Chapter 4

Assessing The Impact of High-Tech Foreign Trade on Türkiye's Economic Growth: An Empirical Investigation for the 1990-2023 Period

Şahin Nas[1]

Abstract

In any economy, foreign trade is one of the dynamics for development and growth, especially international trade of high-tech products offers substantial advantages for achieving sustainable growth. The current paper primarily seeks to explore the cruciality of high-tech foreign trade for growth in Türkiye over the 1990–2023 period. For that, the ARDL model is employed, and the findings indicate, both in short-term and long-term, that high-tech exports enhance growth. In the short-term and long-term, high-tech imports and total foreign trade reduce growth; however, the long-run coefficient (foreign trade) is statistically insignificant. Additionally, control variables, gross fixed capital formation, and government expenditures encourage growth, while foreign direct investments slow down growth. For the robustness checks, FMOLS, DOLS, and CCR estimators are applied. The outcomes obtained by these estimators are consistent with the findings of the ARDL model. Although high-tech exports contribute to growth, high-tech exports' impact remains relatively limited. Therefore, it is essential to enhance high-tech production capacity and implement policies that promote high-tech exports to achieve sustainable economic growth.

1. Introduction

Technological advancements played a significant role in the Industrial Revolution and its subsequent production stages. Moreover, technological advancements, particularly in high technology, have significantly contributed to trade development (Idirs et al., 2021). As the importance of technology in the production process has increased, countries have shifted their focus toward high-tech production and exports rather than simple technology-based production. This shift is driven by high-tech exports becoming profound for sustainable development and growth (Sojoodi & Baghbanpour, 2024). In this context, there are two fundamental approaches to the subject of the impact of technology on growth. The first is the neo-

1 Dr. Öğr. Üyesi, Şırnak Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, snas@sirnak.edu.tr, 0000-0003-3267-4432

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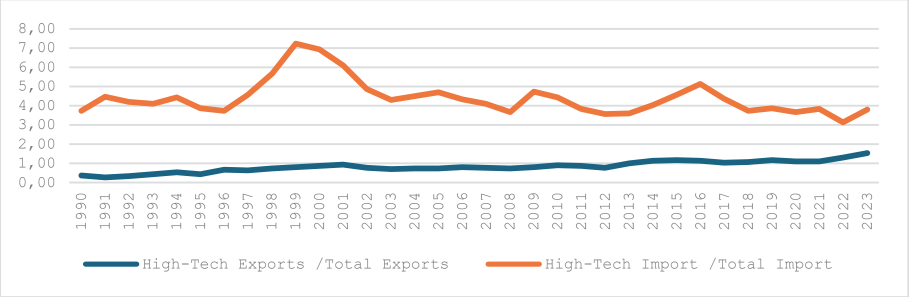
classical model (Sojoodi & Baghbanpour, 2024), primarily based on Solow's (1956) economic growth model. This model treats technology as an exogenous factor (Yilmaz, 2024). According to this framework, it is assumed that technological progress, treated as exogenous in the growth model, will enable developing countries to converge with developed countries over time (Şeker & Özcan, 2029). Another model is the endogenous growth model, inspired by the works of Romer (1986, 1990), Lucas (1988). This model contends that economic growth does not result from exogenous forces but stems from endogenous factors. In the endogenous growth model, technology is considered endogenous, and it is assumed that increases in productivity are directly linked to innovation and investments in human capital. Furthermore, investments in technology generate positive externalities, creating a spillover effect, which is emphasized as boosting growth (Şanlı & Konukman, 2021; Sojoodi & Baghbanpour, 2024; Yilmaz, 2024).

In this context, the advancement of technology and its heavy utilization in production greatly improve a nation's competitiveness in international trade. It is also argued that high-tech products stimulate more global trade growth than other manufacturing industry products (Şanlı & Konukman, 2021; Khan et al., 2024). Additionally, high-tech industries are intricately linked to technological advancement, creativity knowledge, and innovation. It can be maintained that these industries function as pivotal indicators for predicting the economic growth of countries with diverse production structures and their export performance (Carrasco & Tovar-Garcia, 2023). While classical and neoclassical trade theories mainly focus on analyzing trade in raw materials, agricultural products, and labor-intensive industrial goods, modern trade theories highlight the significance of technological progress by examining differentiated, capital-intensive, and technology-intensive industrial goods (Şeker & Özcan, 2019; Zapata et al., 2024). In an economy, high-tech exports generate more positive externalities than low-tech exports by facilitating knowledge transfer and positively impacting economic growth and productivity. In this way, high-tech exports enable developing countries to achieve stable and sustainable growth (Altun et al., 2023). There is an argument to be made that economies that produce and export primary goods are generally more vulnerable to trade shocks. Consequently, this vulnerability can be mitigated through high-tech exports, as such products can enhance and sustain growth (Islam, 2023). Furthermore, under today's global conditions, the production and export of high-tech products following the establishment of a certain technological infrastructure can be seen as a benchmark for economic development (Yilmaz, 2024). The principal research question addressed in this paper is to examine how high-tech foreign trade has impacted growth in Türkiye during the post-1990 period. In this framework, Figures 1 and 2 illustrate the overall trend of high-tech trade in Türkiye's economy from 1990 to 2023.

As depicted in Figure 1, high-tech exports and imports as a share of total trade in Türkiye from 1990 to 2023 are presented. It is evident from Figure 1 that high-tech exports are consistently lower than high-tech imports. As a consequence, high-tech exports represented 0.39% of total exports in 1990, climbing to 1.52% in 2023. In this aspect, the contribution of high-tech exports to total exports has remained largely unchanged, averaging about 1% over the period. Thus, it can be said that Turkey remains relatively weak in high-tech exports. Contrary to this, the proportion of high-tech imports in total imports has shown noticeable fluctuations. In 1990, this share was 3.72%, reaching its peak of 7.21% in 1999. Starting in 1999, high-tech imports' proportion of total imports has gradually decreased, falling to 3.81% in 2023. The evaluation of exports and imports confirms that high-tech trade is at a very low level in Türkiye.

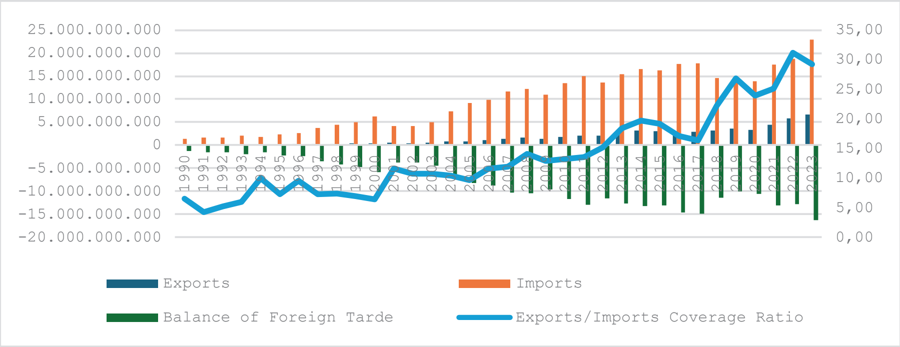
Figure 1: High-Tech's Proportion of Total Exports and Imports in Türkiye, 1990-2023 (%).



Source: Comtrade (2024)

Figure 2 illustrates the trends in high-tech exports and imports in Türkiye during the period from 1990 to 2023. In 1990, total high-tech exports were around $88 million; by 2023, it increased to $7 billion. From 1990 to 2023, high-tech exports averaged about $2 billion. In 1990, high-tech imports totaled $1.5 billion, while by 2023, this figure rose to approximately $23 billion. From 1990 to 2023, high-tech imports amounted to about $10 billion. The trade balance has consistently been in deficit over the period, as high-technology imports have surpassed high-technology exports. Additionally, this deficit has demonstrated a significant and continuous increase over time. In 1990, the trade deficit was $1.274 billion; by 2023, it rose to $16.272 billion. Another important indicator is the export/import coverage ratio. As shown in Figure 2, despite a consistent increase, the export/import coverage ratio remains relatively low. Consequently, in 1990, the ratio of high-tech exports to high-tech imports was 7%, while by 2023, this ratio had risen to 29%.

