World Journal of Applied Economics (2022), 8(2): 51-64
doi: 10.22440/wjae.8.2.1

econworld
Research Article

International Trade, Foreign Direct Investment, Financial Development and Renewable Energy Supply: Panel Data Evidence from Newly Industrialized Countries

Gülçin Elif Yücel[a] Ayfer Ustabaş[b] Tuğçe Acar[c]

Received: 25.08.2022; Revised: 13.11.2022; Accepted: 14.11.2022

In many newly industrializing countries (NICs), increased international trade activities are often triggered by several advancements, including attracting foreign direct investment (FDI), financial development, and technological changes. Recently, abundant and diversified renewable energy sources used in production have also started to take their place among these advancements. Although the relationship between FDI, financial developments, and international trade for NICs has been analyzed in many studies, incorporating renewable energy supply's impact in this linkage has been relatively narrow. This paper aims to fill the gap in the literature by investigating the effects of renewable energy supply on FDI, financial development, and international trade for newly industrialized countries using panel causality and panel cointegration analyses between 1990 and 2019. Our findings indicate (i) uni-directional causality running from international trade to financial development, (ii) uni-directional causality running from renewable energy supply to financial development, and (iii) bi-directional causality between financial development and FDI. The result of the cointegration analysis showed that there is no long-term relationship between the variables.

JEL codes: F14, Q27, C33

Keywords: International trade, Foreign direct investment, Financial development, Renewable energy supply, Panel data analysis

1 Introduction

The traditional trade theory argues that the comparative advantage between two countries is based on diversified relative factor endowments with the assumption of factor immobility among nations (Heckscher & Ohlin, 1991). Nevertheless, this theory was criticized

[a] Corresponding Author. Beykent University, Dept. of International Trade and Finance, İstanbul, Turkey. email: elifyucel@beykent.edu.tr https://orcid.org/0000-0002-5830-7588
[b] İstinye University, Dept. of Economics, İstanbul, Turkey. email: ayferustabas1@gmail.com https://orcid.org/0000-0002-6882-5530
[c] Beykent University, Dept. of Economics, İstanbul, Turkey. email: tugceacar@beykent.edu.tr https://orcid.org/0000-0001-9223-0089

due to its inability to explain a significant portion of current international trade, described by rising international factor mobility, especially through foreign direct investment (FDI) flows and technology transfers. Hence, recent trade theories relaxed the assumptions of traditional trade theory to analyze global trade flows on changing nature of factor endowments and the development of new technologies over time between nations (WTO, 2013).

Various economic theories and empirical studies have assumed capital accumulation, solid and reliable financial institutions, and rich energy and raw material resources have been assumed to be among the fundamental factors shaping the development of international trade activities. In the case of newly industrializing countries (NICs), where domestic resources are insufficient to finance capital needs, FDI is one of the main sources of finance to remedy the lack of sufficient domestic savings (Salvatore, 2013). Besides, numerous empirical studies affirm that the development of financial institutions is a factor that facilitates a country to obtain a comparative advantage in terms of international trade patterns (Beck, 2002; Svaleryd & Vlachos, 2005). At this point, financial development is important not only to create financial sources but also to attract foreign capital inflows.

Like FDI and financial development, energy is also a factor serving as a crucial input shaping production and trade activities (WTO, 2010; Ruta & Venables, 2012). Although the contribution of renewable energy resources still does not constitute the majority, the view that these resources will greatly shape trade in the future is becoming more common in the context of rising energy prices (WTO, 2013).

The relationship between international trade, FDI, financial development, and energy has been investigated in various economic studies, but renewable energy supply has been examined as an emerging variable in recent years. According to our literature review, our paper is among the seminal empirical studies investigating the linkage between all four variables, namely international trade, FDI, financial development, and renewable energy supply, concerning the NICs during the period of 1990-2019. Panel data analysis was used, as it includes a combination of both cross-sectional data and time series data. Within the framework of these purposes, our paper's motivation is to answer the following questions: Is there any causal relationship between international trade, FDI, financial development, and renewable energy supply in terms of NICs? To what extent are these variables interrelated in the short and long term if there is such a causal relationship? Which variables do the policymakers of these countries need to focus on to develop their foreign trade, encourage their financial development, and improve FDI inflows and renewable energy supply?

The remainder of the study is organized as follows. Sections 2 and 3 examine the theoretical and empirical literature, respectively. Section 4 is devoted to the econometric methodology and empirical results. The conclusion and discussion are presented in the final section.

