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Trade Policy Uncertainty and Beyond: Asymmetric Macroeconomic Determinants of Türkiye's Food Exports to the U.S.

Ticaret Politikası Belirsizliği ve Ötesi: Türkiye'nin ABD'ye Gıda İhracatının Asimetrik Makroekonomik Belirleyicileri

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Abstract
Food exports hold growing importance for Türkiye and the United States is one of the leading markets in this sector. Several economic factors affect Türkiye's food export revenues to the U.S. such as income levels, global food prices, trade policy-related uncertainties and currency strength. Using quarterly data for the 2002: Q1-2024: Q4 period, this study applies a nonlinear ARDL model that decomposes each factor into its positive and negative shocks to uncover asymmetric effects. The findings show that, in the short run, positive shocks to global food prices increase Türkiye's food-export revenues to the U.S. and negative shocks to uncertainty also boost them. In the long run, food prices and income become statistically insignificant and it implies structural rigidities. However, uncertainty exhibits a significant asymmetric effect. While higher uncertainty yields trade diversion gains but stability generates substantially larger increases in export revenues. Additionally, real appreciation of the Turkish lira significantly reduces revenues, whereas depreciation does not boost them. These results underscore the importance of flexible export strategies that account for structural constraints and policy changes.

Keywords: Food exports, trade policy uncertainty, asymmetry, NARDL model

Öz
Gıda ihracatı Türkiye için giderek artan bir öneme sahipken, Amerika Birleşik Devletleri bu sektördeki başlıca pazarlardan biridir. Gelir düzeyi, küresel gıda fiyatları, ticaret politikası belirsizliği ve reel döviz kuru gibi çeşitli ekonomik faktörler. Türkiye'nin ABD'ye yaptığı gıda ihracatı gelirlerini etkilemektedir. Bu çalışma, 2002: Q1-2024: Q4 dönemi çeyreklik verilerini kullanarak, asimetrik etkileri ortaya çıkarmak amacıyla her bir faktörü pozitif ve negatif şoklarına ayıran doğrusal olmayan ARDL modelini uygulamaktadır. Bulgular, kısa vadede küresel gıda fiyatlarındaki pozitif şokların Türkiye'nin ABD'ye gıda ihracatı gelirlerini arttırdığını, belirsizlikteki negatif şokların da gelirleri desteklediğini göstermektedir. Uzun vadede ise gıda fiyatları ve gelir değişkenleri istatiksel olarak anlamsız hale gelmekte, bu durum yapısal katılıklara işaret etmektedir. Ancak belirsizlik, anlamlı bir asimetrik etki sergilemektedir. Yüksek belirsizlik ticaret sapması yoluyla kazanç sağlasa da istikrar ihracat gelirlerinde çok daha büyük artışlar yaratmaktadır. Ayrıca, Türk lirasının reel değerlenmesi gelirleri önemli ölçüde azaltırken, değer kaybı ihracatı arttırmamaktadır. Bu sonuçlar, yapısal kısıtları ve politika değişikliklerini dikkate alan esnek ihracat stratejilerinin önemini vurgulamaktadır.

Anahtar Kelimeler: Gıda ihracatı, ticaret politikası belirsizliği, asimetri, NARDL modeli

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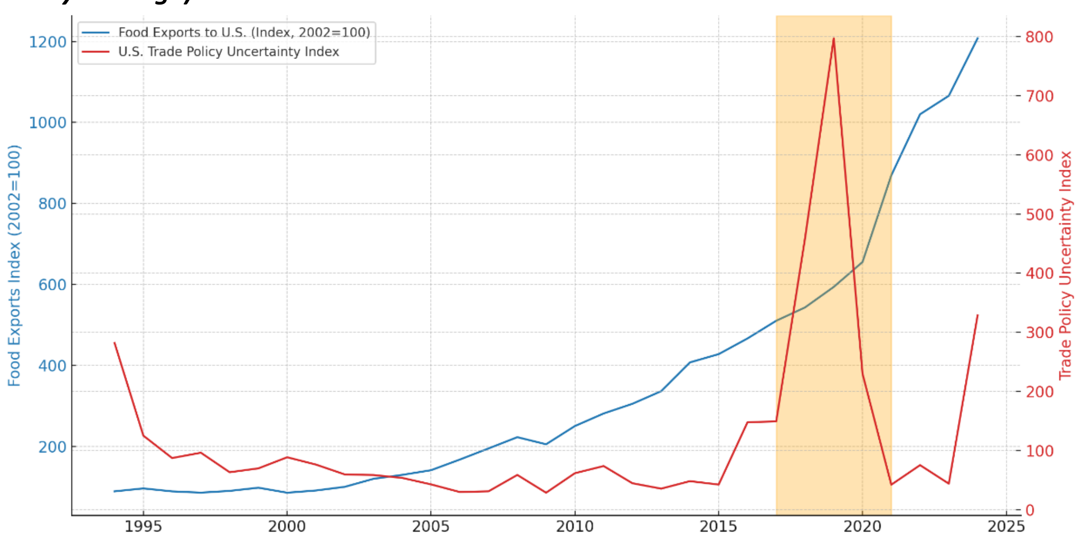
Introduction

The food sector holds a strategic position in Türkiye's economy due to its significance both for domestic consumption and foreign trade. This sector encompasses not only agricultural production but also livestock and processed food products. The considerable importance of the food industry further emphasizes its role in Türkiye's foreign trade. Ensuring sustainability and enhancing competitiveness require a precise analysis of the factors influencing the sector's export performance. In 2023, food exports reached USD 25.4 billion, accounting for 10.95% of total exports (Turkish Statistical Institute, 2025). The United States (U.S.) is also an important export market for Türkiye where the value of these exports is rapidly increasing. In 1994 the total value of food product exports was only USD 100.74 million and it remained almost at the same level until the beginning of the 2000s. However, it started to increase in 2002 and reached USD 1.36 billion in 2024. It makes the U.S. a major food export market for the country (Turkish Statistical Institute, 2025). Nevertheless, exports are highly sensitive to the fluctuations in trade policies and changes in regulations can significantly impact trade flows by increasing costs, causing supply chain disruptions and leading to cautious investment decisions among exporters. In 2017, when Donald Trump first took office, the U.S. trade policy uncertainty increased sharply. Figure 1 illustrates both the increasing exports and the peak periods of policy uncertainty:

Figure 1.