Figure 2: High-Tech Exports and Imports in Türkiye, 1990-2023.



Source: Comtrade (2024)

There have been crucial debates and extensive empirical research in the literature for decades concerning the function of foreign trade in fostering growth. However, while most studies indicate a theoretical and empirical correlation between foreign trade and growth, it cannot be claimed that there is a consensus on the magnitude of the effects or the direction of causality (Panta et al., 2022). In this regard, the literature includes various hypotheses testing the impact of foreign trade, such as export-led growth (ELG), growth-led exports (GLE), import-led growth (ILG), and growth-led imports (GLI) (Orhan et al., 2022; Nonato & Carrasco-Gutierrez, 2023). As stated above, the paper's main purpose is to test the effect of high-tech foreign trade on growth in Türkiye's economy for the 1990–2023 period. Empirical analyses related to the hypotheses discussed in the literature have primarily investigated the nexus between exports, imports, and growth. However, papers investigating how high-tech foreign trade influences economic growth are relatively scarce. In line with this, this paper seeks to enrich the existing literature. The current paper consists of five sections: the introduction in the first section outlines the paper's purpose and discusses the development in foreign trade; a review of the empirical literature is in the second section; the research methodology and dataset are in the third section; the outcomes of empirical estimation and its discussions presents in the fourth section; and research's conclusion and policy recommendations are in the fifth section.

2. Empirical Literature Background

The rapid globalization trends observed in the world economy have significantly transformed the economic structure over the past few decades (Seok & Kim, 2024). Trade liberalization is one of the most critical factors driving this change and transformation. The adoption of free trade policies has led to a substantial increase in trade volume, making it important in driving productivity and growth (Madaleno et al., 2023; Istaiteyeh et al., 2023). With the increasing importance of foreign trade in economies, it can be argued that an extensive body of empirical research has emerged in the literature, and these studies typically test the hypotheses of export-led growth, import-led growth, growth-led exports, and growth-led imports across various countries and country groups. Researchers have generally utilized variables such as exports, imports, trade volume, and high-tech exports in this context scope. For instance, Sojoodi and Baghbanpour (2024) posited that, depending on the outcomes of the system Generalized Method of Moments (GMM), high-tech exports don't have a substantial role in the growth of developed and developing countries from 2007 to 2009. Additionally, referencing the conclusions of Konya (2006) and Dumitrescu-Hurlin (2012), the authors point out the presence of a unidirectional causality. When we evaluated the empirical paper conducted by Shadab and Alam (2024) for the United Arab Emirates, it revealed a similar finding regarding causality (a unidirectional causality from high-tech exports to growth). In contrast, the same paper offers distinct outcomes for the coefficient. Based on this result, they applied the Autoregressive Distributed Lag (ARDL) model, high-tech exports considerably enhance growth during the 1992–2020 period. Yilmaz (2024) also applied the method used by Shadab and Alam (2024) and, as a result, asserts the presence of a bidirectional causality between high-tech exports and growth for countries exporting high-tech products above the world average over the period 2007-2020. Another researcher who employed the ARDL model is Khan et al. (2024). The authors identified a positive relationship between growth and technological innovation in both the short-term and long-term during the period from 1990 to 2021 in Pakistan. In the short term, there exists a positive and significant relationship among technological innovation, medium- and high-tech exports, and growth. Kuzu and Arslan (2023) carried out an analysis for BRICS-T[1] countries, and they applied the Vector Autoregression (VAR) Granger causality test in their analysis for the period between 2000 and 2021. When we assessed their study, we observed that the authors reported outcomes similar to those of Sojoodi and Baghbanpour

[1] Brazil, Russia, India, China, South Africa and Türkiye.

(2024) and Shadab and Alam (2024). The paper by Islam (2023) utilized the Toda-Yamamot (1995) causality test, which also supports the same finding for Bangladesh. Also, in this paper, the NARDL method was employed, and the authors argue that export revenues contribute to increased growth. over the period of 1986-2019. The outcomes of Usman's (2023) study are aligned with the outcomes obtained by Yilmaz (2024). Because, according to the outcomes of the Granger causality test applied by the author, a two-way causal relationship between exports and growth is observed in China spanning 1992 to 2021. On the other hand, the ARDL results within the same study show discrepancies, demonstrating that exports suppress growth. When we reviewed the paper by Panta et al. (2022), we observed that the authors tested four different hypotheses[2] for Nepal. By virtue of these tests, the authors asserted that the hypothesis of import-led growth in the short run and growth-led exports in the long run is valid for the 1965–2020 period. Lee and Yu (2022), in their paper on Russia's 80 regions and 8 federal districts, emphasize that during the period 2011-2020, FDI and exports contributed positively to growth. Like Kuzu and Arslan (2023), Mangır and Ertuğrul (2022) conducted a study on BRICS-T countries, although both periods and the methods[3] they used differ. Based on the analysis results, the authors indicate that export increases growth, while import has no effect from 2006-2022. However, the causality results are in line with the outcomes of Kuzu and Arslan (2023).

When we examine the study by Paswan and Jha (2021) on India, based on the results of the Granger causality test, the authors present findings indicating a unidirectional causality from growth to export, while a bidirectional causality is observed between growth and imports. In the same study, the authors note that based on the VECM findings, they observed that the impact of imports on growth is higher than that of exports for the period 1991-2018. Following the approach of Khan et al. (2024) and Usman (2023), Lee and Fernando (2021) implemented the ARDL model. It has been established that the outcomes of the analysis found by the authors are compatible with the outcomes of Khan et al. (2024), while they are not aligned with the outcomes of Usman (2023). Accordingly, the authors find that FDI and exports contributed to growth over the span of 1981-2018 in Indonesia. Tah et al. (2021) also present similar findings for South Africa. Their paper concluded that, both in the short and long term, foreign trade

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[2] The hypotheses are as follows: Export-led Growth, Import-led Growth, Growth-led Export, and Growth-led Import.

[3] In their study, the authors used CCEGM, CCEGM, and AMG estimators, and for robustness tests, they employed DOLS, FMOLS, and CCR estimators. Additionally, Toda-Yamamoto (1995) causality test was applied.

contributed to economic growth over the period from 1970 to 2015. When the paper concluded by Lee and Huruta (2020) for ASEAN+3 countries is examined, it becomes clear that the findings correspond with Lee and Fernando (2021). Similarly, the findings of the paper emphasize that FDI and exports promote growth between 2008 and 2018. While the country selection and study period vary, Asafo (2020) and Fraser et al. (2020) tested the export-led growth hypothesis in their studies. When both papers are evaluated, Asafo (2020) in Ghana for the period 1970-2028 and Fraser et al. (2020) in Suriname for the period 1971-2025 find that the export-led hypothesis is valid. Jebran et al. (2018) also applied the ARDL model for empirical analysis in their study. The findings obtained in this study on Pakistan's economy differ from the results achieved by Khan et al. (2024) for Pakistan. The reason for this may be that the terms of trade is used as a variable in the study, and the terms of trade have a negative effect on growth in the 1980-2023 period. Lastly, upon reviewing Ee (2016), it is apparent that the author, in a manner similar to Asafo (2020) and Fraser et al. (2020), examined the validity of the export-led growth hypothesis. In this study, which focuses on Sub-Saharan African (SSA) countries for the period of 1985-2014, the author confirm the validity of the export-led growth hypothesis.

