



Uncertainty, Demand, and Exchange Rates in Türkiye's Automobile Exports to France: An Augmented ARDL Approach

Türkiye'nin Fransa'ya Otomobil İhracatında Belirsizlik, Talep ve Döviz Kurları: Genişletilmiş ARDL Yaklaşımı

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ARTICLE INFO

Article Type

Research Article

Keywords

Automobile Exports
Economic Policy Uncertainty
Bilateral Real Exchange Rate
A-ARDL

Received: May, 12, 2026

Accepted: Jul, 17, 2026

ABSTRACT

France is one of Türkiye's most important automobile export markets, yet the determinants of this bilateral flow have not been studied separately. This paper estimates the short- and long-run effects of France's economic policy uncertainty (EPU), French passenger car demand, and the bilateral real exchange rate (BRER) on Türkiye's real automobile exports to France over 2010Q1–2025Q3, using the Augmented Autoregressive Distributed Lag (A-ARDL) approach, which jointly estimates short- and long-run coefficients and remains valid in degenerate cases where the conventional ARDL bounds test may mislead. A stable long-run relationship is confirmed. France's EPU has negative short-run effects but a positive long-run effect, consistent with uncertainty shifting French demand toward lower-cost imports. French car registrations raise Türkiye's exports in both horizons, while a long-run real appreciation of the lira reduces them. Policies supporting cost efficiency and model diversification toward entry-level vehicles can strengthen sector resilience.

MAKALE BİLGİSİ

Makale Türü

Araştırma Makalesi

Anahtar Kelimeler

Otomobil İhracatı
Ekonomi Politikası Belirsizliği
İkili Reel Döviz Kuru
A-ARDL

Geliş Tarihi : 12 Mayıs 2026

Kabul Tarihi: 17 Temmuz 2026

ÖZ

Fransa, Türkiye'nin en önemli otomobil ihracat pazarlarından biridir; ancak bu ikili ticaret akımının belirleyicileri ayrı olarak incelenmemiştir. Bu çalışma, 2010Q1–2025Q3 döneminde Fransa'nın ekonomi politikası belirsizliğinin, Fransa'daki binek otomobil talebinin ve ikili reel döviz kurunun Türkiye'nin Fransa'ya yönelik reel otomobil ihracatı üzerindeki kısa ve uzun dönem etkilerini Artırılmış Otoregresif Dağıtılmış Gecikme (A-ARDL) yaklaşımıyla tahmin etmektedir. Bu yöntem, kısa ve uzun dönem katsayılarını birlikte tahmin etmekte ve geleneksel ARDL sınır testinin yanıltıcı olabileceği dejenere durumlarda geçerliliğini korumaktadır. Bulgular, istikrarlı bir uzun dönem ilişkisinin varlığını doğrulamaktadır. Fransa'nın ekonomi politikası belirsizliği kısa dönemde negatif, uzun dönemde ise pozitif etki göstermektedir; bu durum, belirsizliğin Fransız talebini daha düşük maliyetli ithal araçlara yönlendirebileceği görüşüyle uyumludur. Fransa'daki otomobil kayıtları her iki dönemde de Türkiye'nin ihracatını artırırken, Türk lirasındaki uzun dönemli reel değerlenme ihracatı azaltmaktadır. Maliyet etkinliğini destekleyen ve model çeşitliliğini giriş seviyesi araçlara yönelten politikalar sektörün dayanıklılığını güçlendirebilir.

1. Introduction

The automotive sector is one of the most important economic activities in Türkiye's economy. Approximately 5% of the Gross Domestic Product (GDP) is created by this sector (Michalski, 2025). The annual number of vehicles produced in Türkiye reached 1 445 921 in 2025, of which 872 532 were automobiles (Otomotiv Sanayii Derneği [OSD], 2025a). Automotive exports have been the country's leading exports for 19 of the last 20 years. They increased by 11.6% in 2025 and hit a record 41.5 billion US dollars. This number accounts for 16.2% of Türkiye's total exports (Uludağ Otomotiv Endüstrisi İhracatçıları Birliği [OİB], 2026). One of the most distinctive characteristics of this sector is its deep integration into European supply chains. In 2025, 30.11 billion US dollars of automotive exports were made from Türkiye to European Union countries, which is 72.5% of the total value of the entire sector (OİB, 2026). Here, France plays a particularly important role. It is integrated with Türkiye through the Oyak Renault joint venture, which was established in 1969

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and has been producing vehicles since 1971 (OSD, n.d.; Renault Group, n.d.). This factory produced 387 113 passenger cars in 2025, which is the highest amount of passenger car production among the manufacturers in Türkiye such as Hyundai, Toyota, etc. Also, 270 325 units of this production were exported, mostly to European markets (OSD, 2025a: 2; OSD, 2025b: 15; OSD, n.d.). Besides, France recorded a very strong annual export growth in 2025, at 17% (OİB, 2026). This long-standing relationship and market-level features make Türkiye's passenger car exports to France an important case to investigate.

The strategic importance of the automotive sector for Türkiye is well studied; however, a closer empirical investigation of Türkiye's exports to France is worth conducting. Among European markets, France is one of the key countries for Türkiye's automotive exports. Also, the production networks between France and Türkiye are strongly linked due to Renault's vehicle production in Bursa for over half a century. Accordingly, the determinants of Türkiye's automotive exports to France should be investigated separately. The determinants chosen for this study are uncertainty conditions, automobile market demand in France, and bilateral relative price movements between the two countries.