Türkiye's Food Exports to the U.S Index (1994–2024, 2002 =100) and The U.S. Trade Policy Uncertainty Index (1994–2024, Yearly Average)



Note: Turkish Statistical Institute, 2025 & Trade Policy Uncertainty and Market Volatility, 2025. https://www.policyuncertainty.com/trade_uncertainty.html

As highlighted in Figure 1, the U.S. trade policy uncertainty index shows a sharp increase during Donald Trump's first presidency (2017–2021). Initially, the protectionist policies implemented by Trump's administration directly targeted China and average import tariffs on Chinese products increased to 18.3% in May, 2019 from 3.1% in January, 2017 (Bown & Zhang, 2019). The increase in U.S. tariffs across all countries was less sharp, rising from less than 2% in January 2017 to 4% in May 2019 (Bloom et al., 2019). Although these tariff spikes affected bilateral trade between the U.S. and its main trade partners, they also created opportunities for other countries. Fajgelbaum et al. (2024) find that global trade increased by 3% in this period, as export growth was stronger on average. As U.S.-China trade contracted, significant trade diversion occurred as importers sought alternative suppliers. Nicita (2019) estimates that USD 21 billion of the U.S. imports diverted to other countries in the first half of 2019 and USD 1.06 billion of this amount consisted of agri-food imports. The trade war curbed global trade growth and changed trade patterns; however, some exporting countries clearly benefited from it.

Agriculture and food trade were specifically at the center of the trade war, as many retaliatory tariffs targeted U.S. farm products. Retaliating countries raised tariffs on 908 products and this affected about USD 32 billion of the U.S. agriculture and food exports (Carter & Steinbach, 2020, p. 1). However, this massive contraction in U.S. food and agriculture exports created a substantial trade reorientation in global food markets. According to Carter and Steinbach's (2020) estimates, South

American and European exporters gained about USD 13 billion in new sales by supplying former U.S. customers. Food sector supply chains quickly adjusted and identified alternative suppliers. For example, grain and oilseed flows were rerouted with remarkable agility. Importers like China secured their supplies from non-U.S. companies and even U.S. exporters were able to find new buyers for their excess production (International Food Policy Research Institute, 2025). In summary, the trade war resulted in a significant reshuffling of market relationships. Once the tariffs were reduced again, some of the shifts were partially reversed; however, many of them became permanent. Although the food sector initially suffered from this war, it rapidly recovered and adapted to the trade barriers.

Similar to South American and European exporters, Türkiye also benefited from the trade diversion mechanism as U.S. importers sought to mitigate tariff risks and diversify their supply sources away from China. Crucially, the Section 301 tariffs imposed by the U.S. specifically targeted Chinese agricultural and food products under List 3, such as fruit and vegetable preparations (HS Chapter 20) and sugar confectionery (HS Chapter 17) (Office of the United States Trade Representative, 2018). Although Türkiye lost its Generalized System of Preferences (GSP) duty-free status in 2019, the standard tariffs applied to Türkiye remained significantly lower than the prohibitive punitive tariffs faced by Chinese competitors. Thus, Türkiye retained a relative price advantage and benefited from trade diversification (Nicita, 2019, p. 15).

Türkiye's food exports to the U.S. have expanded significantly, particularly over the past 15 years. In the early 2010s, the value of the annual food exports was only a few hundred million USD; however, it surpassed USD 1 billion in 2021 (Turkish Goods, 2022). The U.S. became Türkiye's second largest food export market following Iraq as of 2022 (World Bank, 2025a). Despite the U.S. terminating the GSP for Türkiye -which had previously allowed duty-free export access for various goods, including food products- Türkiye's food exports to the U.S. continued to increase (United States Trade Representatives, 2019). Türkiye's food exports to the U.S. encompass a wide range of categories. The leading sectors in Turkish food exports to the U.S. are cereals, pulses, oilseeds, fruit and vegetable products (both fresh and processed), olives, olive oil and fishery products (Duran, 2022). Significantly, the share of value-added products, such as juices and processed foods, is increasing relative to bulk agricultural commodities, aligning with Türkiye's strategy to export more "branded" and processed foods. In 2021, the single highest-value food item exported to the U.S. was gummy candies, valued at USD 120 million. This was followed by apple juice concentrates at USD 80 million and corn kernels at USD 79 million (Turkish Goods, 2022). As a result, Türkiye's food export sector has achieved remarkable growth in the U.S. market over the past decade. It has transformed from a minor player into a significant source of certain foods. This growing importance emphasizes the need to analyze the factors affecting Türkiye's food exports to the U.S. In particular, with Donald Trump's election for a second term as the U.S. President in 2025, trade policy uncertainty emerges as one of the most critical factors.

While extensive research explores food trade determinants, gaps remain in understanding the effects of disposable income per capita, global food prices, exchange rates and trade policy uncertainties on food exports. As the world stands on the verge of a rapid increase in trade policy uncertainties following Donald Trump's reelection as U.S. President, estimating the impact of these uncertainties becomes critical. Moreover, while most studies focus on linear relationships this study investigates asymmetric effects using the Nonlinear Autoregressive Distributed Lag (NARDL) model. This focus on asymmetry is particularly relevant for Türkiye. Due to the country's economic structure, Turkish exporters have historically operated under domestic economic volatility and possess a high degree of structural adaptability. This unique characteristic suggests that Türkiye might not merely be passively affected by global uncertainty but could actively expand during such crises by rapidly filling the supply gaps created by U.S. trade policy shifts. Furthermore, when uncertainty is anticipated because the tariffs are announced before the implementation, importers may bring purchases forward (front-loading). This behavior can amplify short-run trade diversion effects as it favors adaptable suppliers like Türkiye. These conditions make a nonlinear approach necessary for Türkiye. Nevertheless, it should be noted that limitations still remain, including data constraints on disaggregated exports and firm-level heterogeneity, which future researches should address.

The remainder of the study is organized as follows: Section 2 outlines the theoretical framework. Section 3 introduces the dataset and details the NARDL model. Section 4 presents econometric analysis results and section 5 discusses them. Finally, section 6 provides the conclusion and policy recommendations based on findings.

Theoretical Concept

First, as applicable to all types of demand, food demand is closely related to income level. According to Keynes (1936), higher income leads to higher consumption, including imported food products. In particular, imports of certain food categories with high-income elasticity, such as processed or high-value food, tend to rise strongly in line with increasing importer income (Suanin, 2021, p. 2). Conversely, Engel's Law suggests that, when food is considered as a necessity, the share of income spent on food falls as incomes grow (Zimmerman, 1932, p. 78). This does not necessarily imply that the absolute value spent on food decreases; however, food expenditure and the income do not always move in the same direction. Moreover, this relationship may not be linear. According to the Relative Income Hypothesis (Duesenberry, 1967), consumption behavior is downward sticky. When income decreases, consumers act asymmetrically and try to maintain their consumption standards, which creates a ratchet effect. This implies that, imports may not fall as sharply as they rose during an income decline. Another important theoretical framework regarding food exports and the income is the Linder Hypothesis. According to Linder (1961), countries with similar per capita income levels are more likely to engage in bilateral trade for the products like foods as they may share similar preferences and tastes. In this context, Türkiye seems to have a disadvantage as its GDP per capita was USD 13,105 compared to the U.S.' GDP per capita of USD 80,410 in 2023 (World Bank, 2025b). This significant gap implies that Turkish and American consumers may have different preferences, potentially limiting demand for Turkish food products. Nevertheless, it is essential to consider that Türkiye's food production can adapt to products consumed by other countries. Even though these products are not widely consumed by domestic consumers, there is a notable shift in Türkiye's agricultural production towards tropical fruits such as avocado, mangoes, dragon fruit, guava and papaya especially in the Mediterranean region. For example, the avocado production area increased to 16,500 acres in 2024 from 265 acres in 2012 in Alanya (East Fruit, 2024). Thus, contrary to Linder's hypothesis, Türkiye, with its rapid adaptation ability, can adjust its agricultural production to meet the demands of countries with higher per capita income and different food preferences.

