https://doi.org/10.52642/susbed.1944472

Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 2026; (60): 257-270
- Araştırma Makalesi / Research Article -

Is EKC Hypothesis Valid Between Exports and Exchange Rate: Evidence From Türkiye

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ABSTRACT

The purpose of this study is to examine if the export-performance-exchange rate relationship for Türkiye is characterized by a non-linear EKC-style pattern. In order to analyze this relationship, an ARDL framework is constructed with annually observed data over the period from 1987-2024 and total imports as a control variable. First, the integration properties of all variables have been tested with KPSS tests. None of the variables are found to have integration orders higher than one, and thus ARDL modelling criteria is met. Then, bounds testing proves the cointegration between exports, the exchange rate, and imports which means there exists a long run equilibrium between these three variables. The long-run analysis clearly indicates a positive exchange rate coefficient and negative quadratic exchange rate coefficient, proving a U-shaped relationship between exchange rate value and export performance. The battery of diagnostic tests performed at the end clearly demonstrates that there is no serial correlation, heteroscedasticity, non-normality, specification errors or parameter instability in the model.

Keywords: Exports, Exchange Rate, Stationarity, Cointegration, Ardl Analysis.
JEL Classification: F14, F31, C22.

İhracat ve Döviz Kuru Arasında EKC Hipotezi Geçerli mi? Türkiye'ye İlişkin Kanıtlar

ÖZ

Bu çalışma, Türkiye'de ihracat ile döviz kuru arasındaki uzun dönemli ilişkinin Çevresel Kuznets Eğrisi (EKC) tipi doğrusal olmayan bir yapı sergileyip sergilemediğini 1987-2024 dönemi yıllık verileri üzerinden incelemektedir. Analizde ihracat bağımlı değişken, döviz kuru temel açıklayıcı değişken, ithalat ise kontrol değişkeni olarak kullanılmış; tüm değişkenler Dünya Bankası WDI veri tabanından elde edilmiştir. Değişkenlerin bütünleşme dereceleri KPSS durağanlık testiyle belirlenmiş ve serilerin ARDL sınır testi için gerekli koşulları sağladığı görülmüştür. AIC kriterine göre seçilen ARDL(5,1,0,1) modeliyle yapılan eşbütünleşme analizi, ihracat, döviz kuru, döviz kurunun karesi ve ithalat arasında istatistiksel olarak anlamlı uzun dönemli bir ilişki bulunduğunu göstermektedir. Uzun dönem tahminlerinde döviz kuru katsayısının pozitif, döviz kurunun karesi katsayısının ise negatif ve anlamlı bulunması, Türkiye'de ihracat ile döviz kuru arasında ters-U biçimli bir ilişkinin varlığını desteklemektedir. Bulgular, ihracatın belirli bir kur eşiğine kadar arttığını, bu eşiğin aşılmasıyla kur artışlarının ihracat performansını zayıflatabildiğini göstermektedir. İthalat değişkeninin pozitif ve anlamlı etkisi, Türkiye'de ihracat üretiminin ithal girdi yapısıyla güçlü biçimde bağlantılı olduğunu ortaya koymaktadır.

Anahtar Kelimeler: İhracat, Döviz Kuru, Durağanlık, Eşbütünleşme, ARDL Analizi.
JEL Sınıflandırması: F14, F31, C22.

1. Introduction

The fluctuations in the exchange rate constitute a basic macroeconomic transmission mechanism through which open economies are linked to the outside world. For exporting firms, the exchange rate has far more significance than just the relative price it represents: it affects production costs, revenues in foreign currencies, the costs of intermediate goods bought abroad, pricing decisions and overall market uncertainty. While according to classical trade theory, exchange rate depreciation makes exports more competitive by making goods cheaper to the foreigners; the empirical evidence points to a much more

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Makale Gönderim ve Kabul Tarihleri/Article Submission and Acceptance Dates: 05.05.2026-08.07.2026

Citation/Atıf: Okşak, Y., & Yalçınkaya Koyuncu, J. (2026). Is EKC hypothesis valid between exports and exchange rate: evidence from Türkiye. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 60*, 257-270. https://doi.org/10.52642/susbed.1944472

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complex non-linear relationship, since what determines the real response of exports to exchange rate movements depend on market structures, exchange rate pass-through, imported inputs as production inputs and firms' abilities to cope with abrupt cost changes (Campa & Goldberg, 2005; Dornbusch, 1987; Goldberg & Knetter, 1997).

Adding to the complexity, is the role played by production costs. For countries with high dependence on imports of intermediate and capital goods, exchange rate depreciation works as a two-edged sword: it makes prices more competitive to the foreigner but at the same time makes the cost of using key inputs (machinery, fuel, high-tech materials, etc) in local currency higher. Therefore, depreciation beyond some optimal point may lead to a decline, not an increase, in exports. This is a similar logic to exchange rate pass-through literature where the response of trade prices to exchange rate movements are neither complete nor universal (Amiti et al., 2014; Burstein & Gopinath, 2014; Bussière et al., 2014).