This study estimates the short-run and long-run effects of France's economic policy uncertainty (EPU), destination market automobile demand and the bilateral real exchange rate (BRER) on Türkiye's automobile exports to France over the period 2010Q1-2025Q3. The empirical analysis is conducted using the Augmented Autoregressive Distributed Lag (A-ARDL) approach, which allows the relationship to be examined within a dynamic time series framework.

Most empirical work on automotive trade pools destinations together or uses aggregate income to stand in for car demand, which obscures the channels through which a specific bilateral relationship actually moves. This paper takes the opposite approach. It treats Türkiye's passenger car exports to France as a single bilateral flow worth studying on its own terms. It is a relationship anchored by more than five decades of Renault production in Bursa, a 17% jump in exports in 2025 alone, and France's position as one of the largest European destinations for Türkiye's vehicles. Three determinants are estimated jointly: France's EPU, French new passenger car registrations as a direct measure of destination demand rather than a GDP proxy, and the bilateral real exchange rate. Combining these in a single specification makes it possible to separate the demand-side, uncertainty, and price-competitiveness channels that the existing literature has only examined in isolation. The A-ARDL framework is chosen because it reports short run and long run coefficients together and stays valid in the degenerate cases where the conventional ARDL bounds test can produce misleading inferences.

The paper is organized as follows. In section 2, the theoretical background is explained. Section 3 presents a comprehensive literature review. The dataset and methodology of the study are described in Section 4. In Section 5, the empirical findings are reported and discussed. Section 6 concludes with policy implications and directions for future research.

2. Theoretical Background

Automobile exports are shaped by more than demand alone. Because cars are durable manufactured goods traded in differentiated markets, export performance is expected to respond not only to demand but also to uncertainty and exchange rate fluctuations. In this manner, this section discusses the channels that connect Türkiye's automobile exports to France's EPU, new passenger car registrations, and the BRER, each of which plausibly affects Türkiye's automobile exports.

Uncertainty is selected as the first determinant of automobile exports in this study. Uncertainty fluctuations may create results that differ according to the time horizon. In the short run, when policy uncertainties increase, automobile exports may decline because cars are considered durable goods and consumers postpone their purchase decision. This behavior is

consistent with irreversibility under uncertainty argument introduced by Bernanke (1983). According to this argument, when decisions are difficult to reverse, agents compare the gain from early commitment with informational benefit of waiting. Action is taken only when the expected return from commitment is high enough relative to the value of deferring the decision (Bernanke, 1983: 89-90). Real options theory also supports this framework. In this theory, investments or commitments are treated as options. Their value increases when uncertainty is high and it is possible to wait (Myers, 1977: 147; Dixit & Pindyck, 1994: 3). Although these mechanisms are valid in the short run, they can change in the long run. Uncertainty can possibly increase exports through two mechanisms: one is exporter reallocation and the other one is demand-substitution towards goods priced lower. If the uncertainty is permanent, weak exporters may lose their market shares while stronger ones preserve or even expand their positions. This is consistent with heterogeneous-firm reallocation and exporter concentration (Melitz, 2003: 1695; Zhang & Hu, 2023: 1). Also, consumers tend to buy smaller or cheaper cars during downturns, which shifts the automobile demand from higher priced or bigger cars (Klein et al., 2021: 6). Therefore, the EPU effect is expected to be negative in the short run but positive in the long run: uncertainty may initially delay export demand, but over time may direct demand and market shares toward more resilient and lower-priced suppliers such as Türkiye.

Another important determinant of exports is demand so Türkiye's automotive exports to France can be explained through the standard export demand channel. In the imperfect substitute framework, imports and exports are not perfect substitutes for domestic goods and trade demand depends on income and relative prices in the importing market (Goldstein & Khan, 1985: 7-8). Accordingly, stronger automobile demand in France can increase demand for the automobiles produced in Türkiye as Turkish vehicles are part of relevant set of differentiated suppliers. In the short run, this demand increase may raise export orders through the existing trade channel between the importing market and foreign producers. In the long run, sustained foreign demand can support a stronger export orientation and production response in supplying automotive sector, especially because automotive industries with high export dependence are strongly tied to foreign demand developments (Paredes, 2017: 5-6; Klein et al., 2021: 6, 8). Also, the short-run response is typically smaller than the long-run response because dealer inventories, order to deliver lags and production scheduling slow the transmission of demand shocks into export shipments (Zettelmeyer et al., 2006: 5).

The relationship between car exports and exchange rates is rooted in the imperfect-substitutes framework already discussed for the demand channel, where exports depend jointly on income and relative prices in the importing market (Goldstein & Khan, 1985: 7-8). When the Turkish lira appreciates in real terms against the euro, the foreign currency price of cars produced in Türkiye rises relative to cars produced in France. This situation erodes the price competitiveness of Turkish exports. In the short run, however, trade volumes do not respond immediately because they are tied to existing contracts, as introduced in the "currency contracts" view of the J-curve (Magee, 1973). Following a lira appreciation, the contract-fixed quantities of cars already ordered by French dealers continue to flow even though their euro price has risen, so the immediate effect of BRER on export value can be positive rather than negative. Once contracts are renegotiated, the standard Marshall-Lerner mechanism takes over. If the sum of the elasticities of exports and imports with respect to the real exchange rate is greater than one, it is expected that real depreciation of the exchange rate improves the trade balance (Krugman et al., 2012: 460). Equivalently, a real appreciation of the lira is expected to reduce Turkish car exports to France in the long run.