Considering the literature review, it is apparent that substantial and extensive literature has been established regarding the effect of foreign trade on Türkiye's economy. From this perspective, one of the most recent papers was performed by Emek (2024). Through an examination of causal relationships, the author identified a bidirectional reinforcing causality between exports and growth for the period of 2016:Q1-2023:Q12 within the framework of the findings of Fourier Toda-Yamamoto causality. Kara et al. (2024) also focused on the role of exports from two different sub-sectors (agricultural and industrial) in growth. The authors maintain that exports from both sectors are an important component of growth and contribute to growth enhancement. Similar to Emek (2024) but with a different methodological approach (Granger causality test), Pınar (2024) scrutinizes the relationship between exports, imports, and growth. The results of Pınar (2024) also vary, with the author asserting that no causality exists between exports and growth, as well as between imports and growth for the period 1998–2022. Furthermore, a causality from imports to exports was identified in the paper, and for this reason, the author suggests that an import-led export model fueled growth. In their paper, Çakmak and Doğan Çalışkan (2024) concentrate on a more specific sector. The authors focus on the role of international freight transport service trade in growth for the period 1984-2022, and according to outcomes, freight transport service imports hurt growth, while freight transport service exports positively affected growth. Unlike the previous paper, Yılmaz (2024) examined how foreign trade and economic growth affect income distribution. To analyze this effect, the author used the ARDL model, and the outcomes of the model show that economic growth has a negative impact on income distribution, whereas foreign trade positively influences income distribution from 1980 to 2022. Another study using a similar methodology to this study was conducted by Ergül and Karataş (2024), and the authors argue that agricultural product exports stimulate growth over the period of 1980-2022. Drawing on the ARDL model, Yılmaz and Albayrak (2023) affirmed that imports support growth, whereas exports restrained it in Türkiye. On this account, the authors suggest that this evidence indicates Türkiye's economy demonstrates an import-dependent growth pattern throughout the 1980-2020 period. Tunçsiper and Horoz (2023) report different results despite using a similar methodology, and their findings indicate that between 1980 and 2021, exports and imports positively influenced growth. The paper led by Erdinç and Aydınbaş (2023) also centers on the role of agricultural product exports in growth, as did Kara et al. (2024), and for that, the Toda-Yamamoto (1995) causality test was applied. The authors claim, from their findings, that bidirectional causality exists. Despite Kendirkıran and Emirmahmutoğlu (2022) employed the Granger causality test, it seen that they follow a different methodology. In this research, Granger, REW Granger, and TVP Granger causality tests are utilized for the period of 1998Q1-2020Q3. The outcomes derived from the traditional Granger causality show an absence of causality between exports and growth, while a bidirectional causality exists between imports and growth. According to the outcomes of the TVP Granger causality, a bidirectional causality exists between exports, imports, and growth. However, the REW Granger results differ, and according to the findings, the direction of causality is as follows: a unidirectional causality from growth to exports and imports during the 2011-2016 period, a unidirectional causality from exports and imports to growth between 2006 and 2008, and a bidirectional causality between imports and economic growth in 2007-2008 and 2016. Orhanl et al. (2022) also applied the Granger causality test for the period 1991Q1-2021Q4, and the authors state that there is causality from growth to exports for the period 1991Q1-2013Q4 and a bidirectional causality in the period 2014Q1-2021Q4. Yılmaz (2022), who employed the Toda-Yamamoto (1995) causality test, emphasizes that a unidirectional causality running from foreign trade to economic growth in Türkiye's economy for the 1970-2019 period. Similarly, Yengül Bülbül and Acaravcı (2022), who examine the role of foreign trade, based on Granger causality, prove that a bidirectional causality between foreign trade and growth. In the same paper, the authors, who utilized the ARDL model, found that foreign trade increased growth in 2000Q1-2018Q4.

A similar methodological approach to that of Yengül Bülbül and Acaravcı (2022) is observed in the study by Demirel and İşcan (2021). The authors argue that exports stimulate growth, but imports have a negative impact from 1987 to 2018. As per the causality outcomes, a two-way causality exists between imports and exports, whereas a one-way causality exists from growth to exports. Akyol and Mete (2021) also employed the ARDL model in their paper, covering the period from 2002 to 2020. But differently, the authors categorized exports on technological classification to investigate their importance for growth over the period of 1987-2018. According to empirical evidence presented in the paper, there isn't an observable effect of high-tech, medium-high-tech, medium-low-tech, and low-tech imports and exports on growth. Nonetheless, it has been observed that high-tech exports stimulate growth in the short-run. Likewise, it is argued that medium-high-tech, medium-low-tech, and low-tech imports have a growth-enhancing effect in the short term. The paper concluded by Karakaş and Burtan Doğan (2021) addresses to the role of foreign trade developments in growth after the Customs Union Agreements. For that, the authors applied Granger causality, and the outcomes prove a unidirectional causality from exports to growth and from imports to growth in the period of 1996 to 2019. Like Akyol and Mete (2021), Şeker and Özcan (2019) also concentrate on high-tech exports. The authors used VECM Granger causality and DOLS estimator to assess the role of high-tech exports in growth for the 1989-2016 period. The outcomes of the VECM Granger causality prove that there is no causality between high-tech exports and growth. As shown by the outcomes of the DOLS estimator, all sectors, with the exception of the computer and office machinery industry and the pharmaceutical sub-sectors, positively and significantly affect economic growth. Yenisu (2019) evaluates the importance of foreign trade for growth by establishing two separate models for imports and exports. For both models, the ARDL was utilized, and according to the outcomes, exports and imports acted as catalysts for economic growth for the period of 1980-2016. Balkanlı (2019) suggests that the results of the Granger causality test for the period 2006Q1-2018Q3 indicate no causality relationship between imports, exports, and growth in Türkiye. The findings suggest that only a unidirectional causality running from imports to exports. A similar study was conducted by Çütçü and Yaşar (2019), but their results differed, because, according to the causality test employed in the study, there is a causality from growth to imports in the period 1921-2025. Karabulut (2018) directed attention to the impact of foreign trade on the national income over the period 1970-2016. The impulse-response analysis indicates that shocks in exports and imports do not significantly impact national income. This suggests that foreign trade does not substantially affect national income. Nonetheless, it is argued that shocks in national income in the short term affect exports and imports. At the same time, the author employed Granger causality to determine the direction of causality between exports, import, and growth. As a result, only a causality from growth to exports is reported in the study. Dereli (2018) used data spanning from 1969 to 2016 with a similar methodology. Dereli (2018) also argues no causality from growth to exports, while a causality relationship from growth to imports has been identified. Acaravcı and Akyol (2017) followed the same methodology but obtained different results. In this regard, The authors argue that there is a causality from exports to growth and from imports to growth in the period 1998Q1-2015Q3. Differently, Yıldız and Akduğan (2014) analyze the importance of foreign trade for both growth and employment. For this purpose, the authors examined two distinct phases: the import-substitution period (1923–1979) and the outward-oriented period (1980–2013). When both periods are compared, there is a causality finding from exports to growth in the import-substitution period and from imports to growth in the outward-oriented period. When the period is considered as a whole, it is seen that imports have a negative effect on growth and employment. During the pre-1980 period, growth increases were associated with reduced employment and exports, while stimulating imports. However, in the post-1980 period, growth increases led to enhanced employment and exports while reducing imports. These findings suggest that the export-oriented policies implemented after 1980 were effective. Similarly, while export growth reduced economic growth and imports before 1980, it has been reported to promote growth in the post-1980 period. Finally, when the study of Aytaç and Akduğan (2012) is evaluated, the authors emphasize that, based on Granger causality results, there is a causality from imports to exports and growth, and from exports to growth.