2 Theoretical Framework

The concept of "competition" is theorized to originate from the competitive nature of human relations, but its economic past is based on mercantilism. Mercantilism, a theory that prevailed between the end of the Middle Ages and the industrial revolution and continued its existence until the 18th century, sees trade as a zero-sum game (Cho & Moon, 2000). Its goal was to create strong and centralized nation states in European countries after the disintegration of the industrial and commercial organization structures in the Middle Ages. The theory of mercantilism holds that this goal can be achieved by increasing exports more than imports and increasing the quantity of precious metals owned as much as possible (Aizenman & Lee, 2007). Mercantilism lost its importance – especially after the industrial revolution – when it could not meet the needs of free trade for mass production activities (Irwin, 1991).

A change in the thought of economic systems was brought about by the Physiocrats (Orain & Steiner, 2016). Largely ignored during the period of mercantilism, physiocracy prioritizes farmers who can produce on large scales and agriculture for economic development (Kazgan, 2000). Physiocracy states that agriculture is superior to industrial activities and natural and free order is necessary for all processes of the economy, including the competitive environment (Charbit, 2002). In addition, increasing foreign trade does not always contribute to the welfare of the country since the increase in demand for precious metals increases the prices which, in turn, increases imports from cheaper countries (Aktan, 2010).

However, the most important theoretical development in international trade theory occurred with Adam Smith's "The Wealth of Nations" in 1776, a theorist who is regarded as the founder of Classical Liberalism or the Classical School of Economics (Smith, 2006). According to classical liberalism, individuals act according to their economic interests, the state does not interfere with their behavior (i.e., laissez-faire, laissez-passer), and the "invisible hand" regulates economic life as an assumed price mechanism.

Smith demonstrated the benefits of international specialization in his work. According to his "Absolute Advantage Theory", under the assumption of homogeneous labor cost, countries should specialize in the production of goods they produce at a lower cost and import the goods they produce at a higher cost. This theory fell short of explaining how free foreign trade would take place if the same country produced more than one good at a lower cost. In turn, David Ricardo's "Theory of Comparative Advantages" closed this explanatory gap and offered an improved basis for international trade theory, also contributing to the development of later theories (Ricardo, 2008). Ricardo's theory state that if a country is more efficient in the production of more than one good than the other country, it should specialize in the good that it produces at a relatively lower cost. Ricardo argued that specialization in this way would positively impact foreign trade and growth. According to classical economists, the comparative advantage was based on the difference in labor productivity among nations. However, they did not provide an explanation for such a difference in productivity. The Heckscher-Ohlin Theory, or Factor Endowment Theory, identified the difference in relative factor abundance between nations as the basic determinant of comparative advantage and, thus, international trade (Heckscher & Ohlin, 1991). Accordingly, each country can specialize in the production and export of the product intensive in its relatively abundant input and import the product in its relatively scarce input (Salvatore, 2013).

From the Heckscher-Ohlin Theory, three different theories have emerged. The first one is the "Factor Price Equalization Theory", which states that the prices of identical factors of production, such as capital rent or rent wage rate, will equalize between countries as a result of international commodity trade. This theorem by Samuelson (1948) assumes that there are two goods and two factors of production, for example, labor and capital. According to this theory, it is free trade, not intercountry factor movements, that ensures the equalization of intercountry factor prices (Samuelson, 1997). The second approach is the "Stolper Samuelson Theory" which demonstrates how changes in output prices affect the prices of the factors when positive production and zero economic profit are maintained in each industry. It describes the relationship between relative factor rewards—specifically, real wages and real returns to capital and relative prices of output (Stolper & Samuelson, 1941). The last approach derived from the Heckscher-Ohlin Theory is the Rybczynski Theory which demonstrates how changes in an endowment affect the outputs of the goods when full employment is maintained. According to this, if the supply of a factor increases, the production of the good that uses it intensively expands, and the production of the other good decreases (Rybczynski, 1955).

Due to the difficulty of determining the factor endowment of a commodity, the Heckscher-Ohlin Theory could not be tested for many years. It was first tested empirically thanks to Harvard University professor Wassily Leontief's input-output table. Leontief evaluated the foreign trade data of the American economy in 1947 with this quantitative technique and revealed findings that completely contradicted the results of the Heckscher-Ohlin Theory. This contradiction, which has great repercussions and is referred to as the "Leontief Paradox" in the literature, arises from the finding that the American economy, which should export capital-intensive goods, exports labor-intensive goods while importing capital-intensive goods (Leontief, 1953). The common point of the subsequent discussions is that the Heckscher-Ohlin Theory is mostly trade between capital-rich developed countries and unskilled labor-rich underdeveloped countries, i.e., inter-industry trade. In the 1960s, the gradual increase in trade between the capital-abundant and developed countries, i.e., intra-industry trade, paved the way for the emergence of new international trade theories, such as the "Theory of Skilled Labor" (Keesing, 1965; Kenen, 1965), the "Technological Gap Hypothesis" (Posner, 1961), and the "Product Periods Hypothesis" (Vernon, 1966).