In order to test this hypothesis, a non-linear methodology inspired by EKC is chosen in this paper. According to Kuznets (1955) hypothesis there is a inverse U shape relation between economic growth and income distribution, a hypothesis developed in environmental economics where there is an inverse U relationship between pollution and per capita income-meaning that pollution levels rise up to some turning point of per capita income and then fall with higher income levels (Dinda, 2004; Grossman & Krueger, 1995). In this case only we are only interested in the macro economics so we use the inverse U logic of EKC, to test the relation between exchange rate and exports assuming that with increase in exchange rates export volumes initially rise to a certain turning point and then begin to decrease when the depreciation becomes excessive. The Turkish economy is a very appropriate testing ground for this non-linear assumption since after the outward looking restructuring of economy, exports are very important source for the Turkish industrial output, macroeconomic stability and growth but structurally these export volumes are very dependent on imported intermediary goods. As confirmed by Erduman, Eren, & Gül (2020), the import content within Turkish productions and exports has increased over the past years and because of this, the depreciation of the local currency has a major cost-push impact that can easily neutralize the competitiveness effect brought by the lower lira.

There is empirical evidence supporting the claim that non-linear effects must be studied for Türkiye; it is established by Thorbecke and Sengonul (2023) that trade volumes do not respond symmetrically to exchange rates changes. It is the case that currency depreciation does not automatically bring forth a boost in exports; therefore a linear model can lead to misleading conclusions. Thus studying a threshold model where exports increase with depreciation of local currency up to a certain point and then fall after that would show a more realistic picture of national economy.

The worldwide literature about exchange rates and trade does not provide a consistent result as well. Hooper and Kohlhagen (1978) pointed out that currency uncertainty more effectively affects prices than trade volumes, and Rose (1990) indicated that for developing economies currency depreciation has a limited effect on exports volumes, while Arize, Osang, & Slottje (2000) argues that currency volatility may negatively affect export volumes. This lack of consensus suggests that the relationship between exchange rate fluctuations and trade performance is far from linear. Consequently, instead of a universal economic rule, we assume that trade volumes depend more on a country's specific industrial structure, institutional framework, and the degree of its integration into global value chains.

This paper contributes to the existing literature on three accounts; firstly, it breaks from tradition linear testing and employs EKC non-linear logic on export-exchange rate dynamics. Secondly it tests the hypothesis in Türkiye, which is a developing country that is heavily export oriented and therefore its overall growth depends on foreign markets and at the same time its imports component makes exports sensitive to changes in its exchange rate. Lastly, it also includes the role of imports so to model the cost push mechanism while controlling for the competitiveness effect.

The objective of the empirical analysis is to test long run cointegration relation among exports, exchange rate, squared exchange rate and imports in Türkiyeover the period 1987-2024. The inclusion of exchange rate squared term allows the possible threshold effect in the exchange rate mechanism's influence on exports. We test for cointegration using the bounds testing approach of ARDL models. The ARDL bounds test provides robust results regarding long run relationships among mixed order integrated

variables without any variable having an order of integration of 2 (Pesaran et al., 2001). However, before bounds testing we test for stationarity of the individual variables using KPSS test against the alternative that a series has a unit root (Kwiatkowski et al., 1992).

The rest of the paper is organized as follows. Section 2 surveys theory and existing empirical literature of exchange rate and non-linear trade dynamics. Section 3 details the data and empirical methods used. Section 4 presents result which include the result on stationarity test, bounds test and results regarding the estimation of long and short run models with related robustness checks. Section 5 concludes the paper with discussion of findings and policy implications.

2. Literature Review

The interaction between exchange rate and international trade has been an everlasting focal point of international economic discussions. Early models emphasized that currency volatility and risk aversion inhibit exports. For example, Clark (1973) argued that exchange rate variability would have an adverse effect on the level of trade as risk-averse firms are unable to secure a hedge. But later studies by Ethier (1973) showed that risk can be eliminated through use of forward exchange markets allowing firms to predict future changes more reliably. In an early empirical contribution, Hooper and Kohlhagen (1978) showed that exchange rate volatility has a more significant effect on export prices than on trade volumes. Together these seminal works demonstrate that the exchange rate – trade relation hinges not only on changes in relative prices, but also on factors such as hedgability of exchange risk, firms' risk preferences, contract design and other market specific factors.

