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FOREIGN DIRECT INVESTMENT, TRADE GLOBALISATION, RENEWABLE ENERGY, AND INDUSTRIALISATION IN TÜRKİYE

TÜRKİYE'DE DOĞRUDAN YABANCI YATIRIMLAR, TİCARİ KÜRESELLEŞME, YENİLENEBİLİR ENERJİ VE SANAYİLEŞME

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Abstract: *Recently, interest in industrialisation has increased again, and re-industrialisation policies have begun to be discussed. Because empirical and theoretical evidence indicates that industrialisation plays a significant role in economic growth and development. Nevertheless, studies analysing the factors affecting industrialisation are limited. In consequence, the main purpose of this paper is to analyse the dynamics of industrialisation in Türkiye over the period 1990-2020. For this purpose, the effects of foreign direct investments (FDI), trade globalisation, and renewable energy, which are thought to affect industrialisation significantly, are investigated. The ARDL bounds test, and the Toda-Yamamoto (1995) causality test are employed in this respect. The findings prove that FDI, trade globalisation, and renewable energy consumption positively impact industrialisation in the long-run. At the same time, Toda-Yamamoto's (1995) causality test results indicate a unidirectional causality from FDI to industrialisation, bidirectional causality between renewable energy and industrialisation and no causality between trade globalisation and industrialisation. In this regard, for sustainable industrialisation, effective policies are necessary for FDI, trade globalisation, and renewable energy. In addition, FDI inflows should be directed to specific sectors.*

Keywords: *Industrialisation, Foreign Direct Investments, Trade Globalisation, Renewable Energy, Türkiye's Economy*

Öz: Son dönemlerde sanayileşmeye tekrar bir ilgi artmış ve yeniden-sanayileşme politikaları tartışılmaya başlanmıştır. Çünkü ampirik ve teorik kanıtlar sanayileşmenin ekonomik büyüme ve kalkınma sürecinde önemli bir rol oynadığını göstermektedir. Ancak buna rağmen sanayileşmenin etkileyen faktörlerini analiz eden çalışmalar sınırlıdır. Bu nedenle çalışmanın temel amacı da 1990-2020 dönemi için Türkiye ekonomisinde sanayileşmenin dinamiklerini analiz etmektir. Bu amaçla sanayileşmeyi önemli derecede etkilediği düşünülen doğrudan yabancı yatırımlar (DYY), ticari küreselleşme ve yenilebilir enerjinin sanayileşemeye etkisi araştırılmaktadır. Bu doğrultuda, çalışmada ARDL sınır testi ve Toda-Yamamoto (1995) nedensellik testi kullanılmıştır. Elde edilen bulgular, uzun dönemde, doğrudan yabancı yatırımlar, ticari küreselleşme ve yenilenebilir enerji sanayileşmeye pozitif etkilemektedir. Aynı zamanda Toda-Yamamoto (1995) nedensellik test sonuçları DYY'den sanayileşmeye tek yönlü bir nedensellik, yenilenebilir enerji ve sanayileşme arasında çift yönlü bir nedensellik olduğunu, ticari küreselleşme ve sanayileşme arasında ise bir nedensellik ilişkisi olmadığını göstermektedir. Bu bağlamda, sürdürülebilir sanayileşme için DYY, ticari küreselleşme ve yenilenebilir enerjiye yönelik etkin politikalar üretilmelidir. Ayrıca özellikle DYY girişleri belirli sektörlere yönlendirilmelidir.

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Anahtar Kelimeler: Sanayileşme, Doğrudan Yabancı Yatırımlar, Ticari Küreselleşme, Yenilenebilir Enerji, Türkiye Ekonomisi.

JEL: *L16, L60, F41, F60*

1. Giriş

The historical process (since the Industrial Revolution) shows that industrialisation plays a crucial role in growth/development. Also, there is a consensus in the literature regarding the role of industrialisation (Horrell, 1966; Kaldor, 1967; Mokyr, 1977; Kuznets, 1973; Tregenna, 2015; Stiglitz, 2017; Haraguchi, Martorano, and Sanfilippo, 2019; Kruse, Mensah, Sen, and de Vries, 2023). This implies that the main driver of growth and the key force that speeds up structural change in the economy is the manufacturing industry (Kaldor, 1967; Kuznets, 1973). After the 1950 period, there was a significant interest in the industry, especially in developing countries. Owing to this interest, economic growth has been pursued by implementing import-substituting industrialisation and inward-oriented policies. As a result of these policies, significant economic growth has occurred in developing countries. However, in the post-1980 period, industrialisation lost its importance along with liberalisation policies. As a result, export- and outward-oriented growth policies have gained importance (Taymaz and Voyvoda, 2017; Doğruel and Doğruel 2017; Soydan, 2018).