3. Data and Methodology

Even though the cruciality of foreign trade for growth has been studied intensively, both theoretically and empirically, according to the literature review, studies concentrated on the role of high-tech exports in Türkiye are relatively scarce. This gap observed in the literature has been the main motivation for this paper, and for this reason, the cruciality of high-tech foreign trade for growth in Türkiye has been investigated using annual data for the period 1990-2023. In this sense, the definition and source of the annual data used are given in Table 1. Building on this, Gross Domestic

Product (constant 2015 US$) and General Government Expenditures (constant 2015 US$) were retrieved from the World Bank database. Data on Foreign Direct Investment was sourced from the United Nations Conference on Trade and Development (UNCTAD) database. Gross Fixed Capital Formation (constant 2015 US$) was gathered from the Organization for Economic Co-operation and Development (OECD) database. Data on foreign trade[4] is obtained from the Comtrade database.

Table 1: Data Description and Source

Variable	Description	Data Source
gdp	Gross Domestic Product	WB-WDI (2024)
htexp	High-tech Exports	Comtrade (2024)
htimp	High-tech Imports	Comtrade (2024)
htftrd	High-tech Foreign Trade	Comtrade (2024)
htnx	High-tech Net Exports	Comtrade (2024)
gfcf	Gross Fixed Capital Formation	OECD (2024)
fdi	Foreign Direct Investments	UNCTAD (2024)
gov	General Government Expenditure	WB-WDI (2024)

Referring to prior research in literature, with the objective of empirically analyzing the cruciality of foreign trade for growth, the following three models are constructed (Fraser et al., 2020; Lee & Fernando, 2021; Yilmaz, 2024):

$$lngpd_t = \beta_0 + \beta_1 lnhtexp_t + \beta_2 lnhtimp_t + \beta_3 lngfcf_t + \beta_4 lnfdi_t + \beta_5 lngov_t + \varepsilon_t \quad (1)$$

$$lngpd_t = \beta_0 + \beta_1\, lnhttrd_t + \beta_2 lngfcf_t + \beta_3 lnfdi_t + \beta_4 lngov_t + \varepsilon_t \quad (2)$$

$$lngpd_t = \beta_0 + \beta_1 htnx_t + \beta_2 lngfcf_t + \beta_3 lnfdi_t + 4lngov_t + \varepsilon_t \quad (3)$$

In Equation (1), β_0 represents the coefficient of the constant term, while β_1, β_2, β_3, β_4, and β_5 denote the coefficients of the variables lnhtexp, lnhtimp, lngfcf, lnfdi, and lngov, respectively. ε_t represents the error term. Similarly, in Equation (2), the parameter β_1 represents the coefficient of lnhtftrd, while in Equation (3), the parameter β_1 denotes the coefficient of lnhtnx. All

[4] Following the studies of Idris et al. (2021) and Hatzichronoglou (1997), high-tech foreign trade products have been aggregated into nine categories: aerospace, computer and office machinery, electronics and telecommunications, pharmaceuticals, scientific instruments, electrical machinery, chemicals, non-electrical machinery, and armaments.

variables in the equations, except htnx, are normalized by taking their natural logarithm.

The Autoregressive Distributed Lag (ARDL) approach is used to test the empirical models established in Equation (1), Equation (2), and Equation (3). This approach, developed by Pesaran et al. (2001), provides several advantages. Firstly, this approach can be used even if the study sample is small. The second important advantage of the approach is that it eliminates the endogeneity problem. The third advantage of this approach is related to the stationarity of the series. This approach provides notable flexibility concerning stationary, and the series does not need to be stationary to the same level (or at the first difference I(1)). However, ARDL can be applied provided that the dependent variable is I(1) (Pesaran et al., 2001; Shadab & Alam, 2024; Bertsatos et al., 2022).

Following the determination of the stationarity levels of the series, it is tested whether the series are cointegrated in the first stage of the ARDL model. The presence of cointegration between the series is determined by the ARDL bounds test, which is based on the F-statistic. Accordingly, the following equations are formulated to test whether the series are cointegrated in all three models (Usman, 2023; Islam, 2023; Khan et al., 2024):

$$\Delta lngdp_t = \beta_0 + \Sigma_{t=1}^{n}\beta_{1i}\Delta lngdp_{t-i} + \Sigma_{t=1}^{n}\beta_{2i}\Delta lnhtexp_{t-i} + \Sigma_{t=1}^{n}\beta_{3i}\Delta lnhtimp_{t-i} + \Sigma_{t=1}^{n}\beta_{4i}\Delta lngfcf_{t-i} + \Sigma_{t=1}^{n}\beta_{5i}\Delta lnfdi_{t-i} + \Sigma_{t=1}^{n}\beta_{6i}\Delta lngov_{t-i} + \theta_1 lngdp_{t-1} + \theta_2 lnhtexp_{t-1} + \theta_3 lnhtimp_{t-1} + \theta_4 lngfcf_{t-1} + \theta_5 lnfdi_{t-1} + \theta_6 lngov_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta lngdp_t = \beta_0 + \Sigma_{t=1}^{n}\beta_{1i}\Delta lngdp_{t-i} + \Sigma_{t=1}^{n}\beta_{2i}\Delta lnhtftrd_{t-i} + \Sigma_{t=1}^{n}\beta_{3i}\Delta lngfcf_{t-i} + \Sigma_{t=1}^{n}\beta_{4i}\Delta lnfdi_{t-i} + \Sigma_{t=1}^{n}\beta_{5i}\Delta lngov_{t-i} + \theta_1 lngdp_{t-1} + \theta_2 lnhtftrd_{t-1} + \theta_3 lngfcf_{t-1} + \theta_4 lnfdi_{t-1} + \theta_5 lngov_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta lngdp_t = \beta_0 + \Sigma_{t=1}^{n}\beta_{1i}\Delta lngdp_{t-i} + \Sigma_{t=1}^{n}\beta_{2i}\Delta lnhtnx_{t-i} + \Sigma_{t=1}^{n}\beta_{3i}\Delta lngfcf_{t-i} + \Sigma_{t=1}^{n}\beta_{4i}\Delta lnfdi_{t-i} + \Sigma_{t=1}^{n}\beta_{5i}\Delta lngov_{t-i} + \theta_1 lngdp_{t-1} + \theta_2 lnhtnx_{t-1} + \theta_3 lngfcf_{t-1} + \theta_4 lnfdi_{t-1} + \theta_5 lngov_{t-1} + \varepsilon_t \quad (6)$$

In Equations (4), (5), and (6), the symbol Δ represents the first differences, while *n* indicates the lag lengths. The coefficients θ_1, θ_2, θ_3, θ_4 and θ_5 in the equations represent the long-term cointegration relationship. Accordingly, the cointegration relationship in Equations (4), (5), and (6) has been tested using the following hypothesis (Jebran et al., 2018; Akyol & Mete, 2021; Lee & Fernando, 2024):

$$H_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0 \quad \text{there is no co-integration} \tag{7}$$

$$H_1 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0 \quad \text{there is co-integration} \tag{8}$$

