

Research Article / Araştırma Makalesi

## THE IMPACT OF E-COMMERCE ON INTERNATIONAL TRADE: A RESEARCH FOR THE EUROZONE

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### ABSTRACT

In the 21st century, with the rapid development of technology and the increase in globalization, the effects of these advancements have begun to be observed in commercial activities as well. With the advancement of information and communication technologies, internet usage has also increased. As the internet has developed, the impact of digitalization on trade has started to become evident, leading to the growth of e-commerce. Through e-commerce, companies have begun to reach customers all over the world and conduct their commercial activities via the internet. E-commerce, which operates independent of time and place, also contributes to the development of international trade. This study was conducted to determine the impact of e-commerce on international trade in the Eurozone countries, which include both developed and developing country groups. Additionally, the effects of per capita gross domestic product and the internet on international trade were also investigated. The study analyzed the data from Eurozone countries for the years 2010-2021 using the panel ARDL model. The results obtained from the analysis indicate a negative and significant relationship between exports and e-commerce in the long term, and a positive and significant relationship between exports and both per capita gross domestic product and the internet in the long term.

**Keywords:** E-commerce, International Trade, Internet, Panel Data Analysis, Export

**JEL Classification:** F10, C33, L81.T

## E-TİCARETİN ULUSLARARASI TİCARETE ETKİSİ: EURO BÖLGESİNE YÖNELİK ARAŞTIRMA

### ÖZET

21. yüzyılda teknolojinin hızla gelişmesi ve küreselleşmenin artmasıyla birlikte bu gelişmelerin etkisi ticari faaliyetlerde de görülmeye başlanmıştır. Bilgi iletişim teknolojilerinin gelişmesiyle birlikte internet kullanımı da artmıştır. İnternetin gelişmesine bağlı olarak ticarete dijitalleşmenin etkisi görülmeye başlanmış ve e-ticaret gelişmiştir. E-ticaret ile birlikte firmalar internet aracılığıyla dünyanın her yerindeki müşterilerine ulaşmaya ve ticari faaliyetlerini gerçekleştirmeye başlamışlardır. Zaman ve mekandan bağımsız olan e-ticaret aynı zamanda ticaretin uluslararası gelişimine de katkı sağlamaktadır. Bu çalışma gelişmiş

\* This study was produced from the master's thesis titled "The Impact of E-Commerce on International Trade: Research on the EURO Region" prepared under the supervision of Assoc. Prof. Çağatay Başarır at Bandırma Onyedi Eylül University, Institute of Social Sciences on 17.07.2023.

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*ve gelişmekte olan ülke gruplarının bir arada olduğu EURO bölgesi ülkelerinde e-ticaretin uluslararası ticarete etkisini tespit etmek amacıyla yapılmıştır. Aynı zamanda kişi başına gayri safi yurtiçi hasıla ve internetin uluslararası ticarete etkileri de araştırılmıştır. Panel ARDL modelinin kullanıldığı çalışmanın EURO Bölgesi ülkelerinin 2010-2021 yıllarına ait verileri analiz edilmiştir. Analizden elde edilen sonuçlar, ihracat ile e-ticaret arasında uzun dönemde negatif ve anlamlı bir ilişki olduğunu, ihracat ile kişi başına düşen gayrisafî yurt içi hasıla ve internet arasında uzun dönemde pozitif ve anlamlı bir ilişki olduğunu göstermektedir.*

**Anahtar Kelimeler:** E-Ticaret, Uluslararası Ticaret, İnternet, Panel Veri Analizi, İhracat  
**JEL Sınıflandırması:** F10, C33, L81.T

## 1. Introduction

Radical changes in fields such as communication, transportation, technology infrastructure, trade, finance are affected by the recent developments in the information technologies and spreading globalization especially in the last two decades. Internet technology, as a result of the rapid strides in information communication technologies, is considered as a milestone. Moving forward together with the widespread internet use, brand new structure is built involving the individuals as well as companies and states. First and foremost, economic factors started to prefer to make their transactions via internet using technological devices. In the light of these developments, the concept of e-commerce is introduced as a new and springboard method both for the business processes, internet environment and online commerce.