3. Literature Review

3.1. Export and Uncertainty Relationship

Few studies link automotive exports and uncertainty directly. Most of the papers look at aggregate exports, manufacturing exports, or bilateral trade flows. The review below therefore draws

on both strands: the broader export literature and the handful of papers focused specifically on vehicles.

Hu and Liu (2021) analyzed the dynamic effect of global and Chinese EPU on China's export fluctuations using data for the 2002–2021 period. A TVP-SV-VAR model was used to examine China's total exports as well as exports to One Belt One Road and Regional Comprehensive Economic Partnership members. The results show that EPU effects are time-varying and structurally different across periods; in particular, the pandemic period produced mainly short-term negative effects on exports through global EPU. Bahmani-Oskooee and Xu (2022) investigated the effects of U.S. and Chinese policy uncertainty on bilateral trade between two countries across 87 two-digit industries for 2002–2019 period. They used ARDL models and the results showed that in the long run, U.S. policy uncertainty generally weakens exports and imports, including vehicle related HS 87 category, however China's policy uncertainty often raises trade. Aslan and Açıkgöz (2023) examined the effects of GEPU on export flows in 28 emerging market economies using data for 2006–2019 period. Applying a panel VAR model, they found that GEPU negatively and significantly affected real exports. Bahmani-Oskooee and Harvey (2023) examined asymmetric effects of U.S. and Mexican policy uncertainty on bilateral trade between the two countries across 93 two-digit industries for the 2002–2019 period. A nonlinear ARDL model was applied, and the results show that while Mexican uncertainty reduces U.S. vehicle-related exports, increases in U.S. uncertainty help vehicle and parts exporting industries in Mexico. Zhang and Hu (2023) examined how foreign Economic Policy Uncertainty affects exporter dynamics across 64 exporting countries and 95 industries over 1997–2014. Using panel regression, they showed that higher foreign uncertainty reduces export values. They also found that uncertainty increases exporter concentration and market share of large exporters. Akpiliç et al. (2024) examined the relationship between GEPU and Türkiye's manufacturing industry exports using data for 2013–2023 period. An ARDL approach was used for the analysis, and it was found that GEPU does not significantly affect manufacturing exports in either the short run or the long run. Zhao and Tang (2024) studied the effects of Policy Environmental Uncertainty and Market Environment Uncertainty on China's electric vehicle exports to 154 countries worldwide for 2017–2022 period. Panel regression method was used for the study and the results revealed that increasing uncertainties weaken automobile-related exports in the given period which was considered as short-term effect. Nguyen et al. (2026) investigated the effect of EPU on bilateral export flows among 14 Asia-Pacific economies over the 2018Q1–2024Q4 period. The structural gravity model revealed that EPU significantly reduces exports in the baseline model, however, the negative impact is neutralized by free trade agreements and extreme geopolitical conflict periods generate a resilience effect through stockpiling and supply-chain adaptation.

Overall, the evidence regarding the relationship between uncertainty and exports is mixed. Most studies find that as uncertainty increases, automobile exports are depressed. However, a few studies report the opposite and attribute the positive effect to exporter resilience, stockpiling, market reallocation towards stronger firms or other adjustment channels. The one study on Türkiye finds no significant link at all. The direction of the effect appears to depend on which country is exporting, what kind of uncertainty is measured and whether the effects are calculated for short-run or long-run.

3.2. Export and Demand Relationship

Several demand proxies are adopted in the empirical literature on car exports and demand. These range from aggregate measures, such as GDP and GDP per capita of the importing country, to sector-specific measures, such as new car registrations and household-level vehicle purchases. The reviewed studies include all these proxies to capture the effects of the demand conditions of the importer countries on the export flows.

Uemoto and Ramstetter (2004) examined the rapid growth of Thailand's vehicle exports using export data by product group and destination market, mainly for 1996-2001 period. Applying a standard gravity model, they found that partner-country GDP and GDP per capita are generally positively associated with Thailand's vehicle exports. Paredes (2017) examined whether car-purchase subsidies and demand shocks affect car registrations and production in eight euro-area countries using data for 1996 to 2014. Structural Bayesian VAR and Global VAR frameworks are applied and the study found that price reductions induced by policies and demand shocks increase car registrations. Higher demand can also raise domestic and foreign car production through cross-country spillovers. Huseyni et al. (2019) studied the determinants of Türkiye's automotive industry exports to 68 major trade partners over the 2007-2015 period. Panel quantile regression was used for the estimation, and it was found that GDP per capita of the importer country positively affects Turkish automotive exports at the lower and median quantiles. Klein et al. (2021) examined the effects of the Covid-19 crisis on the automotive sector in Central and Eastern European countries. Using descriptive sectoral evidence, they showed that the sector is highly dependent on foreign demand, with around 65% of motor vehicle production exported and therefore linked to foreign demand. They also note that car sales move with the business cycle and that weak car demand negatively affects automotive production. Montoriol Garriga and Díaz (2021) analyzed Spain's automotive industry and its post-pandemic transformation using descriptive sectoral evidence. The study shows that Spain's automotive sector is highly export-oriented as more than 80% of vehicles are produced for export, and external demand from European markets helped the sector recover after the Covid-19 shock. Leard and Wu (2023) estimated demand elasticities for new passenger vehicles in the United States by using household level survey data and it covered new vehicle purchases and leases from 2017Q4 to 2018Q3. Instrumental variable estimation is used for the analysis and they found that new passenger vehicle demand is price-sensitive and that the sensitivity increases among lower-income households. Crisandy et al. (2025) examined Indonesia's HS 87 motor vehicle exports to nine developing countries over 1994-2023 period by using a gravity model and ECM framework. Their results show that importer country's real GDP has a positive and significant effect on Indonesia's vehicle exports both in the long and short run.

