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FDI and Trade Connectivity in EU: New Evidence from a Non-Linear Panel Smooth Transition VECM

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Abstract: This study examines the relationship between real gross domestic product (GDP) per capita, trade openness and foreign direct investment (FDI) inflows, for the group of the European Union (EU) countries over the period 1995-2020. Using recently developed panel unit root and cointegration techniques, the empirical results confirm the existence of a long-run relationship among the variables. A structural break in the cointegrating relationship appears in 2009. Taking into account the 2009 regime shift, we estimate a panel smooth transition vector error correction model (PST-VECM) to examine whether real GDP per capita, trade openness, and FDI have non-linear short-term and long-term causal relationships. Our findings demonstrate how crucial it is to consider potential non-linearities when assessing FDI-trade-growth causality nexus and designing macroeconomic policies. Overall, the study's findings suggest that trade is a more effective growth stimulant, than FDI. Policy implications are then explored in the conclusions.

Keywords: FDI; trade openness; panel data; structural break VECM.

JEL classification: B23; C33; C50.

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1. INTRODUCTION

In the international business and economics literature, there has been a growing interest regarding the relationship among FDI, trade openness and economic growth. The global trading system has grown increasingly competitive and open over the last few decades. We can identify two major research directions about the relationship between trade and FDI, based on economic theory. The first research direction argues that foreign direct investments (from multinational corporations operating in a nation) have the potential to replace exports, lower unemployment rates, and overall boost growth rates. Economic openness can have a substantial impact on the size and growth of a national economy, since it fosters the effective distribution of sources, increases competitiveness in both domestic and international markets, and stimulates the transfer of technology and knowledge within the workforce (Chang *et al.*, 2009).

Conversely, the second research direction implies that the link between the openness of trade and FDI is supplementary, resulting in a positive link between them. There are numerous discussions in favor of the possibility of bidirectional causal relationships between FDI and trade. However, to our knowledge, the majority of research tends to conclude that increased FDI inflows result higher growth rates than vice versa. In addition to encouraging private investment and the creation of new jobs, foreign direct investments also transfer knowledge and technology skills within the workforce and generally strengthen the economy of the host countries (Chowdhury and Mavrotas, 2006).

Nevertheless, the impact of trade and FDI are worthy of empirical investigations, as it seems to depend on a set of factors, such as policy and macroeconomic stability, economic freedom/quality of economic institutions, open trade regime, market size, human capital, infrastructure, etc. (Bhatt, 2013; Kumari *et al.*, 2023). In addition, the stage of economic development of the country also depends on the nature of FDI and the sectoral growth that is possible, when the foreign investor invests/or target that particular sector (Kumari *et al.*, 2023).

After the 1990s, Europe saw a notable increase in the share of FDI inflows to GDP. According to UNCTAD (2022), the increase was over 1% in high-income economies throughout the 1980s and over 5% in 2007. However, the growth in FDI inflows was less (almost 2% after 2000) in low- and middle-income economies, indicating a slightly higher relevance of FDI inflows in developing countries in the most recent time period. Regarding the countries of Central and Eastern Europe, considerable increases in FDI inflows occurred as soon as the accession negotiations began (Ozturk, 2007). Open economies have more market prospects, but they also face more competition from enterprises operating in other nations.

FDI is the primary means by which knowledge/technology is transferred from developed to developing nations. Consequently, decision-makers in transitional economies have sought it out (Borensztein *et al.*, 1998). For this reason, transition countries have generally implemented the following reforms (Stejskal *et al.*, 2018):

1. Liberalization: Allowing competitive free markets to decide pricing and removing trade barriers.
2. Macroeconomic stabilization: Monetary and fiscal approaches to control inflation.
3. Restructuring & privatization: Transferring enterprise ownership from the government to private owners and establishing a robust banking sector to assist private businesses.
4. Legal and institution reforms: Bringing democracy to the economy and reducing government meddling.

The purpose of this study is to investigate the potential short-term, long-term and causal relationships between FDI inflows, openness of trade and economic growth with a focus on the European Union (EU) countries. The sample dataset is annual time series data for the period 1995-2020. This research seeks to add to the literature in a number of ways:

1. It augments the literature with empirical proofs related to the links among FDI inflows, trade openness and economic growth. The study aims to revisit the issue of the effects of trade and FDI on growth, for the group of the EU member states.
2. In accordance with the authors' best knowledge there aren't many studies that include these three variables together based on a structural break test and the panel causality analysis, under the non-linear framework. This study considers structural breaks that, if ignored, could lead to an incorrect rejection of the null hypothesis and, thus, inaccurate estimates (Hobbs *et al.*, 2021).
3. The methodology used in the paper relies on recent data and proper econometric techniques for which we support that they are the correct estimation procedures. Since prominent panel unit root tests (first generation tests) have been applied, we continue employing the unit root tests proposed by Im *et al.* (2005) and Lluís Carrion-i-Silvestre *et al.* (2005), Bai and Perron (2003) panel cointegration methodology, as well as FMOLS technique. Finally, the non-linear panel smooth transition vector error correction model (PST-VECM), rather than traditional Granger causality approach, is used to analyze the causal links between the examined variables.
4. Another difference of the study is that, in the current analysis (in contrast to the existing studies), we investigate not only the causal relations among the examined variables but also the potential of short-term, long-term and strong causality relations among FDI inflows, trade openness and economic growth.
5. Findings of this research will give a richer depiction as to whether there exist long run relationships between the involved variables. Our results highlight the significance of considering potential non-linearities in order to analyze the causality nexus, as well as designing macroeconomic policies.
6. Finally, the study presents some conclusions and policy implications that may serve as a debate for further investigation. Furthermore, the study analyzes the trade-growth nexus in the EU, specifically examining both the "trade-led growth" and the "growth-led trade" hypotheses. The results of the analysis will clarify whether export earnings have a major impact on economic development or whether domestic growth dynamics are what first enhance export capacity in the EU.