Events on a global scale have led to this point globally. Most remarkable event is the contingency of coronavirus epidemic. During the time of coronavirus epidemic, which started in Wuhan, China, in 2019 and spread all over the world in a short time, countries had to implemented quarantine measures rapidly. Quarantine measures changed some concepts forever. Most of the enterprises in the global and local chain experienced disruptions in their business and supply processes. However, at this point, e-commerce has created an alternative opportunity for businesses and consumers. When consumers are confined to their homes and cannot go out, shopping online has ceased to be a luxury and has become a necessity. Businesses that have the necessity to meet this demand and want to get through the pandemic period unharmed have also preferred to move forward with e-commerce. In this regard, businesses without any e-commerce activities or any websites have quickly turned to these areas and started trading online. In this process, with the increase in the time spent at home and the transition to remote working and distance learning, people had to do their shopping online. In the Covid-19 Pandemic period, the use of e-commerce has become widespread and perhaps the technological developments that were expected to happen in this field 4-5 years later have been observed sooner than anticipated. In the light of these developments, a significant increase in e-commerce is observed and brand-new areas have been introduced in the e-commerce sector.

Transaction is completed online over the internet network instead of mutual interaction when E-commerce is considered. Widespread use of internet has declined the importance of physical distance that hinders the development of international trade. E-commerce, referring to online shopping over the internet, has enabled international trade to be carried out independently of space and time, providing businesses with the ability to reach customers all over the world.

It offers consumers the opportunity to shop from all stores in the world. In particular, services such as digital music, games and movies, which do not require physical delivery and can be bought, sold and delivered over the internet, have a positive impact on the development of international trade by providing significant cost and time advantages (Nair, 2017: 328).

E-commerce is a sector that has developed and will continue to develop with advances in technology and information systems. However, countries vary in terms of income, education, infrastructure, internet usage, and their levels of adaptation to technological developments. Developed countries adapt quickly to technological advancements due to high level of investment in infrastructure and technology. On the other hand, developing countries tend to adapt to technological developments later as they go through the process of imitating and disseminating technology. This leads to differences in technology usage among countries. E-commerce is a new trading method that has emerged with the development of information and communication technologies and has the potential to increase international trade. However, differences in the level of development and investment in information and communication technologies among countries lead to variations in the development of e-commerce among country groups. As internet usage becomes more widespread and internet infrastructure projects increase in developing countries, e-commerce activities will also increase. Consequently, the competition of developing countries with advanced countries in international trade will increase. In this study, the impact of e-commerce on international trade in the EURO Zone countries, which include both developed and developing country groups, is analyzed using panel ARDL model based on data from 2010 to 2021. However, there are some difficulties in accessing e-commerce data for certain countries, and the study is limited to EURO Zone countries due to the economic and monetary union, and countries from other economic unions could not be included in the study. In the next part of the study, firstly the definition and development of e-commerce will be given, then the literature information will be included and then the study will be concluded with a general evaluation by presenting the panel ARDL model and the results of the model.

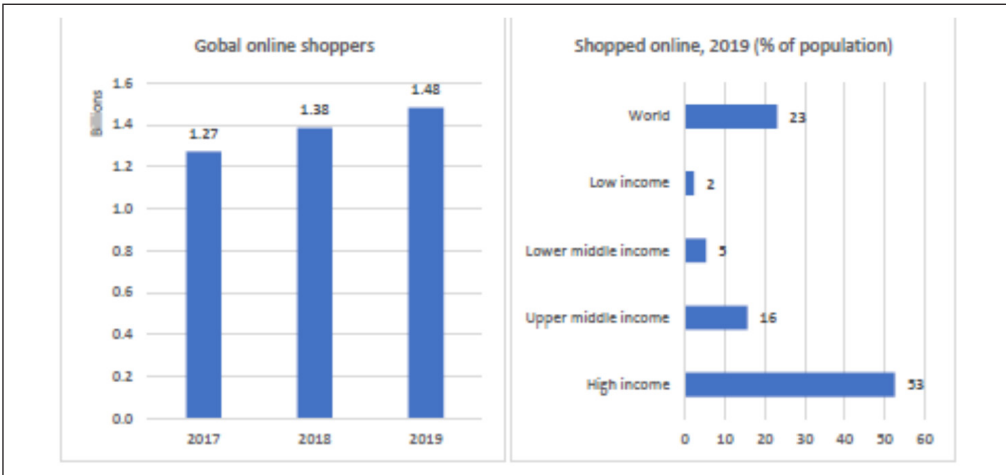
## **2. Definition and Development of E-commerce**

E-commerce has multiple definitions with different scopes regarding the various organizations. The World Trade Organization defines e-commerce as “the production, distribution, marketing, sale or delivery of goods and services by electronic means.” (WTO, 1998). E-commerce is defined by the OECD as “Commercial activities based on the processing and transmission of digitized written text, audio and video that concern organizations and individuals.” (OECD, 1997).