The null hypothesis *(H_0)* in Equation (7) states that the series are not cointegrated and the alternative hypothesis *(H_1)* in Equation (8) states that the series are cointegrated. If H_0 is rejected and *(H_1)* is accepted as a result of the tests performed, it means that the series are cointegrated. In the presence of cointegration, the long-run coefficient of the ARDL model $(\rho_1, \rho_{2,} \rho_{3,} \rho_4, \rho_5)$ can be estimated by the following equations (Yenisu, 2019; Ergül & Karataş, 2024; Shadab & Alam, 2024):

$$lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} lngdp_{t-i} + \sum_{t=0}^{\rho_2} \beta_{2i} lnhtexp_{t-i} + \sum_{t=0}^{\rho_3} \beta_{3i} lnhtimp_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i} lngfcf_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i} lnfdi_{t-i} + \sum_{t=0}^{\rho_6} \beta_{6i} lngov_{t-i} + \varepsilon_t \tag{9}$$

$$lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} lngdp_{t-i} + \sum_{t=0}^{\rho_2} \beta_{2i} lnhtftrd_{t-i} + \sum_{t=0}^{\rho_3} \beta_{3i} lngfcf_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i} lnfdi_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i} lngov_{t-i} + \varepsilon_t \tag{10}$$

$$lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i} lngdp_{t-i} + \sum_{t=0}^{\rho_2} \beta_{2i} lnhtimp_{t-i} + \sum_{t=0}^{\rho_3} \beta_{3i} lngfcf_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i} lnfdi_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i} lngov_{t-i} + \varepsilon_t \tag{11}$$

The short-term coefficients and the error correction model (ECM) are estimated using the following equations (Lee & Fernando, 2021; Demirel & İşcan, 2021; Yılmaz, 2024);

$$\Delta lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i}\, \Delta lngdp_{t-i} + \sum_{i=1}^{\rho_2} \beta_{2i}\, \Delta lnhtexp_{t-i} + \sum_{i=0}^{\rho_3} \beta_{3i}\, \Delta lnhtimp_{t-i} + \sum_{i=0}^{\rho_4} \beta_{4i}\, \Delta lngfcf_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i}\, \Delta lnfdi_{t-i} + \sum_{t=0}^{\rho_6} \beta_{6i}\, \Delta lngov_{t-i} + \delta ECM_{t-1} + \varepsilon_t \tag{12}$$

$$\Delta lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i}\, \Delta lngdp_{t-i} + \sum_{i=1}^{\rho_2} \beta_{2i}\, \Delta lnhtftrd_{t-i} + \sum_{i=0}^{\rho_3} \beta_{3i}\, \Delta lngfcf_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i}\, \Delta lnfdi_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i}\, \Delta lngov_{t-i} + \delta ECM_{t-1} + \varepsilon_t \tag{13}$$

$$\Delta lngdp_t = \beta_0 + \sum_{i=1}^{\rho_1} \beta_{1i}\, \Delta lngdp_{t-i} + \sum_{i=1}^{\rho_2} \beta_{2i}\, \Delta lnhtnx_{t-i} + \sum_{i=0}^{\rho_3} \beta_{3i}\, \Delta lngfcf_{t-i} + \sum_{t=0}^{\rho_4} \beta_{4i}\, \Delta lnfdi_{t-i} + \sum_{t=0}^{\rho_5} \beta_{5i}\, \Delta lngov_{t-i} + \delta ECM_{t-1} + \varepsilon_t \tag{14}$$

Equations (12), (13), and (14) represent the lagged values of the long-term residuals in the ARDL. The term ECM_{t-1} in the models indicates the coefficient of the error correction model, while the symbol δ represents the speed at which short-term imbalances in the models will adjust towards long-term equilibrium. This coefficient is expected to be negative and statistically significant (Islam, 2023; Usman, 2023; Shadab & Alam, 2024).

4. The Empirical Findings and Discussion

4.1. The Empirical Findings

Determining the stationarity levels of the series is an important step for the model to be used for empirical analysis. Therefore, unit root tests should be applied to determine the stationarity levels of the series before testing the model. For this purpose, unit root tests, namely the Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1981), the Phillips and Perron (PP) test developed by Phillips and Perron (1988), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test developed by Kwiatkowski et al. (1992), have been applied. The findings obtained as a result of these tests are given in Table 2. When the results in Table 2 are evaluated, it is seen that the series are I(1), which shows that ARDL is applicable.

Table 2: Outcomes of Unit Root Test

Variables		**ADF**		**PP**	
		I (0)	**I (1)**	**I (0)**	**I (1)**
lngdp	c	0.542508 (0.9857)	-5.836853 (0.0000)	1.702249 (0.9994)	-6.918693 (0.0000)
	c/t	-2.650092 (0.2623)	-5.811860 (0.0002)	-2.564262 (0.2978)	-7.701217 (0.0000)
htexp	c	-0.238522 (0.9236)	-5.549478 (0.0001)	0.371388 (0.9786)	-5.582052 (0.0001)
	c/t	-2.313427 (0.4155)	-5.473890 (0.0005)	-2.391571 (0.3769)	-5.490575 (0.0005)
htimp	c	-2.597486 (0.1042)	-4.235915 (0.0023)	-2.286956 (0.2145)	-4.917059 (0.0004)
	c/t	-3.162656 (0.1098)	-4.104392 (0.0149)	-2.191466 (0.4785)	-4.503803 (0.0057)
htftrd	c	*-3.357021 (0.0204)*	*-4.257385 (0.0022)*	-2.111032 (0.2418)	-3.752816 (0.0078)
	c/t	*-3.441191 (0.0636)*	*-4.199298 (0.0122)*	-2.070218 (0.5426)	-3.310985 (0.0826)
htnx	c	-0.513882 (0.8760)	-4.774139 (0.0005)	-0.466131 (0.8856)	-4.682175 (0.0007)
	c/t	-2.314405 (0.4150)	-4.668164 (0.0038)	-2.314405 (0.4150)	-4.574340 (0.0048)
lngfcf	c	-0.696531 (0.8340)	-6.181032 (0.0000)	-0.637697 (0.8485)	-6.211293 (0.0000)
	c/t	-2.646573 (0.2637)	-6.084161 (0.0001)	-2.646573 (0.2637)	-6.182735 (0.0001)

lnfdi	c	-1.126226 (0.6931)	-8.580290 (0.0000)	-1.177960 (0.6720)	-8.096563 (0.0000)
	c/t	-0.701539 (0.9644)	-8.603873 (0.0000)	-1.646170 (0.7521)	-8.219309 (0.0000)
lngov	c	0.175830 (0.9668)	-6.305715 (0.0000)	0.270214 (0.9730)	-6.377223 (0.0000)
	c/t	-3.098074 (0.1233)	-6.227938 (0.0001)	-3.100363 (0.1228)	-6.298088 (0.0001)
KPSS					
		I (0)		**I (1)**	
lngdp	c	0.950725		0.108627***	
	c/t	0.558185		0.035572***	
htexp	c	0.885253		0.210273***	
	c/t	0.251019		0.090652***	
htimp	c	1.554292		0.204956***	
	c/t	0.494504		0.057067***	
htftrd	c	0.805695		0.180542***	
	c/t	0.345184		0.053093***	
htnx	c	0.902154		0.063813***	
	c/t	0.541519		0.063305***	
lngfcf	c	1.726900		0.068726***	
	c/t	0.284228		0.068043***	
lnfdi	c	0.868079		0.185090***	
	c/t	0.405501		0.117283***	
lngov	c	0.951411		0.081310***	
	c/t	0.362324		0.069347***	
cv		%1	%5	%10	
	c	0.739000	0.463000	0.347000	
	c/t	0.216000	0.146000	0.119000	

Note:

1. The notations in the table indicate that c represents "with constant", c/ t represents "with constant & trend", and n represents "without constant & trend"
2. The ADF unit root test was conducted with a maximum lag of 1, and the lag length was determined using the Akaike Information Criterion (AIC).
3. The PP unit root test was conducted using the Bartlett Kernel and Newey-West Bandwidth for the spectral estimation.