A review of the empirical literature presents evidence of inconsistency in determining whether depreciation or volatility of exchange rates results in higher or lower exports. As documented in a vast survey of relevant studies by McKenzie (1999), both the theoretical predictions and the empirical results are far from consistent. Following the same pattern, Bahmani-Oskooee and Hegerty (2007) analyzed many empirically studies, and conclude that the effect of exchange rate volatility on international trade are highly ambiguous. Overall, this large literature suggests that, the impact of exchange rate volatility on exports strongly depends on the country, sector, time period, and estimation methodology. Hence, standard linear estimation frameworks do not adequately capture the complexities of the exchange rate-export relationship.

Parallel strands of the literature explore pricing behavior and the phenomenon of exchange rate pass-through. Dornbusch (1987) examined how exchange rate movements filter into prices. This depends importantly on firms' pricing behavior, product differentiation and industry structure. In a broad survey, Goldberg and Knetter (1997) stressed that exchange rate pass-through to consumer prices is seldom full. Supporting this point, Campa and Goldberg (2005) showed, using OECD import data, that pass-through varies significantly across countries. More recently, Burstein and Gopinath (2014) provided a synthesized account of this literature, highlighting that the speed of pass-through to prices is strongly affected by imported input dependence, currency of invoicing and pricing frictions. All these works have clear implications for countries with deeply embedded global supply chains: there may be muted, slow or asymmetric responses to exchange rate shocks on export prices and volumes.

The recent literature with dominance of global invoicing currencies and firm level data supports similar observations. Amiti, Itskhoki, & Konings (2014) identified significant dependence on imported inputs for major exporters and argued this factor is the major explanation for muted pass-through of exchange rate changes. Their results suggest that an increase in devaluation may not contribute to the improvement of international competitiveness if the cost of necessary imported inputs rises more sharply than the depreciation itself. Building on this point, Gopinath et al. (2020) developed the idea that the dominant currency paradigm (with importance on imported inputs, pricing synergies and one dominant invoicing currency) could jointly explain these small or asymmetric trade volume responses and pricing adjustments to currency shocks. Such points are particularly relevant to emerging economies, which are heavily dependent on foreign inputs in export production.

Asymmetric and nonlinear effects of exchange rates also highlight important dimensions of the phenomenon. From the perspective of the J-curve, Bahmani-Oskooee and Ratha (2004) presented

evidence showing that the balance of trade has differential responses to depreciation in the short and long run. Focusing on emerging East Asian economies, Chit et al. (2010) showed convincing evidence that exchange rate volatility had a negative impact on exports. Expanding on this study, Chit and Judge (2011) established that the negative effect of exchange rate volatility is inversely related to the country's level of financial development; it reduces export volumes more severely in developing economies with underdeveloped financial markets. Likewise, Hricourt and Poncet (2015), using Chinese firm-level data, documented that real exchange rate variability affects export volumes negatively and reduces firms' export participation, especially for financially constrained firms. These findings indicate that firm-specific factors, credit conditions and import input dependence are crucial in determining how export volumes respond to exchange rate movements.

Within this, Türkiye provides an unusually interesting case study as it faces high currency and export/import linkages. Studying 2002-2018, Erduman, Eren, & Gül (2020) tracked the import content within Turkish manufacturing and exports. The result suggests that the level of import intensity of overall production has remained relatively stable while the import content of exports has risen consistently, and mostly higher than that of domestic production. It is the last aspect which becomes critical to our study as it is a strong evidence for the duality of currency depreciation-it may theoretically help improve export competitiveness but it undeniably raises the cost of producing exports. Thus, for an export sector highly dependent on foreign inputs, it is highly possible that the weak Turkish lira has the short run boost to the exports and long run negative effect.

Multiple empirical studies have attempted to explicitly analyse the currency-export relationship of Türkiye. At micro level, Solakoglu, Solakoglu, & Demirag (2008) examined the relationship between real exports and currency volatility. They do not find the significant positive or negative impact but argued that the firms can utilize import generated foreign revenues to cover the exposure naturally, that the exposure of an individual firm to exchange rates is determined by firm specific import dependence and mitigating ability. Further, Tunc and Solakoglu (2017) analyzed a rich data set of Turkish enterprises over the period 1989-2013. They found a significant negative average impact of volatility on foreign sales but also identified large cross-firm heterogeneity of the impact (or its direction) across firm types, namely small and medium sized enterprises, unlisted firms, foreign market size of exporting firms being more sensitive to exchange rates volatility. It is clear that aggregate data may be masking an uneven non-linear structure within firms.

On the macroeconomic side, Tarakçı, Ölmez, & Durusu-Çiftçi (2022) used both ARDL and NARDL methods to estimate the impacts of currency volatility on exports to Türkiye's major trading partners for the period 2002-2019. They confirmed the significance of the exchange rate volatility but also find it is not only asymmetric but also differentiated by trading partners and type of product. In particular, they confirmed the short-run stimulating effects on exports but argued the adverse impacts are predominately in the long-run. The different impact in short and long run clearly shows it does not react in a constant or linear way but shift across the period.