The improvements in the internet and web technology plays a major role in the expansion of e-commerce. Progressions in information and communication technologies has become the principle focus of many countries in the world. The continuing application and expansion of the Internet and electronic commerce, as well as advances in information technology (IT), are also fundamentally changing global economic activities. Many people around the world use the internet for a wide range of activities, from research to buying products online. Effectively implementing internet and electronic technology is becoming both an opportunity and a necessity for businesses (Anvari & Norouzi, 2016: 354).

The beginning of e-commerce dates back to the 1960s. E-commerce has a rich history, from primitive data transactions in the 1960s to the first online retail transactions in 1994 and the rise to popularity of e-commerce giants such as Amazon and eBay. With the development of information communication technologies and connecting to the internet via mobile phones, e-commerce is now conducted anywhere, anytime and is constantly changing and evolving. Especially with the quarantine measures taken with the Covid-19 epidemic in 2019, curfew was introduced. This situation has led consumers to online shopping, providing fast and secure access to the internet. Consumers' tendency towards online shopping has made it mandatory for businesses to provide services in this field. The Covid-19 epidemic has enabled e-commerce to develop rapidly and become widespread.

**Figure 1: Distribution of Global Online Shoppers by Income Level in 2017-19 and 2019**

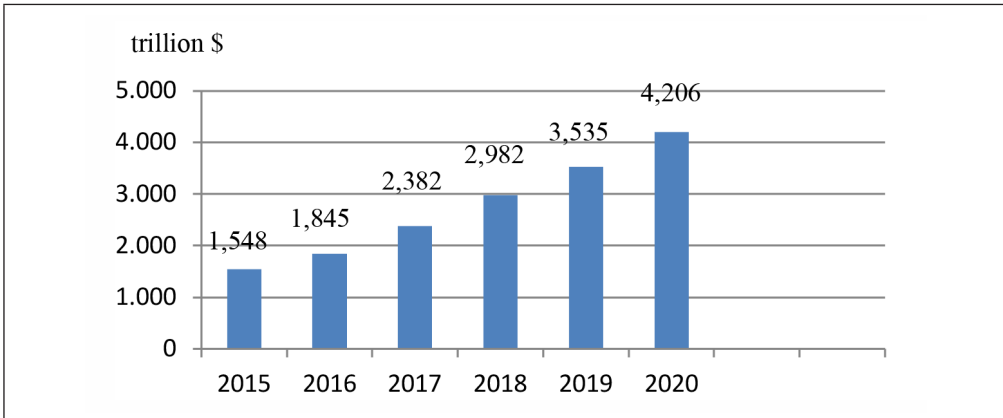


Source: UNCTAD (2020)

When figure 1. is analyzed, 1.5 billion people aged 15 and over shopped online in 2019. This figure constitutes 27% of the world's population and represents a 7% increase compared to the previous year. While the rate of online shoppers in 2019 was 2% in low-income countries, it constituted more than half of the population in high-income countries. As the income levels of countries increase, the proportion of the population engaged in e-commerce also increases (UNCTAD, 2020). These indicators show that developed countries that invest in the development of information and communication technologies benefit more from the positive effects of e-commerce.

When figure 2 is examined, it is seen that retail e-commerce sales have increased worldwide over the years. The main reason for this increase is the increasing internet usage around the world and the fact that companies have increased their e-commerce activities with the spread of the internet.

**Figure 2: Worldwide Retail E-commerce Sales**



Source: Eticaret.gov.tr

The development of e-commerce offers time, research and speed advantages for governments, companies and consumers. However, e-commerce may also cause some problems not encountered in traditional commerce. The fact that e-commerce is carried out over the internet may cause some problems in security, delivery and payment. Whereas, blockchain technology enables transactions to be made securely without the need for intermediary institutions by establishing an electronic payment system based on cryptographic proof (Nakamoto, 2008: 2). It also provides high security, faster transactions and traceability with payments made with cryptocurrencies such as bitcoin, which has a decentralized network structure. Blockchain can be expressed as a decentralized, safer, faster and cheaper technological development that prevents the creation, recording and modification of data and allows access to data only by authorities (Özyüksel & Ekinci, 2020: 83). By using blockchain technology in e-commerce activities, mutual trust can be achieved. Blockchain makes every stage of the procurement process accountable and enables customers to track the origin of purchased products. With this technology, data is shared simultaneously between the parties at every stage of the supply chain, shipment is made faster, and the parties can follow the transactions in real time (Bulsara & Vaghela, 2020: 3794).

The costs of information are decreasing through the internet and e-commerce applications, reducing the importance of geographical proximity and traditional business networks. In this context, the internet facilitates the removal of trade barriers, thereby increasing imports and exports. Consequently, the internet and e-commerce contribute to the growth of international trade volume.