The studies show that the positive relationship between car exports and the demand of the importer country is consistent regardless of the demand measure, across emerging and advanced exporters, different time periods and econometric methods. The effects are also present in both the short and long run. This consensus among the studies supports that the demand variable is one of the core determinants of this study's model.

3.3. Export and Exchange Rate Relationship

In the literature, different exchange rate measures are used to investigate their effects on car exports. Bilateral exchange rates, real effective exchange rates or volatility indicators are some of the examples. Below studies that include these different measures are investigated to capture how exchange rate movements shape car export flows.

Avsar and Turkcan (2013) examined how exchange rate volatility and bilateral exchange rates affect U.S. automotive exports to 37 trading partners over 1996-2008. Panel cointegration with FMOLS and DOLS methods was used for the analysis, and the results show that bilateral exchange rates negatively affect motor vehicle exports while exchange rate volatility has heterogeneous effects across final vehicles and auto-parts. Thorbecke (2017) examined how exchange rates affect Japanese automobile exports to 30 countries over 1992-2015. Weighted panel DOLS analysis results show that Japanese motor vehicle exports are highly sensitive to bilateral exchange rates, with exchange rate elasticities often exceeding unity. Huseyni et al. (2019) included the ratio of Türkiye's real exchange rate to the partner country's real exchange rate, together with importer GDP per capita; the real exchange rate effects on Türkiye's automotive industry exports were found to be insignificant. Crisandy et al. (2025) also included partner country exchange rate which is

measured as local currency per U.S. dollar in their study beside demand determinant and the results indicated that exchange rate has a negative and significant effect in both short and long run. The result means that partner-currency depreciation weakens Indonesia's vehicle exports. El Ebiary et al. (2026) investigated the effect of exchange rates on Egyptian automotive exports under global supply chain participation for 2000-2020 period. A bounds-test approach and estimated export-demand models showed that Egypt's strong dependence on imported automotive components weakens the conventional export-enhancing effect of currency depreciation. Hekim (2026) examined the asymmetric effects of real exchange rate movements on Türkiye's automotive trade balance with the EU for the 2002–2025 period using a NARDL framework. The results show that real depreciation of the Turkish lira significantly improves the automotive trade balance, whereas appreciations have weak or mostly insignificant effects.

The studies show that the effect of exchange rates on car exports is not uniform. While some studies find a clear negative effect, others report insignificant, asymmetric or heterogeneous effects across products and time horizon. This mixed evidence supports the inclusion of BRER in our model as a key determinant of Türkiye's automobile exports to France.

4. Dataset and Methodology

4.1. Dataset

In this study, the effects of France's economic policy uncertainty (EPU), France's new passenger car registrations and the bilateral real exchange rate (BRER) of the Turkish lira against the euro on Türkiye's automobile export value to France are examined. The quarterly dataset covers 2010Q1-2025Q3 period. The dependent variable is Türkiye's automobile export value to France under HS 8703, denominated in euros and obtained from the Turkish Statistical Institute (TÜİK). Since a bilateral HS 8703 export unit value index or product-specific export price index for Türkiye's automobile exports to France is not directly available, the nominal export series is converted into real terms by using the Harmonized Index of Consumer Prices: Motor Cars for France (Index 2025=100), retrieved from the Federal Reserve Economic Data (FRED) database. This deflator is selected because it is product-specific, destination-market based, and directly related to passenger cars, making it more appropriate for this bilateral automobile export series than broader price indicators such as the all-items CPI or GDP deflator. The resulting series therefore represents Türkiye's real automobile export value to France rather than export quantity. Also, the recent electric vehicle transformation in the European automobile market, where electric cars have become an increasingly important component of the new car sales (International Energy Agency, 2024). This transformation is not separately modeled because HS 8703 data are available only as aggregate quarterly automobile export values, without a consistent breakdown by electric, hybrid and conventional vehicles. After deflation, the real export series is seasonally adjusted using the X-13 ARIMA-SEATS procedure.

The first independent variable, France's EPU Index, developed by Baker et al. (2016) retrieved from the Economic Policy Uncertainty database. The original series is published at monthly frequency and it is converted to quarterly frequency by taking the simple arithmetic average of the three-monthly observations within each quarter. The second independent variable used to reflect France's car demand is the number of new passenger car registration in France, retrieved from the Institut National de la Statistique et des Études Économiques (INSEE) under the series "*Transport statistics – New passenger car registrations*". This series is also published at monthly frequency and it is converted to quarterly frequency by summing the three-monthly observations within each quarter. The BRER between Türkiye and France is computed as $BRER = \frac{HICP_{TR}}{(EUR/TRY) \times HICP_{FR}}$ where $HICP_{TR}$ and $HICP_{FR}$ denote Harmonized Indices for Türkiye and France, both retrieved from FRED database and EUR/TRY is the nominal exchange rate of the euro against the Turkish lira, retrieved from the Electronic Delivery Data System (EVDS) of the Central Bank of the Republic of Türkiye (CBRT). By

construction, an increase in BRER reflects a real appreciation of the Turkish lira against the euro. All the variables are log-transformed before the analysis. The transformed series enter the model as *LNEXPSA*, *LNFEPU*, *LNCARDEM* and *LNBREER* respectively.