The structure of the paper is as follows: Section 2 reviews the theoretical and empirical literature. Section 3 presents the data. Section 4 presents the econometric approach and the discussion of the results. Concluding remarks and policy implications are given in the Section 5.

2. A THEORETICAL AND EMPIRICAL LITERATURE REVIEW

Given that production parameters are globally immobile, the relationship between trade and foreign direct investments is not clearly defined in neoclassical trade theories, such as those of Heckscher-Ohlin and Ricardo. According to these models, international commodity trade involves an indirect exchange of factors between countries (Anthony, 2013). In developing nations, the Heckscher-Ohlin-Samuelson model is a crucial tool for increasing real wages and promoting economic growth (Erkisi and Ceyhan, 2019).

Solow (1956), in his fundamental study of the neoclassical growth model, analyzed the aggregate production function which is connected to the labor force and overall output of the

economy. He concluded that, because FDI brought new technologies to the manufacturing process, it had a positive impact on economic growth.

Krueger (1978) and Balassa (1985), who made a great contribution to neo-classical economics, developed models emphasizing export-based development and asserting that increased exports positively impacted real GDP growth.

Mundel (1957) used the neoclassical Heckscher-Ohlin and Samuelson models' presumptions to investigate the relationship between trade and FDI. His analysis's findings showed that flows of FDI depend on the differences in financing and prices of each country. Nevertheless, given the quick capital movement, these differences seem to be smaller. Finally, Mundel (1957) argued that mobility of capital, which is driven by foreign direct investments, constitutes a perfect substitute for exports for each country.

Schmitz and Helmberger (1970), a few years later, supported that trade and FDI have a complementary connection. They stated that when capital mobility is imported into a nation, trade volume rises.

The dynamic advantages obtained as a result of openness to international trade constitute the primary features of the endogenous growth theories led by Romer (1986) and Lucas (1988). In endogenous growth models, it is feasible to demonstrate long-term relationships between trade liberalization and economic development. According to the theory, sophisticated capital goods will accelerate technology transfer via imports concurrently with liberalization.

2.1 Technological Diffusion, through FDI, as a Key Factor for Economic Growth

As endogenous growth theories suggest (Romer, 1986), FDI can boost economic growth through mechanisms including innovation and knowledge transfer from foreign to domestic companies. Using data from 1987 to 1996, Keller and Yeaple (2009) examined the technology transfer from FDI to manufacturing firms in the United States (US). Their results showed that FDI spillovers accounted for 11% of productivity growth in US firms. The authors' conclusion was that high technology industries had stronger FDI spillovers, which highlights the variability of FDI effects across industries.

However, the effects of FDI seem to depend on the host country’s characteristics, such as technological innovation, human development index, financial development and financial institution quality, as well as openness to trade (Borensztein *et al.*, 1998).

Using data from 25 Eastern European countries between 1990 and 1998, Campos and Kinoshita (2002) found a strong positive correlation between FDI and economic growth through technology (and know-how) transfer to the host country industries. Furthermore, the authors claimed that the impact of FDI inflows is not determined by human capital.

On the other hand, Li and Liu (2005) argued that FDI boosts economic growth both directly and indirectly (via human capital), using a panel dataset of 84 developed and developing economies from 1970 to 1999. However, the developing countries (the host countries) saw a decline in economic growth as a result of their weaker absorptive capacity (which is a result of their low level of human capital development).

A similar study was carried out by Curwin and Mahutga (2014). They claimed that FDI decrease economic growth rates over the long and short terms, using data from 25 Eastern European economies between 1990 and 2010. This could be explained due to rapid share of FDI inflows, in these economies. Privatization schemes resulted in large budgetary shocks, because of poor institutional frameworks in competition policy and governance.

Furthermore, Islam *et al.* (2020) investigated the relationship between FDI and financial development, given the significance of FDI inflows for a host country's long-term economic development. Their empirical study suggests that financial institutions are more attractive to FDI than financial markets. Therefore, governments should support reputable financial institutions in order to make the country more appealing to foreign investors.

2.2 Trade Liberalization and Economic Growth

Countries gain from foreign trade in a number of ways. Trade improves the efficiency of global resource allocation (by equating the values of products and services), as well as allows countries to specialize in areas where they are most effective (in the creation of commodities and services) (Tupy, 2005).

A dynamic panel model of growth was examined by Greenaway *et al.* (2002), for 73 developing economies in the context of various measures of liberalization. They discovered that whereas trade liberalization initially has a negative effect on GDP per capita, over time this effect fades as economic development increases. The results of the study show a relationship between the variables in the shape of a "J" curve: evidence that holds true for different samples and liberalization levels.