The Global Food Price Index (GFPI) is an indicator reflecting worldwide prices for food commodities. Its fluctuations are closely related to export revenues. As Türkiye is a significant food exporter, higher global food prices generate higher export earnings per unit sold, which increases export revenues through a price effect (Terra, 2015, p. 76). This study employs the GFPI as an indicator of global food price conditions that affect export revenues. However, given that food security is critical, this positive linkage may change quickly depending on policy interventions. Following a surge in food prices, some exporting countries adopt export restrictions such as bans, quotas and taxes to protect domestic consumers from these spikes (Martin et al, 2024, p. 3). For example, during the 2007-2008 and 2010-2011 food price spikes, Russia curbed wheat exports to protect domestic consumers (Kharas, 2011). Accordingly, an increase in the global food price index can either boost or reduce exports depending on the exporter's trade policies. This situation creates a potential nonlinearity. While price drops may follow market dynamics, price increases often trigger asymmetric policy interventions such as bans and quotas. These interventions disrupt the standard supply curve.

The changes in trade policies directly affect international trade as expected, including food trade. Donald Trump's reelection has raised the possibility of a resurgence in protectionist tendencies in international trade and an increase in trade policy uncertainty, similar to the 2017-2021 period. In early February 2025, he announced the imposition of an additional 25% tariff on imports from Canada and Mexico and an additional 10% tariff on imports from China (Lawder et al., 2025). These measures indicate the onset of a new trade war era, making it crucial to accurately assess the impact of rising trade policy uncertainties on exporters. These increasing uncertainties are expected to be detrimental to international trade. The Theory of Irreversible Investment developed by Bernanke (1983) and the Real Options Theory introduced by Dixit (1989) argue that, under uncertainty and sunk costs, firms may delay investment due to the option value of waiting. This mechanism implies an asymmetry. Exporters face both uncertainty and high sunk costs, making the option to delay entry more relevant when uncertainty rises, whereas reduced uncertainty may not always trigger an immediate rebound. However, once uncertainty declines, the option value of waiting diminishes and previously postponed trade decisions may also be executed without further delay (Bernanke 1983; Dixit, 1989). The real options framework thus suggests a negative relationship between uncertainty and firms' export intensity (Cintio et al., 2023, p. 291). However, in some cases, exporters can find alternative markets for their products and it may even increase their total export values or uncertainty might be totally insignificant (Minondo, 2023, p. 1272). In addition, when uncertainty is concentrated on major suppliers, importers often allocate their sourcing away from these suppliers and shift toward third countries, which creates trade diversion effects (Nicita, 2019, p. 16). For example, a study conducted by Minondo (2023) revealed that the export revenue of firms in the U.S. affected by tariff hikes did not decline significantly compared to other Spanish exports as Spanish firms mitigated the impact by substituting tariffed products with those from unaffected countries and shifting to untaxed varieties. Beyond the Real Options Theory, increases in uncertainty may also be anticipated in advance. For example, tariff hikes are typically announced before they are implemented. In this case, importers may bring purchases forward (known as “front-loading”) and build inventories (import stockpiling) during the announcement to implementation window. This anticipation effect may cause imports to increase temporarily prior to tariff implementation so importers can avoid the tariff effects (Ma & Meng, 2023, p. 167). For example, prior to the imposition of higher U.S. tariffs in 2018, imports of washing machines and solar panels surged (Amiti et al., 2019, p. 195). Consistently, the stockpiling model predicts a surge in imports at the announcement of a future tariff increase and a magnified decline follows it after the tariff implementation when stockpiling is economical (Riker, 2019, p. 2).

The real effective exchange rate (REER) measures the value of the Turkish lira against a basket of currencies adjusted for relative inflation. An increase in REER means that the Turkish lira has appreciated in real terms and it makes Turkish goods and services more expensive to foreign buyers. A decrease in REER means a depreciation of the Turkish lira in real terms, which makes Turkish goods and services cheaper for foreign buyers and enhances their competitiveness. However, price elasticities are crucial for this mechanism to work, as explained by the Marshall-Lerner condition. The depreciation of the currency improves the trade balance of a country in the long run only if the sum of the price elasticities of import and export is greater than 1 (Bahmani-Oskooee & Baek, 2015). Additionally, firms may respond to exchange rate movements asymmetrically due to the Hysteresis Hypothesis (Baldwin, 1988). According to this hypothesis, strong exchange rate shocks can induce market entry or exit decisions that are not easily reversed due to sunk costs. Thus, an appreciation may lead to a market exit that is not symmetrically reversed by a subsequent depreciation. However, the imported input cost effect, which is also known as exchange rate pass-through (ERPT), plays a significant role on the effects of exchange rate volatility. ERPT refers to the percentage change in import prices, measured in the local currency, that occurs due to o one percent fluctuation in the exchange rate between the exporting and importing country (Campa, 2002, p. 5). ERPT may create an imported input effect; thus, when the currency appreciates, exporters benefit from cheaper imported inputs, which can offset the negative impact of currency appreciation on export competitiveness (Vigfusson et al., 2007, p. 4). For example, Casas (2020) revealed that industries relying heavily on imported inputs exhibit a stronger exchange rate pass-through effect on prices. In the food sector, dependency on imported inputs such as energy, fertilizers and machinery etc. causes costs to increase when the lira depreciates and reduces competitiveness. Acar (2014) shows that Türkiye is import-dependent for animal feed. Atalaysun (2016) also indicated that, the country is highly dependent on imports for food additives such as enzymes and processing aids. These dependencies significantly reduce the potential gains that can be derived from lira depreciation and may even cause a decrease in exports due to the loss of price advantage.

As a summary, the response of food exports to different variables depends on a country’s economic structure. Higher income boosts imports of high-value foods, yet Engel’s Law and the Linder Hypothesis suggest different effects. Global food prices raise export revenues but may also trigger trade restrictions. Trade policy uncertainty deters investment but can be mitigated through market diversification. While a depreciation of REER should theoretically boost exports, Türkiye’s reliance on imported inputs raises costs and limits gains. Moreover, consumption behavior exhibits ratchet effects (Duesenberry, 1967), market entry/exit decisions are subject to hysteresis during exchange rate fluctuations (Baldwin, 1988) and due to irreversibility, consumption and investments respond to uncertainty asymmetrically (Bernanke, 1983). Therefore, to capture these dynamic and asymmetric behaviors, this study employs the Nonlinear Autoregressive Distributed Lag (NARDL) approach as the appropriate empirical strategy.

