trade

openness could be due to an endogeneity problem. For example, there could be omitted variable bias. It could be the case that a variable is not included in the Pooled Ordinary Least Squares regression, but this excluded variable has an effect on the level of trade openness and the level of inflation. In particular, there may be country-specific variables that have an effect on inflation and the level of trade openness. Therefore, this study also performed a fixed effect regression and a random effect regression to test for these time-invariant factors.

5.2 Fixed Effects model and Random Effects model

This study performed both fixed-effects and random-effects regression. To test for autocorrelation in the panel data, a Woolridge test was used. A Hausman test was also performed to determine whether the random effects regression or the fixed effects regression best fit the data. The results of the Wooldridge and Hausman tests are shown in table 7. According to the results in table 7, the null hypothesis of the Hausman-test could not be rejected in all models ($p>0.05$). The random effects regression is more efficient than the fixed effects regression under the null hypothesis of the Hausman-test. As a result, the random effects regression results are shown in table 7. According to the results in table 7, the null hypothesis of no autocorrelation of the Woolridge-test is rejected for all three models ($p< 0.05$). As a result, robust standard errors are used in the regressions. Model 1 included trade share (measured as import plus export as a percentage of GDP) as a measure of trade openness; the results are shown in column 2 of table 7. Model 2 included the export ratio (as a percentage of GDP) as a measure of trade openness; the results are shown in column 3 of table 7. Model 3 included an import ratio (as a percentage of GDP) as a measure of trade openness; the results are shown in column 4 of table 7. Financial development, inflation, labor force, and technology are included as control variables in the regressions and are shown in column 1 of table 7. Economic growth, as measured by the annual percentage growth rate of GDP per capita, is the dependent variable in all of the models. The logarithm and first difference are taken from the variables trade share, export ratio, import ratio, financial development, inflation,

labor force, and technology.

Table 7: Results of the Woolridge-test, Hausman-test, and corresponding Random Effects regression and Fixed Effects regression

Dependent variable: **Economic growth**	**Model 1: RE (Trade share)**	**Model 2: RE (Export ratio)**	**Model 3: RE (Import ratio)**
$\Delta ln(Tradeshare)$	14.863***		
	(1.42)		
$\Delta ln(Exportratio)$		12.919***	
		(3.351)	
$\Delta ln(Importratio)$			15.855***
			(3.242)
$\Delta ln(Financial-$	-23.93^{***}	-28.03^{***}	-26.607^{***}
development)	(3.524)	(5.262)	(4.991)
$\Delta ln(Inflation)$	-15.974	16.093	12.221
	(14.448)	(14.476)	(14.303)
$\Delta ln(Laborforce)$	31.485*	39.511**	36.907**
	(16.436)	(17.398)	(17.112)
$\Delta ln(Technology)$	0.806	0.898	1.174*
	(0.871)	(0.924)	(0.699)
Constant	0.559	0.208	0.372
	(0.339)	(0.362)	(0.362)

Wooldridge-test	0.000	0.000	0.000
Hausman-test	0.2428	0.4874	0.2774

Note. ***, **,* indicate statistically significant at 1 percent level, 5 percent level, and 10 percent level. Standard errors are in the parentheses. Model 1 use trade share as a measure for trade openness. Model 2 use the export ratio as a measure for trade openness. Model 3 use import ratio as a measure for trade openness. RE correspond to Random Effects model. Δ correspond to the differential operator of first order. Robust standard errors are used.

According to the findings in table 7, trade share, as a measure of trade openness, has a positive and significant effect on economic growth in the short run. In the Pooled Ordinary Least Squares regression, the effect of trade share was also positive and significant, yielding consistent results. In the Pooled Ordinary Least Squares regression, a one percent increase in trade share results in a 0.14946 percent increase in economic growth in the short run. In the random effect regression, this is reduced to 0.14863 percent. The findings in table 7 show that the export ratio, as a measure of trade openness, has a positive and significant short-run effect on economic growth. In the Pooled Ordinary Least Squares regression, the effect of the export ratio was also positive and significant, yielding consistent results. In the Pooled Ordinary Least Squares regression, a one percent increase in trade share results in a 0.11837 percent increase in economic growth in the short run. In the random effect regression, this is increased to 0.12919 percent. The results in table 7 show that the import ratio, as a measure of trade openness, has a positive and significant short-run effect on economic growth. In the Pooled Ordinary Least Squares regression, a one percent increase in trade share results in a 0.14505 percent increase in economic growth in the short run. In the random effect regression, this is increased to 0.15855 percent. The findings of the Random Effect regressions with multiple measurements for trade openness all have a significant and positive effect on the economic growth of countries in the European Union in short terms. According to the findings, trade openness increases economic growth by around 0.11837 percent and 0.15855 percent in the

