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Causal Linkage between Economic Growth, Financial Development, Trade Openness and CO2 Emissions in European Countries

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Abstract In this paper, we examine the linkage between economic growth, financial development, trade openness and CO2 emissions. Empirically, we use the General Linear Model (GLM) for a panel data of 40 European countries over the period from 1985 to 2014. Our econometric methodology is based on the Cobb-Douglas production function. The empirical results show that there is evidence of bidirectional causality between economic growth and financial development, economic growth and trade openness, economic growth and CO2 emissions, financial development and trade openness and trade openness and CO2 emissions. From the linkage between economic growth and CO2, we verify the existence of the environmental Kuznets curve. Additionally, we validate the feedback hypothesis of the bidirectional causality between trade openness and financial development. Also, we identify the neutrality hypothesis between environmental degradation measured by CO2 emissions and financial development. Finally, we prove the bidirectional causality between economic growth and financial development and between economic growth and trade openness.

Keywords Economic growth, Financial development, Trade openness, CO2 emissions, European countries, GLM

1. Introduction

The twentieth century was marked by the extraordinary success of the global economic system, with the industrialization and unprecedented technological progress has in the twentieth century size of its wealth more than twenty times. With these developments, the quality of life could be significantly improved for a large part of the population. The daily intake of calories per person indicates general upward trend in both developed and developing countries.

Similarly, the proportion of people in poverty is illustrated by a general decline over the last fifty years. In a century, this extraordinary material enrichment has catalyzed an extremely rapid population growth, increasing global population of one billion people in more than six billion. The mortality rates have fallen dramatically, life expectancy has increased by more than two years on average, and infant mortality has been reduced to less than 60 per 1000 live births.

At present, environmental concerns have taken center stage in national and international policy debates. Environmental problems are thus the concern of public opinion. They are now part of the political and economic choices.

In addition, the international trend shows that various economies have resisted in attaining economic growth, financial development and trade openness exclusive of parallel observing a boost in CO2 emissions. Then, the relationship between economic growth, financial development, trade openness and environmental degradation is examined by various studies in the recent decades because the linkage between these factors has not been studied in detail recently, this research focuses on the bidirectional causality between all these economic aggregates.

In this context, the main goal of our study is based on the question as follow: Why does our happiness decline as we become richer? Based on this question, the objective of this paper is to investigate empirically the bidirectional linkage causality between economic growth, financial development, trade openness and CO2 emissions. Methodologically, we use the General Linear Model (GLM) to estimate this causality from a panel data of 40 European countries during the period 1985 to 2014. The empirical results indicate that there is evidence of bidirectional causality between economic growth and financial development, economic growth and trade openness, economic growth and CO2 emissions, financial development and trade openness and trade openness and CO2 emissions. However, we remark the absence of the relationship between the financial development and CO2 emissions. These results are in

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conformity with the related literature.

The rest of the paper is organized as Section 2 provides a review of related literature on the linkage between economic growth, financial development, trade openness and CO2 emissions. In Section 3, we describe the methodology. In section 4, we present the data used for empirical analysis. Section 5 offers the empirical results and a discussion of the study. Concluding remarks are presented in section 6.

2. Related Literature

Several studies have been devoted to analyzing the existing of bidirectional causality between economic growth, financial development, trade openness and CO2 emissions.

The analysis of the causality between economic growth and CO2 emissions is studied in much empirical research. This causality is based on the environmental Kuznets curve (EKC) hypothesis. This hypothesis provides that the relationship between economic growth and CO2 emissions is highly significant. In their studies, Grossman and Krueger (1991) [1] and Selden and Song (1994) [2] indicate that the causality between economic growth and CO2 emissions is positively significant. Their empirical results show that an increase in the economic growth augments the environmental degradation measured by the CO2 emissions.

In addition, there are several books that focus on the existence of a large interaction between trade and the environment more precisely between trade liberalization and pollution (Anderson and Blackhurst, 1992 [3]; Etsy, 1994 [4]; Chichilnisky, 1994 [5]; Copeland and Taylor, 1994 [6]; Cole, 2000 [7]). In fact, it was verified that trade openness can, ceteris paribus; decrease pollution emissions that countries are facing a developed competitive pressure can be more solid in the use of resources. Others who have studied the practical implementation of trade liberalization through the GATT / WTO and assessed the level to which countries may limit imports of products dangerous to the environment. Nevertheless, Grossman and Krueger (1991) established the study of the correlation between trade and the environment that results distributed in three different effects. First, the scale effect is the probable augment into pollution resulting of the economic growth created by greater access to markets. Second, the technical effect submits to the evolution of production techniques which are likely to accompany the liberalization of trade. These can result from demand following the increase in income for the largest environmental regulations and better access for production technologies that respect the environment. Third, the composition effect refers to the changing composition of the economy and which has been occurring next the liberalization of trade that countries specialize more and more in activities that supply a comparative advantage. In fact, the composition effect is more interesting for the EKC and is the mechanism through which pollution haven would have an impact on the pollution.

At the same time, these come when the continuous augmentation into revenue drive the change from capital intensive cumbersome industry activities to a service economy that produce less pollution. All in all, this phenomenon is named composition effect (Shafik, 1994) [8].