Baldwin (1971), employing the 1958 input-output structure and 1962 trade data, reaffirmed the Leontief Paradox. Hillman & Bullard (1978) continued in the tradition of the Leontief-Baldwin studies by investigating the Heckscher-Ohlin Theorem and the United States (US) trade on the basis of the 1963-1967 input-output production structures and the concurrent trade flows; their methods differ from the previous studies in that they employ "energy" as a reference factor of production. Although energy is a produced factor of production, they do not treat it as an intermediate good. They focus on the raw material content of energy inputs. Their model indicates that such an advantage in international trade does not have the consequence of a switch in the commodity direction of trade due to factor mobility. The US appears as having a comparative advantage in labor-intensive output when traded goods sectors are defined in the Leontief manner inclusive of intra-industry trade. On the other hand, it has a comparative advantage in capital-intensive output when sectors are identified on a directional trade basis, such as one-way or two-way, by their net trade balances. The disappearance of natural resource sectors diminishes the factor-intensity demarcation between domestic import-competing and exporting sectors. However, for traded goods specifications both inclusive and exclusive of intra-industry trade investigated, the qualitative conclusion of the US comparative advantage in labor-intensive production remains confirmed. The presence of the third input, energy, permits an interpretation of the outcome of the perceived relation between factor endowments and intensities without recourse to the concept of paradox.

3 Empirical Literature Review

In the past few decades, several studies used different statistical and mathematical models to analyze the relationship between environmental indicators (carbon dioxide, fossil fuels, greenhouse gases), economic development (FDI, GDP, and trade) and energy consumption. In other words, in the literature, the studies are mostly covered by the analysis of energy consumption, economic growth, foreign trade and current account deficits.

A review of the literature reveals that studies on energy issues can be divided into four broad areas analyzing; the relationships between energy consumption and income, financial development, FDI, or trade. Since most of the existing studies in the empirical literature include renewable energy consumption, there is no study that addresses the effects of renewable energy supply on international trade. It is also difficult to find a study for NICs. For this reason, studies mentioned in the literature section indirectly contribute to the subject of this study. The main motivation of this study is to analyze the relationship between renewable energy supply and international trade, specifically to contribute to the related field.

The factors affecting international trade and economic growth have been researched extensively in the literature by analyzing the effects of macroeconomic variables such as FDI, trade openness, inflation, exchange rate, capital formation and financial development. The studies mostly use some combinations of these variables and include different country groups and/or individual countries. The panel data econometric methods are widely used in these studies.

Usman & Balsalobre-Lorente (2022) examine the influence of industrialization, total reserves and the expansion of financial, renewable and natural resources on the ecological footprint by using panel data for the period from 1990 to 2019 in newly industrialized countries. The panel test results revealed a unidirectional causality from industrialization and renewable energy to ecological footprint and from ecological footprint to natural resources. A bidirectional causality relation was also found between financial development and total reserves, and ecological footprint.

Doğan & Özarslan Doğan (2021) find a positive relationship between financial development, innovation and GDP and renewable energy for Turkey in the 1968-2015 period using the Distributed Lag Autoregressive (ARDL) Bounds Test approach.

Guan et al. (2021) examine the dynamic connections and causation between economic growth, financial growth, and the usage of energy from renewable sources in China by using panel data techniques spanning the years 2011 to 2020. According to the cointegration test findings, energy consumption from renewable sources, financial development, and growth of GDP in China and three other areas are all at long-term equilibrium. Panel estimates show that long-term financial and economic growth in China, particularly in West China, has a major impact on energy from renewable sources use. There is a strong unidirectional link between China's financial growth and its energy use from renewable sources, as shown by the Granger causality tests, particularly in East China.

Kasperowicz et al. (2020) examine the nexuses between renewable energy and economic activities in European countries. Their study shows the long-term equilibrium association between renewable energy and international trade.

Halıcıoğlu & Ketenci (2018) explore the impact of renewable energy, non-renewable energy, international trade, capital and labour on output level in the case of the EU-15 countries over the period of 1980-2015. The ARDL empirical results indicate the existence of cointegration relationships among the variables in the case of seven countries of the EU-15. In addition, the GMM-based analysis revealed a long-run relationship for the entire EU-15. The ARDL procedure suggests that the relative impact of renewable and non-renewable energy inputs on output levels varies considerably for individual countries. The GMM results demonstrate the existence of the relative importance of renewable and non-renewable energy inputs along with international trade on output in the EU-15 countries.

Liu et al. (2018) employ panel multivariate technology to probe the impact of renewable energy and trade (imports and exports) on the output and to study the Granger causality between the mentioned variables with a sample of 15 Asia-Pacific countries for the period of 1994–2014. Short-run causality tests show a bidirectional causal relationship between the output and exports and no Granger causal relationship from imports to renewable energy or the output. Moreover, long-run causality tests show bidirectional causality between the output and renewable energy and unidirectional causality from international trade (imports and exports) to the output and renewable energy.