International trade is influenced by numerous factors such as the social, economic, cultural, and political conditions of countries. Other elements that affect international trade include technological advancements and the production systems of countries. Progressive developments in these areas enable countries to increase their activities in international markets. The improvements of information and communication technologies, the increase in internet usage, and the consequent growth of e-commerce have reduced the significance of national

borders. E-commerce encompasses purchasing, selling, and payment transactions conducted over the internet. This allows businesses to reach global markets through their e-commerce activities, in addition to domestic markets. Therefore, international trade is now conducted not only with regional countries but also with all countries worldwide. This situation increases efficiency, imports, and exports, positively impacting the economic growth of countries.

The Technology Gap Theory highlights the effects arising from differences in technological development levels between countries. According to the theory, the products that countries export and import are shaped by the technological advancements in industrialized countries. New products and technology are typically developed by innovative firms located in advanced industrialized countries. Over time, due to the imitation of technology or its free circulation, products and technology are imitated by developing and underdeveloped countries (Seyidoğlu, 2007: 76-79). Investment in information communication tools and internet infrastructure are at higher levels in developed countries. Consequently, the development and use of e-commerce in these countries become more widespread, and e-commerce activities conducted over the internet, independent of time and place, are added to traditional trade, having positive effects on the foreign trade of these countries. This situation plays a role in increasing the gross domestic product of developed countries. However, over time, as investment in information communication technologies and internet infrastructure increase in developing countries, internet usage will also rise. This will contribute to the development of e-commerce conducted over the internet. Additionally, with the increase in internet usage and technological advancements like smartphones, e-commerce will become feasible anytime and anywhere. This will lead to the development of e-commerce in developing countries, which will also be widely used in international trade. Thus, small and medium-sized enterprises in developing countries will be able to collaborate with enterprises in developed countries. This will increase trade between developing and developed countries. The export of goods and services produced in developing countries will increase, contributing to the improvement of trade balances and economic growth in these countries.

### 3. Literature

Researches from literature explore the impact of e-commerce on international trade from different angles. Freund & Weinhold (2000) searched the impact of the internet on international trade for 56 countries. In the study conducted using panel data analysis, the effect of the internet on international trade was significant for the years 1998-1999. Accordingly, a 10% increase in internet usage in the specified years increased international trade by 1%. Another conclusion drawn from the study is that increasing internet use in developing countries would provide more advantages in international trade.

Freund & Weinhold (2004) researched the impact of the internet on international trade for 56 countries, including Bolivia, using a panel gravity model. According to the results obtained, a 10 % increase in internet usage in Bolivia would increase international trade by more than 1%. The analysis result shows that internet usage had a positive impact on Bolivia's international trade.

Clarke & Wallsten (2006) investigated the impact of the internet on international trade using least squares, two-stage least squares and cross-sectional gravity model analyses, using

data from 26 developed and 72 developing countries. In the study conducted for the years 1991-2001, a 1 % increase in internet usage increased total exports by 0.3 percent. At the same time, it was concluded that a 1% increase in internet usage increased exports from developing countries to developed countries by 0.4 percent. According to the results of the study, the increase in internet use in developing countries would increase exports and improving internet access would encourage exports to developed countries.

Clarke (2008) analyzed the impact of the internet on exports using 1999, 2002 and 2005 data from businesses in low- and middle-income countries in Central Asia and Eastern Europe. It is concluded that internet use increased export performance by facilitating businesses' access to markets and consumers in developed countries. As a result of the study, it is seen that internet use did not lead to a significant increase in exports in the service sector compared to the manufacturing sector.

Artan & Kalaycı (2009) tested the impact of the internet on international trade for 30 OECD countries using the panel data method and generalized gravity model. The model was built for three different periods: 1997-2006, 1997-2001 and 2002-2006. It is concluded that the internet had a positive impact on international trade in all three examined periods. At the same time, it is determined that gross domestic product per capita, common language and common border also positively affected international trade, while the increase in distance between countries negatively affected international trade.

Choi (2010) investigated the impact of the internet on international service trade through panel data analysis using data from 151 countries between 1990 and 2006. The study found that a 10 percent increase in internet usage increases trade in services by 2 percent to 4 percent. The financial depth variable was also included in the analysis and it was observed that financial depth had positive effects on international trade.

Salmani et al., (2013) studied the of internet use on international service trade in developing countries using panel data and gravity model. In the analysis conducted for the years 1990-2011, it was determined that internet use had a positive and significant impact on international service trade in developing countries.