Using panel data from 22 emerging economies over the period 1972-1997, Santos-Paulino and Thirlwall (2004) discovered that the increase in exports, brought about by trade liberalization, had an impact on wage inequality, income distribution, unemployment rate, and economic devlepoment. Authors argued that increased imports have weaker effects on these variables, and that trade liberalization affects the balance of payments by boosting imports.

Kilavuz and Topcu (2012) examined the effects of different classifications of trade on economic growth, in 22 developing countries from 1998 to 2006. The main finding of the study is that exports, investments, and imports of high-technology manufacturing firms have a major and beneficial impact on economic development.

A recent study conducted by Erkisi and Ceyhan (2019) in order to investigate the relationship between economic growth and trade liberalization, for the case of 13 transition countries in Europe using data covering the period 1995-2016. The results indicate that trade liberalization positively affects economic growth in mutual way between exports, imports and economic growth according to the feedback hypothesis.

2.3 Interrelationship between FDI, Trade Openness and Economic Growth

The relationships between FDI, trade openness, and economic development have been the subject of several studies. The literature on the interrelationship between FDI, trade openness and economic growth has been quite varied and often inconclusive.

Using Granger causality approaches and panel data analysis, Hsiao and Hsiao (2006) investigated the link between exports, FDI, and GDP for 8 East and Southeast Asian economies from 1986 and 2004. Their study's findings demonstrated that FDI affects GDP both directly and indirectly (via exports). Furthermore, the authors found a bidirectional causal relationship between the group of countries' GDP and exports.

Ciftcioglu *et al.* (2007) investigated the effects of FDI inflows on unemployment, trade openness and economic growth, in 9 Central and East European countries using data covering the period 1995-2003. The analysis's key conclusion is that an increase in FDI inflows has a

negative effect on the unemployment rate. Authors came to the conclusion that these economies ought to prioritize measures that boost FDI inflows' beneficial effects on technical progress and therefore on economic growth.

Between 1994 and 2008, Acaravci and Ozturk (2012) examined the connections among FDI, exports and economic growth for 10 European countries. They found that there is a causality relation between exports, FDI, exports and economic growth in four out of the ten economies.

Dritsakis and Stamatiou (2014) used annual panel data covering the years 1970-2011 to investigate the relationships between exports, FDI, and GDP in five Eurozone countries. Their findings support that there is a bidirectional causal relationship between exports and economic development, but not between FDI and growth nor exports and FDI. Authors concluded that a rise in these nations' domestic output volumes would drive their export volumes and growth rates.

Cinar and Nulambeh (2018) examined the effects of trade liberalization and foreign direct investments on economic growth in 34 Sub-Saharan African countries from 2006 and 2015. Their results showed that trade openness and foreign direct investments play important roles in explaining economic growth. The authors came to the conclusion that governments should keep up their efforts to foster a business-friendly environment and design macroeconomic policies that promote infrastructure development and economic openness.

Banday *et al.* (2021) examined the causal relationship between FDI, trade openness and economic growth in BRICS countries using data for the period of 1990-2018. Their analysis's principal finding is that FDI and trade openness have a positive impact on long-term growth rates. The causality results of the study reveal bidirectional causalities between FDI and economic growth and between trade openness and FDI, as well as a unidirectional causality running from trade openness to FDI.

In this paper, we go a few steps further related to the existing literature in the field, by focusing on EU countries, viewed as group. More importantly, we apply modern econometric techniques, for which we support that they are the correct estimation procedures within the non-linear panel framework.

3. DATA

The following variables were measured annually for the 27 member states of the European Union: GDP per capita in current US dollars (GDP), trade openness in current US dollars (TO) expressed as the sum of imports and exports divided by GDP per capita, and inflows of foreign direct investments in current US dollars per capita (FDI). To convert current prices into constant prices, each country's GDP deflator (2015=1) was used (to deflate all variables). The selection of the sample is based on the data availability. All data needed, collected from WDI (2022) and UNCTAD (2022).

4. METHODOLOGY AND RESULTS

4.1 Panel Unit Root Tests

To find the integration order of the corresponding variables, we begin our analysis with the panel unit root tests. The tests by Breitung (2001) and Levin *et al.* (2002) pre-suppose that the dynamics of the autoregressive coefficients are homogeneous for every unit of the panel.

However, Phillips and Sul (2003) show that this idea frequently results in the null hypothesis being rejected mistakenly.

The unit root test of Im *et al.* (2003) permits heterogeneity in the panel's autoregressive coefficients' dynamics. Furthermore, based on the Fisher-ADF and Fisher-PP tests, Maddala and Wu (1999) presented a non-parametric technique that permits heterogeneity between panel units.

Finally, Hadri (2000) proposed a Lagrange Multiplier test based on residuals to test the null hypothesis that the time series are stationary around a deterministic trend for each *i*, while contrasting it with the alternative of a unit root in panel data. In all cases except Hadri (2000), the null hypothesis is that the variable contains a unit root.

The results of these panel unit roots are displayed in Table no. 1. The results show that all three variables are non-stationary in their levels, with an intercept and trend. Evidently, the results indicated that all variables are stationary in their first differences.