Literature Review

International food trade is influenced by a range of factors such as income levels, global commodity prices, trade policy uncertainties and exchange rate volatility. Evaluating the influence of these factors is essential for countries like Türkiye which are integrating into global food markets. This literature review synthesizes key findings from various empirical studies on the determinants of agricultural and food exports, focusing on the roles of income, global food prices, policy uncertainties and exchange rate dynamics. It aims to contextualize Türkiye’s food exports to the U.S. within the broader academic discourse.

Several studies confirm that the income of importing countries plays a significant role in determining food trade, though the magnitude of this effect varies. Generally, these studies use Gross Domestic Product (GDP) as a measure of income.

Crescimanno et al. (2013) identified a strong positive relationship between importer GDP and Italy's agri-food exports to non-EU Mediterranean countries. Elshehawy et al. (2014) and Tesfaye (2014) reported that importer GDP positively influences agricultural exports from Egypt and Sub-Saharan Africa. Bojnec and Ferto (2015) found that larger OECD economies generate higher demand for agro-food exports, though wealthier nations may shift towards domestic production while de Jesus Xaiver and dos Reis (2022) found that Brazil's agricultural exports respond positively to GDP growth in importing nations. Sugiharti et al. (2020) and Abdullahi et al. (2022) confirmed similar findings for Indonesia and China, noting that economic size drives export demand. Barma (2017) and Ristanović and Stevanović (2022) further supported these results for India and Serbia, though the impact was modest in Serbia due to competitive dynamics within the EU. However, contrasting findings also exist. For example, Laurentino and Reis (2022) reported that while importer GDP positively affects Brazilian exports of certain products, others like maize and soybean cake show a negative correlation, possibly due to shifts in consumption preferences.

Several studies examine global food prices as a determinant of food exports. The studies indicate that the direction and magnitude of this relationship vary. Elgali et al. (2011) found that higher world food prices significantly increase Sudan's agricultural exports. Cojocaru and Diaconu (2018) reported that food price indices positively influence Moldova's agricultural exports, as higher prices boost export revenues. Adnan et al. (2024) also confirmed a strong positive relationship between food prices and Jordan's food exports, imports and agricultural sector GDP. However, Martin and Anderson (2012) argued that when commodity prices boom, governments frequently implement insulating trade policies to protect domestic consumers. These measures sever the link between international price signals and domestic markets, thereby preventing global price increases from translating into export growth. Villoria (2012) found that China's rising food demand contributes to global food price inflation, benefiting some food-exporting nations, particularly in the oilseeds and processed food sectors, but not necessarily leading to a broad-based increase in food exports across all developing countries. Meanwhile, Bozma and İmamoğlu (2023) showed that higher food prices reduce Türkiye's vegetable exports by decreasing purchasing power and increasing competition, though fruit exports are more sensitive to exchange rate fluctuations. These findings suggest that while rising food prices generally support export revenues, their impact varies depending on trade policies, market structures and sectoral dynamics.

There are several studies that have worked on the relationship between food exports and both trade and economic policy uncertainties (TPU/EPU). Generally, these studies indicate that uncertainties affect these exports negatively. Gopinath (2021) analyzed U.S. agricultural trade and found that TPU disrupts trade flows, particularly during events such as Brexit and the U.S.-China trade war. Ma et al. (2023) adopted a different approach regarding China's WTO accession during the 2000-2007 period and found that the decline in TPU significantly increased its agricultural exports especially for the non-state firms that trade with developing countries. Yu et al. (2023) also showed that higher U.S. TPU reduced China's agricultural exports and imports with the U.S.; however, it increased imports from other regions due to trade diversion. Gignarta et al. (2024) conducted a global analysis, finding that both EPU and TPU significantly reduce agricultural exports across 60 countries, with emerging economies being more severely affected. In contrast to studies showing a negative relationship between uncertainties and trade, some studies demonstrate a positive relationship between these variables depending on the source of uncertainty, product categories and country-specific factors. For example, Nicita (2019) showed that although U.S. tariffs on China had a negative effect on Chinese agri-food exports to the U.S., reducing them by over 25% in the first half of 2019, the heightened policy uncertainty led to positive trade diversion effects for third countries, increasing their agri-food exports to the U.S. by approximately USD 1.065 billion during the same period. Bahmani-Oskooee and Xu (2022) showed that although U.S. policy uncertainty had a negative long-run effect on many U.S. agricultural exports to China, increased Chinese EPU sometimes led to a positive or insignificant effect on U.S. agricultural exports and China's imports. Lastly, Yang et al. (2024) found that the impact of U.S. TPU on China's grain trade is time-varying. According to this study, while wheat and maize exports were negatively affected, soybean exports showed positive responses during the 2018-2019 trade war. These findings underscore that, adaptive strategies such as market diversification can even create positive outcomes during the rise of uncertainties.

Agricultural trade and exchange rate movements are often studied by researchers; however, the results vary across countries, time periods and commodity types. For example, an early study by Edwards (1987) examined U.S. agricultural exports and revealed that, in general, currency depreciation boosts exports by making goods more competitive abroad. Buguk et al. (2003) focused on Türkiye and identified a long-run relationship between real exchange rates and agricultural exports, however, when inflationary and competitive pressures exist, there is no consistent short-run relationship. Kandilov

(2008), conducted a global analysis. The results showed that, especially, agricultural exports of developing countries with weaker financial systems are negatively affected by the exchange rate volatility. Erdem et al. (2010) also studied the role of exchange rate uncertainty for Türkiye and revealed that increasing uncertainty reduces agricultural trade. Yanikkaya et al. (2013) confirmed that when the real exchange rate depreciates, the exports of several Turkish products such as raisins and citrus are enhanced, however, the response is negative or mixed for monopolistic goods such as dried figs. Kohler and Ferjani (2018) studied the effects of the Swiss franc appreciation and the results indicated that agro-food exports decrease due to inelastic demand. Ali (2020), using firm-level data from Pakistan, revealed that depreciation improves both the value and variety of primary agricultural goods. Fedoseeva (2014) added that depreciation has a stronger positive effect on European agricultural exports to the U.S. than appreciation has a negative one, which indicates asymmetric responses. Mukhebi et al. (2024) reported that Kenya's agricultural export competitiveness improves with depreciation, however, short-term effects are limited. Lastly, Aslan (2024) showed that exchange rate shocks affect Türkiye's agricultural exports after a short delay, but the long-run impact is weak due to the low elasticity of global food demand. In conclusion, while depreciation generally enhances export performance, its effects may vary according to market structures, product characteristics and input cost dependencies.