In the post-1980 period, de-industrialisation began due to structural transformation in the global economy (Bayar and Günçavdı, 2018). This process has occurred in the form of premature de-industrialization in developing countries (exp., Latin American and Sub-Saharan African countries) (Tregenna, 2011; Tregenna, 2015; Rodrik, 2016a; Rodrik, 2016b). However, it can be argued that re-industrialisation[1] policies have started to be discussed again recently (Tregenna, 2011). The reason for this is factors such as disruptions in supply-chains, geopolitical competition, middle-income trap, increasing regional disparities, and the permanent impact of financial crises (Taymaz and Voyvoda, 2017; Aiginger and Rodrik, 2020; Juhasz, Lane, and Rodrik, 2023). From this perspective, the manufacturing industry is crucial for mitigating these factors' negative impact and promoting sustainable economic growth. Because the manufacturing industry sector can provide strong economic growth due to advantages such as returns to scale, technological diffusion, high productivity, capital accumulation, learning by doing, strong forward and backward linkage effects (Tregenna, 2011; Rodrik, 2016a; Haraguchi et al., 2019; Kaygusuz, Atiyas, and Polat, 2023). Also, In Türkiye's economy, trade liberalisation started in the 1980s, and Türkiye's economy has gradually opened to international competition. The integration process with the world economy has advanced to a further stage with the opening of the capital markets in 1989 (Bayar and Günçavdı, 2018; Kozal and Barbaros, 2023). In line with this transformation, export- and outward-oriented economic growth policies have started to be implemented in Türkiye. As a result of these policies, industrial production has lost importance, and the services sector has gained importance (Soydan, 2018). Doğruel and Doğruel (2017) also emphasise that the loss

[1] In an economy, industrialisation, de-industrialisation, and re-industrialisation are related to the composition of GDP. De-industrialisation is both the decline in the share of employment in total employment and the decline in the share of manufacturing industry value added in GDP/value added. Premature de-industrialization is whereby developing countries undergo deindustrialization at an earlier stage and at a lower per capita income level compared to developed countries (Tregenna, 2015; Rodrik, 2016).

of importance of the industrial sector is the effect of globalisation, which accelerated in the final years of the 1990s.

As the globalisation inreases, industrial production has lost importance, and the size of the services sector (especially financial activities) has increased (Soydan, 2018). Therefore, the resources allocated to the industrial sector are now shifted to the services sector. In this context, Rodrik (2016b) and Bakır, Özçelik, Özmen, and Taşıran (2017) argue that openness in foreign trade and globalisation have a negative impact on industry and are potential determinants of de-industrialization. At the same time, in this process, foreign direct investment (FDI) flows have increased considerably, defined as long-term capital movements, to developing countries (Dumludağ, 2021). In developing countries, FDI can be important in transforming the manufacturing sector. FDI flows can increase competitiveness in the manufacturing industry by providing advantages such as technology, know-how, and participation in international networks (Kaygusuz et al., 2023). Recently, in addition to these dynamics, in the world economy, it can be argued that the threat of climate change has radically changed production methods. Reducing environmental pollution, lowering carbon footprint, and increasing energy efficiency have become important policy goals for achieving sustainable development and economic growth. However, the transition to renewable energy may affect production costs, and green transformation may affect the dynamics of the manufacturing industry (Kaygusuz et al., 2023).

It can be said that Türkiye's industrial structure is also affected by these developments (Doğruel and Doğruel, 2017). While before the 1980 period, the industrial structure was closed to external developments, it can be said that in the post-1980 period, manufacturing had become more sensitive to external developments. Therefore, these developments impacted the development and performance of the manufacturing industry. Within this context, the paper is primarily driven by the goal of examining the industrialisation dynamics within Turkey's economy. There is an empirical and theoretical consensus in the literature that the manufacturing industry is the main engine of economic growth and development. The static and dynamic effects of the manufacturing industry create this effect. In this framework, there is an extensive literature, both empirical and theoretical, exploring the significance of the manufacturing industry in the context of growth/development. However, in a period when re-industrialisation has gained importance, studies analysing the dynamics affecting industrialisation are limited. Therefore, this paper aims to analyse how FDI, trade globalisation and renewable energy consumption affect industrialisation in Türkiye's economy. It can be proposed that within the existing literature, the analysis of the impact of these dynamics on economic growth is broad, while there is a scarcity of studies specifically examining their effects on industrialisation. For this reason, it is thought that the paper will make an important contribution to the literature. This paper is structured into six sections. The introductory section provides general information about the study and outlines its motivation. The second section reviews the empirical literature related to the variables analysed. The third section covers the data and methodology used. Findings from the analyses are presented in the fourth section, while the fifth section discusses the results. The final section, the sixth, comprises conclusions and policy recommendations.

2. Literature Background

There is extensive literature analysing the impact of both the manufacturing industry and FDI, renewable energy, and trade globalisation of trade on growth. This paper investigates the impact of FDI, trade globalisation and renewable energy on industrialisation. In this framework, the literature section is divided into three sub-sections: i-) the relationship between FDI and industrialisation, ii-) the relationship between trade globalisation and industrialisation, iii-) the relationship between renewable energy and industrialisation.

2.1. Industrialisation and Foreign Direct Investments

In their study covering 49 African countries, Gui-Diby and Renard (2015) argue that, in 1980-2019 period, FDI does not affect industrialisation. Ngouhouo and Ewane (2020), using the PMG estimator for 15 African countries, claim that FDI support industrialisation over the period 1990-2017. Emako, Nuru, and Menza (2022a) prove that FDI increase structural change in 44 developing and four newly industrialised countries using the system GMM. In another study by Emako, Nuru, and Menza (2022b), the ARDL model was applied. The authors prove that FDI increased industrialisation in Ethiopia during the period 1981-2019. Darko and Xu (2022) state that, according to system GMM results, China's FDI in 49 African countries increase industrialisation over the period 2003-2020. In the study conducted by Müller (2020), it is claimed that FDI negatively affects industrialisation. Similarly, Oduola, Bello, and Popoola (2022), using Pooled OLS, Fixed Effects and system GMM, emphasize that FDI negatively affects industrialization in Sub-Saharan African countries over the period of 1996-2018. However, in the study conducted by Appiah, Gyamfi, Adebayo, and Bekun (2023), using AMG and CCEMG methods, opposite findings were obtained. Hereunder, in 1996-2017 period, financial development and growth increase industrialisation, while FDI decreases it. According to the ARDL and NARDL methods applied by Akorsu and Okyere (2023) for Ghana, they prove that positive shocks in FDI increase industrialisation. Kitole and Utouh (2023) conducted research for Tanzania using the VAR method. As a result of the analysis, for the 1960-2020 period, the authors present findings that FDI negatively affects industrialisation.