Table no. 1 – Unit Root Results

Level			
	GDP	**TO**	**FDI**
LLC	2.545	-1.471	-0.312
Breitung	1.841	-1.613	-0.554
IPS	2.328	-0.972	0.744
ADF	4.517	9.687	2.338
PP	0.039	5.711	2.439
Hadri	4.447***	4.441***	1.728**
First Difference			
	GDP	**TO**	**FDI**
LLC	-4.446 ***	-7.574 ***	-3.009 ***
Breitung	-4.156 ***	-2.720 ***	-2.308 **
IPS	-2.074 **	-4.244 ***	-2.619 ***
ADF	18.903 ***	36.093 ***	16.846 ***
PP	13.538 **	48.267 ***	29.188 ***
Hadri	0.713	-0.005	1.209

Notes: Panel data include all countries. ***, **, denotes rejection of null hypothesis at the 1% and 5% level of significance, respectively. Lag length selection automatic based on Schwarz criterion.

To further investigate the validity of the first generation panel unit root tests, we additionally employ the tests proposed by Im *et al.* (2005) and Lluís Carrion-i-Silvestre *et al.* (2005) that allow endogenous determined structural breaks. More precisely, the above mentioned approaches permit one break in the level of each series, as well as an arbitrary number of breaks, respectively. In Im *et al.* (2005) test, the null hypothesis is that the series contain a unit root (non-stationarity), whereas the null hypothesis for the Lluís Carrion-i-Silvestre *et al.* (2005) test is stationarity.

The findings of the approaches used by Im *et al.* (2005) and Lluís Carrion-i-Silvestre *et al.* (2005) are presented in Table no. 2. The null hypothesis pertaining to non-stationarity in levels is not rejected by the Im *et al.* (2005) technique. However, at 1% level of significance, the null hypothesis is rejected when the variables are converted to first differences. Furthermore, at the 1% level of significance, the Lluís Carrion-i-Silvestre *et al.* (2005) test rejects the null hypothesis of stationarity in levels. Nevertheless, the null hypothesis cannot

be rejected once the variables have been converted to first differences. We conclude that GDP, TO and FDI are integrated of order one (i.e. *I*(1)), with a structural break occurring in 2009.

Table no. 2 – Unit Root Results (Break Included)

Level	**GDP**	**TO**	**FDI**
Im *et al.* $\Gamma_{LM}^{B}(p)$	-2.90	-2.60	-2.50
Carrion-i-Silvestre *et al.* $LM(\lambda)$	24.40***	35.30***	25.60***
First Difference	**GDP**	**TO**	**FDI**
Im *et al.* $\Gamma_{LM}^{B}(p)$	-28.40***	-38.50***	-28.60***
Carrion-i-Silvestre *et al.* $LM(\lambda)$	1.50	1.40	1.30

Notes: The critical value for the $\Gamma_{LM}^{B}(p)$ test is -4.26 at 1% level of significance. In addition, for the $LM(\lambda)$ test the critical value is 10.63 at 1% level of significance. Break location 2009. *** denotes rejection of null hypothesis at the 1% level of significance. The maximum number of common factors and structural breaks in the Lluís Carrion-i-Silvestre *et al.* (2005) test are set equal to five according to the literature.

4.2 Non-linear Panel Cointegration

The economic literature states that one of the most important factors determining long-term economic growth is investment or capital accumulation. This is especially true when determining an economy's long-run productive capacity because investments produce new capital products and causes the capital stock to grow quickly (Romer, 2001).

Additionally, Chakraborty and Mukherjee (2012) provided evidence supporting the idea that FDI inflows will assist recipient countries economically in a number of ways, potentially spurring economic growth through positive externalities and spillover effects. Furthermore, trade openness is included in this study's analysis as an explanatory variable within the sources of growth equation. International commerce may lead to a significant elasticity of substitution, as determined by Mankiw *et al.* (1992). In accordance with Hsiao and Hsiao (2006), we define the model's generic form as follows:

$$GDP_{it} = f(TO_{it}, FDI_{it}) \tag{1}$$

After defining the integration order, we proceed by using the panel cointegration methodology, taking any structural breaks into account. Equation (2) specifies the overall form of the model within a break augmented panel regression framework.

$$GDP_{it} = a_{ij} + \beta_{1i} TO_{it} + \beta_{2i} FDI_{it} + \varepsilon_{it} \tag{2}$$

where: a_{ij} *(j=1,...,m_i+1)* represent the country specific intercept that is subject to m_i structural breaks, β_{1i} are the country specific slopes that are assumed to be constant over time and ε_{it} is assumed to be independent and identically distributed over time periods and across cross-sectional units.

With regard to equation (2), the traditional cointegration techniques can be used assuming that the series has no structural breaks. The relationship in equation (2) is no longer linear in the case that there are structural breaks, so the conventional panel cointegration tests do not yield reliable findings. Westerlund (2007) recommends applying Bai and Perron (2003) least squares method, which is predicated on resolving the following minimization problem:

$$(\tau_{i1...}\tau_{\min}) = \arg\min_{\tau_{i1}...\tau_{\min}} \sum_{j=1}^{m_i+1} \sum_{t=\tau_{ij-1}+1}^{\tau_{ij}} \varepsilon_{it}^2 \quad (3)$$

where: ε_{it} stands for the residuals in equation (5) based on the partition τ_{ij} with $j = 1...m_i$ and a trimming parameter of $\tau_{\min}$, with the minimum length of each subsample to be $\tau_{ij} - \tau_{ij} - 1 > \tau_{\min}$.