Another important stage, along with unit root tests, is determining the optimal lag lengths. The model is estimated according to the determined lag lengths, which increases the predictive power and reliability of the model. Therefore, before estimating the model, the optimal lag lengths were determined based on the Vector Autoregression (VAR) analysis. The optimal lag lengths determined for each of the three models are presented in Table 3. Accordingly, a lag length of 3 is specified for Model 1 and Model 2, whereas a lag length of 1 is identified for Model 3.

Table 3: Optimal Lag Lengths

Model	Lag	LogL	LR	FPE	AIC	SC	HQ
Model 1	0	58.7888	NA	1.34E-09	-3.405729	-3.128183	-3.315256
	1	206.1246	228.1329	1.06E-12	-10.58868	-8.645863*	-9.955373
	2	253.3467	54.83853*	6.85E-13	-11.31269	-7.704591	-10.13654
	3	*312.9957*	*46.17988*	***3.58e-13****	***-12.83843****	*-7.565058*	***-11.11944****
Model 2	0	33.44114	NA	1.10E-07	-1.834912	-1.603624	-1.759518
	1	176.6818	231.0333	5.48E-11	-9.463343	-8.075613*	-9.010977
	2	208.1394	40.59039*	4.14E-11	-9.879959	-7.335788	-9.050623
	3	*241.8278*	*32.60168*	***3.48e-11****	***-10.44050****	*-6.739889*	***-9.234194****
Model 3	0	-638.1369	NA	7.21E+11	41.4927	41.72399	41.5681
	1	*-499.9538*	***222.8759****	***4.98E+08***	*34.19057*	***35.57830****	***34.64293****
	2	-472.2012	35.80981	4.78e+08*	34.01298*	36.55715	34.84232
	3	-448.6845	22.75809	7.75E+08	34.10868	37.80929	35.31499

After conducting preliminary tests (optimal lag lengths and unit root tests), the co-integration relationship is tested by selecting the determined lag lengths. Whether the series are co-integrated was tested using Equation (4), Equation (5), and Equation (6). The outcomes of the co-integration test are presented in Table 4. When evaluating the findings presented in this table, the F-statistic indicates the presence of co-integration in all three models. When evaluating the findings presented in this table, it is observed that the calculated F-statistic exceeds the upper bounds I(1) critical values in all three models, as a result, H_0 is rejected, and H_1 is accepted. Hence, this reveals that co-integration is present in all three models.

Table 4: The Outcomes of Co-integration (ARDL Bounds Test)

Model	F-statistic		10%		5%		1%	
Model 1	**33.69391**	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
		30	2.407	3.517	2.91	4.193	4.134	5.761
		35	2.331	3.417	2.804	4.013	3.900	5.419
		Asymptotic	2.080	3.000	2.390	3.380	3.060	4.150
Model 2	**16.06815**	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
		30	2.525	3.560	3.058	4.223	4.280	5.840
		35	2.460	3.460	2.947	4.088	4.093	5.532
		Asymptotic	2.200	3.090	2.560	3.490	3.290	4.370
Model 3	**14.88069**	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
		30	2.525	3.560	3.058	4.223	4.280	5.840
		35	2.460	3.460	2.947	4.088	4.093	5.532
		Asymptotic	2.200	3.090	2.560	3.490	3.290	4.370

Upon detecting a co-integration relationship in the model, the long-run coefficients of the series are estimated. Considering this, the estimated long-run coefficients for all three models, derived from Equation (9), Equation (10), and Equation (11), are included in Table 5. At the same time, the short-run coefficients and the ECM coefficient estimated using Equation (12), Equation (13), and Equation (14) are presented in Table 5. Based on the estimated coefficients for Model 1, it can be seen that high-tech exports stimulate growth in both the short-term and long-term. On the basis of the obtained outcomes, a 1% increase in high-tech exports (htexp) boosts growth by approximately 0.18% in the long-term and 0.10% in the short-term. High-tech imports, on the other hand, have an adverse effect on growth. In other words, a 1% increase in high-tech imports (htimp) leads to a decrease in growth by around 0.5% in the long-term and 0.04% in the short-term. It has been found that gross fixed capital formation (gfcf) also creates a growth-boosting effect, and a 1% increase in gross fixed capital formation (gfcf) leads to a growth increase of about 0.15% in the long-term and 0.21% in the short-term. Like high-tech imports, foreign direct investments (FDI) have also had an adverse impact. That is, 1% increase in foreign direct investments (FDI) decreases growth by approximately -0.06% in the long-termand -0.03% in the short-term. Ultimately, government expenditures (gov) also increase growth, and it is a crucial dynamic for growth because the effect of government expenditures (gov) is higher than other variables. That is, a 1% increase in general government expenditure (gov) results in an approximate growth increase of 0.78% in the long run and 0.28% in the short run.

In Model 2, total foreign trade has been included in the equation, and the model has been estimated accordingly. When the findings obtained for this model are evaluated, it has been determined that high-tech total foreign trade (htftrd) does not exhibit a growth-enhancing feature. Although total foreign trade exhibits a negative effect, its long-term coefficient is statistically insignificant. In this respect, a 1% increase in high-tech trade in the short run results in an approximate reduction of 0.4% in growth. In Model 3, net exports has been included in the equation, and the model has been estimated. The findings indicate that the effect of high-tech net exports (htnx) on growth is statistically insignificant. The findings obtained for the other variables included in Model 2 and Model 3 are observed to be consistent with the findings obtained for these variables in Model 1. The error correction model coefficient is negative and statistically significant in all three models. This indicates that the error correction model functions effectively in all three models. Therefore, the imbalances occurring in the short term in the models are corrected and return to equilibrium in the long term.

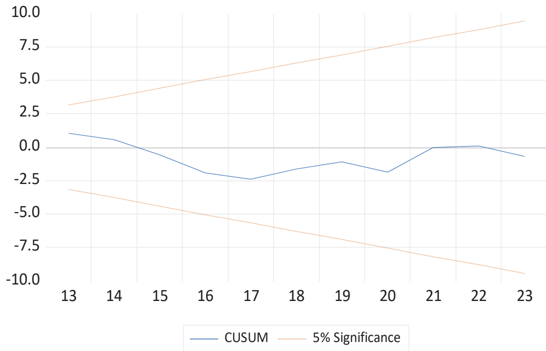
Table 5: Long-run and Short-run Coefficient

Model 1			Model 2			Model 3		
Variables	Coefficient	Prob.	Variables	Coefficient	Prob.	Variables	Coefficient	Prob.
lnhtexp	0.183114	0.0000						
Δlnhtexp	0.105851	0.0000						
htimp	-0.051036	0.0000	htftrd	-0.03027	0.2295	htnx	1.24E-11	0.2139
Δhtimp	-0.036159	0.0000	Δhtftrd	-0.043612	0.0005	Δhtnx	-1.63E-12	0.5327
lngfcf	0.153160	0.0000	lngfcf	0.435368	0.0043	lngfcf	0.419710	0.0008
Δlngfcf	0.211420	0.0000	Δlngfcf	0.264696	0.0000	Δlngfcf	0.309811	0.0000
lnfdi	-0.061152	0.0000	lnfdi	-0.103666	0.0153	lnfdi	-0.071029	0.0386
Δlnfdi	-0.033230	0.0112	Δlnfdi	-0.043940	0.0028	Δlnfdi	-0.021763	0.0377
lngov	0.780061	0.0000	lngov	0.673322	0.0000	lngov	0.734815	0.0000
Δlngov	0.284359	0.0021	Δlngov	0.575164	0.0002	Δlngov	0.123704	0.1957
ECM	***-0.739320***	***0.0000***	***ECM***	***-0.645519***	***0.0001***	***ECM***	***-0.268983***	***0.0000***

Another important step to consider when estimating the models is testing whether there is a diagnostic problem in the models. Therefore, diagnostic tests have been conducted for all three models, and the results are presented in Table 6. According to the outcomes in Table 6, no diagnostic problems are observed in any of the three models. Along with the diagnostic tests, the Cusum and Cusum-Q tests are used to determine the stability of the models. Figures 3, 4, and 5 present the findings of these two tests, which indicate that the models are stable and that no structural break is present in the models.