Although there is extensive literature on FDI in Türkiye, the impact of FDI on industry is limited, and there are few studies. For this reason, we focused on studies similar to our hypothesis. For example, in their analysis for Turkey using Hacker and Hatemi-J Bootstrap causality tests, Köse and Dineri (2020) claim a unidirectional causality from FDI to industrial employment in 1980-2017. Çubukçu, Emsen, and Türkmen (2021) apply the ARDL model and suggest that FDI increased exports in the textile sector in the period 2005Q1-2019Q2. Yurtançıkmaz and Emsen (2021) applied the ARDL model for Turkey and found that FDI increases the stock market industrial index. Udemba and Keleş (2022) state that according to Granger's causality results, there is no causality relationship between FDI and industrialisation in Türkiye over the period of 1970-2018. Finally, the results of the ARDL model applied by Demirtaş and Artık (2022) prove that FDI has no effect on industrialisation over the period of 2005Q1-2019Q4.

2.2. Industrialisation and Trade Globalisation

Chandran and Munusamy (2009) apply the ARDL model for Malaysia. As the findings of the model suggest, trade globalisation increases manufacturing industry growth for the 1970-2003 period. Lopez (2017) employed the Fixed Effects model to scrutinise the link between trade liberalisation and industrialisation in eight Latin American countries (Colombia, Brazil, Ecuador, Uruguay, Bolivia, Mexico, Costa Rica, and Argentina) over the period 1970-2014. The findings obtained in the paper expose that trade liberalisation has a negative impact on industrialisation. In their analysis of the 14 COMESA member countries from 1993 to 2016, Jiya, Sama, and Ouedraogo (2020) emphasize that by applying the PMG, AMG, and Dynamic Fixed Effects model, FDI reduces industrialisation. The system GMM results applied by Mignamissi and Nguekeng (2022) prove that trade globalisation increased industrialisation in Africa over the period of 1990-2019. However, Fankem and Feyom (2023) present contrary findings for Sub-Saharan African countries. According to the authors, trade openness negatively affected industrialization in the period 1985-2014. Cengiz and Manga (2024) applied the AMG method for the period 2000-2019 for the Western Balkan countries. The authors' results indicate that trade openness increases industrialisation. Aktürk, Akan and Gültekin (2023) prove that trade openness increases manufacturing industry production in 40 countries for the 2000-2014 period. Aktürk, Akan and Gültekin (2023) prove that trade openness boosted manufacturing industry production in 40 countries for the 2000-2014 period.

In Türkiye, the studies investigating the relationship between trade openness and industrialisation are limited. In this context, Tonus (2015) has undertaken one of the studies examining the connection between trade openness and industrialisation. Tonus's (2015) study's findings indicate that trade openness promotes industrialisation in Türkiye for the period 1996Q1-2006Q2 in the post-Customs Union period. The author argues that trade liberalisation increases trade volume but does not lead to industrialisation. According to VAR analysis results, Kurt and Kılıç (2019) suggest that economic and political globalisation increased defence expenditures in Türkiye for the 1974-2015 period. In his analysis for Türkiye, Hilal (2019) argues that, in the 1980-2015 period, globalisation increased industrialisation in the years when there was no structural break, but the opposite was true in the years when there was a structural break. Ergül and Soylu (2022) applied the Random Effects model for 12 regions of Turkey. The results of the Random Effects model indicate that trade openness increased the industrial sector's energy consumption in the 2015-2019 period.

2.3. Industrialisation and Renewable Energy

As a result of the literature study, it was seen that the studies on renewable energy and industrialisation are very limited. For this reason, in this section, the studies on renewable energy growth are summarised.

In this context, using the Granger causality, Mudakkar, Zaman, Khan, and Ahmad (2013) claim that, in Pakistan, the unidirectional causality relationship from nuclear energy to industrialisation in the 1975-2011 period. Pan, Uddin, Saima, Jiao, and Han (2019) argue that industrialisation increased energy intensity in Bangladesh during the 1986-2015 period. Gyamfi, Bein, and Bekun (2020) apply DOLS and FMOLS estimators and argue that renewable energy reduces growth in E7 countries over the period 1990-2018. Similar results can be observed in the analysis carried out by Musah (2020). The findings of the CCEMG and DCCEMG estimators applied in this study show that renewable energy does not have a significant impact on growth in West Africa over the period 1990-2018. Hieu and Mai (2023) used several methods in their study, such as MMQR, FMOLS, DOLS and fixed effects. According to the results of these methods, renewable energy has a growth-enhancing effect in the period 1990-2020 in 80 developing countries. Similarly, Iqbal, Tang and Rasool (2023) applied more than one method for BRICS countries. Accordingly, ARDL, PMG and AMG results prove that renewable energy is an important dynamic of growth. At the same time, according to the Dumistrescu-Hurlin results, a unidirectional causality from growth to renewable energy.