This approach's primary benefit is its ability to test for numerous breaks at arbitrary dates. To reliably calculate the number of breaks, it estimates each break point using a specific-to-general technique (Esteve and Requena, 2006). The process operates as follows: For each break number $m_i = 1...m_{\max}$, we first calculate the minimum of the sum of the squared residuals related to structural breaks τ_{ij}. The Schwarz criterion is used to estimate the number of structural breaks for each i in the second phase.

The first step in the Bai and Perron (2003) process is to minimize the objective function with respect to a_{ij} and τ_{ij}, and while maintaining β_{1i} and β_{2i} fixed. The objective function of a pure structural change is minimized given that β_{1i} and β_{2i} stay fixed. In the second phase, the objective function is minimized in relation to a_{ij}, β_{1i} and β_{2i}, and while maintaining the τ_{ij} fixed (Apergis and Payne, 2014).

The following table shows the results of the cointegration test conducted by Bai and Perron (2003). For the group of the selected EU countries, Table's no. 3 results validate a cointegrating vector among the variables under examination. At the panel level, the null hypothesis of cointegration is accepted. Put otherwise, the findings indicate that, over time (long run), GDP, TO, and FDI are all moving together.

Table no. 3 – Cointegration Results

Bai and Perron		
	Statistic	**P-Value**
Intercept Break	9.503	0.550

Notes: The p-value is based on the bootstrap distribution.

After cointegration is established, we use the fully modified OLS (FMOLS) technique for heterogeneous cointegrated panels to estimate the long-run relationship. This FMOLS estimator permits more flexibility in the case that heterogeneity exists in the cointegrated vectors (Pedroni, 2001b, 2001a). Furthermore, in addition, the superior estimator consider

both serial correlation and endogeneity problems, so it is preferable than the OLS estimator (Phillips, 1995). The following equation displays the estimator's formula:

$$\beta_{FM} = \left[\sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \overline{x_i})(x_{it} - \overline{x_i})' \right]^{-1} \left[\sum_{i=1}^{N} \left(\sum_{t=1}^{T} (x_{it} - \overline{x_i}) y_{it}^{*} + T\Delta_{EM}^{*} \right) \right] \quad (4)$$

where: y_{it}^{*} is the transformed variable of y_{it} in order to achieve the endogeneity correction and Δ_{EM}^{*} is the serial correlation error correction term.

We continue by estimating the long-run equilibrium relationship's parameters. The following table presents the findings from Pedroni (2001a)'s FMOLS estimations.

Table no. 4 – FMOLS Results

	Independent Variables	
	TO	**FDI**
Coefficient	0.212	0.375
	(0.016**)	(5.140***)
Pesaran (CD)	0.644 [p-value = 0.289]	

Notes: The numbers in parentheses denotes t-statistic, *** and ** denotes significant at 1% and 5% level of significance.

Trade openness (TO) and foreign direct investments (FDI) are significant contributors to economic growth, as demonstrated by the FMOLS estimator. More specifically, at the 5% and 1% significance levels, respectively, TO and FDI are two significant factors that boost growth rates. A 1% increase in TO tends to lead GDP in the group of selected European Union countries increasing by 0.212%. In addition, a 1% increase in FDI tends to lead GDP increasing by 0.375%. The study's findings are consistent with those of Hsiao and Hsiao (2006), who argued that, among a group of industrialized economies, exports and FDI combined play the most significant role in the process of economic growth. The Pesaran (2004) cross-sectional dependence (CD)[1] is likewise shown in Table no. 4 and provides reliable values for both small and large samples. The results of the test fail to reject the null hypothesis of no cross-sectional dependence, indicating that the residuals (in the cointegrating vector) are not cross section dependent.

4.3 Panel Causality Analysis

We continue using a non-linear panel smooth transition vector error correction model (PST-VECM) to analyze the causal links between the variables under investigation. The PST-VECM takes into account potential non-linear dynamics, in addition to the long term relationship adjustment.

Following Gonzalez *et al.* (2005), as well as Omay and Öznur Kan (2010), the equations of the PST-VECM are given below:

$$\Delta GDP_{i,t} = a_{1,i} + \lambda_{1,i} ECT_{i,t-1} + \sum_{k=1}^{p} \beta_{1,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{1,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \beta_{1,3,i,k} \Delta FDI_{i,t-k}$$
$$+ G(S_{it};\gamma,c)\left[\lambda_{1,1,i} ECT_{i,t-1} + \sum_{k=1}^{p} \delta_{1,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \delta_{1,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \delta_{1,3,i,k} \Delta FDI_{i,t-k} \right] + u_{1,i,t} \quad (5)$$

$$\Delta TO_{i,t} = a_{2,i} + \lambda_{2,i} ECT_{i,t-1} + \sum_{k=1}^{p} \beta_{2,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{2,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \beta_{2,3,i,k} \Delta FDI_{i,t-k}$$
$$+ G(S_{it};\gamma,c)\left[\lambda_{2,1,i} ECT_{i,t-1} + \sum_{k=1}^{p} \delta_{2,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \delta_{2,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \delta_{2,3,i,k} \Delta FDI_{i,t-k} \right] + u_{2,i,t} \quad (6)$$

$$\Delta FDI_{i,t} = a_{3,i} + \lambda_{3,i} ECT_{i,t-1} + \sum_{k=1}^{p} \beta_{3,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \beta_{3,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \beta_{3,3,i,k} \Delta FDI_{i,t-k}$$
$$+ G(S_{it};\gamma,c)\left[\lambda_{3,1,i} ECT_{i,t-1} + \sum_{k=1}^{p} \delta_{3,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \delta_{3,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \delta_{3,3,i,k} \Delta FDI_{i,t-k} \right] + u_{3,i,t} \quad (7)$$

where: $a_{j,i}$ (j = 1, 2, 3, 4) represents the fixed individual effects, $G(S_{it};\gamma,c)$ is the transition function bounded between 0 and 1 (depends on the transition variable S_{it}), γ is the transition parameter that describes the slope of the transition function, c is a threshold parameter, $u_{j,i}$ is the error term assumed to be a martingale difference with respect to the history of the vector of variables with mean zero and variance, $ECT_{i,t-1}$ is the error correction term (ECT) derived from the long run cointegration equation.