Table 1: Summary of the Variables

Abbreviation	Description	Source	Adjustment
LNEXPSA	Türkiye's real automobile exports to France	TÜİK; FRED	Deflated; X-13 adjusted; natural log
LNFEPU	France Economic Policy Uncertainty Index	PolicyUncertainty.com	Quarterly average; natural log
LNCARDEM	France new passenger car registrations	INSEE	Quarterly sum; natural log
LNBREER	Türkiye–France bilateral real exchange rate	FRED; EVDS of CBRT	Computed index; natural log

4.2. Methodology

First, time series characteristics of the variables are initially examined through the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit-root tests in order to verify that none of the series is integrated beyond the first order. The Zivot–Andrews (ZA) test is then employed to account for possible structural breaks in the variables.

This study employs the Augmented Autoregressive Distributed Lag (A-ARDL) bounds testing approach to examine the short-run and long-run relationship among the variables. The A-ARDL approach extends the conventional ARDL bounds testing procedure introduced by Pesaran et al. (2001) by adding a test on the lagged levels of the independent variables to the standard overall F-test and the t-test on the lagged dependent variable. This structure, consisting of three tests, is important because the conventional bounds test may lead to misleading conclusions in the presence of degenerate cases; therefore, the augmented procedure provides a clearer basis for determining the cointegration status of the model (McNown et al., 2018; Sam et al., 2019). Another advantage of the method is that it relaxes the need to assume that the dependent variable is strictly $I(1)$, while preserving the ARDL framework's flexibility in models involving $I(0)$ and $I(1)$ variables, provided that none of the variables is $I(2)$ (Pesaran et al., 2001; Sam et al., 2019). In addition, the ARDL framework allows the short-run dynamics and long-run coefficients to be estimated within a single-equation error correction mechanism, which is useful for time-series models with a clearly defined dependent variable (Kripfganz & Schneider, 2023). Consequently, the model used to examine the cointegration relationship among variables is as follows:

$$\begin{aligned}
 \Delta LNEXPSA_t = & \gamma_0 + \alpha_1 LNEXPSA_{t-1} + \alpha_2 LNFEPU_{t-1} + \alpha_3 LNCARDEM_{t-1} \\
 & + \alpha_4 LNBREER_{t-1} \\
 & + \sum_{i=1}^{p-1} \beta_{1i} \Delta LNEXPSA_{t-i} \\
 & + \sum_{j=0}^{q_1-1} \beta_{2i} \Delta LNFEPU_{t-j} + \sum_{j=0}^{q_2-1} \beta_{3i} \Delta LNCARDEM_{t-j} \\
 & + \sum_{j=0}^{q_3-1} \beta_{4i} \Delta LNBREER_{t-j} + \mu_t
 \end{aligned} \tag{1}$$

In Equation (1), γ_0 is the constant term, Δ denotes the first-difference operator, and μ_t is the error term. The coefficient α_1 belongs to the lagged dependent variable, whereas α_2 , α_3 and α_4 are the coefficients of the lagged independent variables. These level terms are used to test the existence of a long-run relationship. The coefficients β_{1j} , β_{2j} , β_{3j} and β_{4j} capture the short-run dynamic effects of the differenced variables. The optimal lag lengths are determined by the Akaike Information Criteria (AIC) and indicated as p , q_1 , q_2 and q_3 respectively. AIC was used for all the analysis conducted in this study.

For A-ARDL, the overall F-test is (Pesaran et al., 2001):

$$H_0^F: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0 \quad (2)$$

t-test on the lagged value of dependent variable (Pesaran et al., 2001):

$$H_0^t: \alpha_1 = 0 \quad (3)$$

Additional F-test on independent variables (Sam et al., 2019):

$$H_0^{F_{ind}}: \alpha_2 = \alpha_3 = \alpha_4 = 0 \quad (4)$$

Equation (4) is the additional F-test on the lagged independent variables, which distinguishes the A-ARDL framework from the standard ARDL test.

5. Results and Discussion

5.1. Results

The descriptive statistics of the log transformed variables are reported in Table 2 as an initial stage of the empirical analysis:

Table 2: Descriptive Statistics

	LNEXPSA	LNFEPU	LNCARDEM	LNBRER
Mean	19.7926	5.6008	13.0846	4.3737
Median	19.8385	5.6097	13.0804	4.4084
Maximum	20.3125	6.2077	13.3489	4.7204
Minimum	19.1658	5.0912	12.6201	3.9512
Std. Dev.	0.2988	0.2679	0.1388	0.2478
Skewness	-0.1535	0.4177	-0.5167	-0.1836
Kurtosis	1.8383	2.6234	3.5542	1.4988
Jarque-Bera	3.7898	2.2042	3.6096	6.2697
Probability	0.1503	0.3322	0.1645	0.0435

According to the descriptive statistics, the variation of the samples is low over the sample period. The mean and median values are close so they do not show a serious imbalance in distribution. Although skewness values suggest mild asymmetry, kurtosis values point to non-extreme distributions. Except for *LNBRER*, all the variables are normally distributed at 5% level according to the Jarque-Bera test results.

Before estimating A-ARDL model, it is necessary to examine the stationarity properties of the series. Although A-ARDL framework allows variables integrated at different orders, $I(0)$ or $I(1)$, none of the variables should be integrated of order two, $I(2)$. Therefore, the results of the ADF, PP and ZA unit-root tests are reported in Table 3.