Mert & Çağlar (2016) analyze the effect of financial development on renewable energy production in Turkey for the 1970-2011 period but could not determine causality toward financial development from renewable energy sources. On the other hand, causality has been determined from negative shocks in financial development to negative shocks in renewable energy resources.

Rahman & Mamun (2016) investigate the existence of either an energy-led growth or trade-led growth hypothesis in Australia for a 53-year period (1960–2012) using a multivariate extended growth model. The study applied the ARDL bounds testing approach of cointegration, the Granger Causality Test, and Impulse Response Functions but found evidence of no long-run cointegration between the variables of interest. The Granger causality test confirms a bidirectional causal relationship between international trade and per capita GDP growth but does not find any Granger causal relationship between energy use and per capita GDP growth.

Sadorsky (2012) studies the relationship between energy, output and trade for a sample of seven South American countries. Empirical results reveal that there exists a long-run relationship between output, capital, labor, energy, and exports; and output, capital, labor, energy, and imports. In the same vein, trade (exports or imports) and energy consumption have a causal relationship. The results also indicate a short-run bi-directional relationship between energy and exports, output and exports, and output and imports.

Apergis & Payne (2011) estimates a production function using the heterogeneous panel cointegration technique on the data for six Central American countries from 1980 to 2006. The production function includes GDP, renewable energy, capital and labour variables, and the econometric results indicate a positive impact of renewable energy on output.

Menegaki (2011) tests the role of renewable energy on GDP in both the short run and the long run for the panel of 27 European countries. The empirical results state that, by taking into account the shortage of non-renewable energy sources in Europe, it is important to implement new policies to improve energy efficiency that would leave the neutrality of renewable energy sources, which means that the consumption of renewable energy has a minor role in the determination of GDP, in the past.

Ahuja & Tatsutani (2009) aim to reveal the importance of renewable energy for sustainable development in the period of 1999-2008 and to explore the experience of Germany, which can benefit many developing countries of the world, including Arab countries. They found that renewable energy is extremely important in protecting the environment, and its use should be widespread since it is a clean and non-polluting energy.

4 Econometric Methodology

Panel data consists of N number of observations and T time periods. Models created through panel data are called panel data models. The tests and methods applied to analyze panel time series contain elements of panel data and time series analysis methods (Tatoğlu, 2013). In this context, it is necessary to investigate the existence of unit roots in series. This phenomenon expresses that the mean, variance, and covariance remain constant and are expressed as weak or covariance stationarity. In other words, it is the clustering of the series around a certain value in the long run.

Performing analysis with non-stationary series can cause spurious regression problems. In this respect, even if there is no relationship between the variables, it can give the impression that there is a relationship due to the strong trend effect in the series. Estimates made under spurious regression conditions lead the researcher to misleading conclusions. For this reason, in the first stage of the analysis, it is necessary to investigate whether the series is stationary or not, and if not, it should be made stationary.

Unit root tests of the stationarity of the series are divided into first and second-generation unit root tests, depending on whether there is a cross-section dependency in the series. Cross-section dependence indicates a relationship between the residuals in the regressions obtained from all units in the panel data model. In this framework, it is necessary to check whether there is a cross-sectional dependence before proceeding to the unit root analysis. Pesaran (2004)'s CD test was used to test cross-sectional dependence.

The Pesaran (2004) CD test was developed to eliminate the problems encountered when the number of cross-section units (N) is large and the time dimension (T) is finite (Pesaran, 2004). In the case of N>T, it was stated that the test performed well in the presence of non-stationarity, structural break and heterogeneity. The null and alternative hypotheses of the Pesaran CD test are as follows:

$$\begin{aligned} H_0 : cov(u_{it}, u_{jt}) \; &= \; \rho_{ij} \; = \; 0 \; (\forall \; t, i \neq j) \\ H_1 : \rho_{ij} &\neq 0 \end{aligned}$$

where ρ_{ij} represents the correlation coefficient between the residuals of the units. The test statistic for the balanced panel data set is presented in equation (1).

$$CD \; = \; \sqrt{\frac{2\,T}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}} \tag{1}$$

Before proceeding to the unit root analysis, it is also necessary to test whether the constant and slope parameters are homogeneous with respect to the cross-section units. In the study, the Swamy S test is used for homogeneity testing. In the Swamy S test, it is assumed that the distribution of vector coefficients does not change according to the translations during the effect of time (Swamy, 1970). The test statistic for the Swamy S test is calculated as follows.

$$\hat{S} \; = \; \chi^2_{k(N-1)} \; = \; \sum_{i=1}^{N} (\hat{\beta}_i \; - \; \bar{\beta}^*)' \; \hat{V}_i^{-1} \; (\hat{\beta}_i \; - \; \bar{\beta}^*) \tag{2}$$

Equation (2) represents the OLS estimators, $\hat{\beta}_i$, obtained from regressions, $\bar{\beta}^*$ is the weighted WE estimator, and $\hat{V}_i^{-1}$ is the difference between the variance of the two estimators. Swamy S test statistic has degrees of freedom and χ^2 distribution.