In the above equations (5), (6), and (7), the transition between regimes is addressed using the next logistic and exponential functions:

$$G(S_{it};\gamma,c) = \left[\frac{1}{1+\exp\left(-\gamma \prod_{j=1}^{m}(S_{it}-c)\right)} \right] \quad (8)$$

where: $\gamma > 0$ and $c_1 \le c_2 \le \ldots \le c_m$

According to Gonzalez *et al.* (2005), it is adequate to take into account only the cases in which *m = 1* or *m = 2*. A logistic transition function is present when *m = 1*. In the other case *(m =2)*, the transition function is an exponential type.

In equations (5), (6), and (7), the short run causal relationship between the variables depends on:

1. For the causal relationship between GDP and TO:

$\beta_{1,2,i,k} + \delta_{1,2,i,k} G(S_{it};\gamma,c)$ and $\beta_{2,1,i,k} + \delta_{2,1,i,k} G(S_{it};\gamma,c)$ for $k = 1,..,p$

2. For the causal relationship between GDP and FDI:
$\beta_{1,3,i,k} + \delta_{1,3,i,k} G(S_{it};\gamma,c)$ and $\beta_{3,1,i,k} + \delta_{3,1,i,k} G(S_{it};\gamma,c)$ for $k = 1,..,p$

3. For the causal relationship between GDP and TO:
$\beta_{2,3,i,k} + \delta_{2,3,i,k} G(S_{it};\gamma,c)$ and $\beta_{3,2,i,k} + \delta_{3,2,i,k} G(S_{it};\gamma,c)$ for $k = 1,..,p$

In addition, the long run causalities depend on:

$$\lambda_{1,i} + \lambda_{1,1,i} G(S_{it};\gamma,c),\ \lambda_{2,i} + \lambda_{2,1,i} G(S_{it};\gamma,c) \text{ and } \lambda_{3,i} + \lambda_{3,1,i} G(S_{it};\gamma,c).$$

As we see, the transition variable S_{it} is a key variable in the causality relation among GDP, TO and FDI.

The following steps are part of the smooth VECM estimation technique. First, we compare the alternative of non-linearity (smooth transition) to the null hypothesis of linearity. In the case that linearity is rejected, we proceed to determine the shape of the transition function. Luukkonen *et al.* (1988) state that the transition function can be replaced with the k^{th} order Taylor expansion around γ in the next auxiliary equations (5), (6), and (7). In the end, we estimate the parameters in the smooth panel VECM that we have chosen.

$$\begin{aligned}\Delta GDP_{i,t} &= \psi_{1,i} + \lambda_{1,i} ECT_{i,t-1} + \sum_{k=1}^{p} \pi_{1,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi_{1,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi_{1,3,i,k} \Delta FDI_{i,t-k} \\ &+ \lambda_1' S_{it} ECT_{i,t-1} + \sum_{h=1}^{k} \left(\sum_{k=1}^{p} \pi'_{1,1,i,k} S_{it} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi'_{1,2,i,k} S_{it} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi'_{1,3,i,k} S_{it} \Delta FDI_{i,t-k} \right) + u_{1,i,t}\end{aligned} \tag{9}$$

$$\begin{aligned}\Delta \mathrm{TO}_{i,t} &= \psi_{2,i} + \lambda_{2,i} ECT_{i,t-1} + \sum_{k=1}^{p} \pi_{2,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi_{2,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi_{2,3,i,k} \Delta FDI_{i,t-k} \\ &+ \lambda_2' S_{it} ECT_{i,t-1} + \sum_{h=1}^{k} \left(\sum_{k=1}^{p} \pi'_{2,1,i,k} S_{it} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi'_{2,2,i,k} S_{it} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi'_{2,3,i,k} S_{it} \Delta FDI_{i,t-k} \right) + u_{2,i,t}\end{aligned} \tag{10}$$

$$\begin{aligned}\Delta FDO_{i,t} &= \psi_{3,i} + \lambda_{3,i} ECT_{i,t-1} + \sum_{k=1}^{p} \pi_{3,1,i,k} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi_{3,2,i,k} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi_{3,3,i,k} \Delta FDI_{i,t-k} \\ &+ \lambda_3' S_{it} ECT_{i,t-1} + \sum_{h=1}^{k} \left(\sum_{k=1}^{p} \pi'_{3,1,i,k} S_{it} \Delta GDP_{i,t-k} + \sum_{k=1}^{p} \pi'_{3,2,i,k} S_{it} \Delta TO_{i,t-k} + \sum_{k=1}^{p} \pi'_{3,3,i,k} S_{it} \Delta FDI_{i,t-k} \right) + u_{3,i,t}\end{aligned} \tag{11}$$

Testing $\gamma = 0$ in equations (5), (6), and (7) is equivalent to testing the hypothesis H_0: ω1=ω2=ω3=0 in equations (9), (10), and (11) (where $\omega_i \equiv (\lambda', \pi')$). This test can be undertaken using an LM test statistic approximated by and F-distribution as shown below:

$$LM = [(SSR_0 - SSR_1) / mk] / [SSR_0 / TN - N - mk] \rightarrow F(mk, TN - N - mk) \quad (12)$$

where: SSR_0, SSR_1 are the sums of squared residuals under the null and the alternative hypothesis, k is the number of explanatory variables.