Wang et al. (2017) analyzed the impact of e-commerce on international trade using the panel data analysis model, using data from the 2011-2015 period covering all provinces of China. According to the analysis results, it was concluded that China's increasing e-commerce activities positively affected its international trade. It is stated that the reason for this is the positive policies implemented for e-commerce. At the same time, it is found that the effect of e-commerce on international trade played a more important role in belt and road provinces in the study.

Özcan (2018), in his study examining Turkey's foreign trade flows, investigated the impact of the use of information and communication technologies on international trade between Turkey and 34 countries with which it has established foreign trade relations, using a panel gravity model for the years 2000-2014. According to the results obtained, it is determined that the development of information communication technologies in Turkey positively affected both exports and imports, but the development of information communication technologies had a greater impact on imports than exports.

Zhiyuan (2018) searched the impact of e-commerce on international trade using the panel gravity model, using the economic data of 40 counties in Zhejiang province in 2014 for the Zhejiang region, where China's e-commerce development is fastest. The study concluded that a 1 % increase in e-commerce in Zhejiang Region increased exports by 0.546 percent and trade by 0.597 in that period. The results from the analysis show that e-commerce positively affected the exports and trade of Zhejiang Region.

Xing (2018) examined the impact of e-commerce and the internet on bilateral trade flows for 30 OECD countries and 21 least developed and developing countries using the panel gravity model. According to the results of the study, the use of information communication technology and fast internet with secure servers increases the potential use of e-commerce for developing and least developed countries. The study found that the adoption of e-commerce and better access to information and communication technologies promote international bilateral trade at various levels. In addition, the close distance between countries, political ties, common language used, country economies and gross domestic product per capita also positively affect international bilateral trade.

Wardani et al., (2019) investigated the impact of the development of information and communication technologies on Indonesia's bilateral trade with ASEAN countries using an extended panel gravity model and panel data model for the period 2010-2017. The results show that the development of information communication technologies had a positive impact on Indonesia's exports to ASEAN countries. At the same time, population and real gross domestic product also positively affected exports. However, real exchange rate and distance negatively affected exports.

Wang & Chio (2019), analyzed the impact of information communication technologies on international trade volume in BRICS countries using the panel data method for the years 2000-2016. The results of the analysis show that the effect of information and communication technologies on exports is more positive than on imports. At the same time, it is determined in the research that the improvement and increased use of information communication technologies affects international trade more positively in labor-intensive countries than in capital-intensive countries.

Artan et al., (2021) tested the effects of e-commerce on international trade with a cross-sectional and panel data gravity model for the years 2014-2019, using data from G20 countries. The study concluded that e-commerce positively affects international trade. While distance and transportation costs between countries negatively affect bilateral trade, having a common culture has a positive effect. It was also determined in the study that speaking a common language does not have any effect on bilateral trade.

Hayakawa et al., (2021) studied the role of e-commerce in reducing the effects of Covid-19 on international trade using a panel gravity model. For this purpose, they examined bilateral trade with 34 countries and their 145 trading partner countries that reported in January-August 2019 and 2020. According to the results of the study, the higher number of cases and deaths seen in importing and exporting countries negatively affects international trade. However, while e-commerce reduces the negative impact of Covid-19 on international trade in importing countries, it is determined that it has no effect in exporting countries.



Hava (2022) investigated the impact of the potential increase in e-commerce on international trade on an export basis during the Covid-19 Pandemic. Qualitative method was used in the research and it was interpreted by analyzing and synthesizing e-commerce, export and online retail sales data from 2018-2020. According to the results of the study, the Covid-19 Pandemic had positively affected e-commerce in selected countries. However, this situation was not reflected in international trade. The measures taken during the pandemic period caused disruptions in the supply chain, which disrupted international trade in goods and services and caused disruptions.

When the studies on the impact of developments in information and communication technologies, the internet, and e-commerce on international trade are evaluated as a whole, it is observed that these variables have positive effects on international trade. In our study, it is found that e-commerce had neither a positive nor a negative impact on international trade, making this study different from others in the literature in this aspect. At the same time, some studies have tested the impact of the internet and per capita gross domestic product on international trade and found that these variables positively influence international trade. Similarly, our study also has investigated the impact of the internet and per capita gross domestic product on international trade and has found that they have a positive effect, consistent with the findings in the literature.