Table 3: ADF, PP and ZA Unit Root Test Results

		Level				First Difference	
		ADF	PP	ZA	Break Date	ADF	PP
With Intercept							
LNEXPSA	t-Stat.	-0.9462	-3.6398***	-4.8530*	2016Q3	-5.9170***	-17.3342***
LNFEPU	t-Stat.	-3.6859***	-3.6790***	-4.9128*	2017Q3	-10.6146***	-11.0959***
LNCARDEM	t-Stat.	-3.5053**	-3.5053**	-5.7529***	2020Q1	-8.3702***	-16.6576***
LNBRRER	t-Stat.	-1.0152	-1.0231	-3.1122	2017Q4	-7.5911***	-7.5902***
With Trend and Intercept							
LNEXPSA	t-Stat.	-2.1069	-6.1721***	-5.1459**	2016Q2	-5.9281***	-17.6485***
LNFEPU	t-Stat.	-4.3937***	-4.4663***	-5.2912**	2023Q2	-10.5342***	-11.5329***
LNCARDEM	t-Stat.	-4.0423**	-4.0213**	-5.6805***	2020Q1	-8.2958***	-16.4363***
LNBRRER	t-Stat.	-2.0494	-2.1555	-3.6027	2020Q2	-7.5549***	-7.5557***

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. For the ZA test, significance is evaluated according to the ZA critical values, not the reported standard p-values.

The unit root test results reveal that the variables have fixed order. For *LNEXPSA*, although the ADF test does not reject the unit-root null at level, both PP and ZA reject it at level. Since the ZA test accounts for an endogenous structural break, *LNEXPSA* can be treated as level-stationary with a break, $I(0)$. For *LNFEPU*, ADF, PP and ZA generally reject the unit root at level. Therefore, *LNFEPU* is stationary in level, $I(0)$. For *LNCARDEM*, ADF, PP and ZA consistently reject the unit-root null at level. This is the clearest $I(0)$ variable in the system. For *LNBRRER*, ADF, PP and ZA do not reject the unit-root null at level, while ADF and PP strongly reject it after first differencing. Therefore, *LNBRRER* is $I(1)$. The results confirm that the variables are a mixture of $I(0)$ and $I(1)$, and none is $I(2)$. Therefore, the stationarity requirement for the A-ARDL approach is satisfied.

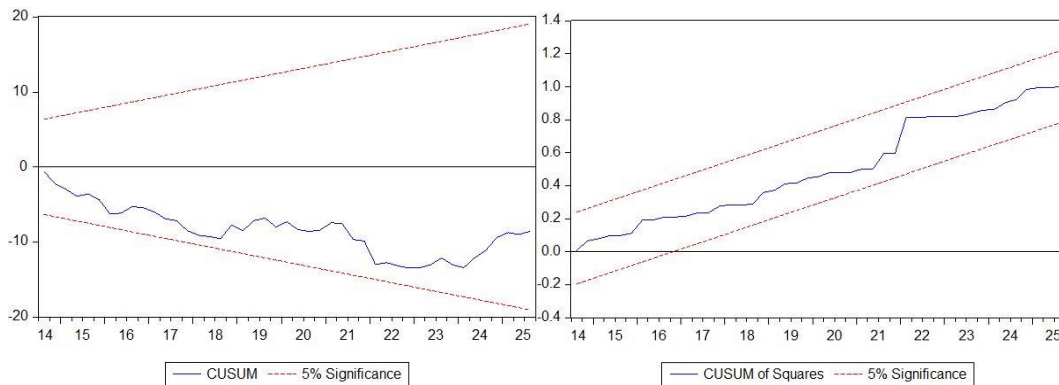
Although the ZA test suggests a possible structural break in *LNEXPSA* in 2016Q3, the inclusion of a step dummy taking the value of 1 from 2016Q3 onward does not materially change the estimation results. The dummy variable is statistically insignificant both in the short and the long run while the main coefficient signs and cointegration evidence remain unchanged. Therefore, following the parsimony principle, the baseline ARDL(1,4,1,4) specification without the dummy is retained as the main model, and the dummy-augmented specification is only considered as a robustness check.

Prior to proceeding with the bounds test, several diagnostic tests were conducted to validate the consistency of the model. These findings are reported in Table 4 and both CUSUM and CUSUMSQ test results are presented in Figure 1. The results confirm that the model is econometrically valid and structurally stable.

Table 4: Residual and Stability Diagnostics for ARDL(1, 4, 1, 4)

Test	Statistics
Jarque-Bera normality test	3.1814
Breusch-Godfrey LM test (Obs.*R ²)	0.4221
Breusch-Pagan-Godfrey test (Obs.*R ²)	14.7973
Ramsey RESET test (F-statistic)	1.3534
R ²	0.7675

Figure 1: CUSUM and CUSUMQ Results



The diagnostic test results and the R2 value of 0.76 suggest that the model does not suffer from major econometric problems such as non-normality, serial correlation, heteroskedasticity or functional form misspecification. In addition, the CUSUM and CUSUMQ plots remain within the 5% significance bounds, indicating that the estimated coefficients are stable over the sample period.