The following tables provide the panel smooth VECM estimate results. Since we have selected the appropriate transition variable S_{it}, we apply a sequence of F tests as suggested by Terasvirta (1994) in order to choose the type of the transition function. The choice of trade openness as the transition variable was made in light of the literature's theoretical and empirical support for the idea that economic openness can affect both FDI and economic growth at the same time. Despite this, Chaboud and Wright (2005) argued that alternative transition variables can have the same policy implications in specific situations.

Table no. 5 – Selection of the Transition Function break date 2009

	F1	F2	F3
GDP	0.055	0.095	0.189
TO	0.040	0.123	0.177
FDI	0.039	0.112	0.411

Notes: Reported numbers are prob. values. Order Taylor approximation equals to 3.

The findings indicate that F_1 has the smallest p-value among the F tests, indicating that F_1 is a suitable logistic function to utilize as the transition function. Since the estimated value of c is extremely near to zero (-0.001), extreme regimes are associated with both positive and negative growth values prior to and following the structural break.

We now proceed with the regime-wise Granger causality analysis to examine the short and long term correlations among the variables for each regime (pre-2009, post-2009 periods), as we have chosen both the suitable transition variable and the transition function. Additionally, we test for the strong causality based on the joint significance of the error correction term and the long term coefficients.

We proceed with regime-wise short and long term Granger causalities. The lagged values of the first-difference of the relevant variables are used to test for short run causalities. Furthermore, depending on the statistical significance of the corresponding error correction terms, the long term causalities are perfumed. Finally, we use the joint significance of the lagged values of the variables' first-difference and the error correction term, to assess the strong-form of causality.

Tables no. 6 and no. 7 present the results of the regime-wise Granger-causality tests, for the pre-2009 and the post-2009 period, respectively.

The short-run causality results show that trade openness and economic growth have a bidirectional causal relationship for the pre-2009 period, in addition to two unidirectional causalities that flow from trade openness to FDI and from FDI to economic growth. Furthermore, there may be long-term convergence of dynamic equilibrium based on the statistical importance of the error correction terms in the corresponding equations (5), (6), and (7). Value of the estimated coefficient of the *ECT* shows the speed of adjustment (convergence). Finally, the aforementioned causality links are validated in terms of the joint test of the long-run and short-run (strong causality).

Table no. 6 – Causality Results (pre-2009 period)

	Short-run F-values			Long-run t-values	Joint (short-long-run) F-values		
	ΔGDP	**ΔTO**	**ΔFDI**	**ECT**	**ΔGDP ECT**	**ΔTO ECT**	**ΔFDI ECT**
ΔGDP		0.719	-0.870	-0.350		3.371	-2.155
		(0.023)**	(0.017)**	(0.040**)		(0.043)**	(0.036)**
ΔTO	0.630		0.192	3.630	0.114		2.124
	(0.025)**		(0.316)	(0.034)**	(0.030)**		(0.131)
ΔFDI	-0.069	-0.710		-0.667	0.080	1.850	
	(0.843)	(0.069)*		(0.063)*	(0.922)	(0.089)*	

Notes: Partial F-statistics with respect to short run changes in the independent variables. The optimal lag lengths were selected by using the Akaike information criterion, The numbers in parenthesis are p-values calculated under the null hypothesis of no causality, ***, ** and * show significant at 1%, 5% and 10% levels respectively.

Table no. 7 – Causality Results (post-2009 period)

	Short-run F-values			Long-run t-values	Joint (short-long-run) F-values		
	ΔGDP	**ΔTO**	**ΔFDI**	**ECT**	**ΔGDP ECT**	**ΔTO ECT**	**ΔFDI ECT**
ΔGDP		0.593	0.035	-0.411		1.049	0.838
		(0.025)**	(0.855)	(0.084)*		(0.198)	(0.438)
ΔTO	1.850		0.081	-0.405	3.428		0.342
	(0.091)*		(0.963)	(0.089)*	(0.072)*		(1.115)
ΔFDI	0.227		-0.160	-0.039	0.460		0.900
	(0.299)		(0.150)	(0.697)	(0.211)		(1.234)

Notes: Partial F-statistics with respect to short run changes in the independent variables. The optimal lag lengths were selected by using the Akaike information criterion, The numbers in parenthesis are p-values calculated under the null hypothesis of no causality, ***, ** and * show significant at 1%, 5% and 10% levels respectively.

The short-run causality results for the post-2009 period show that trade openness and economic growth have a bidirectional causal relationship, but there is no causal relationship between trade openness and FDI nor between FDI and economic growth. Furthermore, the statistical significance of the error correction terms in the corresponding equation (5) implies the presence of long-term convergence of dynamic equilibrium. The value o the estimated coefficient of the *ECT* shows the speed of adjustment (convergence). Finally, in terms of the joint test of the short-run and long-run (strong causality), the above mentioned causality relation is confirmed.