Compared with earlier works, Thorbecke and Sengonul (2023) is closest to our intention of the study. Using NARDL models for estimation of Turkish trade flows, they found clear asymmetries and that only appreciation consistently increases trade flows while deprecation typically has no effect on exports. The main reason for this situation lies in a dual-constraint regime, which requires imported inputs for exports and where a stronger lira may even decrease a firms' burden of credit. It is a key finding for our study as it shows that devaluation of Turkish Lira will not necessarily help exports given the existence of credit constraint and imported inputs costs.

Taking an economy-wide perspective, Asteriou, Masatci, & Pilbeam (2016) provide complementary evidence by investigating the link between trade and exchange rates volatility for Mexico, Indonesia, Nigeria and Türkiye (MINT). Their study using GARCH and ARDL bound testing concluded that generally the impact of volatility on trade is weak or negligible in the long-run; Türkiye is the exception where an impact although negligible exists. This indeed aligns with the view that the degree of and channel of influence is firm or economy-specific, depending on imports structure, foreign currency usage in invoicing, sectorial composition, and country-specific financial structure.

Synthesizing the literature above yields three main findings: First, the actual relationship between volatility and exports is varied, and even ambiguous in theory; Second, export promotion effect from currency depreciation may be outweighed or offset by firm heterogeneity, liquidity constraints, pricing strategy and imported inputs dependence. Third, empirical studies on Türkiye have more recently highlighted the importance of import dependence and asymmetric non-linear impacts on exports as opposed to appreciating currency. However, how export reacts to currency depreciation over long run is yet to be examined under EKC-like model, hence our study filling this gap by using the ARDL framework to test whether Türkiye's exports increase as Lira depreciates to some optimal level and then start declining, considering explicitly the effects of imports.

3. Data and Methodology

The aim of this empirical study is to investigate if a long-run, non-linear, EKC type, relationship exists between export performance and exchange rate behavior in Türkiye over the period 1987-2024 using the ARDL estimation methodology. This investigation focus only on the relationship between exports and the exchange rate, as currency valuation is arguably the most important variable explaining a company's exports behavior. Following the EKC hypothesis' logic, we posit that the relationship between exports and the exchange rate is non-linear, and thus as the exchange rate increases aggregate exports volumes will grow until certain optimal level, but afterward the rise in the exchange rate will discourage export performance.

In the empirical model we estimate the exports (EXPORTS) as the volume of goods and services exported, measured in constant 2015 U.S dollars, as dependent variable and the exchange rate (EXCHRATE), as period-average official exchange rate (Local Currency Units per U.S. Dollar) as the main explanatory variable. A second important control variable is the imports (IMPORTS), measured as imports of goods and services, in constant 2015 U.S dollars, is also include in the equation. The coefficient of this variable is expected to be positive, as it represents a fact about the structure of the economy. A significant portion of Turkish exports depends on intermediate inputs which are imported, thus the ability to import is one of the main determinants of export supply, justifying the positive sign for the IMPORTS variable coefficient.

All data series were collected from the World Development Indicators (WDI) from the World Bank All the time series data were converted to their natural log transformations in order to be able to directly interpret estimated coefficients as elasticities, and before to apply the estimation techniques. Table 1 present the definitions and data sources for the dependent, independent and control variables in our estimated equations.

Table 1. Data Definitions and Sources

Variable	Definition	Source
EXPORTS	exports of goods and services (constant 2015 US$)	WDI
EXCHRATE	official exchange rate (LCU per US$, period average)	WDI
IMPORTS	imports of goods and services (constant 2015 US$)	WDI

Cointegration analysis of this study is performed by using ARDL bounds test for the following two model:

$$\Delta \text{EXPORTS}_t = \alpha_0 + \sum_{i=1}^{p} \delta_i \Delta \text{EXPORTS}_{t-i} + \sum_{i=0}^{q} \phi_i \Delta \text{EXCHRATE}_{t-i} + \sum_{i=0}^{r} \lambda_i \Delta \text{EXCHRATESQ}_{t-i} + \sum_{i=0}^{s} \gamma_i \Delta \text{IMPORTS}_{t-i} + \theta_0 \text{EXPORTS}_{t-1} + \theta_1 \text{EXCHRATE}_{t-1} + \theta_2 \text{EXCHRATESQ}_{t-1} + \theta_3 \text{IMPORTS}_{t-1} + \varepsilon_t \quad (1)$$

Regarding to the explanations of symbols used in Equation 1 above: θ0, θ1, θ2, and θ3 symbols stand for the long-run coefficients; δi, ϕi, λi, and γi symbols reflect short-run coefficients; Δ symbol gives the first degree difference operator; α0 symbol represents the intercept term of the model, and symbol is white noise error term of the model.