Furthermore, there exists extensive literature analysing renewable energy and growth in Türkiye. Some of these are summarised in the paper. For example, Alper (2018) used Bayer-Hanck and Toda-Yamamoto causality tests, and they found unidirectional causality from growth to renewable energy in Türkiye from 1990 to 2017. However, Erdoğan, Dücan, Şentürk, and Şentürk (2018) emphasise that renewable energy is the cause of growth in the period 1998-2015 in Turkey. Similarly, based on Johansen and Granger causality results, Canbay (2020) argues that energy use promote growth in Turkey in the period 1985-2017. Bölük, Çağlar, and Mert (2022) used the NARDL method for the 1987-2015 period. According to the findings of the authors, renewable energy increases growth in Türkiye. According to Toda-Yamamoto results applied by Demir (2023), unidirectional causality from renewable energy consumption to growth in Türkiye over the period of 1990-2020. Similarly, Çınar (2023) argues that unidirectional causality relationship from renewable energy to growth in Turkey.

A review of the literature reveals that studies examining the relationship between FDI, trade globalisation, renewable energy and industrialisation are limited. For this reason, it is predicted that this study, which analyses the dynamics of industrialisation in the Türkiye, make an important contribution to the literature.

3. Data Description and Empirical Methodology

The aim of the paper is to scrutinise the nexus FDI, trade openness, renewable energy and industrialisation. Table 1 is a summary of the data, and the sources of the data. Manufacturing industry value added (constant 2015 US$) is used as a proxy for industrialisation. Manufacturing industry value added is taken from the World Bank database. FDI is taken from the United Nations Conference on Trade and Development database. The trade globalisation index is taken from the ETH Zürich KOF database. Renewable energy consumption is taken from the Our World in Data database.

Table 1. Data Description and Source

Variable	Description	Data Source
lnmva	Manufacturing Value Added	WB-WDI (2023)
lnfdi	Foreign Direct Investment	UNCTAD (2023)
lntrdgi	Trade globalisation Index	ETH*zürich* KOF (2023)
lnrnw	Renewable Energy Consumption Per Capita	OWID (2023)

Considering the literature, the empirical methodology can presented as follows (Gui-Diby and Renard, 2015: Müller, 2021; Oduola et al., 2022; Mignamissi and Nguekeng, 2022; Appiah et al., 2023; Akorsu and Okyere, 2023; Fankem and Feyom, 2023):

$$lnmva_t = \beta_0 + \beta_1 lnfdi_t + \beta_2 lntrdgi_t + \beta_3 lnrnw_t + \varepsilon_t \qquad (1)$$

In equation (1), β_0 is the coefficient of the constant term, β_1, β_2, and β_3 are the coefficient of the parameters, i.e lnfdi, lntrdgi, and lnrnw, respectively, and ε_t

represent error term. In equation (1), all variables are normalised using natural logarithms. Globalisation has facilitated trade and financial flows between countries. At the same time, trade and financial flows have had a significant impact on both sectors and the economy as a whole. In this sense, foreign direct investments have significant effects on industrialisation. FDI can provide both financial resources and advanced technology to the industrial sector. FDI can create some advantages in the industrial sector, such as increasing productivity, adapting to supply chains, and ensuring capital flows. Concurrently, FDI can create benefits in the industrial sector through channels such as forward and backward linkages and technological transfers and can be a catalyst for industrialisation (Gui-Diby and Renard, 2015: Müller, 2021; Oduola et al., 2022; Appiah et al., 2023). Therefore, FDI is included in the model. Similarly, trade openness can positively impact both the industrial sector and economic growth by providing cheap technology, cheap intermediate inputs, and international market access (Mignamissi and Nguekeng, 2022; Akorsu and Okyere, 2023; Fankem and Feyom, 2023). In this context, the trade openness variable is included in the model. Energy use is an important dynamic in economic growth and the industrial production process. However, the environmental impact of energy consumption (especially non-renewable energy) has recently led to an increased demand for renewable energy (Paramati, Bhattacharya, Ozturk, and Zakari, 2018; Koengkan, Fuinhas, and Santiago, 2020; Malik, 2021). For this reason, renewable energy consumption is included in the model to analyse the effect of renewable energy on industrialisation.

In this framework, The Autoregressive Distributed Lag (ARDL) bounds testing method is employed to estimate the logarithmic equation model in equation (1). The ARDL model developed by Pesaran, Shin, and Smith (2001) provides some advantages; firstly, this model can be applied even with a small sample; second, the ARDL eliminates the endogeneity problem; third, the ARDL model can also be applied when the independent variables are I(0), I(1) or a mix of both (Peseran et al., 2001; Bertsatos, Sakellaris, and Tsionas, 2022).