short run. The results in table 7 show that financial development has a negative and significant effect on economic growth in all three models in the short run. In contrast, Udeagha and Ngepah (2020) discovered a positive relationship between financial development and economic growth. Model 1 shows that a one percent increase in financial development decreases the annual percentage growth rate of GDP per capita by 0.2393 percent in the short run. The results of model 2 shows a 0.2803 percent relationship between financial development and economic growth in the short run, and in model 3 this relationship is 0.26607 percent. The effect of the labor force on economic growth is positive and significant in all three models in the short run. According to the results, labor force increases economic growth by around 0.31485 percent and 0.39511 percent in the short run, respectively. This is in line with the argument made by Omri and Kahouli (2014), who cites the labor force as a key factor in economic growth because an economy cannot function without labor. In model 3, the effect of technology became significant when compared to the Pooled Ordinary Least Squares regression. According to Model 3, a one percent increase in technology results in a 0.01174 percent increase in economic growth in the short run. This is consistent with Udeagha and Ngepah (2020) assertion that new technologies can increase employee productivity, and higher productivity leads to economic growth. In both models 1 and 2, this effect is still positive, but it has become insignificant. This demonstrates that the impact of technology is dependent on the trade openness measurement and that this impact can be influenced by factors that differ across trade openness measurements. According to the results in table 7, the effect of inflation is insignificant for all three models. Furthermore, when trade share is used as a measure of trade openness, the sign of the coefficient of inflation is inverse when compared to when the export ratio or import ratio is used as a measure of trade openness. The same was true for the Pooled Ordinary Least Squares regression. This shift in the sign of the coefficient of inflation could be due to an endogeneity issue.

5.3 Endogeneity

Financial Development, Inflation, Labor Force, and Technology have been incorporated as control variables into the models to address the endogeneity issue. However, the omitted variable bias may still exist. There could still be variables that are not time-invariant and are not taken into account in the regression of this research but are correlated and explanatory. Furthermore, there could also be a simultaneity bias problem. One could argue that countries with stronger economic growth are also more open to trade, which may lead to a simultaneity bias. With simultaneity bias, is economic growth an explanatory variable for trade openness.

6 Conclusions

This study did research on the effect of trade openness on economic growth in the 27 countries of the European Union for the period 2007–2021. This study performed a Pooled Ordinary Least Squares regression, a Fixed Effects regression, and a random effects regression. Trade openness is measured by three different criteria to guarantee the robustness of this study. The first measure of trade openness is trade share, which is measured as exports plus imports as a percentage of Gross Domestic Product. According to the findings, the impact of trade share on economic growth was found to be positively significant. Short-term economic growth increases by 0.14863 percent for every one percent increase in trade share. The export ratio, which is calculated as exports as a percentage of GDP, is the second indicator of trade openness. The results show a significant positive relationship between the export ratio and economic growth. For every one percent increase in the export ratio, short-term economic growth increases by 0.12919 percent. The import ratio, which is calculated as imports as a percentage of GDP, is the third indicator of trade openness. The import ratio has a significant positive impact on economic growth, according to the findings. In the short run, a one percent increase in the import ratio increases economic growth by 0.15855 percent. The conclusion to the hypothesis is that trade openness has a significant and positive effect on the economic growth of countries

in the European Union in the short run. This study uses the 27 countries of the European Union for the period 2007–2021. The findings support the importance of trade openness for increasing economic growth in the short run in these countries within the European Union. The results support the idea to implement policies that stimulate international trade activities in order to stimulate short-term economic growth.

As control variables, financial development, inflation, labor force, and technology are included in the different models. It has come to light that financial development significantly decreases economic growth in the short run in all the different models. Furthermore, the labor force significantly positive affects economic growth in the short run. Also, technology has a positive effect on economic growth in the short run. The findings indicate that the effect of inflation is dependent on the different measurements of trade openness, which could be because of omitted variable bias. There could be variables that are not included in the regression that have an effect on the level of trade openness and the level of these control variables. Additionally, it is unclear whether there is simultaneity bias. It is unclear whether countries of the European Union that are more open experience higher economic growth as a result or whether countries of the European Union that have a higher economic growth are therefore more open. Further research could include more control variables and thereby conduct more in-depth studies on the effect of trade openness on economic growth. Further research could also use other econometric tools to identify the endogeneity problem. Lastly, the variables used in this study were non-stationary, which resulted in the first-order difference of these variables being taken, which resulted in losing long-run interpretations. Further research could use other econometric tools to determine whether there is a long-term causal relationship.

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7 Appendix