The A-ARDL bounds test includes two auxiliary tests in order to rule out degenerate cases that may falsely indicate cointegration. These three tests are: (i) standard overall F-test on all lagged level coefficients; (ii) a t-test on the lagged dependent variable; and (iii) an additional F-test on the lagged independent variables only. All these three test results are presented in Table 5:

Table 5: A-ARDL Bounds Test Results

Hypothesis	Test statistic	I(0) 1% Critical Value	I(1) 1% Critical Value
Overall F-test	13.645	4.29	5.61
t-test on $LNEXPSA(-1)$	-7.2896	-3.43	-4.60
Independent F-test	14.3627	4.24	6.83

All three A-ARDL conditions are satisfied at the 1% level, as the test statistics are above the I(1) upper bounds for all of them. These results are the robust evidence of a valid long-run cointegration relationship among $LNEXPSA$, $LNFEPU$, $LNCARDEM$, $LNBRER$.

The short-run and error correction term (ECT) coefficients estimated by the A-ARDL model are presented in Table 6:

Table 6: Short-Run and ECT Results

Variable	Coefficient	t-statistic
D(LNFEPU)	0.2065	1.7345*
D(LNFEPU(-1))	-0.3889	-2.7401***
D(LNFEPU(-2))	-0.2013	-1.4229
D(LNFEPU(-3))	-0.2827	-2.4517**
D(LNCARDEM)	0.8838	4.0346***
D(LNBRER)	-0.3867	-0.9926
D(LNBRER(-1))	0.8071	2.0426**
D(LNBRER(-2))	0.0637	0.1531
D(LNBRER(-3))	0.9639	2.2983**
ECT(-1)	-0.9679	-7.2896***

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The optimal lag structure (1, 4, 1, 4) is determined by the AIC.

ECT(-1) has a coefficient of -0.9679 and is statistically significant at the 1% level. This indicates a strong and rapid adjustment toward the long-run equilibrium. Approximately 96.79% of the previous quarter's disequilibrium is corrected within one quarter. The high adjustment speed is consistent with the fact that *LNEXPSA* is $I(0)$. Since a stationary dependent variable is mean-reverting, deviations from the long-run level relationship are corrected rapidly. Therefore, the large and significant ECT coefficient does not indicate a problem; it reflects fast convergence.

In the short run, France's EPU has mixed effects on Türkiye's real automobile exports to France. The contemporaneous coefficient of *D(LNFEPU)* is positive and weakly significant, indicating that 1% increase in uncertainty is associated with a 0.21% increase in exports in the same quarter. However, the first and third lags of *D(LNFEPU)* are negative and statistically significant. It shows that a 1% increase in uncertainty reduces exports by 0.39% after one quarter and 0.28% after three quarters while the second lag is statistically insignificant. *D(LNCARDEM)* has a positive and highly significant coefficient. This result indicates that 1% increase in new passenger car registration increases Türkiye's real automobile exports by 0.88% in the short run. For *LNBREER*, the contemporaneous and second-lag effects are statistically insignificant, whereas the first and the third lags are positive and significant. Since an increase in *LNBREER* represents the real appreciation of the Turkish lira against the euro, 1% increase in *LNBREER* is associated with a 0.81% increase in exports after one quarter and 0.96% after three quarters.

The long-run coefficients estimated by the A-ARDL model are presented in Table 7:

Table 7: Long-Run Results

Variable	Coefficient	Std. Error	t-statistic
Constant	3.5047	2.9189	1.2007
LNFEPU	0.6546	0.1538	4.2571***
LNCARDEM	1.2721	0.2171	5.8587***
LNBREER	-0.9137	0.1195	-7.6466***

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

In the long run, the constant term is statistically insignificant and it does not have a meaningful standalone effect in the model. *LNFEPU* has a positive and statistically significant coefficient at the 1% level. This coefficient shows that 1% increase in France's EPU is associated with a 0.65% increase in Türkiye's real automobile exports to France. *LNCARDEM* is also positive and statistically significant at the 1% level. A 1% increase in new passenger car registrations in France increases Türkiye's real automobile exports by 1.27% in the long run. *LNBREER* has a negative coefficient, which is also significant at 1% level. Accordingly, 1% real appreciation of the Turkish lira against the euro decreases Türkiye's real automobile exports to France by 0.91%.

5.2. Discussion

In the short run, France's EPU does not affect Türkiye's real automotive exports to France uniformly. The immediate coefficient of *D(LNFEPU)* is positive but weakly significant; the first and third lagged coefficients are both negative and significant at 1% level. According to these results, the uncertainty reduces exports after a short delay. The short-run negative effects are also consistent with Hu and Liu's (2021) results, who report that EPU can generate short-term effects on exports and with Zhao and Tang's (2024) study which shows that uncertainty diminishes automobile-related exports in the short run. However, the long-run coefficient of *LNFEPU* is both positive and statistically significant. This positive relationship is also found by Bahmani-Oskooee and Xu (2022) and Bahmani-Oskooee and Harvey (2023), who showed that uncertainty can produce positive long-run trade effects in some contexts. In this present study, this result should not be interpreted as direct evidence of a demand-composition mechanism. Rather, it suggests a possible channel through which higher uncertainty may be associated with a shift in French automobile demand toward relatively lower-cost imported vehicles. Köhler and Calleja Jiménez (2012) showed

that increasing uncertainty may shift car demand towards low-cost and used cars and increase market polarization. Therefore, the positive coefficient of uncertainty may reflect a possible reallocation of demand toward the types of vehicles in which Türkiye has a stronger export position. However, since the model does not include vehicle segment level or model level export data, this interpretation should be treated as a plausible explanation rather than a directly tested mechanism.