In the initial phase of the ARDL model, the presence of a long-term relationship between variables is examined. The assessment of this long-term relationship or co-integration is conducted using the ARDL bounds testing approach, relying on the F-statistic. To evaluate the co-integration relationship in the model, the following model was formulated (Iqbal et al., 2023):

$$\Delta lnmva_t = \beta_0 + \sum_{t=1}^{n} \beta_{1i} \Delta lnmva_{t-i} + \sum_{t=0}^{n} \beta_{2i} \Delta lnfdi_{t-i} + \sum_{t=0}^{n} \beta_{3i}\, \Delta lntrdgi_{t-i} + \sum_{t=0}^{n} \beta_{4i} + \theta_1 lnmva_{t-1} + \theta_2 lnfdi_{t-1} + \theta_3 lntrdgi_{t-1} + \theta_4 lnrnw_{t-1} + + \varepsilon_t \quad (2)$$

In equation (2), Δ denotes the first order differences of the series, n denotes the lag lengths of the series and ε_t denotes the error term. The co-integration relationship between the variables is expressed by the coefficients $\theta_1, \theta_2, \theta_3, \theta_4$. Equation (2) is tested based on the following hypotheses (Kong, Peng, Ni, Jiang, and Wang e, 2021):

$$H_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0 \quad \text{there is no co-integration} \quad (3)$$

$$H_1 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0 \quad \text{there is co-integration} \quad (4)$$

If hypothesis H is accepted, the long-run coefficients of the model can be estimated. In this case, the long-run coefficients in the ARDL $(\rho_1, \rho_{2,} \rho_{3,} \rho_4)$ model are estimated as follows (Özbaş and Yıldırım, 2023):

$$lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} lngdp_{t-i} + \sum_{t=0}^{\rho_2} \beta_{2i} lnman_{t-i} + \sum_{t=0}^{\rho_3} \beta_{3i} lntropn_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i} lnrnw_{t-i} + \varepsilon_t \quad (5)$$

After estimating the long-run coefficients in the model, the following equation is used for the error correction model (Tahir, Ali, Naseem, and Burki, 2023):

$$\Delta lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} \Delta lngdp_{t-i} + \sum_{i=0}^{\rho_2} \beta_{2i} \Delta lnman_{t-i} + \sum_{i=0}^{\rho_3} \beta_{3i} \Delta lntropn_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i} \Delta lnrnw_{t-i} + \delta ECM_{t-1} + \varepsilon_t \quad (6)$$

Equation (6) is the lagged value of the residuals of long-term. The term ECM_{t-1}denotes the error correction coefficient of the ARDL model. The symbol δ indicates how long the model's short-run imbalances take to converge to long-run equilibrium. For the model to work, this coefficient must be negative and statistically significant (Kong et al., 2021; Tahir et al., 2023).

4.Empirical Estimation and Findings

4.1. Preliminary Tests

Before applying the ARDL model, the stationarity of the variables included in the model must be determined. Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root tests are used to determine the stationarity of the variables. Table 1 presents the results of unit root tests. Unit root test results indicate that, except trade globalisation (lntrdgi), all variables are stationary at first differences I(1). Trade globalisation (lntrdgi) is stationary at level I(0) with constant, but stationary at first differences I(1) with constant and trend and none. In that case, if the dependent variable is stationary at first differences I(1), the ARDL model can be applied if the independent variables are at level or at first differences or a mix of both (Peseran et al., 2001; Bertsatos et al., 2022).

Table 2. Results of Unit Root Test

Variables		ADF		PP	
		I (0)	I (1)	I (0)	I (1)
lnmva	c	-0.318432 (0.9107)	*-5.387229 (0.0001)*	-0.183176 (0.9304)	*-6.051175 (0.0000)*
	c & t	-2.618388 (0.2753)	*-5.283748 (0.0010)*	-2.687532 (0.2483)	*-5.874142 (0.0002)*
	n	3.850800 (0.9999)	*-3.808737 (0.0004)*	6.486093 (0.9996)	*-3.877588 (0.0004)*
lnfdi	c	-0.644028 (0.8454)	*-7.343983 (0.0000)*	-0.625529 (0.8503)	*-7.141186 (0.0000)*
	c & t	-2.025398 (0.5644)	*-7.213217 (0.0000)*	-2.092203 (0.5291)	*-7.030262 (0.0000)*
	n	2.432088 (0.9952)	*-6.313137 (0.0000)*	2.247762 (0.9926)	*-6.292262 (0.0000)*
lntrdgi	c	*-3.109202 (0.0366)*	*-5.077317 (0.0003)*	*-3.323808 (0.0226)*	*-5.073006 (0.0003)*
	c & t	-2.863543 (0.1876)	*-5.266088 (0.0000)*	-2.852444 (0.1911)	*-5264232 (0.0010)*
	n	1.302267 (0.9477)	*-4.912895 (0.0000)*	1.405208 (0.9567)	*-4.887191 (0.0000)*
lnrnw	c	-0.925605 (0.7659)	*-6.408745 (0.0000)*	-0.715276 (0.8279)	*-6.823231 (0.0000)*
	c & t	-2.068047 (0.5419)	*-6.366381 (0.0001)*	-2.040036 (0.5567)	*-7.174535 (0.0000)*
	n	1.116072 (0.9275)	*-6.142687 (0.0000)*	1.752849 (0.9782)	*-6.153747 (0.0000)*

Note:
1. c; with constant, c & t; with constant & trend, n; without constant & trend
2. For the ADF test, the lag length is determined by the Akaike Information Criterion (AIC), and the maximum lag is 1

3. The spectral estimation method Bertleet Kernel and Newey-West Bandwidth is chosen for the PP test.

After determining the stationarity of the series, the ARDL bounds test is applied to determine whether there is cointegration in the model. However, it should determine the optimal lag lengths before performing the co-integration test. The optimal lag lengths in the model are determined by VAR analysis. Table 2 shows lag lengths, and as a result of VAR analysis, the lag length of the model is 1.