Table 6: Diagnostic Test and Stability Test

	Model 1		**Model 3**		**Model 3**	
	F-stat.	**Obs*R^2**	**F-stat.**	**Obs*R^2**	**F-stat.**	**Obs*R^2**
Autocorrelation Test (Breuch-Godfrey Serial Correlation LM Test)	0.542411 (0.5901)	1.782396 (0.4102)	1.743295 (0.2048)	5.275856 (0.0715)	0.901398 (0.4193)	2.305653 (0.3157)
Heteroscedasticity Test (Breusch-Pagan-Godfrey)	1.191148 (0.3935)	17.130224 (0.1041)	0.349320 (0.9750)	8.025459 (0.9228)	1.325149 (0.2815	7.7282206 (0.2587)
	t-statistic	**F-statistic**	**t-statistic**	**F-statistic**	**t-statistic**	**F-statistic**
Ramsey RESET Test	0.274960 (0.7926)	0.075603 (0.7926)	0.395044 (0.6988)	0.156060 (0.6988)	1.131963 (0.2684)	1.281341 (0.2684)
Normality Test (Jarque-Bera)	1.907915 (0.385213)		1.790981 (0.408407)		1.654282 (0.437298)	



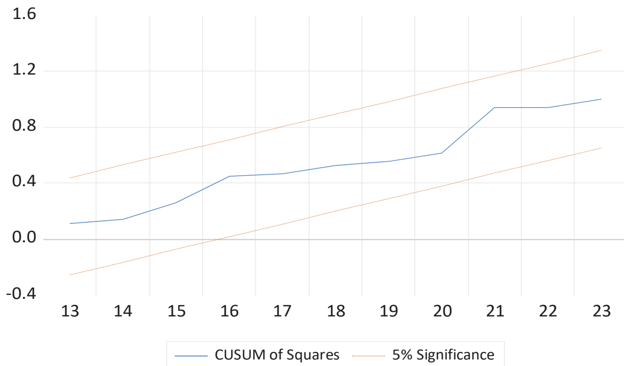


Figure 3: Cusum and Cusum-q Test for Model 1

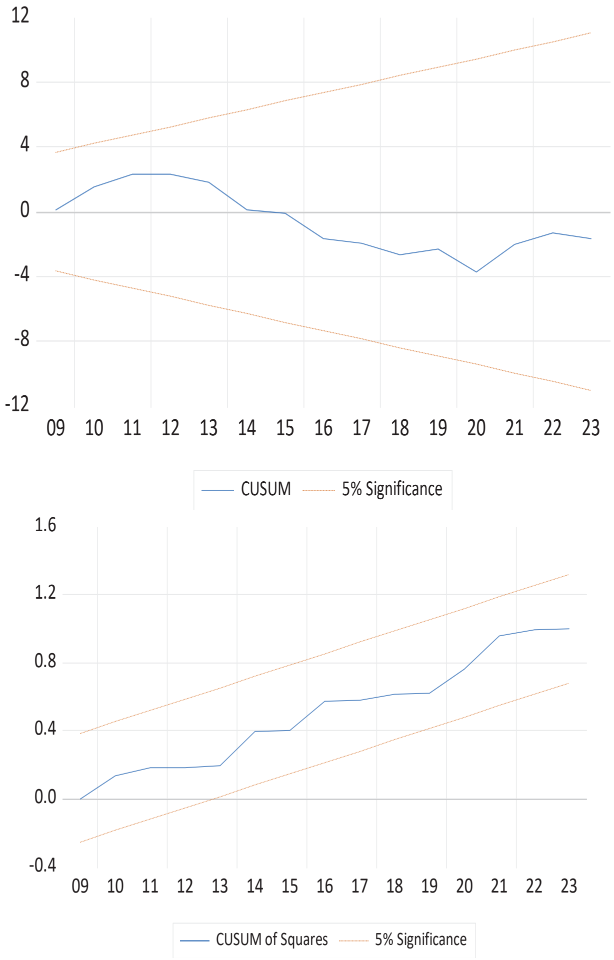


Figure 4: Cusum and Cusum-q Test for Model 2

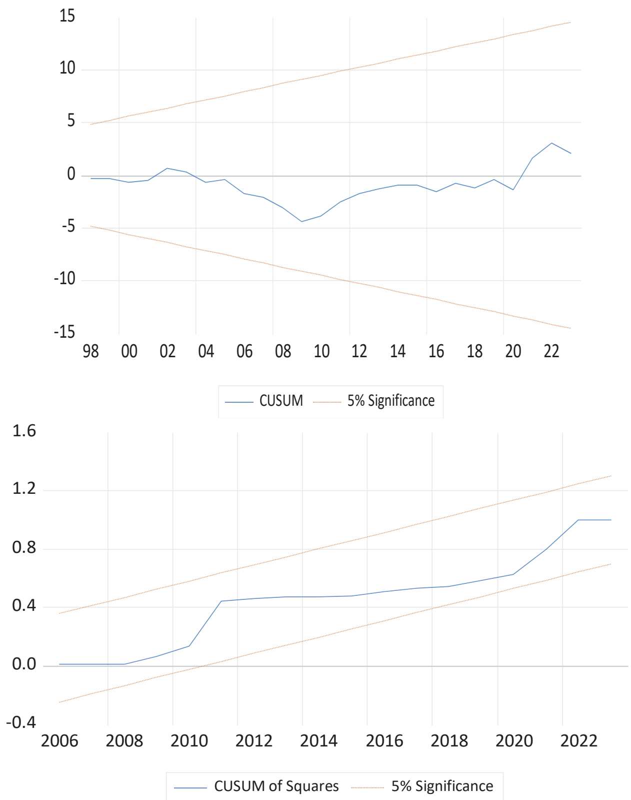


Figure 5: Cusum and Cusum-q Test for Model 3

Furthermore, to confirm the long-term coefficient estimates of the ARDL model, we utilized the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Cointegrating Regression (CCR) estimators. Applying these estimators requires all series to be stationary at first differences, denoted as I(1). According to the unit root test results, the series in the models are stationary at first differences. The results of the FMOLS, DOLS, and CCR estimators are presented in Table 7. The findings in Table 7 are consistent with the long-run coefficients estimated by the ARDL model presented in Table 5.

Table 7: Robustness Check

	Model 1					
	FMOLS		DOLS		CCR	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
htexp	0.095409	0.0079	0.176616	0.0354	0.105951	0.0206
htimp	-0.022969	0.0000	-0.037969	0.0000	-0.023250	0.0001
lngfcf	0.286550	0.0000	0.215646	0.0000	0.295477	0.0000
lnfdi	-0.069331	0.0000	-0.064757	0.0000	-0.072115	0.0000
lngov	0.683231	0.0000	0.718319	0.0000	0.673549	0.0006
Model 2						
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
htftrd	-0.008145	0.1570	-0.027255	0.1166	-0.021556	0.0055
lngfcf	0.297639	0.0000	0.248476	0.0299	0.310547	0.0000
lnfdi	-0.082432	0.0000	-0.078038	0.0001	-0.089826	0.0000
lngov	0.774151	0.0000	0.811532	0.0000	0.764615	0.0000
Model 3						
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
htnx	3.32E-12	0.3153	3.71E-13	0.8876	2.26E-12	0.5466
lngfcf	0.349570	0.0000	0.427670	0.0000	0.357808	0.0000
lnfdi	-0.074478	0.0000	-0.104574	0.0000	-0.081682	0.0000
lngov	0.712200	0.0000	0.647163	0.0000	0.709252	0.0000

4.2. Discussion

The role of foreign trade in growth and development has been a continuously debated topic since the Industrial Revolution. Considering the ongoing debates, scrutiny of theoretical and empirical studies suggests a consensus that foreign trade is a vital component of growth. In recent decades, the growing emphasis on liberalization policies has played a key role in enhancing the importance of foreign trade. As a result, both theoretical and empirical studies suggest that foreign trade policies have gained increasing significance over time in developed and developing countries, leading to major structural transformations. In this context, Türkiye's economy has experienced significant structural changes. Especially after 1980, Türkiye transitioned from an import-substitution growth to an export-oriented growth strategy and embraced free market economy policies. Following the liberalization of capital movements in 1989, liberalization of financial policies were also enacted, enabling Türkiye's economy to integrate with the global market and fully adopt liberal policies (Yeldan, 2016; Orhangazi, 2020).