As the activities of pollution in the developed countries are dealing with higher regulatory costs than poor countries, international trade and globalization boost the relocation of polluting industries to countries with the least regulated economic (Mani and Wheeler, 1998) [9]. This is referred to pollution haven hypothesis. This assumption can clarify, according to Mani and Wheeler (1998), reductions in the levels of deterioration of the environment in the developing countries and rising environmental degradation levels in the middle-income countries. During this time Andreoni & Levinson (2001) [10] reinforce the view that the EKC depends most directly upon the existence of scale economies in the elimination of pollution instead of the externalities, institutional political and the dynamics of growth.

Besides, different argument that assists to clarify the EKC as the elasticity from demand for environmental quality. It is proved that the growth of GPD per capita leads to a further degradation of the environment in the first stages of economic development. But, income growth stimulates demand for a cleaner environment by expand the resource vacant to address versus pollution (World Bank, 1992) [11].

Additionally, Roca (2003) [12] indicated that the willingness to pay for improvements in the quality of the environment increase a higher proportion than revenue, after encounter with some freeze of income. Furthermore, the quality of the environment probably will be regarded as a luxury good for certain levels of income. If the fundamental needs of people are achieved, their preoccupation for the environment rises (Dasgupta et al., 2002) [13].

Likewise, when a community moves towards the realization of the social objectives, her institutions are reinforced to improving the regulatory framework and effectiveness of the control bodies which apply the existing legislation. Therefore individuals change their consumption habits towardsmore environmentally friendly products and the government pressure produce more strict environmental regulations (Dinda, 2004) [14]. As a result, Dinda (2004) show that the fragility of regulation in the developing countries led to a reduced capacity to uphold the established rules, that attracts multinational companies that develop highly polluting production processes.

Azomahou et al. (2006) [15] show the existence of a linear relationship between economic growth and CO2 emissions. Lean and Smyth (2010) [16] and Saboori et al. (2012) [17] improve the presence of the inverted U-shaped relationship. The study developed by Friedl and Getzner (2003) [18] indicate an N-shaped relationship between economic growth and CO2 emissions. However, Richmond and Kaufmann (2006) [19] concluded a no causal relationship between economic growth and CO2 emissions.

The causal relationship between economic growth and environmental can be shown by referring to the environmental Kuznets curve (EKC) hypothesis. The EKC explain the nexus between economic growth and environmental degradation since the 1990s. Then, Grossman and Krueger (1991) and Selden and Song (1994) developed empirical evidence which indicated that economic growth leads to a gradual degradation of the environment. Their impact is providing, in the initial stages and after a certain level of growth, the EKC hypothesis postulates that the link between economic growth and environmental degradation is non-linear and inverted-U shaped. This implies that economic growth is linked with an augment in CO2 emissions initially and declines it, once economy matures.

The EKC hypothesis is studied by some researchers which found a conflicting result (Stern et al., 1996 [20]; Ekins, 1997 [21]; Heil and Selden, 1999 [22]; Managi and Jena, 2008 [23]; Fodha and Zaghdoud, 2010 [24]; Jaunky, 2010 [25]; Ozturk and Acaravci, 2010 [26]; Saboori et al., 2012).

For country-specific study, Ang (2008) [27] for Malaysia, Soytas and Sari (2009) [28] for Turkey, Fodha and Zaghdoud (2010) for Tunisia, Ghosh (2010) [29], succeed in finding bidirectional causality between economic growth and CO2 emissions. But, Ang (2007) [30] for France, Jalil and Mahmud (2009) [31] for China, Nasir and Rehman (2011) [32] for Pakistan, and Saboori et al. (2012) for Malaysia succeed in finding an inverted-U shaped curve between economic growth and CO2 emissions.

For multi-country study, Tsai (1994) [33] for 62 countries, Apergis and Payne (2009) [34] for 6 Central American countries and Omri (2013) [35] for 12 MENA countries concluded in their results an inverted-U shaped curve between economic growth and CO2 emissions. Also, the methodology employed in all these study is based on Granger causality.

However, the relationship between economic growth and CO2 emissions is not found by Richmond and Kaufmann (2006) for panel of 36 countries, Halicioglu (2009) [36] for turkey, Ozturk and Acaravci (2010) for Turkey; Jaunky (2010) for 36 high-income countries, and Menyah and Wolde-Rufael (2010) [37] for South Africa.

The importance of CO2 emissions in the environmental protection and their implication in all economic and financial sectors motivated some studies to integrate potential indicators to test the EKC hypothesis. Then, CO2 emissions are related to trade openness by Halicioglu (2009), Nasir and Rehman (2011), Shahbaz et al. (2013) [38], Omri et al. (2014) [39] and Omri et al. (2015) [40], to urbanization by Zhang and Cheng (2009) [41], Hossain (2011) [42], Sharma (2011) [43], Omri et al. (2014) and Omri et al. (2015), to financial development by Tamazian et al. (2009) [44], Tamazian and Rao (2010) [45], Yuxiang and Chen (2010) [46], Ozturk and Acaravci (2013) [47], Omri et al. (2014) and Omri et al. (2015).