Table 3. Optimal Lag Lengths

Lag	LogL	LR	FPE	AIC	SC	HQ
0	24.70586	NA	2.68E-06	-1.47899	-1.288675	-1.420809
1	*106.4608*	*134.3117**	*2.48e-08**	*-6.175771**	*-5.224196**	*-5.884865**
2	118.1786	15.90269	3.65E-08	-5.869897	-4.157063	-5.346267
3	132.2616	15.08895	5.18E-08	-5.73297	-3.258876	-4.976615

4.2. Co-integration Results

The F-statistic, as suggested by Pesaran et al. (2001), is employed to identify a long-term cointegration relationship among the variables. The results of the ARDL bounds test (F-statistic) are presented in Table 3. If the calculated F-statistic value exceeds the upper bounds I(1) critical values, the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) from Equation 4 is accepted. The results in Table 3 signify that the H1 hypothesis is accepted, indicating a long-term cointegration relationship among the variables.

Table 4. ARDL Bounds Test (Co-integration)

F-statistic		10%		5%		1%	
9.146870	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	30	2.676	3. 586	3.272	4.306	4.614	5.966
	Asymptotic	2.370	3.200	2.790	3.670	3.650	4.660

Long-run and short-run coefficient estimates can be obtained if there is a long-run co-integration relationship between variables in the ARDL model. The short and long run coefficient estimates of the ARDL model are presented in Table 4. According to the findings in Table 4, FDI has a positive and statistically significant effect on industrialisation in the long run, and results indicate that a 1% increase in FDI increases industrialisation by 0.647535%. The coefficient of trade globalisation is also positive and statistically significant, which shows that a 1% increase in trade globalisation increases industrialisation by 0.292087%. At the same time, the coefficient of renewable energy is positive and statistically significant, and results indicate that a 1% increase in renewable energy promotes industrialisation by 0.385085%.

Even so, in the short-run, the coefficient of al variables are positive, the coefficient other than renewable energy consumption are statistically insignificant. Accordingly, the coefficient of FDI is positive and statistically insignificant. In the short run, a 1% increase in FDI increases industrialisation by approximately 0.031518%. The coefficient of trade globalisation is positive and statistically insignificant, which shows that a 1% increase in trade globalisation increases industrialisation by approximately 0.246711%. Finally, the coefficient of renewable energy consumption is positive and statistically significant, which indicates that a 1% increase in renewable energy consumption increases industrialisation by approximately 0.134598%.

The error correction model is applied to test whether or not the ARDL model works. The error correction model shows how long it takes for a short-run imbalance in the model to converge to its long-run equilibrium. The error correction model results are presented in Table 4 and show that the coefficient of the error correction model meets the theoretical and statistical expectations. The error correction coefficient is estimated as -0.425866, and it means that an imbalance occurring in the short run will converge to the long-run equilibrium after approximately 42 per cent.

Table 5. ARDL Long-Run and Short-Run Estimated Results

Long-Run		**Short-Run**	
Variables	**Coefficient**	**Variables**	**Coefficient**
lnfdi	0.647535 (0.0519)	Δlnfdi	0.031518 (0.3230)
lntrdgi	0.292087 (0.0000)	Δlntrdgi	0.246711 (0.1926)
lnrnw	0.385085 (0.0003)	Δlnrnw	0.134598 (0.0113)
		ECM	***-0.425866 (0.0000)***

4.3. Stability Test and Diagnostic Tests

After estimating the ARDL model, several diagnostic tests are applied to the validity of the model results. Diagnostic test results are given in Table 5, and according to the test results, there is no diagnostic problem in the model. At the same time, CUSUM (Figure 6) and CUSUMQ (Figure 7) figures are drawn to test the stability of the model. According to both Figure 6 and Figure 7, the ARDL model is stable, and there is no structural break in the model.

Table 6. Diagnostic Test and Stability Test

	F-stat.	**Obs*R^2**
Autocorrelation Test (Breuch-Godfrey Serial Correlation LM Test)	0.1773952 (0.9474)	1.027903 (0.9055)
Heteroscedasticity Test (Breusch-Pagan-Godfrey)	0.286093 (0.9161)	1.687501 (0.8905)
	t-statistic	**F-statistic**
Ramsey RESET Test	0.407881 (0.6871)	0.166367 0(.6871)
Normality Test (Jarque-Bera)	3.721028 [0.1555]	