The setting of the null hypothesis of ARDL bounds test is given by H0:θ0=θ1=θ2=θ3=0 and this setting implies that there is no cointegrating association among the variables of exports, exchange rate, square of exchange rate, and imports. On the other hand the setting of the alternative hypothesis of ARDL bounds test is given by HA:θ0≠θ1≠θ2≠θ3≠0 and this setting hints that there is cointegrating association among the variables of exports, exchange rate, square of exchange rate, and imports. Considering the decision rule in ARDL bounds test, F-statistic value obtained from ARDL bounds test exceeding the upper critical value endorses the presence of cointegrating relationship, but F-statistic value obtained from ARDL bounds test falling short of lower critical value indicates the non-existence of cointegrating relationship. Finally if F-statistic value obtained from ARDL bounds test locates anywhere between lower and upper critical values then we are unable to conclude on cointegrating relationship.

We got the coefficient estimations for short-run and long-run by estimating the following the model:

$$\text{EXPORTS}_t = \beta_0 + \sum_{i=1}^{p} \alpha_i \Delta \text{EXPORTS}_{t-i} + \sum_{i=0}^{q} \mu_i \Delta \text{EXCHRATE}_{t-i} + \sum_{i=0}^{r} \theta_i \Delta \text{EXCHRATESQ}_{t-i} + \sum_{i=0}^{s} \pi_i \Delta \text{IMPORTS}_{t-i} + \gamma ECM_{t-1} + \varepsilon_t \quad (2)$$

The explanations of notations in Equation 2 as follows: αi, μi, θi, and πi notations reflect dynamic coefficients; ECM term represents error correction term; notation stands for the speed of adjustment. It is required for the coefficient of ECM term to be statistically significant and take negative sign.

In Table 2 we reported summary statistics for our dependent and independent variables. As pointed out by Table 2, the variable with the largest and lowest variations is exports and exchange rate variables respectively. The minimum and maximum values of exchange rate variable are 0.000857 and 32.80586 respectively.

Table 2. Descriptive Statistics

	EXPORTS	EXCHRATE	IMPORTS
Mean	1.40E+11	3.477291	1.48E+11
Median	1.26E+11	1.426995	1.50E+11
Maximum	3.19E+11	32.80586	3.09E+11
Minimum	2.60E+10	0.000857	2.75E+10
Std. Dev.	9.27E+10	6.782296	8.84E+10
Skewness	0.505462	3.103365	0.136160
Kurtosis	2.013562	12.33959	1.635047
Jarque-Bera	3.158797	199.1064	3.067322
Prob.	0.206099	0.000000	0.215744
Sum	5.30E+12	132.1371	5.63E+12
Sum Sq. Dev.	3.18E+23	1701.983	2.89E+23
Observations	38	38	38

In Figure 1 we displayed the behavioral pattern of variables of EXPORTS, EXCHRATE, and IMPORTS over the estimation period. We observe similar pattern for EXPORTS and IMPORTS variables with an upward trend with some small fluctuations for some interval periods. Conversely we observe a soft upward trend in EXHRATE variable until 2020 and a sharp rise after 2020.

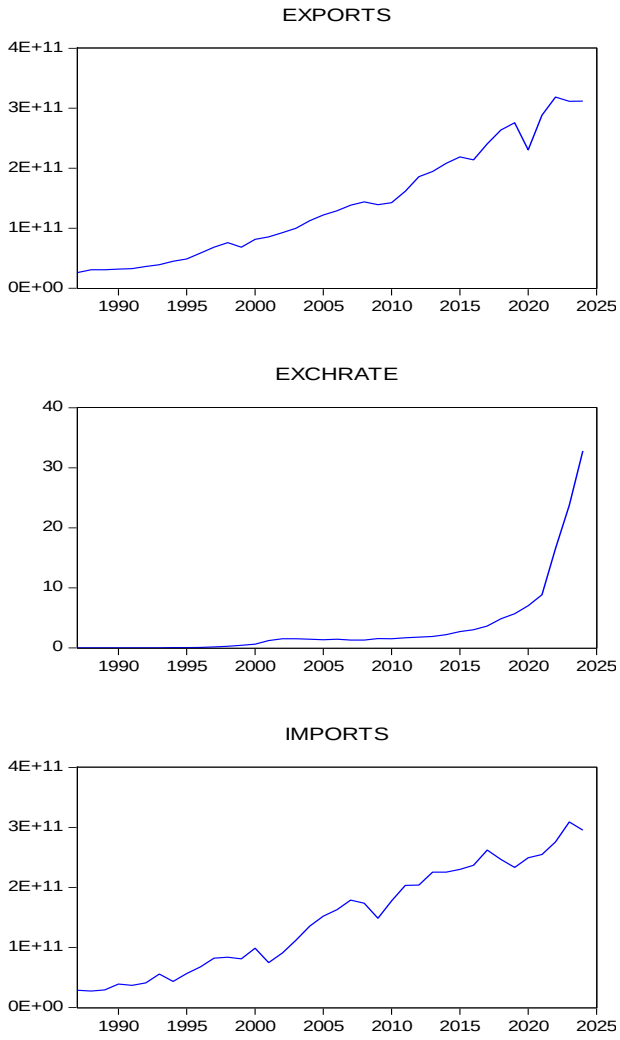


Figure 1. The Figure of Exports, Exchrate, And Imports Variables

In Table 3 we show the correlation coefficients between relevant variables with t-statistic and P-values As can be deduced from Table 3, correlation coefficients are statistically significant at 1% significance level with positive signs.