In fact, in case of the link between CO2 emissions and trade openness, Halicioglu (2009) examine how trade openness can explore the relationship between economic growth, CO2 emissions and energy consumption in Turkey. Their empirical results indicate that trade openness are one of the main determinants to economic growth while income increase the level of CO2 emissions. For Chinese provinces, Chen (2009) [48] concluded that industrial sector's development is linked with an augment of CO2 emissions due to energy consumption. By using ADF unit root test and co integration test, Nasir and Rehman (2001) studied EKC in Pakistan and indicated a positive effect of trade openness on CO2 emissions. However, Shahbaz et al. (2012) [49] show that trade openness reduces CO2 emissions. Moreover, Tiwari et al. (2013) [50] proved that trade openness increase environmental degradation in case of India.

For the relationship between CO2 and all others economic and financial aggregates, Tamazian et al. (2009) examine the effect of other potential contributors to CO2 emissions such as economic, institutional, and financial indicators. In their study, Tamazian et al. (2009) investigated the effect of financial development on CO2 emissions in case of Brazil, Russia, India, China, Untied States and Japan. Furthermore, Tamazian and Rao (2010) studied the impact of institutions on CO2 emissions. Their empirical results indicated that economic development, trade openness, financial development and institution shave an important role to control the environment degradation while supporting the presence of Environmental Kuznets Curve hypothesis. Yuxiang and Chen (2010) prove that financial sector polices in China enables the firms to use advanced technology which reduceCO2 emissions and increase domestic production.

Third strand deals with country case studies, for example in case of United States, Soytas et al. (2007) [51] examined the dynamic link betweenCO2 emissions, income and energy consumption. Their empirical results indicated that environmental degradation Granger causes income and energy consumption which contributes to CO2 emissions. Similar evidence was developed by Ang (2007, 2008) in France and Malaysia. The results showed that economic growth Granger causes energy consumption and CO2 emissions in two countries; France and Malaysia, unidirectional causality are found running from economic growth to energy consumption. From case of Tunisia, Chebbi (2010) [52] examine the causal relationship between energy consumption, income and CO2 emissions. The empirical results showed that energy consumption stimulates economic growth which Granger causes CO2 emissions. Ghosh (2009) uses Indian data to study the causal relationship between income and CO2 emissions by incorporating investment and employment as additional determinants of carbon emissions but the results show the absence of causality between income and CO2 emissions. In addition, Chang (2010) [53] applied multivariate causality test for Chinese data to investigate the causal linkage between economic growth, energy consumption and CO2 emissions. The results of the study indicated that economic growth Granger causes energy consumption that leads to carbon emissions.

Based in all studies listed previously, our paper is addressed to investigate the causal relationship between economic growth, financial development, trade openness and CO2 emissions. Then, we use some additional determinants, as FDI, energy consumption, inflation, urbanization and capital stocks, which can play an important role to determinate this causal linkage. The empirical evidence is formed from panel data composed by 40 European countries during the period from 1985 to 2014. The econometric methodology is based on the utilization of the Cobb-Douglas production function which is estimated by the General Linear Model.

3. Econometric Methodology

To examine the linkages between economic growth, CO2 emissions, financial development, and trade openness, in European countries, we refer to the Cobb-Douglas production function. In this function, we explain the gross domestic product per capita (GDP) by tow economic aggregates; depends on capital and labor force. In addition, the economic growth measured by the GDP per capita depends also on financial development (FD), trade openness (T), foreign direct investment (FDI) and CO2 emissions (CO2). In this paper, we refer to the Cobb-Douglas production function. Then, we use four equations, as follow:

$$\ln GDP_{it} = \alpha_0 + \alpha_{1i} \ln CO2_{it} + \alpha_{2i} \ln FD_{it} + \alpha_{3i} \ln ENC_{it} + \alpha_{4i} \ln FDI_{it} + \alpha_{5i} \ln INF_{it} + \alpha_{6i} \ln K_{it} + \alpha_{7i} \ln T_{it} + \alpha_{8i} \ln U_{it} + \varepsilon_{it} \quad (1)$$

$$\ln FD_{it} = \alpha_0 + \alpha_{1i} \ln GDP_{it} + \alpha_{2i} \ln CO2_{it} + \alpha_{3i} \ln ENC_{it} + \alpha_{4i} \ln FDI_{it} + \alpha_{5i} \ln INF_{it} + \alpha_{6i} \ln K_{it} + \alpha_{7i} \ln T_{it} + \alpha_{8i} \ln U_{it} + \varepsilon_{it} \quad (2)$$

$$\ln T_{it} = \alpha_0 + \alpha_{1i} \ln FD_{it} + \alpha_{2i} \ln GDP_{it} + \alpha_{3i} \ln CO2_{it} + \alpha_{4i} \ln ENC_{it} + \alpha_{5i} \ln FDI_{it} + \alpha_{6i} \ln INF_{it} + \alpha_{7i} \ln K_{it} + \alpha_{8i} \ln U_{it} + \varepsilon_{it} \quad (3)$$

$$\ln CO2_{it} = \alpha_0 + \alpha_{1i} \ln T_{it} + \alpha_{2i} \ln FD_{it} + \alpha_{3i} \ln GDP_{it} + \alpha_{4i} \ln ENC_{it} + \alpha_{5i} \ln FDI_{it} + \alpha_{6i} \ln INF_{it} + \alpha_{7i} \ln K_{it} + \alpha_{8i} \ln U_{it} + \varepsilon_{it} \quad (4)$$

Where, GDP is the gross domestic product per capita, FD is the financial development, T is the trade openness, CO2 is the CO2 emission per capita, ENC is the energy consumptions, FDI is the foreign direct investment, INF is the inflation rate, K is the capital stock, and U is the urbanization rate. α_0 is the constant. ε_{it} is the error term. α_{ji} are the estimated coefficients of all independent variables which $j = 1, \ldots, 8$. The subscript $i=1,\ldots,40$ denotes the country. The subscript $t = 1, \ldots, 30$ denotes the time period. Table 1 summarizes all variables used in this paper.