For the test of stationarity in the series, it will be correct to use first-generation and second-generation panel unit root tests, depending on whether there is a cross-section dependency. In studies based on empirical analysis, the estimation of the relationship between variables is important. The relationship between the variables can be unilateral or reciprocal. In this context, causality analysis is used to determine the direction of the relationship between the variables of the analysis. Dumitrescu & Hurlin (2012)'s panel causality analysis, which is used for heterogeneous panels, is used for panel causality testing. Consider the following panel VAR model equality.

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{it-k} + \sum_{k=1}^{K} \beta_i^{(k)} X_{it-k} + \epsilon_{it} \tag{3}$$

In equation (3), the lag length (k) is the same for each panel unit and represents the balanced panel, while the autoregressive parameter and the slopes change according to the cross-section units. While the main hypothesis of the Dumitrescu-Hurlin causality test states that there is no causality from X to Y, the alternative hypothesis expresses causality. The Westerlund panel cointegration test is used for the cointegration relationship, which produces resistant critical values with the bootstrap method in the case of inter-unit correlation. Critical values are included in Westerlund (2007). This test allows for unequal series lengths in units and hence an unbalanced panel. At the same time, this test allows heterogeneity in the long- and short-run parameters of the error correction model.

4.1 Data set and model

In the manuscript, cointegration analysis to explore panel causality and long-term relationship within the data set between 1990-2019 for newly industrialized countries (South Africa, Brazil, Mexico, China, India, Indonesia, Malaysia, Phillippines, Thailand and Turkey), considering the availability of the data set has been utilized. The independent variables are renewable energy supply, FDI, and financial development. Following Abidin et al. (2015), domestic credit provided by the banking sector is chosen as the indicator of financial development. The panel data model considered in the analysis is presented in equation (4).

$$LNIT_{it} = \alpha_i + \beta_{it}\, LNFD_{it} + \theta_{it}\, FDI_{it} + \gamma_{it}\, LNRE_{it} + \epsilon_{it} \tag{4}$$

where the dependent variable is international trade.

Table 1: Variable description

Variable	Description	Source
IT	Import + export (% of GDP)	WDI
FD	Domestic credit provided by banking sector (% of GDP)	WDI
FDI	Foreign direct investment, net inflows (% of GDP)	WDI
RE	Renewable energy	OECD Stat

Data were obtained from Wold Data Bank (financial development, FDI, international trade and OECD Stat (renewable energy). The natural logarithm of the variables has been used to eliminate the scale difference. Since FDI is already a rate with negative values, its original values rather than the natural logarithm are included in the analysis. Variable definitions are presented in Table 1.

4.2 Empirical results

Firstly, the existence of inter-unit correlation, in other words, cross-sectional dependence in the series, was tested in the study. The Pesaran CD test, of which tests statistics and the probability values for inter-unit correlation are provided in Table 2, rejects the null hypothesis that there is no inter-unit correlation for all variables except FDI at the 5% statistical significance level.

Table 2: Pesaran (2004) CD test results

Variable	Statistics	Probability
IT	8.15***	0.000
FD	14.02***	0.000
FDI	1.68*	0.093
RE	24.48***	0.000

Note: H_0: There is cross-sectional dependence, *, **, *** denote 10%, 5% and 1% significance level, respectively.

Since there is a correlation between the units in the series, CIPS panel unit root test procedure of Im et al. (2003), which considers the extended version of ADF regression with lagged cross-section averages, is conducted to test the stationarity of variables other than FDI. Accordingly, FDI is level stationary (Table 3), and international trade, financial development, and renewable energy are stationary at the first difference (Table 4).

Table 3: The unit root test results for FDI

	IPS	Fisher PP	Fisher ADF
W-t-bar	-4.189*** (0.000)		
Inverse chi-squared		65.973*** (0.000)	43.972*** (0.001)
Inverse normal		-4.823*** (0.000)	-3.464*** (0.000)
Inverse logit		-5.493*** (0.000)	-3.490*** (0.000)
Modified inverse chi-squared		7.269*** (0.000)	3.790*** (0.000)

Note: *, **, *** denote 10%, 5% and 1% significance level, respectively.

Table 4: CIPS panel unit root test for other variables

	FD	**IT**	**RE**
Z [t-bar]	-0.032 (0.487)	0.517 (0.697)	-1.314 (0.094)
	ΔFD	**ΔIT**	**ΔRE**
Z [t-bar]	-6.804*** (0.000)	-4.760*** (0.000)	-5.422*** (0.000)

Note: *, **, *** denote 10%, 5% and 1% significance level, respectively.