#### **4. Data Set and Descriptive Statistics**

In the study, the effect of e-commerce on international trade in Euro Zone countries (Germany, Austria, Belgium, Estonia, Finland, France, Netherlands, Ireland, Spain, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Portugal, Slovakia, Slovenia) was investigated. Since some data from Greece, a Eurozone country, could not be accessed, it was not included in the study. E-commerce, exports, gross domestic product per capita and internet usage data of 18 countries between 2010 and 2021 were included in the study. With Panel Regression analysis, the effects of e-commerce, gross domestic product per capita and internet use on international trade were investigated. Data for selected countries were obtained from data providers, The World Bank and Eurostat. The data set used in the research and descriptive statistics related to the data set are shown in Table 1.

**Table 1: Data and Variables Used in Application**

Data Name	Data Abbreviation	Description and Data Range	Data Source
<b>Export</b>	Inex	Exports of goods and services as a percentage of GDP 2010-2021	EUROSTAT ( <a href="https://ec.europa.eu/eurostat/databrowser/view/tet00003/default/table?lang=en">https://ec.europa.eu/eurostat/databrowser/view/tet00003/default/table?lang=en</a> )
<b>E-commerce</b>	Inetrd	E-commerce sales by size class of businesses 2010-2021	EUROSTAT ( <a href="https://ec.europa.eu/eurostat/databrowser/view/ISOC_EC_ESELS__custom_5032050/default/table?lang=en">https://ec.europa.eu/eurostat/databrowser/view/ISOC_EC_ESELS__custom_5032050/default/table?lang=en</a> )
<b>Internet</b>	Innet	Individuals' internet usage 2010 -2021	EUROSTAT ( <a href="https://ec.europa.eu/eurostat/databrowser/view/ISOC_CI_IFP_IU__custom_4946438/default/table?lang=en">https://ec.europa.eu/eurostat/databrowser/view/ISOC_CI_IFP_IU__custom_4946438/default/table?lang=en</a> )
<b>Gdp</b>	Ingdp	Gross domestic product per capita 2010-2021	WDI ( <a href="https://databank.worldbank.org/indicator/NY.GDP.PCAP.CD/1ff4a498/Popular-Indicators">https://databank.worldbank.org/indicator/NY.GDP.PCAP.CD/1ff4a498/Popular-Indicators</a> )

Source: Created by the author.

The econometric method and empirical findings regarding the analyze made in the study are standard deviation, mean, maximum value, minimum value, etc. for the data set used. Descriptive statistics such as are presented in Table 2.

**Table 2: Descriptive Statistics of the Data Set Used in the Application**

Variables	Observation (NxT)	Average	Standard deviation	Maximum	Minimum	Probability Value
LNETRD	216	2.723200	0.418318	3.572346	1.335001	0.000037
LNEX	216	11.41970	1.407344	14.19265	9.092444	0.000194
LNGDP	216	10.41604	0.529381	11.80253	9.297252	0.075958
LNNET	216	4.404801	0.131354	4.595120	3.970292	0.000000

#### 4.1. Econometric Method and Empirical Findings

In this part of the study, the structure of the panel data set will be examined. In order to specify the method to be used in panel data analysis, it is very important to determine whether the data is homogeneous or heterogeneous. The test developed by Hsiao (1986) was used to determine whether the panel data set used in the study was homogeneous or heterogeneous. According to the results, a cross-sectional dependency test between the variables was performed. According to the result of the cross-section dependence analysis, it was determined whether the unit root tests to be applied to determine the stationarity of the variables would be the first generation or the second generation and according to this result, the appropriate panel unit root test was performed.

The test results determining whether the panel structure is homogeneous or heterogeneous are presented in Table 3. The Hsiao (1986) test is based on three main hypotheses. These hypotheses are:

H<sub>1</sub>: Null hypothesis: The panel is homogeneous, alternative hypothesis: H2

H<sub>2</sub>: Null hypothesis: The panel is heterogeneous, alternative hypothesis: H3

H<sub>3</sub>: Null hypothesis: The panel is homogeneous or partially homogeneous.

**Table 3: Hsiao (1986) Homogeneity Test Results**

Hypothesis	F-statistic	Probability Value
H1	77.40717	3.57E-87
H2	5.165912	4.32E-15
H3	140.7631	1.48E-99

When Table 3 is examined, it is concluded that the panel structure is heterogeneous. The Pesaran CD test can also be applied to heterogeneous dynamic panels and shows robustness against structural breaks. The proposed cross-sectional dependence test is valid within the framework of fixed and random effects models as well as more general heterogeneous slope or random coefficient specifications (Pesaran, 2004: 4). The results of the cross-sectional dependence test related to the variables are presented in Table 4. The hypotheses of the Pesaran (2004) CD test are established as follows:

H<sub>0</sub>: There is no cross-sectional dependence.

H<sub>1</sub>: There is cross-sectional dependence.