The evaluation of the literature reveals that while fundamental economic variables such as income and exchange rates are important for trade flows, their impact varies. The conflicting evidence suggests that linear models may fail to capture the dynamics of food trade. For example, theoretically, depreciation should boost exports; however, if a country has a high import dependency in the agricultural sector, this advantage might be neutralized due to the pass-through effect. Similarly, uncertainty shows a dual mechanism. It generally suppresses trade. Yet, it also creates a trade diversion effects and opportunities for third countries. Consequently, the literature review identifies a theoretical gap as linear approaches struggle to explain why exporters react differently to positive versus negative shocks.

This study aims to fill this gap by investigating asymmetric and nonlinear impacts. Unlike studies that focus on aggregate global trade or use linear econometric models, this research specifically analyses Türkiye's food exports to the U.S., which is an important and growing sector but susceptible to policy volatilities. The trade uncertainty dimension is integrated into the analysis and structural rigidities are taken into account for asymmetric responses. By integrating nonlinear shocks, the study provides a more detailed understanding of how Türkiye's food exports to the U.S. react in an uncertain, price and demand volatile market.

Dataset and Methodology

Dataset

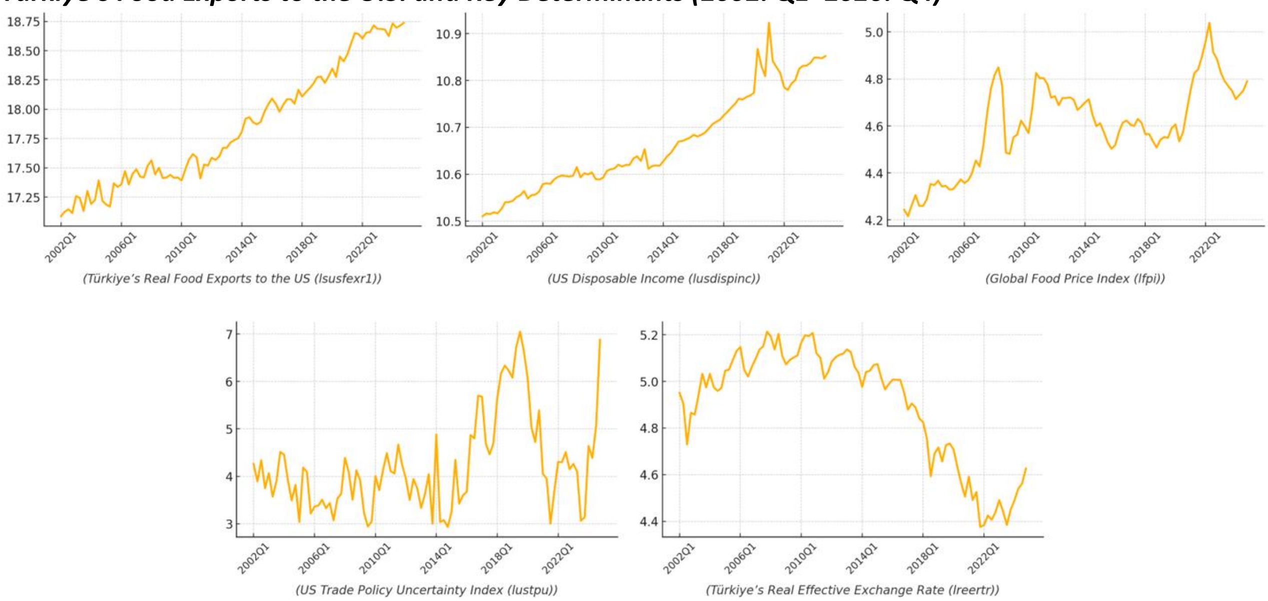
This study aims to estimate the effects of the U.S. disposable income, the global food price index (GFPI), the U.S. trade policy uncertainty index (TPUI) and Türkiye's real effective exchange rate (REER) on Türkiye's food exports to the U.S. for the period 2002: Q1-2024: Q4. All the datasets used in this analysis are quarterly. The dependent variable of the analysis is the value of Türkiye's food export revenues to the U.S., measured in real terms (USD). As these data are not directly available in real terms, nominal values were obtained from the Turkish Statistical Institute (TURKSTAT) database. The dataset corresponds to the "0-Food and Live Animals" category under the Standard International Trade Classification Revision 3 (SITC Rev.3). However, as the Bureau of Labor Statistics (BLS) discontinued several SITC-based price indices in 2005, the nominal values were deflated by the U.S. Import Price Index (End Use): Foods, Feeds, and Beverages (base year: 2000) obtained from the Federal Reserve Economic Data (FRED) of the St. Louis Fed. This substitution is methodologically grounded in Feenstra et al. (2002, pp. 17, 22), as they established a direct concordance between SITC Rev 3. codes and End-Use classifications within the NBER trade database record layouts. The nominal values were divided by this index and multiplied by 100. This variable represents the aggregate volume of food exports to the U.S. from Türkiye. The first independent variable is the real disposable personal income per capita, obtained from the FRED database. This variable was chosen as a proxy for the demand capacity of the U.S. consumers. It allows the model to test the income elasticity of Turkish food exports. The second independent variable is the GFPI, obtained from the Global Food and Agriculture Statistics of the Food and Agriculture Organization (FAOSTAT). This index is included in the model to control for exogenous global price shocks that affect export revenues and to capture the terms of trade effect. The third independent variable is the U.S. TPUI, obtained from policyuncertainty.com, as compiled by Ahir et al. (2018). This variable is a direct proxy for the protectionist policies and tariff volatility. It enables the quantification of the uncertainty shocks. The fourth and the final independent variable is Türkiye's

REER, which is also obtained from FRED. The REER is employed to measure Türkiye's price competitiveness relative to its trading partners. This is essential to verify the trade diversion and hysteresis mechanisms, where exchange rate advantages are crucial for market entry.

Prior to the analysis, all variables were log-transformed and normalized. Given the real value of the food exports data exhibits high seasonality, it was seasonally adjusted using the Census X-13 method. This method was selected over others as it is extensively used in official statistics and its ability to handle complex seasonal patterns (Findley et al., 1998, pp. 127-128). Following these adjustments, the variables are denoted as follows: food exports (*lsusfexr1*), disposable income (*lusdispinc*), GFPI (*lfpi*), the U.S.' TPUI (*lustpu*) and Türkiye's REER (*lreertr*). The Zivot-Andrews unit root test identified 2008: Q4 as a structural break date; therefore, a dummy, variable (*dum01*), taking the value of 1 from 2008: Q4 onwards was included in the NARDL specification to control for this break.

Figure 2 displays the time series plots of each adjusted variable:

Figure 2.
Türkiye's Food Exports to the U.S. and Key Determinants (2002: Q1–2020: Q4)



Note: Prepared by the author.