The paper's empirical outcomes prove that high-tech exports have supported growth over the period of 1990-2023. The results obtained are consistent with the findings of Shadab & Alam (2024), Kara (2024), Çakmak & Doğan Çalışkan (2024), Yılmaz (2024), Ergül & Karataş (2024), Kuzu & Arslan (2023), Tunçsiper & Horoz (2023), Yengül Bülbül & Acaravcı (2022), Lee & Yu (2022), Mangır & Ertuğrul (2022), Lee & Fernando (2021), Lee & Huruta (2020), Ee (2016), and Şeker & Özcan (2019). Yet, these outcomes are inconsistent with those of Sojodi & Baghbonpour (2024), Usman (2023), Yılmaz & Albayrak (2023), Akyol & Mete (2021), Karabulut (2018), Dereli (2018), and Jebran et al. (2028). In an economy, the transition from basic goods exports with simple technology to hig-tech production and exports can significantly contribute to economic growth (Sojoodi & Baghbanpour, 2024). At the same time, the capital gains derived from high-tech exports, in particular, stimulate economic growth by increasing savings and investments (Seok & Kim, 2024). Moreover, transitioning exports from primary commodities to high-value-added, technology-intensive products will help narrow the technological gap between nations (Carrasco & Tovar-Garcia, 2023; Şanlı & Konukman, 2021). In this context, this study empirically demonstrates that high-tech exports are a significant dynamic for economic growth.

Empirical findings indicate that high-tech imports exert an adverse effect on growth. In this regard, our outcomes obtained are congruent with the results of studies conducted by Pınar (2024), Çakmak & Doğan Çalışkan (2024), Demirel & İşcan (2021), Akyol & Mete (2021), Çütçü & Yaşar (2019), Karabulut (2018), and Dereli (2018) in the literature. Türkiye's economy generally has high imports- dependency on high-tech products (Dineri & Işık, 2021). This situation is also observed in Figure 1 and Figure 2, and additionally, during the period from 1990 to 2023, Türkiye's economy has consistently experienced a trade deficit in high-tech products. This also indicates that the country's exports are dependent on imports. At the same time, Türkiye's economy heavily relies on intermediate-input imports for production, resulting in a high volume of imports. Consequently, this reduces the ratio of exports to imports (Coşkun & Başkol, 2022). The persistence of this situation, along with the rising import of high-tech, may exert a detrimental effect on growth. In this paper, the obtained outcomes revealed that total foreign trade also plays a detrimental role in growth, and high-tech total foreign trade negatively affects growth; however, in the long-term, it is statistically insignificant. These outcomes are compatible with the findings of papers executed by Jebran et al. (2018) and Karabulut (2018). It has been determined that net high-tech exports do not affect growth. In the three models, government expenditures, gross fixed capital formation, and foreign direct investments yield similar results. Accordingly, government expenditures and gross fixed capital formation stimulate growth, while foreign direct investments negatively impact growth. In the models, it is apparent that, the effect of government expenditure on growth is higher than other variables for the long-run. A comprehensive evaluation of the 1990–2023 period reveals that high-technology imports and FDI have negatively influenced growth. In contrast, high-technology exports, gross fixed capital formation, and government expenditures have contributed positively to growth dynamics. The results from the FMOLS, DOLS, and CCR estimators also confirm this situation. Therefore, although the policy of economic integration with the outward-oriented, initiated after 1980 and completed with capital mobility in 1990, can be considered partially effective (with the export-led growth hypothesis remaining valid), it can be argued that, particularly during this period, government expenditures had a more significant impact on growth.

5. Conclusion and Policy Recommendations

Since the Industrial Revolution, international trade has been regarded as a crucial dynamic of economies. In parallel, with the increasing importance of free-market policies, foreign trade policies have become a vital instrument for developed/developing countries. Under this paradigm, various hypotheses have been developed to examine the importance of international trade for growth, including the export-led growth hypothesis, the growth-led export hypothesis, the import-led growth hypothesis, and the growth-led import hypothesis. The literature contains an extensive body of empirical research testing these hypotheses, and it can be asserted that most empirical research justifies the export-led growth hypothesis. Within this scope, there is extensive empirical literature, which securitizes the cruciality of foreign trade for growth in Türkiye. Similarly, it can be asserted that most studies conducted on Türkiye's economy support the export-led growth hypothesis. Despite a comprehensive body of literature on Türkiye's economy, studies specifically analyzing the impact of high-tech exports and imports on economic growth remain limited. Therefore, it is expected that this paper contribute to existing literature.

In the post-1950 period, similar to other developing countries, import-substitution industrialization policies were emphasized and implemented in Türkiye's economy. However, with the liberal policies adopted in the global economy after 1980, Türkiye's economy underwent a structural transformation. In other words, the free trade policies implemented globally were also adopted in the Türkiye. In this vein, the policy of opening up, initiated in 1980, transitioned to fully liberal policies with financial liberalization in 1990. Accordingly, import-substitution strategies were discarded, making way for an export-led growth model. Exports are believed to generate income, facilitate capital accumulation, and stimulate economic growth. Additionally, international trade can enhance growth and efficiency through multiple mechanisms, including economies of scale, technological progress, foreign capital inflows, and increased competitiveness. Nevertheless, for growth to be sustained in a country, the export quality is a crucial factor. The shift from primary goods to high-value-added, technology-intensive exports facilitates greater technological spillovers across industries compared to traditional product exports, helping to narrow the technological gap between nations. In light of this, this paper also analyzes the importance of high-tech foreign trade for growth over the span of 1990 to 2023. According to the ARDL model results, throughout the 1990-2023 period, high-tech product exports positively affected economic growth, while high-tech product imports negatively impacted growth. Furthermore, it has been determined that high-tech foreign trade and net exports have no significant impact on growth. In the model, gross fixed capital formation and government expenditures, which are used as control variables, positively affect growth, while foreign direct investments negatively affect growth. The outcomes obtained from the FMOLS, DOLS, and CCR estimators applied for robustness testing supported the results of the ARDL model. Against this backdrop, it has been determined that the export-led growth hypothesis is verified for Türkiye's economy across the 1990-2023 period. However, the impact of government expenditures on economic growth is found to be more pronounced. Furthermore, during the specified period, it has been observed that Türkiye's economy is highly dependent on imports in terms of high technology, and the ratio of exports to imports is notably low. Consequently, for sustainable economic growth, the following policies should be implemented: i) a diversification policy for exports to integrate national and global markets, ii) as economies that produce and export primary goods are more vulnerable to commercial shocks, policies should be introduced to promote high-tech exports and production, iii) infrastructure, education, and cultural policies necessary for high-tech production, and iv) policies that support sectors producing high-tech products to increase foreign exchange inflows.

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