In the equation (1), we examine the impact of the financial development, the trade openness, the CO2 emission per capita, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on economic growth (Ang, 2008; Menyah and Wolde-Rufael, 2010; Anwar and Sun, 2011 [54]; Omri et al., 2014; Omri et al., 2015).

Table 1. Variables definition

Variable	Indicator Name	Source
CO2	CO2 emissions (metric tons per capita)	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.
EC	Energy Consumption (kg of oil equivalent per capita)	International Energy Agency (IEA Statistics©OECD/IEA, http://www.iea.org/stats/index.asp).
FDI	Foreign direct investment, net inflows (% of GDP)	International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, International Debt Statistics, and World Bank and OECD GDP estimates.
GDP	GDP per capita (constant 2005 US$)	World Bank national accounts data, and OECD National Accounts data files.
INF	Inflation, consumer prices (annual %)	International Monetary Fund, International Financial Statistics and data files.
K	Capital stocks, total value (% of GDP)	Standard & Poor's, Global Stock Markets Factbook and supplemental S&P data.
T	Trade (% of GDP)	World Bank national accounts data, and OECD National Accounts data files.
U	Urban population growth (annual %)	World Bank Staff estimates based on United Nations, World Urbanization Prospects.
FD	Domestic credit to private sector by banks (% of GDP)	International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.

Table 2. List of European countries

Rank	Name of country	Area (km^2)	Population (2014)	Population density (per km^2)	Capital
1	Albania	28,748	3,020,209	105.1	Tirana
2	Armenia	29,743	3,018,854	101.5	Yerevan
3	Austria	83,879	8,504,850	101.4	Vienna
4	Belarus	207,595	9,475,100	45.6	Minsk
5	Belgium	30,528	11,198,638	366.8	Brussels
6	Bosnia and Herzegovina	51,197	3,871,643	75.6	Sarajevo
7	Bulgaria	110,994	7,364,570	66.4	Sofia
8	Croatia	56,594	4,284,889	75.7	Zagreb
9	Cyprus	9,251	1,117,000	120.7	Nicosia
10	CzechRepublic	78,866	10,513,209	133.3	Prague
11	Denmark	42,916	5,655,750	131.8	Copenhagen
12	Estonia	45,227	1,315,819	29.1	Tallinn
13	Finland	338,424	5,470,820	16.2	Helsinki
14	France	551,695	66,030,000	115.8	Paris
15	Georgia	69,700	4,935,880	70.8	Tbilisi
16	Germany	357,168	80,716,000	226.0	Berlin
17	Greece	131,957	10,816,286	82.0	Athens
18	Hungary	93,030	9,877,365	106.2	Budapest
19	Iceland	103,001	325,671	3.2	Reykjavík
20	Ireland	70,273	4,609,600	65.6	Dublin
21	Italy	301,338	60,782,668	201.7	Rome
22	Latvia	64,589	1,990,300	30.8	Riga
23	Lithuania	65,300	2,944,459	45.1	Vilnius
24	Luxembourg	2,586	549,680	212.6	Luxembourg
25	Macedonia	25,713	2,058,539	80.1	Skopje
26	Moldova	33,846	3,557,600	105.1	Chişinău
27	Netherlands	41,543	16,856,620	405.8	Amsterdam
28	Norway	385,178	5,136,700	13.3	Oslo
29	Poland	312,679	38,483,957	123.1	Warsaw
30	Portugal	92,212	10,427,301	113.1	Lisbon
31	Romania	238,391	19,942,642	83.7	Bucharest
32	Russia	17,075,400	143,700,000	8.3	Moscow
33	Slovakia	49,035	5,415,949	110.5	Bratislava
34	Slovenia	20,273	2,061,085	101.7	Ljubljana
35	Spain	504,645	46,704,314	92.6	Madrid
36	Sweden	449,964	9,716,962	21.6	Stockholm
37	Switzerland	41,285	8,183,800	198.2	Bern
38	Turkey	783,562	76,667,864	97.8	Ankara
39	Ukraine	603,628	44,291,413	73.4	Kiev
40	United Kingdom	243,610	64,100,000	263.1	London

This table reports the list of European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) used in this paper over the period from 1985 to 2014

Then, in the second equation, we study the effect of the GDP, the trade openness, the CO2 emission per capita, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the financial development (Ahlin and Pang, 2008 [55]; Ozturk and Acaravci, 2013; Omri et al., 2014; Omri et al., 2015).

The equation (3) report the reaction on the Trade openness to the financial development, the GDP, the CO2 emission per capita, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate (Ozturk and Acaravci, 2013; Belloumi, 2014 [56]; Omri et al., 2014).