Methodology
This study employs the Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin et al. (2014) to analyze the relationship between the dependent and independent variables. This model allows for the determination of asymmetric impacts in both the long-run and the short-run. Compared to other methods, the NARDL model offers distinctive advantages over traditional cointegration tests. The most significant advantage is its ability to distinguish between positive and negative changes to capture asymmetric relationships and to estimate short-run and the long-run coefficients within the same model. Furthermore, the NARDL model accommodates variables that are either I(0) or I(1), and the presence of mixed integration orders does not compromise the robustness of the analysis (Allen & McAleer, 2021, p. 16). This model also incorporates an error correction mechanism (ECM) which helps to understand how quickly the variables revert to equilibrium following a disturbance (Nkoro & Uko, 2016, p. 79).

The stationarity of the variables is examined using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kapetanios, Shin, and Snell (KSS) unit root tests to ensure that none of the variables are I(2). Additionally, the Zivot Andrews (ZA) unit root test is applied to check for structural break dates. Following these tests, a Vector Autoregression (VAR) model is estimated to determine the optimal lag length and diagnostic tests are performed on the model to ensure both stability and the robustness.

Based on the asymmetric error correction framework of the NARDL model developed by Shin et al. (2014), the empirical equation utilizes a decomposed structure to capture both positive and negative shocks, as well as the dynamic interactions between the explanatory and dependent variables, as shown in the equation below:

$$\begin{aligned}\Delta lsusfexr1_{\mathrm{t}} &= \beta_0 + \beta_1 lsusfexr1_{t-1} + \beta_2^{+} lusdispinc_{t-1}^{+} + \beta_3^{-} lusdispinc_{t-1}^{-} + \beta_4^{+} lfpi_{t-1}^{+} + \beta_5^{-} lfpi_{t-1}^{-} \\ &+ \beta_6^{+} lustpu_{t-1}^{+} + \beta_7^{-} lustpu_{t-1}^{-} + \beta_8^{+} lreertr_{t-1}^{+} + \beta_9^{-} lreertr_{t-1}^{-} + \gamma dum01_t \\ &+ \sum\nolimits_{i=1}^{p} \alpha_{1,i} \Delta lsusfexr1_{t-i} + \sum\nolimits_{i=0}^{p} \alpha_{2,i} \Delta lusdispinc_{t-i}^{+} + \sum\nolimits_{i=0}^{p} \alpha_{3,i} \Delta lusdispinc_{t-i}^{-} \\ &+ \sum\nolimits_{i=0}^{p} \alpha_{4,i} \Delta lfpi_{t-i}^{+} + \sum\nolimits_{i=0}^{p} \alpha_{5,i} \Delta lfpi_{t-i}^{-} + \sum\nolimits_{i=0}^{p} \alpha_{6,i} \Delta lustpu_{t-i}^{+} + \sum\nolimits_{i=0}^{p} \alpha_{7,i} \Delta lustpu_{t-i}^{-} \\ &+ \sum\nolimits_{i=0}^{p} \alpha_{8,i} \Delta lreertr_{t-i}^{+} + \sum\nolimits_{i=0}^{p} \alpha_{9,i} \Delta lreertr_{t-i}^{-} + \varepsilon_t\end{aligned}$$

In above equation, $\alpha_{k,i}$ indicates short-run coefficients, β_k indicates long run coefficients and γ indicates the coefficient of the dummy variable. The short-run and long-run analyses examine the immediate effects of shocks in the independent variables on the dependent variable, while also assessing the extent of disequilibrium and the speed at which the system reverts to its equilibrium state. p and q denote the optimal lag lengths for the dependent and independent variables, respectively, as determined by the Schwarz Information Criterion (SIC). Finally, the effects of shocks in the independent variables are decomposed into their positive and negative components using partial sum processes, defined as follows:

$$x_t^{+} = \sum_{j=1}^{t} \Delta x_j^{+} = \sum_{j=1}^{t} \max\left(\Delta x_j, 0\right) \, and \; x_t^{-} = \sum_{j=1}^{t} \Delta x_j^{-} = \sum_{j=1}^{t} \min(\Delta \mathrm{x_j}, 0)$$

In above equation, x_t denotes the independent variables in the context of this study. Cointegration is tested using the bounds testing approach based on F-statistics and t-statistics, following the methodologies of Pesaran et al. (2001) and Banerjee et al. (1998). As highlighted by Shin et al. (2014), this approach evaluates asymmetric long-run cointegration by jointly testing all lagged levels of the independent variables. The null hypothesis for the F-statistic ($\beta = \beta^{+} = \beta^{-} = 0$) and the t-statistic ($\beta = 0$) implies the absence of cointegration, while the alternative hypothesis ($\beta = \beta^{+} = \beta^{-} \neq 0$ for F-statistics; $\beta \neq 0$ for t-statistics) suggests the presence of cointegration. If the computed test statistics exceed the upper critical bounds, the null hypothesis is rejected, indicating cointegration; if they fall within the bounds, the result remains inconclusive.

Finally, the cumulative dynamic multipliers based on the NARDL model are derived to trace the asymmetric adjustment patterns of the dependent variable following positive and negative shocks to the explanatory variables. As proposed by Shin et al. (2014), the dynamic multipliers are defined as:

$$m_h^{+} = \sum\nolimits_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^{+}} \; and \; m_h^{-} = \sum\nolimits_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^{-}}, \qquad h = 0,1,2, \ldots$$

Where $h \to \infty, m_h^{+} \to \beta^{+}$ and $m_h^{-} \to \beta^{-}$. Note that y_t represents the dependent variable and x_t represents the independent variables. These multipliers capture how the system transitions from the initial equilibrium in response to asymmetric shocks.

Results

Table 1 presents the descriptive statistics and the correlation matrix for the variables used in the analysis.

Table 1.
Descriptive Statistics and Correlation Matrix of the Variables

Variables	lsusfexr1	lusdispinc	lfpi	lustpu	lreertr
			Descriptive Statistics		
Mean	17.843	10.667	4.599	4.219	4.897
Median	17.726	10.631	4.606	4.064	4.997
Maximum	18.737	10.923	5.039	7.052	5.212
Minimum	17.087	10.510	4.216	2.930	4.375
Std. Dev.	.509	.105	.184	.980	.24
Skewness	.363	.511	-.173	1.100	-.754
Kurtosis	1.838	2.114	2.397	3.733	2.217
Jarque-Bera	7.189**	7.012**	1.849	20.625***	11.065***
			Correlation Matrix		
	lsusfexr1	**lusdispinc**	**lfpi**	**lustpu**	**lreertr**
lsusfexr1	1	.967	.648	.398	-.824
lusdispinc	.967	1	.616	.421	-.814
lfpi	.648	.616	1	.061	-.342
lustpu	.398	.420	.061	1	-.383
lreertr	-.824	-.814	-.342	-.383	1

Note: *(*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.*

The descriptive statistics indicate that the distribution of the variables is relatively balanced, as their mean and median values are closely aligned. The highest variability is observed in *lustpu* while *lusdispinc* exhibits the greatest stability. Skewness values indicate moderate asymmetry in most series. With the exception of *lfpi*, the null hypothesis of the Jarque-Bera normality test is rejected for all variables, which indicates significant non-normality. The correlation matrix reveals a strong positive relationship between *lsusfexr1* and both *lusdispinc* and *lfpi* while a distinct negative correlation exists between *lsusfexr1* and *lreertr*.