Table 3. Correlation Matrix

	EXPORTS	EXCHRATE	IMPORTS
EXPORTS	1		
t-Statistic	-----		
Prob.	-----		
EXCHRATE	0.7237	1	
t-Statistic	6.2923	-----	
Prob.	0.0000	-----	
IMPORTS	0.9760	0.6570	1
t-Statistic	26.8645	5.2290	-----
Prob.	0.0000	0.0000	-----

4. Estimation Results

In this study we implemented ARDL bounds test for cointegration analysis since, unlike the conventional cointegration tests, it allows to use series with integration order zero, one or mixed. Therefore we first controlled the integration order of our dependent and independent variables by

utilizing Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test. KPSS test findings are shown in Table 4 and the results of KPSS test disclose that variables of EXPORTS, EXCHRATE and IMPORTS are stationary at first differences whereas EXCHRATESQ variable is stationary at level. This means that variables of EXPORTS, EXCHRATE and IMPORTS are integrated order one but EXCHRATESQ variable is integrated order zero. The findings obtained from KPSS test confirm our eligibility to use ARDL bounds test for cointegration analysis.

Table 4. KPSS stationarity test

Null Hypothesis: EXPORTS is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.734	0.739 & 0.463	
Null Hypothesis: D(EXPORTS) is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.347	0.739 & 0.463	I(1)
Null Hypothesis: EXCHRATE is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.676	0.739 & 0.463	
Null Hypothesis: D(EXCHRATE) is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.279	0.739 & 0.463	I(1)
Null Hypothesis: EXCHRATESQ is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.416	0.739 & 0.463	I(0)
Null Hypothesis: IMPORTS is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.723	0.739 & 0.463	
Null Hypothesis: D(IMPORTS) is stationary.		
LM-Stat.	Critical Values at 1% & 5%	Integration Order
0.208	0.739 & 0.463	I(1)

A fundamental requirement within the ARDL framework is establishing a parsimonious model by determining the appropriate lag structure. To achieve this, the Akaike Information Criterion (AIC) was employed to evaluate model performance, striking an optimal balance between statistical efficiency and the preservation of degrees of freedom. This rigorous evaluation procedure systematically screened 1,080 potential model configurations. The 20 most competitive specifications, ranked according to their AIC scores, are plotted in Figure 2.

As indicated by the results, the ARDL(5,1,0,1) framework yielded the lowest information criterion value, distinguishing it as the most efficient and robust fit. Consequently, this specific ARDL(5,1,0,1) formulation was designated as the baseline architecture for all subsequent empirical estimations.

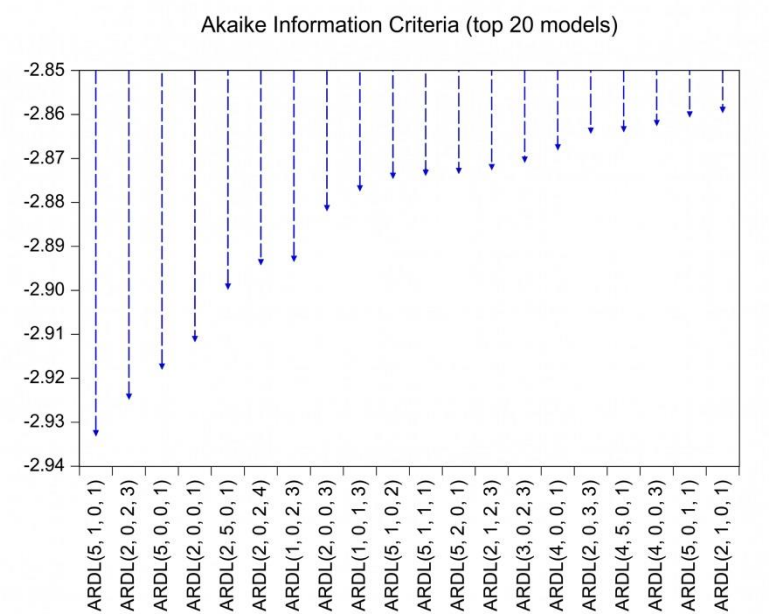


Figure 2. Optimal Lag Length Selection

The results of the bounds test, executed via the optimized ARDL(5,1,0,1) framework, are summarized in Table 5. The computed F-statistic decisively exceeds the upper critical thresholds across all standard levels of significance, irrespective of the sample size considerations. Consequently, the null hypothesis of no cointegration is rejected. This statistical evidence verifies the presence of a stable, long-run equilibrium linking EXPORTS, EXCHRATE, EXCHRATESQ, and IMPORTS.