Based on Lotfalipour et al. (2010) [57], Hossain (2011), Sharma (2011), Saboori et al. (2012), Omri et al. (2014) and Omri et al. (2015), we use the equation (4) to test the impact of the Trade openness, the financial development, the GDP, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the CO2 emissions.

To estimate the above equations, we use the general linear model (GLM) in the case of panel data.

4. Data

This paper studies the relationship between four economic aggregates (Economic growth, financial development, trade, and CO2 emissions) in the European region over the period from 1985 to 2014. We use yearly panel data. The sample is formed by 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom). We present in Table 2 the list of the European countries used in this study.

Table 3 reports all descriptive statistics relative to the variables used to attain our objective. Following the results shown in this table, we remark that on average, the highest levels of CO2 (27.42196), ENC (18774.97), FDI (430.6407), GPD (86127.24), INF (4734.914), K (372.3756), T (371.4397), U (5.657103), and FD (311.0630). Also, we can found that the highest level of the standard deviation, is from per capita GDP (18263.42), followed by ENC (2180.304) and INF (532.3235), respectively.

Following the two statistics of skewness (asymmetry) and kurtosis (leptokurtic) all variables employed in this paper are characterized by non-normal distribution. Then, for the skewness coefficients, are reflect that the variable is skewed to the right and that it is far from being symmetric for all variables expect the urbanization coefficient which is skewed to the left. In addition, the Kurtosis coefficient indicates that the leptokurtic for all variables used in this study show the existence of a high peak or a fat-tailed in their volatilities.

Additionally, the positive sign of estimate coefficients of Jarque-Bera statistics show that we reject the null hypothesis of normal distribution of the variables used in our study. Also, the high value of Jarque-Bera coefficients reflects that the series is not normally distributed at the level of 1%.

Furthermore, the table 4 summarizes the estimation coefficients of Pearson correlation. The results of this table show that all coefficients are not exceed the tolerance limit (0.7) of Pearson, which doesn't cause problems in estimating of the model. We can observe the relation between all variables used in this paper.

We also conducted a test of the unit root panel data in table 5. Thus, we used the test Levin-Lin-Chu (LLC) and the test of Im-Pesaran-Shin (IPS). The null hypothesis of these tests is H0: all series are non-stationary and the alternative hypothesis is H1: all series are stationary.

Table 3. Descriptive statistics

	CO2	ENC	FDI	GDP	INF	K	T	U	FD
Mean	7.397460	3398.665	4.098018	19937.06	108.6164	22.65638	89.18206	0.510334	65.94835
Median	7.004315	3021.391	2.104713	12779.06	4.026683	3.741646	82.38176	0.463411	54.63906
Maximum	27.42196	18774.97	430.6407	86127.24	4734.914	372.3756	371.4397	5.657103	311.0630
Minimum	0.486455	384.5950	-57.42970	565.1557	-4.479938	0.000000	26.25670	-6.547706	1.383941
Std. Dev.	3.935124	2180.304	13.76219	18263.42	532.3235	42.57108	42.70703	1.114888	51.51523
Skewness	1.292063	2.542899	25.22483	0.944021	7.059702	3.241657	2.270208	-0.498009	1.327324
Kurtosis	7.191020	15.25300	775.6845	3.201342	55.39772	16.69964	12.69614	7.374851	5.171778
Jarque-Bera	1206.057	8756.071	29829425	179.3606	146507.7	11428.25	5702.868	1001.536	585.2480
Probability	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*
Observations	1194	1194	1194	1194	1194	1194	1194	1194	1194

Note: This table summarizes descriptive statistics of all variables used in this paper. We used yearly panel data of 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% level is denoted by *.

Table 4. Matrix of Pearson correlation

	CO2	ENC	FDI	GDP	INF	K	T	U	FD
CO2	1.000000								
ENC	0.6202 (0.0000)*	1.000000							
FDI	-0.0286 (0.3231)	-0.0230 (0.4263)	1.000000						
GDP	0.6245 (0.0000)*	0.6879 (0.0000)*	0.0978 (0.0007)*	1.000000					
INF	-0.1731 (0.0000)*	-0.1647 (0.0000)*	-0.3692 (0.0000)*	-0.4931 (0.0000)*	1.000000				
K	0.4591 (0.0000)*	0.4831 (0.0000)*	0.2249 (0.0000)*	0.7119 (0.0000)*	-0.4802 (0.0000)*	1.000000			
T	0.1361 (0.0000)*	0.1672 (0.0000)*	0.4318 (0.0000)*	0.0496 (0.0858)***	-0.1808 (0.0000)*	-0.0804 (0.0053)*	1.000000		
U	-0.1559 (0.0000)*	-0.1143 (0.0001)*	0.0286 (0.3231)	-0.0782 (0.0067)*	0.1091 (0.0002)*	-0.0861 (0.0028)*	0.0921 (0.0014)*	1.000000	
FD	0.3746 (0.0000)*	0.3944 (0.0000)*	0.0935 (0.0012)*	0.6836 (0.0000)*	-0.5115 (0.0000)*	0.5306 (0.0000)*	0.1300 (0.0000)*	-0.0127 (0.6609)	1.000000

Note: This table summarizes the matrix of correlation between all variables used in this paper. We used yearly panel data of 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% and 10% level are denoted by (*) and (***), respectively.