Prior to conducting the nonlinear autoregressive distributed lag (NARDL) analysis, the stationarity of the series was tested as the model requires that none of the variables be integrated of order two, I(2). The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to determine the integration order. Additionally, the Zivot-Andrews (ZA) unit root test was applied to check for the potential structural breaks. Furthermore, Kapetanios et al. (2003) (KSS) test was used to examine the stationarity properties of the series under the assumption of nonlinear adjustment. All unit root tests were conducted using two specifications: intercept only, and intercept with trend. For all the tests, the Schwarz Information Criterion (SIC) was adopted to determine the optimal lag lengths.

The unit root test results from both the ADF and PP test indicate that the variables are non-stationary at levels in general. However, after taking the first differences, all variables become stationary at the 1% significance level. This confirms that they are predominantly integrated of order one, I(1). The KSS test results present a mixed picture. While *lsusfxer1, lustpu and lreertr* support the unit root hypothesis, *lusdispinc* and *lfpi* exhibit nonlinear stationarity under the trend and intercept specification. Similarly, the Zivot-Andrews (ZA) test rejects the null hypothesis of a unit root for most variables at the level. These variables might be stationary with a structural break. Crucially, this mixed evidence of integration orders I(0) and I(1) justifies the use of the NARDL approach. It is valid regardless of whether the underlying regressors are I(0) or I(1), or mutually cointegrated, provided none are I(2). Furthermore, based on the ZA test results, 2008: Q4 was identified as the most significant endogenous structural break date for the dependent variable, *lsusfexr1*. Consequently, a dummy variable, *dum01*, which represents this break, was included in the model to ensure robust estimation. All detailed unit root test results are provided in Appendix A.

The validity of employing the NARDL approach depends on the presence of nonlinear characteristics within the time series. In this context, to test for the asymmetric structure of the variables, the BDS (Brock, Dechert and Scheinkman) linearity test

(Brock et al., 1996) was applied to each variable. The results are presented in Table 2.

Table 2.
BDS Test Results for Nonlinearity

Series	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6
lsusfexr1	.180***	.306***	.395***	.456***	.502***
lusdispinc	.181***	.304***	.389***	.447***	.488***
lfpi	.162***	.270***	.337***	.374***	.390***
lustpu	.100***	.168***	.217***	.246***	.255***
lreertr	.169***	.279***	.355***	.404***	.435***

Note: *(***) denotes the rejection of the null hypothesis of i.i.d. residuals at the 1% significance level.*

The results reported in Table 2 reveal that the null hypothesis of linearity is strongly rejected for all variables. This result confirms that the series exhibit a nonlinear structure. This evidence underscores the limitations of linear models in capturing the underlying dynamics and justifies the adoption of the NARDL model.

Prior to the application of the NARDL model, the maximum lag length was determined using the VAR approach. According to the lag length selection criteria, the maximum lag length was selected as 1 based on the SIC. Consequently, the NARDL model with the lowest SIC value was specified as (1, 0, 0, 0, 0, 0, 0, 0, 0). Prior to the bounds test, several diagnostic tests along with Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMQ) tests are applied to the model. The diagnostic test results indicate that the model satisfies the key assumptions of classical linear regression. The Jarque-Bera test for normality yields a statistic of .563 with a p-value of .755, suggesting that the residuals are normally distributed. The heteroskedasticity test based on the Obs. R-squared statistic produces a value of 9.244 with a p-value of .509, indicating the absence of heteroskedasticity. Additionally, the test for serial correlation returns an Obs. R-squared value of 2.09 with a p-value of .351, implying no evidence of autocorrelation in the residuals. Lastly, the Ramsey RESET test yields an F-statistic of 2.133 with a p-value of .148, which is above the conventional 5% significance level, suggesting no strong evidence of model misspecification. Furthermore, the CUSUM and CUSUMQ graphs show that the model's parameters remain stable over the sample period, as both plots stay within the critical bounds. These plots are provided in the Appendix B. Overall, the model is statistically sound and structurally stable.

Following the completion of diagnostic tests and stability checks, the bounds test was conducted to examine the existence of a long-run cointegration relationship among the variables. The results are presented in Table 3.

Table 3.
Bounds Test Results

Test Statistic	**Value**	**k**
F-statistic	6.472	8
Significance	**I(0) Bound**	**I(1) Bound**
10%	1.85	2.85
5%	2.11	3.15
1%	2.62	3.77

According to the bounds test results, the computed F-statistic exceeds the upper critical value I(1) at all convenient significance levels. This finding leads to the rejection of the null hypothesis of no cointegration. Thereby, the results confirm that a long run relationship exists between the dependent variable and the regressors. Consequently, the short- run coefficients and the Error Correction Term (ECT) are estimated and presented in Table 4.

Table 4.
Short Run Coefficients and Error Correction Term (ECT)

Variable	Coefficient	Std. Error	t-Statistic
D(LUSDISPINC_POS)	-.450	.423	-1.065
D(LUSDISPINC_NEG)	.106	.548	.193
D(LFPI_POS)	.465	.180	2.583**
D(LFPI_NEG)	-.138	.258	-.533
D(LUSTPU_POS)	-.002	.014	-.158
D(LUSTPU_NEG)	-.043	.018	-2.376**
D(LREERTR_POS)	-.349	.212	-1.650
D(LREERTR_NEG)	-.192	.158	-1.213
ECT	-.871	.108	-8.027***

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

According to the short-run analysis results presented in Table 4, positive shocks to global food prices and negative shocks to U.S. trade policy uncertainty are statistically significant whereas the remaining coefficients are statistically insignificant. A 1% increase in global food prices leads to a .465% increase in Türkiye's real food export revenues to the U.S. Regarding uncertainty, the coefficient for the negative shocks to U.S. trade policy uncertainty is -.043. This implies that a 1% decrease in uncertainty results in a .043% increase in export revenues. Crucially, the ECT is negative (-.871), statistically significant at the 1% level and falls within the required range of -1 to 0. This confirms the existence of a strong and stable adjustment mechanism toward the long-run equilibrium. The coefficient magnitude indicates that approximately 87% of the disequilibrium from the previous quarter is corrected in the current period. This high speed of adjustment further validates the robustness of the long-run relationship among the variables.