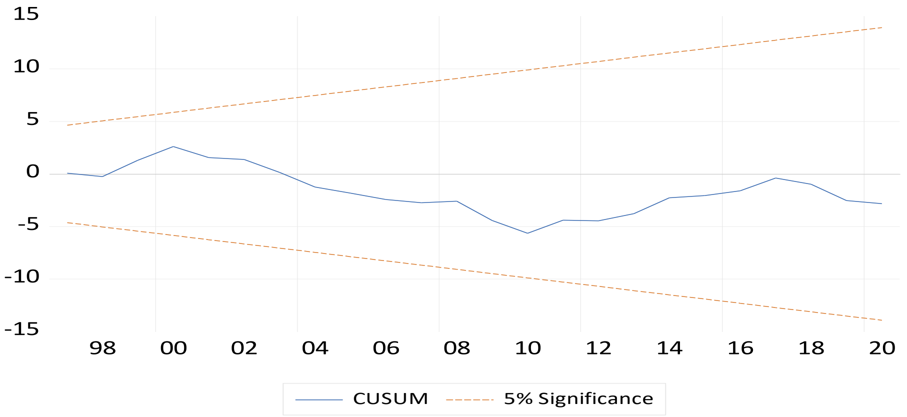

Figure 5. Cusum Test

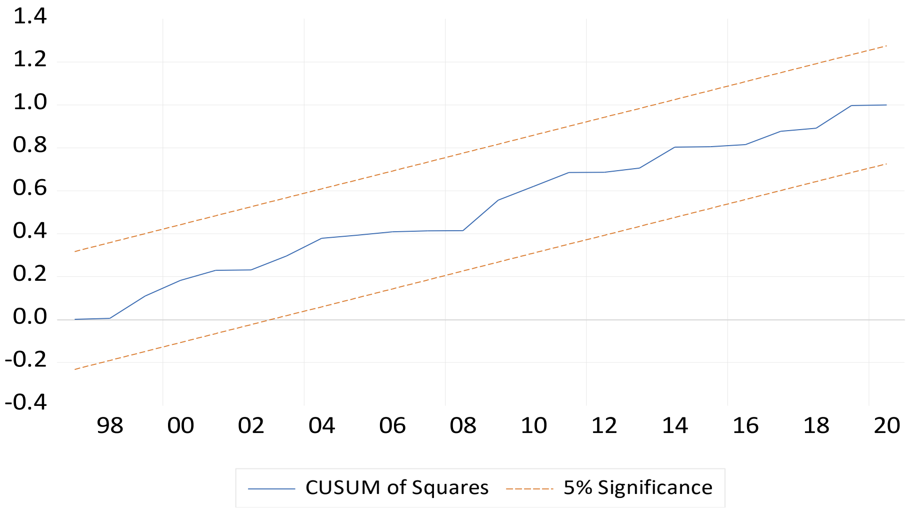

Figure 6. Cusum-q Test

4.4. Toda-Yamamoto (1995) Causality Test Results

Ultimately, the Toda-Yamamoto (1995) causality test is applied in the empirical section. In the Toda-Yamamato (1995) test, series can have different degrees of stationarity. In this test, the series are analysed with level values. This allows for more information in the series (Sijabat, 2022). For applying the Toda-Yamamoto (1995) causality test, it is necessary to determine the maximum degree of integration of the variables (d_{max}) and the optimal lag length (k) (Elian and Suliman, 2015). To perform the causality test, the condition $\boldsymbol{d_{max} \leq k}$ must be satisfied (Toda-Yamamoto, 1995). The optimal lag length is determined by VAR analysis (Faisal, Tursoy, and Resatoglu, 2016). According to Table 2, the optimal lag length is 1 (k = 1).

The maximum degree of integration (dmax) is determined by unit root tests. Unit root test results are presented in Table 1. If the levels of stationarity of the variables are different, the one with the highest level of stationarity gives the maximum degree of integration (Allou, Adeleye, Cheng, and Abdul, 2020). According to Table 1, all variables are stationary at the I(1) level. In this case, the maximum degree of integration is 1 (dmax = 1). After determining the optimal lag length (k) and the maximum degree of integration (dmax), the Toda-Yamamoto (1995) causality analysis based on the VAR (k + dmax) model is performed. Since the optimal lag length is 1 (k = 1) and the maximum degree of integration is 1 (dmax = 1), the Toda-Yamamoto (1995) causality analysis is performed based on a two lag (k + dmax = 2) VAR model (Zou, 2022; Qamruzzaman and Karim, 2020). Toda-Yamamoto's (1995) causality test results are presented in Table 6. The results in Table 6 show that there is no causality relationship between trade globalisation and the manufacturing industry. The results indicate that while there is a unidirectional causality relationship from FDI to industrialisation, there is a bidirectional causality relationship between renewable energy and industrialisation.

Table 7. Toda-Yamamoto (1995) Causality Test

Null Hypothesis	d.f	Chi-Square	Prob.	Causality Direction
lntrdgi ↛ lnmva	2	2.352395	0.1250	No Causality
lnmva ↛ lntrdgi		0.535061	0.4645	
lnfdi ↛ lnmva	2	17.94574	0.0000	Unidirectionally causality (lnfdi → lnmva)
lnmva ↛ lnfdi		0.010689	0.9177	
lnrnw ↛ lnmva	2	7.618237	0.0058	Bidirectionally Causality (lnrnw ↔ nmva)
lnmva ↛ lnrnw		5.773281	0.0163	

5. Discussion

Manufacturing plays an important role in achieving economic growth and development goals through its static and dynamic effects. However, with the acceleration of globalisation trends, some dynamics affect industrialisation. One of these dynamics is FDI, which can play a crucial role in industrialisation. This study's findings suggest that FDI is crucial for industrialisation within this framework. In this context, ARDL findings show that FDI positively affects industrialisation in the short run and long run, but the short-run coefficient is statistically insignificant. These findings are in line with Ngouhou and Ewane (2020), Köse and Dineri (2020), Yurtançıkmaz and Emsan (2021), Emako et al. (2022a, 2022b), Kitole and Utouh (2023). However, Müller (2022), Oduola et al. (2022), Udemba and Keleş (2022), Demirtaş and Artık (2022) and Appiah et al. (2023) show opposite results in their studies. FDI can have a positive impact on the industry and growth if it is targeted in the right area and sectors (Dumludağ, 20201). FDI inflows bring technology, know-how, technological skills and opportunities to participate in international networks. This ensures the transformation of the manufacturing industry.