Table 5. Unit root tests of panel data

Variables	Levin-Lin-Chu (LLC)				Im-Pesaran-Shin (IPS)			
	Level		First Difference		Level		First Difference	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
CO2	-27.8613	0.0000*	-38.6790 (0)	0.0000*	-20.4508	0.0000*	-29.4184 (0)	0.0000*
ENC	-25.9521	0.0000*	-36.4681 (0)	0.0000*	-21.1006	0.0000*	-27.9519 (0)	0.0000*
FDI	-16.2314	0.0000*	-21.1148 (0)	0.0000*	-21.3708	0.0000*	-18.7527 (0)	0.0000*
GDP	-24.3884	0.0000*	-25.0094 (0)	0.0000*	-21.4157	0.0000*	-26.5651 (0)	0.0000*
INF	-13.8674	0.0000*	-16.0891 (0)	0.0000*	-20.4920	0.0000*	-17.0321 (0)	0.0000*
K	-6.1144	0.0000*	-8.4216 (0)	0.0000*	-14.5658	0.0000*	-11.0766 (0)	0.0000*
T	-9.0501	0.0000*	-10.9903 (0)	0.0000*	-18.3855	0.0000*	-12.0632 (0)	0.0000*
U	-19.8526	0.0000*	-20.5643 (0)	0.0000*	-20.7354	0.0000*	-22.4053 (0)	0.0000*
FD	-24.0630	0.0000*	-26.3711 (0)	0.0000*	-23.0861	0.0000*	-28.5783 (0)	0.0000*

Note: In this test the p-value is compared to 10%. If p-value <10% therefore, we reject H0 and p-value> 10% then we accept H0. With H0: all series are non-stationary. Statistical significance at the 1% level is denoted by (*).

The acceptance or rejection of the null hypothesis is based on the value of the p-value. This value is compared to a 10% threshold. If the value of the p-value is less than 10%, then we reject H0 and the value of the p-value is greater than 10%, while we accept H0. Table 4 summarizes the results of study of the stationary of the variables used in this study. From this table, we can show that all variables in level and in first difference are statistically significant under the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests, indicating that all variables non integrated. Thus, we can found that all variables are stationary.

5. Results

We begin our empirical results by the presentation of the estimation coefficients of the equation (1). In this equation, we examine the degree of influence of the financial development, the trade openness, the CO2 emissions, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the economic growth. The estimation results of equation (1) are reported in table 6.

From this table, we can show that CO2 emissions have a positive and significance impact on economic growth with a threshold level of 1%. Then, a 1% increases in the CO2 emissions increase the economic growth per capita within 0.142052%. The 1% increases in the financial development augment the GDP with 0.391342%. This impact is positive with a significance threshold level of 1%. Also, we remark that the energy consumption have a positive impact on the GDP of the European countries in the threshold level of 1%.

We can find that an augment of 1% in the energy consumption increase the economic growth with a level of 0.761925%. The coefficient of the inflation is negative and statistically significant in the threshold level of 1%. This result imply that an increase of 1% in the inflation rate promote a decrease in the GDP with (-0.099471%).

The capital stocks have a positive and significance impact on the economic growth in the threshold level of 1%. Thus, an increase of 1% in the capital stocks increases the economic growth with 0.125451%. The trade openness affects negatively the economic growth with a significance threshold level of 1%. This implies a 1% increase in the trade openness decrease the GDP with a level of (-0.204454%).

Finally, we find that the urbanization rate have a positive and significance impact on economic growth with a threshold level of 10%. This result indicate that the augment of 10% in the urbanization imply an increases of 0.036299% in the GDP. However, the foreign direct investment doesn't affect the economic growth in the Euro zone.

In this equation (2), we study the degree of influence of the economic growth, the trade openness, the CO2 emissions, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the financial development. The estimation results of equation (2) are summarized in table 7.

Table 6. Estimation results of GLM of the Economic growth

Dependent variable: Economic growth				
Independent variables	**Coef.**	**Std. Err.**	**t-statistic**	**p-value**
LnCO2	0.142052	0.048832	2.91	0.004*
LnFD	0.391342	0.024352	16.07	0.000*
LnENC	0.761925	0.053086	14.35	0.000*
LnFDI	-0.007584	0.015095	-0.50	0.615
LnINF	-0.099471	0.011678	-8.52	0.000*
LnK	0.125451	0.009924	12.64	0.000*
LnT	-0.204454	0.053473	-3.82	0.000*
LnU	0.036299	0.020492	1.77	0.077***
Cons	0.469117	0.378179	6.53	0.000*

Note: This table summarizes estimated coefficients from General Linear Model of Economic growth variable. To empirically test this model, we used yearly data panel of 40European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% and 10% level are denoted by (*) and (***), respectively.

Table 7. Estimation results of GLM of the financial development

Dependent variable: Financial development				
Independent variables	**Coef.**	**Std. Err.**	**t-statistic**	**p-value**
LnGDP	0.455319	0.028334	16.07	0.000*
LnCO2	0.007548	0.052859	0.14	0.886
LnENC	-0.206064	0.061727	-3.34	0.001*
LnFDI	-0.088617	0.016081	-5.51	0.000*
LnINF	-0.102911	0.012627	-8.15	0.000*
LnK	0.040507	0.011339	3.57	0.000*
LnT	0.342376	0.057178	5.99	0.000*
LnU	0.046399	0.022092	2.10	0.036**
Cons	-0.093125	0.415149	-0.22	0.823

Note: This table summarizes estimated coefficients from General Linear Model of Financial development variable. To empirically test this model, we used yearly data panel of 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% and 5% level are denoted by (*) and (**), respectively.