The choice of cointegration tests and estimation methods depends on whether the intercept and the slope parameters are homogenous or heterogeneous by cross-section units. Therefore, testing for homogeneity is important. Swamy S test rejected the null hypothesis of homogeneity (Table A.1). Therefore, it would be a more accurate approach to use tests that take into account heterogeneity in causality and cointegration analysis.

Table 5: Westerlund panel cointegration test results

Statistics	**Value**	**Z Value**	**P Value**	**Robust P Value**
Gt	-1.572	-0.575	0.283	0.460
Ga	-3.749	1.200	0.885	0.750
Pt	-3.863	-0.678	0.249	0.730
Pa	-3.059	-0.362	0.359	0.670

The results of the Westerlund panel cointegration test are in Table 5. The table contains four test statistics, Gt, Ga, Pt, and Pa, for the panel cointegration test. Interpreting the results according to Gt and Ga statistics would be a correct approach as they provide robust results against the correlation between units and panels. Accordingly, the Gt and Ga statistics could not determine a cointegration relationship between the variables.

The results of the lag length selection based on the model selection criteria show that R^2 has the highest value in the first lag, Table A.2. According to the Hansen-J test, instrumental variables are valid for all lags. It is seen that the value that minimizes model selection criteria, such as MBIC and Modified MQIC, is the first lag, and the value that minimizes the MAIC criteria is the second lag. Therefore, it will take the appropriate lag length of 1. The cointegration test results, which accept the existence of causality and inter-unit correlation and heterogeneity, are presented in Table 6. According to the results, international trade, renewable energy supply, and FDI are the Granger cause of financial development. In addition, financial development is the Granger cause of FDI.

Table 6: Dumitrescu-Hurlin causality test results

$\mathbf{H_0}$	**Z-bar statistics**	**Significance**
$\mathbf{\Delta IT} \underset{?}{\Longrightarrow} \mathbf{\Delta FD}$	16.438***	0.000
$\mathbf{\Delta FD} \underset{?}{\Longrightarrow} \mathbf{\Delta IT}$	1.536	0.125
$\mathbf{\Delta RE} \underset{?}{\Longrightarrow} \mathbf{\Delta FD}$	2.460***	0.000
$\mathbf{\Delta FD} \underset{?}{\Longrightarrow} \mathbf{\Delta RE}$	-0.436	0.663
$\mathbf{\Delta FDI} \underset{?}{\Longrightarrow} \mathbf{\Delta FD}$	2.712***	0.007
$\mathbf{\Delta FD} \underset{?}{\Longrightarrow} \mathbf{\Delta FDI}$	3.805***	0.000

Note: *, **, *** denote 10%, 5% and 1% significance level, respectively.

5 Conclusion

Newly industrialized countries made a significant transition in their economic development over the past decades and thus shifted from a low level of industrialization to a highly developed one. One of the most important factors in industrialization has been the important leap these countries have made in their export performance. Hence, the investigation of the factors that lead to the development of international trade in terms of NICs has been the subject of many theoretical and empirical studies for many years.

While the relationship between international trade, financial development and FDI is often emphasized among related studies, there are few that examine the role of renewable energy supply. To fill this gap and to contribute to the previous literature by integrating the renewable energy supply, this paper aims to explore the linkage among the above-mentioned variables in NICs over the period of 1990–2019 using the panel causality and panel cointegration analysis.

The empirical results of the study point out a uni-directional causality running from international trade to financial development and a uni-directional causality running from renewable energy supply to financial development. Another result of the study indicates that foreign direct investment and financial development are interrelated, i.e., there is bidirectional causality. Finally, the cointegration analysis reveals that the variables are not cointegrated, i.e., no long-term relationship is present.

The interpretation of the empirical analysis is as follows: in line with the international trade literature, the study suggests that by promoting international trade and by using environmentally friendly energy resources, countries could improve their financial development. From this point of view, our analysis confirms that the openness to trade and renewable energy supply, and thus, more stringent environmental policies are associated with financial development for newly industrializing counties. Moreover, newly industrialized countries can encourage the foreign capital they attract while keeping in mind to improve their financial sector development to achieve sustainable economic development.

The differences in the development strategies of the countries in the newly industrialized country group (South Africa, Brazil, Mexico, China, India, Indonesia, Malaysia, Philippines, Thailand, and Turkey) can be shown as the reason why the variables are not cointegrated. To put it more clearly, the variables used in this study cannot be generalized for all newly industrialized countries' industrial development. Hence, they cannot be based on similar liberal, import-substituting or export promotion models. Nevertheless, the study may shed light on future studies of clusters of countries with similar development models.