**Table 4: Cross Section Dependency Test**

Variables	Pesaran CD11	Probability Value
LNETRD	16.374	0.000
LNGDP	24.314	0.000
LNNET	39.840	0.000
LNEX	23.855	0.000

According to the cross-sectional dependence test results, if the test value is less than 0.05, the H0 hypothesis is rejected at the 5% significance level, and it is accepted that there is cross-sectional dependence among the series (Altıntaş & Mercan, 2015: 359). When table 4. is examined, it is seen that the probability value is less than 0.05. this situation shows the existence of cross-sectional dependence among the variables.

In the next part of the study, unit root tests must be performed to determine the stationarity of the variables. We have a heterogeneous panel data with cross-sectional dependence. Since there is cross-sectional dependence, secondary generation unit root tests must be performed on the variables in panel data analysis (Topaloğlu, 2018: 24). Unit root test results of the variables are given in table 5.

**Table 5: Pesaran Unit Root Test**

Variables	Pesaran	
LNEX	<0.01	I(0)
LNTRD	>=0.10	I(1)
LNGDP	>=0.10	I(1)
LNNET	<0.01	I(0)

When Table 5 is examined, it is seen that the variables lnex and lnnet are in I(0) structure and do not contain unit roots, while the variables lntrd and lngdp are in I(1) structure and contain unit roots. Therefore, in the study, it was determined that some variables were stationary at the first difference and some variables were stationary at the n level.

Pesaran et al. (2001) demonstrated in their study that the relationship between variables can be tested regardless of whether the variables are I(0) or I(1) or whether they are cointegrated (Pesaran et al., 2001: 290). At this stage, the panel ARDL model developed by Pesaran et al. (2001) was used to determine the short-term and long-term relationship between variables. The test results of the ARDL (1,0,0,0) model, selected according to the Schwarz information criterion and with exports as the dependent variable, are shown in Table 6.

**Table 6: Test Result for ARDL (1,0,0,0) Model**

Long-Term (Pooled) Coefficients				
Variables	Coefficient	Standard error	t –statistic	Possibility
LNTRD	-0.069198	0.034243	-2.020765	0.0447
LNGDP	0.754125	0.015824	47.65572	0.0000
LNNET	0.919573	0.041620	22.09461	0.0000
Short-Term (Average Group) Coefficients				
COINTEQ	-0.209731	0.093631	-2.239966	0.0262

In order to determine whether there is a long-term relationship between the variables in the estimated Panel ARDL model, the Cointeq variable must be negative and significant. When Table 6 is examined, it is seen that the coefficient of the variable is negative and significant. This shows that there is a long-term relationship between the dependent and independent variables in the model.

When the long-term coefficients in the table are examined, it is seen that the long-term coefficient of the lntrd variable has a negative relationship with the export variable and is statistically significant at the 5% significance level. In addition, it is seen that the lngdp variable and lnnet variables have a positive relationship with the export variable and are statistically significant at the 1% significance level. These results from the analysis show that if there is a 1% increase in e-commerce, it will reduce exports by 0.06% in the long term and the gross domestic product per capita will decrease. It is interpreted that when it increases by 1%, exports will increase by 0.75% in the long term, and when internet usage increases by 1%, exports will increase by 0.91% in the long term.

**Table 7: ARDL Test Result for Countries**

Countries	Variable	Coefficient	Standard error	t –statistic	Possibility
Austria	cointeq	-1.223011	0.135485	-9.026887	0.0000
Slovakia	cointeq	-1.079793	0.140106	-7.706948	0.0000
Portugal	cointeq	-0.813139	0.184987	-4.395659	0.0013
Slovenia	cointeq	-0.075449	0.036771	-2.051828	0.0673
Lithuania	cointeq	-0.111708	0.057305	-1.949342	0.0798
Ireland	cointeq	-0.051962	0.026948	-1.928235	0.0827
Germany	cointeq	0.045357	0.058428	0.776283	0.4556
Belgium	cointeq	-0.349509	0.193538	-1.805895	0.1011
Estonia	cointeq	-0.046225	0.032653	-1.415651	0.1873
Finland	cointeq	-0.024559	0.043520	-0.564314	0.5850
Holland	cointeq	0.016303	0.035391	0.460666	0.6549
Spain	cointeq	0.012715	0.032449	0.391861	0.7034
Italy	cointeq	0.003399	0.027337	0.124349	0.9035
Cyprus	cointeq	0.000651	0.022873	0.028484	0.9778
Latvia	cointeq	-0.048157	0.050069	-0.961813	0.3588
Luxembourg	cointeq	-0.007984	0.013592	-0.587389	0.5700
Malta	cointeq	-0.028721	0.032176	-0.892609	0.3930
France	cointeq	0.006628	0.023003	0.288149	0.7791