Table 5. Cointegration Test

Null Hypothesis: No levels relationship			
	Signif.	(Lower Crit. Value)	(Upper Crit. Value)
		Asymptotic: n=1000	
F-statistic: 8.422764	10%	2.97	3.74
k: 3	5%	3.38	4.23
	2.5%	3.8	4.68
	1%	4.3	5.23
Actual Sample Size: 33		Finite Sample: n=35	
	10%	3.29	4.176
	5%	3.936	4.918
	1%	5.654	6.926
		Finite Sample: n=30	
	10%	3.378	4.274
	5%	4.048	5.09
	1%	5.666	6.988

Table 6 outlines the estimated short- and long-run coefficients derived from the model. The analysis reveals a statistically significant positive long-run coefficient for the EXCHRATE variable, coupled with a significant negative coefficient for the squared term, EXCHRATESQ. Together, these estimates confirm the presence of an inverted-U (parabolic) trajectory between exchange rate movements and export volumes in Türkiye over the examined period. Fundamentally, these findings validate the core assumption of this study: the long-term relationship between exports and the exchange rate accurately mirrors an EKC-type framework.

Based on the estimations, the specific turning point (threshold) for the EXPORTS model is calculated at 8.9484. This indicates that a depreciating domestic currency stimulates international sales up to this specific exchange rate level, after which the trend reverses. Quantitatively, a 1% increase in the exchange

rate drives an average export expansion of 0.0238% as long as the rate remains below the 8.9484 threshold. However, once the exchange rate breaches this critical limit, further depreciation becomes detrimental, contracting exports by an average of 0.0054% for every subsequent 1% increase. Furthermore, aligning with theoretical expectations regarding production structures, the IMPORTS variable exerts a statistically significant, positive long-run influence on exports.

Examining the short-run dynamics, the first and fourth lags of the EXPORTS variable yield significantly positive coefficients. The immediate (short-run) impact of the EXCHRATE is statistically significant but negative, whereas the short-run effect of IMPORTS remains significantly positive. Crucially, fulfilling the fundamental prerequisite for cointegration, the Error Correction Mechanism (ECM) term is both negative and highly significant, indicating a reliable speed of adjustment toward the long-run equilibrium following short-term economic shocks.

Finally, a comprehensive suite of diagnostic tests was administered to ensure the robustness of the estimations. This included the Jarque-Bera (JB) test for normality, the Breusch-Godfrey (BG) test for serial correlation, the ARCH test for heteroskedasticity, and the Ramsey RESET test for model specification. Alongside the CUSUM parameter stability check, these diagnostics collectively verify that the selected ARDL(5,1,0,1) specification is structurally stable and entirely free from autocorrelation, heteroskedasticity, non-normal distribution, and specification errors.

Table 6. Long-run and Short-run Estimations Results

Long-run Estimation Results				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCHRATE	0.0238	0.0094	2.5415	0.0190
EXCHRATESQ	-0.0054	0.0018	-2.9928	0.0069
IMPORTS	0.2454	0.0729	3.3664	0.0029
TREND	0.0471	0.0050	9.4162	0.0000
EC=EXPORTS-(0.0238*EXCHRATE-0.0054*EXCHRATESQ+0.2454*IMPORTS+0.0471*TREND)				
Short-run Estimation Results				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	28.8161	4.0619	7.0943	0.0000
D(EXPORTS(-1))	0.6481	0.1667	3.8890	0.0008
D(EXPORTS(-2))	0.2111	0.1242	1.7003	0.1038
D(EXPORTS(-3))	0.0605	0.1083	0.5588	0.5822
D(EXPORTS(-4))	0.3624	0.1102	3.2887	0.0035
D(EXCHRATE)	-0.0806	0.0412	-1.9539	0.0642
D(IMPORTS)	0.1461	0.0627	2.3319	0.0297
ECM	-1.6907	0.2388	-7.0806	0.0000
Diagnostic Tests	Test Stat.	Prob.	Results	
JB Test	0.8570	0.6515	No non-normal distribution	
BG Test	0.8416	0.4465	No autocorrelation	
ARCH Test	1.7672	0.1937	No heteroskedasticty	
Ramsey Test	1.4292	0.2459	No model misspecification	
CUSUM test			No parameter instability	

5. Conclusion

The principal goal of this research was to ascertain whether the export-exchange rate nexus in Türkiye (1987-2024) follows a standard linear transmission or is characterized by an EKC-like, non-linear dynamics. Assuming that export responses change significantly once the exchange rate exceeds a specific devaluation threshold, this study contributes to capturing a critical structural fact about Turkish economy that its export production heavily relies on intermediate goods inputs from abroad. To account for this cost-push phenomenon, imports at the aggregate level are implicitly included in the model as a critical control variable.