References

Abidin, İ. S. Z., Haseeb, M., Azam, M., & Islam, R. (2015). Foreign Direct Investment, Financial Development, International Trade and Energy Consumption: Panel Data Evidence from Selected ASEAN Countries. *International Journal of Energy Economics and Policy*, *5*(3), 841-850.

Ahuja, D., & Tatsutani, M. (2009). Sustainable Energy for Developing Countries. *S.A.P.I.EN.S.*, *2*(1), 1-17.

Aizenman, J., & Lee, J. (2007). International Reserves: Precautionary Versus Mercantilist Views, Theory and Evidence. *Open Economies Review*, *18*, 191-214. doi:10.1007/s11079-007-9030-z

Aktan, C. C. (2010). Monetarizm ve Rasyonel Beklentiler Teorisi. *Ekonomi Bilimleri Dergisi*, *2*(1), 168-187.

Apergis, N., & Payne, J. E. (2011). The Renewable Energy Consumption-Growth Nexus In Central America. *Applied Energy*, *88*(1), 343-347. doi:10.1016/j.apenergy.2010.07.013

Baldwin, R. E. (1971). Determinants of The Commodity Structure of US Trade. *American Economic Review*, *61*(1), 126-146.

Beck, T. (2002). Financial Development and International Trade: Is There a Link? *Journal of International Economics*, *57*(1), 107-131. doi:10.1016/S0022-1996(01)00131-3

Charbit, Y. (2002). The Political Failure of an Economic Theory: Physiocracy. *Population*, *57*(6), 855-883. doi:10.3917/popu.206.0849

Cho, D.-S., & Moon, H.-C. (2000). *From Adam Smith to Michael Porter: Evolution of Competitiveness Theory*. World Scientific, London. doi:10.1142/4531

Doğan, E., & Özarslan Doğan, B. (2021). Finansal Gelişme ve İnovasyon, Türkiye'de Yenilenebilir Enerji Üretimini Artırıyor Mu? *Turkish Studies-Economy*, *16*(2), 783-797. doi:10.47644/TurkishStudies.47359

Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger Non-causality in Heterogeneous Panels. *Economic Modelling*, *29*(4), 1450-1460. doi:10.1016/j.econmod.2012.02.014

Guan, D., Comite, U., Sial, M. S., Salman, A., Zhang, B., Gunnlaugsson, S. B., ... Mentel, G. (2021). The Impact of Renewable Energy Sources on Financial Development, and Economic Growth: The Empirical Evidence from an Emerging Economy. *Energies*, *14*(23), 8033. doi:10.3390/en14238033

Halıcıoğlu, F., & Ketenci, N. (2018). Output, Renewable and Non-Renewable Energy Production, and International Trade: Evidence from EU-15 Countries. *Energy*, *159*, 995-1002. doi:10.1016/j.energy.2018.06.197

Heckscher, E. F., & Ohlin, B. (1991). *Heckscher-Ohlin Trade Theory* (H. Flam & M. J. Flanders, Eds.). World Scientific, London.

Hillman, A. L., & Bullard, C. W. (1978). Energy, the Heckscher-Ohlin Theorem, and US International Trade. *American Economic Review*, *68*(1), 99-106.

Im, S., Pesaran, M. H., & Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, *115*(1), 53-74. doi:10.1016/S0304-4076(03)00092-7

Irwin, D. D. (1991). Mercantilism as Strategic Trade Policy: The Anglo Dutch Rivalry for the East India Trade. *Journal of Political Economy*, *99*(6), 1296-1314.

Kasperowicz, R., Bilan, Y., & Štreimikienė, D. (2020). The Renewable Energy and Economic Growth Nexus in European Countries. *Sustainable Development*, *28*(5), 1086-1093. doi:10.1002/sd.2060

Kazgan, G. (2000). *İktisadi Düşünce veya Politik İktisadın Evrimi*. Remzi Kitabevi, İstanbul.

Keesing, D. B. (1965). Labor Skills and International Trade: Evaluating Many Trade Flows with a Single Measuring Device. *The Review of Economics and Statistics*, *47*(3), 287-294. doi:10.2307/1927711

Kenen, P. (1965). Nature, Capital and Trade. *Journal of Political Economy*, *73*(5), 437-460.

Leontief, W. (1953). Domestic Production and Foreign Trade; The American Capital Position Re-Examined. *Proceedings of the American Philosophical Society*, *97*(4), 332-349.

Liu, X., Zhang, S., & Bae, J. (2018). Renewable Energy, Trade, and Economic Growth in The Asia-Pacific Region. *Energy Sources, Part B: Economics, Planning, and Policy*, *13*(2), 96-102. doi:10.1080/15567249.2017.1327994

Menegaki, A. N. (2011). Growth and Renewable Energy in Europe: A Random Effect Model with Evidence for Neutrality Hypothesis. *Energy Economics*, *33*(2), 257-263. doi:10.1016/j.eneco.2010.10.004

Mert, M., & Çağlar, A. E. (2016). Yenilenebilir Kaynaklı Enerji ve Finansal Gelişme: Asimetrik Nedensellik Uygulaması. International Multidisciplinary Conference, Antalya, Turkey, 21-22 April 2016.