Table 7 is examined, it is seen that the cointeq variable of Austria, Slovakia and Portugal is negative and significant at the 0.01% significance level. It can be seen that the cointeq variable of Slovenia, Lithuania and Ireland is negative and significant at the 0.10% significance level. This shows that in these countries there is a relationship between the dependent and independent variables and the effects of the shock that will occur in these countries will disappear in the long term. The cointeq variable of Belgium, Estonia, Finland, Latvia, Luxembourg and Malta is negative, indicating that there is a relationship between the dependent and independent variables in these countries, but this relationship is not significant. The cointeq variable of Germany, the Netherlands, Spain, Italy, Cyprus and France is positive and not significant. This shows that there is no relationship between the dependent and independent variables in these countries.

## 5. Conclusion

The study was conducted to analyze the impact of e-commerce on international trade in Euro Zone countries. For this purpose, e-commerce, internet, export and per capita gross domestic product data for the years 2010-2021 were analyzed through panel data tests. In the study, firstly, homogeneity test was performed and it was determined that the panel data had a heterogeneous structure. Afterwards, cross-sectional dependence was examined and it was concluded that there was cross-sectional dependence among the variables. Since there is cross-sectional dependence among the variables, a second generation unit root test was performed

to determine their stationarity. With the test, it was concluded that some of the variables were stationary at level and some were stationary at first degree. Panel ARDL test was performed to determine the short- and long-term relationship of the variables. As a result of the test in which exports were taken as the dependent variable, it was determined that there was a long-term relationship between the dependent and independent variables.

The results obtained from the analysis indicate a positive and significant relationship between exports and per capita gross domestic product (GDP) as well as the internet. However, there is a negative and significant relationship between exports and e-commerce.

The positive relationship between per capita gross domestic product (GDP) and exports is consistent with the findings of studies conducted by Artan & Kalaycı (2009), Wardani et al. (2019), and Xing (2018). This suggests that an increase in per capita GDP indicates economic growth and higher production by businesses, which contributes to the development of international trade. Developing policies aimed at increasing per capita GDP will provide countries with a competitive advantage in international trade.

The positive and significant relationship between internet usage and exports is consistent with the literature, as reflected in the studies conducted by Freund & Weinhold (2000), Clarke & Wallsten (2006), Clarke (2008), Artan & Kalaycı (2009), Salmani et al. (2013), and Xing (2018). The widespread use of the internet contributes to the development of international trade. Completing infrastructure projects aimed at providing smooth and fast access to the internet, especially in developed and developing countries, will have a positive impact on international trade. Resolving infrastructure issues in underdeveloped and developing countries will also have a positive spillover effect on global trade.

The study has identified a negative and significant relationship between e-commerce and exports. This result is consistent with studies conducted by Wang (2017), Zhiyuan (2018), Xing (2018), and Artan et al. (2021) that also found a significant relationship between e-commerce and exports. However, the negative relationship between e-commerce and exports has a relatively low impact. This difference from other studies in the literature may be due to the specific time periods and countries analyzed, and conducting studies with different time periods and country groups may yield different results. Additionally, the positive and significant relationship between internet usage and exports, coupled with the negative and significant relationship between e-commerce and exports, suggests that some issues specific to e-commerce may be at play. E-commerce continues to develop and expand with the increasing use of the internet. However, infrastructure, security, supply chain, payment, and other issues in developing countries have not yet reached the desired level. Solutions to these issues are necessary for the development of e-commerce. Policies aimed at addressing any problems that negatively impact consumers' and businesses' approach to e-commerce, especially in developing countries, need to be developed and implemented.

According to the results obtained from our country-specific study, there is a relationship between dependent and independent variables in developing countries, while no relationship was found in developed countries. This indicates the need for necessary support for information and communication technology studies in developing countries. Providing internet infrastructure and ensuring fast and secure access to the internet will contribute to the development of

e-commerce in these countries. The development of e-commerce will in turn contribute to the development of trade between developing and developed countries.

It has been observed that the level of development of countries has an impact on the development and proliferation of e-commerce. In this context, factors such as education, culture, and the proportion of young population are also considered to be influential factors on e-commerce. Including these factors in studies focusing on the impact of e-commerce on international trade among different country groups is believed to contribute to the literature.

### **Conflict of Interest**

The authors declare that there is no conflict of interest regarding the publication of this article.

### **Author Contributions**

Equal Contributions.

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