The results of this table show that the economic growth has a positive and significance impact on the financial development with a threshold level of 1%. Then, a 1% increases in the GDP increase the financial development within 0.455319%. Also, we remark that the energy consumption have a negative effect on the financial development in the case of the European countries with the threshold level of 1%. Thus, we can find that an augment of 1% in the energy consumption decrease the financial development with a level of (-0.206064%).

In addition, the coefficient of the foreign direct investment is negative and statistically significant in the threshold level of 1%. This result imply that an increase of 1% in the foreign direct investment indicate a decrease in the financial development with (-0.088617%). The inflation rate has a negative and significance impact on the financial development in the threshold level of 1%. Thus, an increase of 1% in the inflation rate decreases the financial development with (-0.102911%). The capital stocks affect positively the financial development with a significance threshold level of 1%. This implies a 1% increase in the capital stocks increase the financial development with a level of 0.040507%.

The 1% increases in the trade openness augment the financial development with 0.342376%. This impact is positive with a significance threshold level of 1%. Finally, we find that the urbanization rate have a positive and significance impact on financial development with a threshold level of 5%. This result indicate that the augment of 5% in the urbanization imply an increases of 0.046399% in the financial development. However, the CO2 doesn't affect the financial development in the Euro zone.

In this equation (3), we reports the impact of the financial development , the economic growth, the CO2 emissions, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the trade openness. The estimation results of equation (3) are presented in table 8.

The results of this table show that the 1% increases in the financial development augment the trade openness with 0.085359%. This impact is positive with a significance threshold level of 1%. The economic growth has a negative and significance impact on the financial development with a threshold level of 1%. Then, a 1% increases in the GDP decrease the trade openness within (-0.059306%). Additionally, the CO2 emissions have a positive and significance impact on the trade openness with a threshold level of 1%. Then, a 1% increases in the CO2 emissions decrease the trade openness within 0.063953%.

Also, we observe that the energy consumption have a positive effect on the trade openness in the case of the European countries with the threshold level of 1%. Thus, we can find that an augment of 1% in the energy consumption decrease the trade openness with a level of 0.229774%. In addition, the coefficient of the foreign direct investment is positive and statistically significant in the threshold level of 1%. This result imply that an increase of 1% in the foreign direct investment indicate a decrease in the trade openness with 0.135880%. The inflation rate has a negative and significance impact on the trade openness in the threshold level of 1%. Thus, an increase of 1% in the inflation rate decreases the trade openness with (-0.027599%).

The capital stocks affect negatively the trade openness with a significance threshold level of 1%. This implies a 1% increase in the capital stocks decreases the trade openness with a level of (-0.067610%). Finally, we find that the urbanization rate have a positive and significance impact on trade openness with a threshold level of 5%. This result indicate that the augment of 5% in the urbanization imply an increases of 0.045625% in the trade openness.

Table 8. Estimation results of GLM of the Trade openness

Dependent variable: Trade openness				
Independent variables	**Coef.**	**Std. Err.**	**t-statistic**	**p-value**
LnFD	0.085359	0.014255	5.99	0.000*
LnGDP	-0.059306	0.015511	-3.82	0.000*
LnCO2	0.063953	0.026328	2.43	0.015**
LnENC	0.229774	0.030241	7.60	0.000*
LnFDI	0.135880	0.007114	19.10	0.000*
LnINF	-0.027599	0.006428	-4.29	0.000*
LnK	-0.067610	0.005344	-12.65	0.000*
LnU	0.045625	0.010972	4.16	0.000*
Cons	0.728854	0.191620	14.24	0.000*

Note: This table summarizes estimated coefficients from General Linear Model of Trade openness variable. To empirically test this model, we used yearly data panel of 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% and 5% level are denoted by (*) and (**), respectively.

Table 9. Estimation results of GLM of the CO2 emissions

Dependent variable: CO2				
Independent variables	**Coef.**	**Std. Err.**	**t-statistic**	**p-value**
LnT	0.077082	0.031733	2.43	0.015**
LnFD	0.002268	0.015884	0.14	0.886
LnGDP	0.049664	0.017072	2.91	0.004*
LnENC	0.744413	0.026275	28.33	0.000*
LnFDI	-0.020876	0.008906	-2.34	0.019**
LnINF	0.007650	0.007108	1.08	0.282
LnK	0.016431	0.006231	2.64	0.008*
LnU	-0.048879	0.012050	-4.06	0.000*
Cons	-0.929481	0.177171	-27.82	0.000*

Note: This table summarizes estimated coefficients from General Linear Model of CO2 variable. To empirically test this model, we used yearly data panel of 40 European countries (Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Republic of Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom) from 1985 through 2014. Statistical significance at the 1% and 5% level are denoted by (*) and (**), respectively.