Trade globalisation is another important dynamic affecting industrialisation, and in most economies (especially in developing countries such as Latin America and Sub-Saharan Africa countries), trade globalisation has negatively affected industrialisation. The impact of trade globalisation on economic dynamics is controversial. But this paper's results prove that, in the short-run and long-run, trade globalisation positively affects industrialisation in Türkiye. However, the short-run coefficient is statistically insignificant. This result is in line with Chandran and Munusayam (2009), Kurt and Kılıç (2019), Ergül and Soylu (2022), Mignamissi and

Nguekeng (2022), Cengiz and Manga (2024), and Aktürk et al. (2023). However, the findings of the studies conducted by Tonus (2015), Lopez (2017), Jiya et al. (2020), Fankem and Feyom (2023) show the opposite. Globalisation can lead to de-industrialisation. However, with globalisation, economies can access different resources and use them in the production process (Bayar and Günçavdı, 2018). In other words, with globalisation, capital flows from developed countries to developing countries can provide some advantages in areas such as information, technology and innovation. As a result of the effective use of these advantages in the industrial sector, industrial production and productivity increase (Cengiz and Manga, 2024).

Finally, another important variable included in the analysis is renewable energy consumption. According to the analysis results, renewable energy consumption has a positive and significant effect on industrialisation in the short-run and long-run. This finding is in line with Mudakkar et al. (2013), Alper (2018), Erdoğan et al. (2018), Canbay (2020), Musah (2020), Hieu and Mai (2023), and Çınar (2023). Pan et al. (2019), Musah (2020), and Gyamfi et al. (2020) present findings in the opposite direction. Climate change and increasing sensitivity to the environmental conscience can change consumer preferences. This is why improving environmental quality and reducing the carbon footprint have recently become economic policy objectives. Therefore, the structure of the manufacturing industry can be transformed by the transition to green energy. This transformation will increase research and development, information and innovation activities in the manufacturing industry. Therefore, these developments will positively affect industrial production (Kaygusuz et al., 2023).

6. Conclusion and Policy Recommendation

Manufacturing is seen as the main engine of development and growth. There is a theoretical and empirical consensus in the literature to support this claim. An evaluation of the historical process shows that the manufacturing sector is an important driver of development and economic growth. The manufacturing industry was a significant dynamic during the Industrial Revolution. In countries where manufacturing industry production has increased, a significant economic growth has been realised and the gap between developed and developing economies has gradually widened. Industrialisation became a fundamental policy in the countries that gained independence after the Second World War. The implementation of import-substitution industrialisation and inward-oriented policies has increased the efficiency of industrial production. Developing countries achieved significant economic growth through their industrialisation policies, particularly in the period 1950-1975. For this reason, this period is referred to in literature as the golden age of growth. However, the structural changes in the world economy after 1980 led to a loss of interest in the industrial sector. Import substitution industrialisation and inward-oriented policies were abandoned, and export-oriented and outward-oriented growth policies were adopted. In this direction, industrial resources started to shift to the services sector. This has led to premature de-industrialisation, particularly in many developing countries. However, re-industrialisation policies have recently gained importance, especially in developing countries, due to the middle-income trap, supply chain disruptions, increasing economic inequalities, geopolitical competition, and the permanent effects of financial crises. However, it is a fact that the studies in the literature are generally concerned with the effect of industrialisation on growth. Also, in a period when the re-industrialisation policy gained importance, it was observed that studies analysing the dynamics affecting industrialisation were limited.

Therefore, this paper examines the dynamics affecting industrialisation in the Türkiye for the 1990-2020 period. For this purpose, the impact of foreign direct investments, trade globalisation and renewable energy on industrialisation has been analysed. The ARDL model and the Toda-Yamamoto causality test were applied to analyse the impact of the dynamics determining industrialisation. According to the findings of the analysis, FDI has a positive effect on industrialisation in the long-run. In the short run, FDI positively affects industrialisation, but the coefficient is statistically insignificant. Similar findings are also valid for trade globalisation. In the long-run and short-run, trade globalisation has a positive effect on industrialisation; however, the short-run coefficient is statistically insignificant. Renewable energy consumption, in the long-run and short-run, positively and significantly affects industrialisation. Finally, according to the Toda-Yamamoto causality results, there is a unidirectional causality from FDI to industrialisation, a bidirectional causality between renewable energy and industrialisation, while there is no causality relationship between trade globalisation and industrialisation. The results show that FDI, trade globalisation and renewable energy play a decisive role in industrialisation.

In a period where reindustrialisation policies have gained importance, based on the findings obtained in the paper, some policy recommendations can be made: i-) policymakers should play an active role in increasing foreign direct investment inflows, ii-) an effective mechanism should be established to FD to the right and specific sectors, iii-) in order to establish a sustainable industrial policy, coordination among institutions, companies, and the government should be ensured in the FDI inflows, iv-) FDI should be directed and included in industrial and development plans, v-) in the industrial sector, the use of clean energy should be encouraged to promote environmental awareness and reduce carbon emission, vi-) in the industrial sector, the necessary technology should be supported for the use of clean energy, vii-) in the industrial sector, the cost arising from the use of clean energy should be subsidised, viii-) in the trade globalisation process, policy measures should be taken to prevent the negative impact on industrialisation; ix-) in the trade globalisation process, sound policies should be produced to enable access to international resources; x-) finally, in the globalisation process, policies should be produced to protect and support industrial production.

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