$D(LNCARDEM)$ has a positive and statistically significant coefficient in the short run. According to this result, increases in new passenger car registrations in France immediately raise Türkiye's real automobile exports to this market. This result is theoretically consistent because new car registrations directly reflect current automobile demand in the destination country. It is also supported by Paredes (2017), who shows that demand shocks increase car registrations and may raise both domestic and foreign car production through cross-country spillovers. Similarly, Klein et al. (2021) show that the automobile sector is strongly dependent on foreign demand and that weak car demand negatively affects automobile production. In the long run, $LNCARDEM$ also has a positive and statistically significant coefficient. It shows that France's automobile demand is a persistent determinant of Türkiye's automobile exports to France. This long-run result is consistent with Uemoto and Ramstetter (2004), who find that partner-country income indicators positively affect vehicle exports, Huseyni et al. (2019), who report a positive effect of importer country's real GDP per capita on Türkiye's automotive exports and Crisandy et al. (2025), who find that importer country's real GDP positively affects exports in both the short and long run. Overall, the positive coefficients confirm that Türkiye's automobile exports to France are strongly demand-driven, and new passenger car registrations constitute an appropriate sector-specific demand indicator for this relationship.

Lastly, in the short run, the effect of $LNBREER$ on Türkiye's real automobile exports to France is mixed. The contemporaneous and second lag coefficients are statistically insignificant, while the first and third lags are positive and significant. Since an increase in $LNBREER$ represents the real appreciation of the Turkish lira against the euro, the short-run positive coefficients suggest that appreciation does not immediately weaken automobile exports and may temporarily coincide with stronger export value. This short-run result can be linked to the structure of the automotive exports, where export orders, contracts, imported inputs and production planning may delay the conventional price-competitiveness effect of exchange rate movements. This is consistent with studies showing that exchange rate effects on automotive exports may be insignificant, heterogeneous or weakened by sectoral structure and imported input dependence such as Huseyni et al. (2019) and El Ebiary et al. (2026). However, in the long run, $LNBREER$ has a negative and statistically significant coefficient. This result indicates that real appreciation of the Turkish lira reduces Türkiye's automobile exports to France. This finding is consistent with the standard competitiveness channel and it is supported by Avsar and Turkcan (2013), who report a negative effect of bilateral exchange rates on motor vehicle exports, Thorbecke (2017), who shows that automobile exports are highly sensitive to exchange rate movements. It is also compatible with Hekim (2026), who finds that real depreciation improves Türkiye's automotive trade balance. This implies that appreciation is less favorable for export performance. Overall, the long run results indicate that the short-run effect of $LNBREER$ is delayed and heterogeneous whereas the long-run effect follows the expected competitiveness mechanism.

6. Conclusion

In this study, short-run and long-run effects of France's EPU, new passenger car registrations and the BREER on Türkiye's real automotive exports were examined. The study covers 2010Q1-2025Q3 period. A-ARDL method was used for the analysis so long-run relationships could be tested in a dynamic framework. This method also controls for possible degenerate cases, which may give misleading cointegration relationships.

The empirical results confirm that significant relationships exist among the variables both in the short run and in the long run. The ECT coefficient is negative and significant, which shows a rapid adjustment mechanism towards equilibrium in case of deviations. The short-run effects of France's EPU are mixed; however, the negative relationship is statistically stronger. However, the long-run effect is positive, which may suggest that increasing uncertainty shifts car demand in France toward low-cost automotive imports from Türkiye. France's new passenger car registrations affect exports positively both in the short run and the long run and it makes demand a crucial determinant of the exports. The short run effects of the BRER are not only delayed, but also heterogeneous. However, in the long-run, when the Turkish lira appreciates, Türkiye's automobile exports to France decrease. These findings indicate that Türkiye's automobile exports to France are shaped by uncertainty, demand and price competitiveness.

There are several suggestions to be made on automobile export policies using these results. Exchange rate competitiveness is not the sole determinant of Türkiye's automobile export performance. The ability of the automotive sector to maintain its position is also crucial, and this position is highly demand-sensitive. So, the policies should support cost efficiency, local input capacity, export-oriented production planning and model diversification towards entry-level automobiles. These may strengthen Türkiye's resilience against uncertainty and exchange rate pressures. In addition, it is important to monitor destination market demand indicators such as new car registrations, which can help exporters and policymakers to anticipate changes more effectively.

Future research may extend this analysis by using automobile export quantities, firm-level export data or model-specific vehicle segments. The HS 8703 export data used in the analysis aggregate different automobile segments under a single product category. Therefore, Türkiye's automobile exports to France may be treated as a homogeneous export flow. Such extensions would allow a more detailed examination of whether uncertainty and exchange rate movements affect low-cost, middle-segment and higher-segment vehicles differently. Also, COVID-19 period also presents a further limitation. Although the CUSUM and CUSUMSQ results suggest parameter stability for estimated results, the pandemic may still have affected the transmission channels between the dependent and independent variables.

Statement of Support and Appreciation: This research did not receive any external support.

Declaration of Researcher's Contribution Rate: The author is entirely responsible for the research.

Conflict Declaration: The author of the research does not declare any conflict of interest.

Research and Publication Ethics Statement: All rules specified in the "Higher Education Institutions Scientific Directive" were followed at every stage of this research. None of the actions specified under the heading "Actions Contrary to Scientific Research and Publication Ethics" of the directive have been carried out. During the writing process of this study, citations were made in accordance with ethical rules, and a bibliography was created. The work has been checked for plagiarism.

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