The method applied in this analysis is the ARDL bounds testing approach. Preliminary unit root testing via the KPSS test found a clean, methodologically sound setup whereby variables exhibited a pure mixture of strictly first difference stationary (EXPORTS, EXCHRATE, IMPORTS) and one variable which is stationary at level (EXCHRATESQ). There was strict absence of second order integration. As

suggested by AIC, the model form that proved best fit was ARDL(5,1,0,1). Bounds test results for cointegration revealed significant evidence as the F statistic fell outside all upper bound critical values.

The critical contribution of this paper lies in the estimates of long-run coefficients. The exchange rate parameter was found to be positive and highly significant, whereas its squared term parameter was significantly negative. The pair supports an inverted-U relation: export growth seems to rise as the exchange rate falls (domestic currency depreciates) up to a specific point, then start decreasing when the exchange rate continues to fall (depreciates beyond that point). This clearly indicates an EKC-like dynamic for the Turkish export function. Specifically, this turning point has been estimated to be at the exchange rate value of 8.9484. The exports will expand beyond this limit but the falling exchange rate then turns counterproductive. The positive significant estimate of imports implies that the economy has a comparative advantage in expanding its export production when its imports grow, which is quite natural given Türkiye's high reliance on foreign inputs to produce for exports. In fact, the exchange rate operates in a dual role; it provides competitive price stimulus in international markets as well as increase the domestic production costs through importing intermediate goods inputs and capital goods. This explains why continued depreciation eventually becomes harmful for the export sector of Türkiye.

Short-run effects are more intuitive. Lags for exports and import variables are all found positive and highly significant for a couple lags while exchange rate exhibits significantly positive estimate at t0 which turned negative after that. The result that sudden depreciation would immediately affect the cost for export-oriented industries, while continuing imports continue to be a driver for export activities, makes sense as long as import elasticity remains positive in the shorter run. The coefficient on error correction term is large and statistically significant which assures convergence to the long-run equilibrium. The checks for serial correlation, heteroskedasticity, specification errors and stability indicate that the specified model and its findings are statistically valid.

From the policy perspective, the findings are very important. Continuous Engineered depreciation of the currency can never be a stable recipe for Turkish exports. Up to a certain limit, the currency depreciation will be positive, but it can quickly turn into negative for the export performance if continued. Turkish government should ensure that currency stays at a predictable level instead of constant engineered depreciation. Government must also encourage structural changes and productivity growth through appropriate industrial policies and move from high value added to low value added production. They also need to support export through other means than the exchange rate manipulation. Also it has to take care of fact that, trade flows (exports) are not necessarily negatively correlated with import as imports seem to be positive driving force of export performance.

As a contribution to literature, the paper has established that a non-linear dynamic relationship between exports and the exchange rate exists in Türkiye, rejecting linear dynamics and demonstrating the drawbacks of uncontrolled depreciation for export performance in Türkiye. The dependence of this analysis on aggregate yearly statistics could be seen as a limitation and future studies would greatly benefit from considering different industries at different levels or individual firms to investigate more in-depth variations of this turning point. Moreover the additional control variables such as RER, world demands and energy prices are to be analyzed for further clarification of Turkish trade mechanisms.

At the end of the day, while a competitive exchange rate provides the initial stimulus to the export-oriented sector, it is only structural reforms that guarantee sustained growth and resilience of the export sector by shifting it to produce a higher value-added product and reduce dependence on foreign intermediates.

Araştırmacıların Katkı Oran Beyanı / Contribution of Authors

Yazarların çalışmadaki katkı oranları Yüksel OKŞAK %50/ Jülide YALÇINKAYA KOYUNCU %50 şeklindedir.
The authors' contribution rates in the study are Yüksel OKŞAK %50/ Jülide YALÇINKAYA KOYUNCU %50 form.

Çıkar Çatışması Beyanı / Conflict of Interest

Çalışmada herhangi bir kurum veya kişi ile çıkar çatışması bulunmamaktadır.
There is no conflict of interest with any institution or person in the study.

İntihal Politikası Beyanı / Plagiarism Policy

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Bilimsel Araştırma ve Yayın Etiği Beyanı / Scientific Research and Publication Ethics Statement

Bu çalışmada Yükseköğretim Kurumları Bilimsel Araştırma ve Yayın Etiği Yönergesi kapsamında belirtilen kurallara uyulmuştur.
In this study, the rules specified within the scope of the Higher Education Institutions Scientific Research and Publication Ethics Directive were followed.

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