Orain, A., & Steiner, P. (2016). François Quesnay (1694–1774) and Physiocracy. In G. Faccarello & H. D. Kurz (Eds.), *Handbook on the History of Economic Analysis Volume I.* Edward Elgar Publishing, Cheltenham, UK. doi:10.4337/9781785366642.00013

Pesaran, M. H. (2004). *General Diagnostic Tests for Cross-section Dependence in Panels* (Cambridge Working Papers No. 1240).

Posner, M. (1961). International Trade and Technical Change. *Oxford Economic Papers*, *13*(3), 323–341. doi:10.1093/oxfordjournals.oep.a040877

Rahman, M. M., & Mamun, S. A. K. (2016). Energy Use, International Trade and Economic Growth Nexus in Australia: New Evidence from an Extended Growth Model. *Renewable and Sustainable Energy Reviews*, *64*, 806-816. doi:10.1016/j.rser.2016.06.039

Ricardo, D. (2008). *On the Principles of Political Economy and Taxation* (B. Zeren, Trans.). İş Bankası Kültür Yayınları, İstanbul.

Ruta, M., & Venables, A. J. (2012). International Trade in Natural Resources: Practice and Policy. *Annual Review of Resource Economics*, *4*, 331-352. doi:10.1146/annurev-resource-110811-114526

Rybczynski, T. (1955). Factor Endowments and Relative Commodity Prices. *Economica*, *22*(88), 336-341. doi:10.2307/2551188

Sadorsky, P. (2012). Energy Consumption, Output and Trade in South America. *Energy Economics*, *34*(2), 476-488. doi:10.1016/j.eneco.2011.12.008

Salvatore, D. (2013). *International Economics.* Wiley.

Samuelson, P. A. (1948). *Economics on Introductory Analysis.* McGraw-Hill, New York.

Samuelson, P. A. (1997). *Economics (Original Edition: 1948).* McGraw-Hill, New York.

Smith, A. (2006). *The Wealth of Nations* (H. Derin, Trans.). İş Bankası Kültür Yayınları, İstanbul.

Stolper, W. F., & Samuelson, P. A. (1941). Protection and Real Wages. *Review of Economic Studies*, *9*(1), 58-73. doi:10.2307/2967638

Svaleryd, H., & Vlachos, J. (2005). Financial Markets, The Pattern of Industrial Specialization and Comparative Advantage: Evidence from OECD Countries. *European Economic Review*, *49*(1), 113-144. doi:10.1016/S0014-2921(03)00030-8

Swamy, P. (1970). Efficient Inference in a Random Coefficient Regression Model. *Econometrica*, *38*(2), 311-323. doi:10.2307/1913012

Tatoğlu, F. Y. (2013). *İleri Panel Veri Analizi.* Beta Basım Yayım Dağıtım A.Ş, İstanbul.

Usman, M., & Balsalobre-Lorente, D. (2022). Environmental Concern in the Era of Industrialization: Can Financial Development, Renewable Energy and Natural Resources Alleviate Some Load? *Energy Policy*, *162*, 112780. doi:10.1016/j.enpol.2022.112780

Vernon, R. (1966). International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics*, *80*(2), 190-207. doi:10.2307/1880689

Westerlund, J. (2007). Testing for Error Correction in Panel Data. *Oxford Bulletin of Economics and Statistics*, *69*(6), 709-748. doi:10.1111/j.1468-0084.2007.00477.x

WTO. (2010). *World Trade Report 2010: Trade in Natural Resources.* https://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report10_e.pdf. (World Trade Organization)

WTO. (2013). *World Trade Report 2013: Factors Shaping the Future of World Trade.* https://www.wto.org/english/res_e/booksp_e/world_trade_report13_e.pdf. (World Trade Organization)

Appendix: Additional Tables

Table A.1: Swamy S Tests Results

Test Statistics	**Significance**
$\chi^2(36)$: 378.26***	0.0000

Table A.2: Lag length selection

Lag	**CD**	**J**	**J pvalue**	**MBIC**	**MAIC**	**MQIC**
1	0.999	109.221	0.248	-420.610	-90.779	-224.260
2	0.999	57.936	0.928	-339.440	-92.064	-192.170
3	0.999	28.749	0.993	-236.170	-71.251	-137.99
4	0.999	10.666	0.994	-121.750	-39.334	-72.703

Note: MBIC is the Modified Bayesian Information Criterion, MQIC is the Modified "Quasi-likelihood" Information Criterion, and MAIC is the Modified Akaike Information Criterion (MAIC).