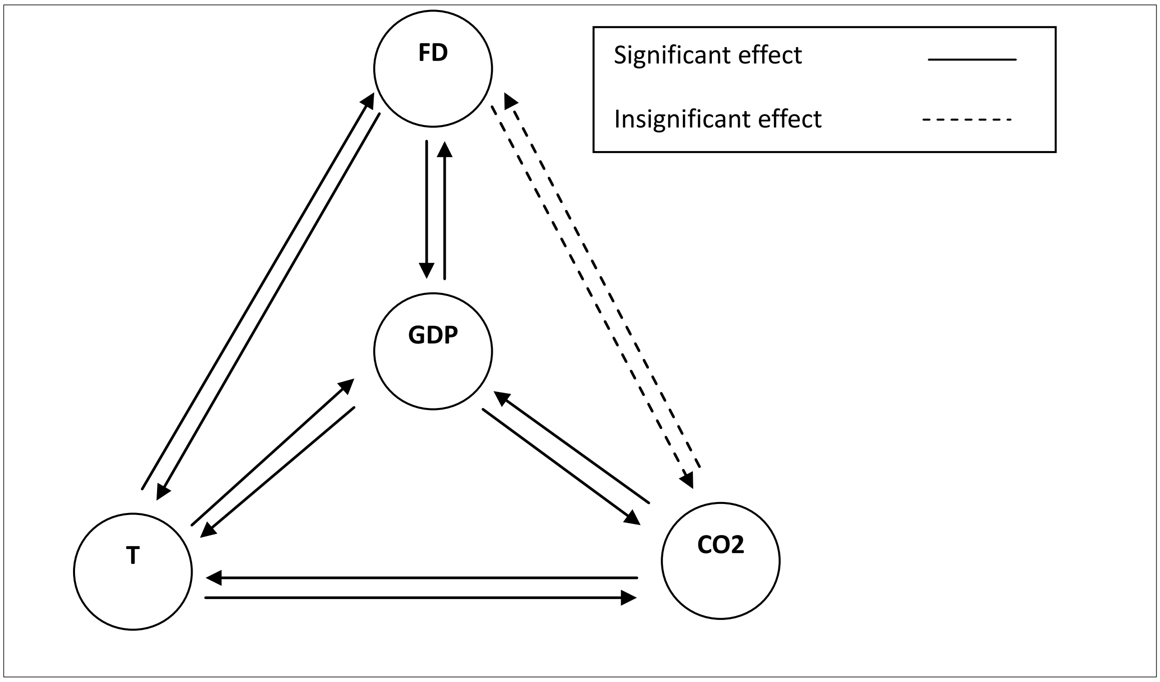

Figure 1. The linkages between economic growth, financial development, trade openness and CO2 emissions

In this equation (4), we reports the impact of trade openness, the financial development , the economic growth, the energy consumptions, the foreign direct investment, the inflation rate, the capital stock, and the urbanization rate on the CO2 emissions. The estimation results of equation (4) are presented in table 9.

The results of this table show that the 5% increases in the trade openness augment the CO2 emissions with 0.077082%. This impact is positive with a significance threshold level of 5%. The economic growth has a positive and significance impact on the CO2 emissions with a threshold level of 1%. Then, a 1% increases in the GDP decrease the CO2 emissions within 0.049664%.

Additionally, we observe that the energy consumption have a positive effect on the CO2 emissions in the case of the European countries with the threshold level of 1%. Thus, we can find that an augment of 1% in the energy consumption decrease the CO2 emissions with a level of 0.744413%. In addition, the coefficient of the foreign direct investment is negative and statistically significant in the threshold level of 5%. This result imply that an increase of 5% in the foreign direct investment show a decrease in the CO2 emissions with (-0.020876%).

The capital stocks have a positive and significance impact on the CO2 emissions in the threshold level of 1%. Thus, an increase of 1% in the capital stocks decreases the CO2 emissions with 0.016431%. Finally, we find that the urbanization rate have a negative and significance impact on the CO2 emissions with a threshold level of 1%. This result signify that the augment of 1% in the urbanization imply a decreases of (-0.048879%) in the trade openness. However, financial development and inflation rate doesn't affect CO2 in case of Euro zone.

6. Conclusions

In this paper, we examine the relationship between economic growth, financial development, trade openness and CO2 emissions. Empirically, we use a General Linear Model from a panel data composed by 40 European countries over the period 1985-2014. The objective of our study is to test the linkages between economic growth, financial development, trade openness and CO2 emissions by employing four structural equations that allow one to observe the impact of (i) CO2 emissions, financial development, trade openness and other variables on economic growth; (ii) economic growth, CO2, trade openness and other variables on financial development; (iii) financial development, economic growth, CO2 emissions and other variables on trade openness; and (iv) trade openness, financial development, economic growth and other variables on CO2 emissions.

The main result of our study show evidence of bidirectional linkage between economic growth and CO2 emissions, economic growth and financial development, economic growth and trade openness, financial development and trade openness, and trade openness and CO2 emissions. However, we find an absence of the significance linkage between financial development and CO2 emissions in the case of the Europeans countries. Figure 1 reports the existing linkage between the four fundamental economic aggregates.

The empirical finding of this study, show that the economic growth and the environmental degradations are positively correlated. The economic growth predicts a positive relationship with the CO2 emissions. Additionally, the economic growth promotes the financial development in the case of Euro zone. But, the economic growth can prevent the trade openness. The increase in financial development can increased the trade openness. Finally, we show a positive relationship between CO2 emission and trade openness. The results presented in this paper conform with the related literature.

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