The study's primary conclusion is that there is no correlation between economic development and foreign direct investments throughout the post-crisis period. FDI does not appear to have a direct or indirect impact on GDP (via trade openness). This result is supporting of the study of Dritsakis and Stamatiou (2014). Dritsakis and Stamatiou (2014) used a panel data sample spanning 42 years for 5 Eurozone economies to find that there is no causal relationship between exports and FDI nor between economic growth and FDI. The main explanation for this is the global financial crisis of 2008. FDI inflows have been significantly impacted by the great recession of 2008-2009 in all European countries. After 2009, FDI inflows into the EU decreased dramatically (57%). From 3.25 (% GDP) in 2009 decreased to 1.38 (% GDP) in 2019 (WDI, 2022).

5. CONCLUSION

This study investigates the relationship among FDI inflows, trade openness and economic growth, within a panel framework for the group European Union (EU) countries during the period 1995-2020. We excluded before 1995s due to a lack of dataset.

By examining a panel of 27 EU countries, this research adds to the growing body of knowledge regarding the factors that affect economic development, within a non-linear panel smooth transition vector error correction model (PST-VECM). Findings show a structural break in the cointegrated vector that occurred in 2009, which coincides with the launch of the recent global financial crisis. The results also confirm positive and statistically significant estimates of long-run elasticity with respect to real GDP per capita, FDI inflows, and trade openness.

Overall, the study's findings suggest that trade is a more effective growth stimulant than FDI. As a result, policy makers seek to assist EU companies in breaking into new markets. The European community should place greater focus on encouraging export-oriented behavior through trade-capacity building programs, aid-for-trade, and further policy initiatives to support the expansion of export-oriented manufacturing businesses (Tekin, 2012). Trade promotion will enable businesses to grow and benefit from economies of scale. Furthermore, more jobs will be created in the economy resulting in higher income levels.

A non-linear PST-VECM, which acknowledges the 2009 regime shift, highlights the significance of obtaining FDI under the trade promotion regime in the pre-2009 period compared to the post-2009 period. Increased FDI is correlated with higher trade levels. While it is true that host country exporting activity reflects local firms' international competitiveness, a higher level of export in a host country signals to foreign investors that there is a potential market in these countries (Pourshahabi *et al*., 2013).

Trade openness may promote technological development, which may in turn lead to long-term growth that is permanent. Nowak and Lehmann (2000) asserts that the promotion of technical progress is related to the attraction of more and better FDI, incentives for innovation in industries where trade liberalization is strongly correlated and stronger capital goods imports. Therefore, FDI can lead to higher growth rates. This can be done through boosting industrial and political security, promoting exports based on industry, growing free trade economic zones, lowering trade barriers, increasing training, and strengthening quality control programs (Saleem *et al*., 2020).

Currency depreciation might be an extra tool for the non-Eurozone economies. By promoting trade and maintaining a stable exchange rate together may create an atmosphere that supports these European countries continued development. However, there are number of factors that go into creating a favorable environment for foreign direct investments, including financial market regulations, tax incentives, trade regimes, free trade zones, the quality of the financial system and infrastructure, the host nation's human capital base, and trade regimes (Bhatt, 2013). Any form of investments still requires the host nation's economies to be politically and macroeconomically stable.

The research findings surprisingly show that there is no causality relation between FDI and economic development nor between trade openness and FDI for the post-2009 period. The global crisis of 2008-2009 had a significant impact on macroeconomic indicators that might change the nomenclature of economic activity in respect to trade and FDI inflows. The region's capital inflows were significantly impacted by the economic crisis, although the exact impact varied widely depending on the kind of inflows and the receiving nation. The sharp

decline in EU foreign direct investment inflows, which were 57% lower than pre-2009 levels (WDI, 2022), was substantive enough to dampen the FDI-growth led relationship. By means of this research, governments could make the decisions associated with the investments in foreign investments after embracing more openness to trade.

5.1 Limitations and Future Research

The current analysis is not without limitations: i) For the variables under investigation, there were just 26 observations available. Due to the fact that 16 of the EU's 27 members entered the union after 1995, subsequent studies utilizing an unbalanced panel data analysis may be used (withdrawal of the UK should also be taken into account). However, most of the time, balanced datasets are generally preferred over unbalanced panels, as they reduce the noise introduced by unit heterogeneity (Baltagi and Song, 2006). ii) Another constraint is the adoption of a proxy for trade openness that was not strategy initiated. Further investigation using trade policy as a metric of a trade openness measures may provide us with increasingly strong results (Kumari *et al.*, 2023). iii) As already mentioned, the influence of foreign investments on economic development is established by the characteristics of the host economy and the capacity of domestic companies to absorb. This paper does not take into account the features of European regions that may have made FDI less effective in promoting economic development. So, firm-level microeconomic research may help policymakers determine the sectors and types of businesses that gain from FDI (Hobbs *et al.*, 2021).

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Notes

[1]The Pesaran (2004) cross sectional statistics is: $CD = \sqrt{\frac{2T}{N(N-1)}}(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\rho_{ij}) \rightarrow N(0,1)$, where ρ_{ij} are the correlation coefficients obtained from the residuals of the model as described in equation (2).