Table 5.
Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic
LUSDISPINC_POS	-.021	.378	-.056
LUSDISPINC_NEG	-.101	.288	-.350
LFPI_POS	.095	.103	.928
LFPI_NEG	.145	.139	1.046
LUSTPU_POS	.025	.013	1.948*
LUSTPU_NEG	-.056	.013	-4.426***
LREERTR_POS	-.180	.091	-1.984**
LREERTR_NEG	-.171	.125	-1.368
DUM01	-.136	.058	-2.340**
C	17.094	.030	563.713***

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

Table 5 presents the long-run asymmetric estimation results. The findings indicate that while asymmetric effects are evident for trade policy uncertainty, they are not observed for income levels or global food prices. Regarding U.S. real disposable income, neither positive nor negative shocks are statistically significant. Similarly, both positive and negative changes in global food prices are found to be insignificant. In contrast to disposable income and global food prices, U.S. trade policy uncertainty exhibits a significant and asymmetric effect on Türkiye's food export revenues to U.S. in the long run. Specifically, a 1% decrease in the U.S. policy uncertainty leads to a .056% increase in export revenues, which is statistically significant at the 1% level. On the other hand, a 1% increase in uncertainty is associated with a .025% increase in exports; however, this effect is weakly significant at the 10% level. Regarding the exchange rate, a real appreciation of the Turkish lira negatively affects its food export revenues to the U.S.; specifically, a 1% appreciation decreases exports by .18%. By contrast, the negative shock (real depreciation) is statistically insignificant. Finally, the coefficient of the dummy variable, *dum01*, is negative (-.136) and statistically significant at the 5% level. This implies that the structural break is associated with a statistically significant and permanent negative level shift in Türkiye's food export revenues to the U.S. over the sample period.

The existence of long-run asymmetry is formally validated with the Wald test. This test evaluates the null hypothesis of symmetry $(\beta^{+} = \beta^{-})$. According to the results, the null hypothesis cannot be rejected for U.S. disposable income, global food prices and the REER. Notably, regarding the REER, although the estimated coefficients in Table 5 suggest a potential divergence, the Wald test statistic confirms that the magnitude of the difference between the positive and negative coefficients is not statistically significant. In contrast, the test strongly rejects the null hypothesis for U.S. trade policy uncertainty. This empirical evidence confirms that the positive and negative shocks to trade policy uncertainty exert significantly different structural impacts on Türkiye's food export revenues to the U.S. These results also align well with the cumulative dynamic multiplier graphs. For lustpu, the adjustment paths diverge significantly. The asymmetry plot lies outside the 95% confidence bounds and confirms long-run asymmetry. In contrast, for lusdispinc, lfpi and lreertr, the response curves align closely and their asymmetry plots remain within the confidence intervals. The Wald test results and the cumulative multiplier graphs are presented in Appendix C.

Discussion

The short-run findings indicate that positive shocks to global food prices increase Türkiye's real food export revenues to the U.S. This finding is consistent with the export-revenue (price) effect discussed by Terra (2015). Although the theoretical framework suggests that price spikes may trigger policy interventions, the positive coefficient indicates that the "revenue effect" dominates any potential "restriction effect" in the short run. This aligns with the finding of Cojocaru and Diaconu (2018) and Adnan et al. (2024), who reported that higher food prices generally boost export revenues.

Regarding uncertainty, the negative shock to U.S. trade policy uncertainty suggests that lower uncertainty supports export performance. This inverse relationship is consistent with the Real Options Theory (Dixit, 1989). When uncertainty decreases, the option value of waiting diminishes and postponed trade decisions are executed. In the literature, the results of Ma et al. (2023) support this finding, as a decrease in uncertainty increases agricultural exports.

By contrast, the lack of significant short-run response to income aligns with Engel's Law (Zimmerman, 1932), which posits that food demand is relatively income inelastic. It is also consistent with downward stickiness implied by the Relative Income Hypothesis (Duesenberry, 1967). According to this hypothesis, food consumption does not adjust sharply especially during income declines. Similarly, the insignificance of exchange rate shocks in the short run may be interpreted through the Hysteresis Hypothesis (Baldwin, 1988), which implies that market entry and exit decisions involve sunk costs; so importers do not instantly react to short-term fluctuations due to the inertia created by sunk costs.

In the long run, the insignificance of disposable income is again consistent with Engel's Law explained by Zimmerman (1932), which posits that food demand is relatively income inelastic and that consumption of basic food items does not rise or fall proportionally with income. Likewise, the long-run insignificance of global food prices contrasts with the short-run findings and suggests that the revenue effect is temporary. This long-run insignificance aligns with Martin and Anderson (2012), who argue that when governments implement insulating trade policies against price volatilities, these policies sever the link between international price signals and domestic markets; thus, export adjustments cannot be sustained. In addition, as discussed in the theoretical framework, food price spikes may trigger intervention policies to protect domestic consumers (Kharas, 2011; Martin et al., 2024). These interventions ultimately weaken the persistence of a price-to-export linkage over the long run.

Unlike disposable income and global food prices, U.S. trade policy uncertainty exhibits a significant and asymmetric long-run effect. Specifically, the negative uncertainty shock strongly supports the Real Options Theory (Dixit, 1989) and the Theory of Irreversible Investment (Bernanke, 1983). Both theories suggest that reduced uncertainty encourages exporters to commit to long-term relationships. In the literature, the findings of Yu et al. (2023) and Gignarta et al. (2024) align with this result, as declines in uncertainty permanently support trade flows.

At the same time, the weakly positive coefficient for positive uncertainty shocks may be explained by the trade diversion hypothesis. Since U.S. policy uncertainty is generally concentrated on major trade partners such as China, U.S. importers may move away from riskier suppliers and shift toward alternative markets such as Türkiye during high-uncertainty periods. This interpretation also aligns with the study conducted by Nicita (2019), which shows that heightened policy uncertainty increased third-country revenues from agri-food exports. However, the positive shock coefficient is smaller in magnitude and only weakly significant compared to the negative shock. This implies that Türkiye benefits significantly more from policy stability than from episodes of heightened uncertainty and trade diversion.

With respect to the exchange rate, the negative impact of real appreciation is consistent with standard trade theories, as appreciation of the local currency weakens price competitiveness in international markets. The empirical analysis of Edwards (1987) also supports this finding. In contrast, the insignificance of the real depreciation shock likely reflects offsetting mechanisms rather than a robust expansion in export revenues. Although depreciation theoretically improves price competitiveness, Türkiye's food sector relies heavily on imported inputs such as energy, packaging and raw materials. Consequently, rising production costs may offset the competitive price advantage gained from a cheaper currency, thereby weakening the net revenue response (Acar, 2014; Atalaysun, 2016; Casas, 2020; Campa, 2002; Vigfusson et al., 2007). Accordingly, exchange rate pass-through and imported input cost considerations can dampen the competitiveness gain and prevent a statistically robust long-run export expansion following depreciation (Campa, 2002; Vigfusson et al., 2007). The insignificance of the negative exchange rate shock also aligns with Aslan's (2024) finding, who suggests that the long-run impact of exchange rate changes is often weak because the price elasticity of the global food demand is low.

Finally, the negative and significant coefficient of dum01 indicates that the structural break identified at 2008: Q4 corresponds to a permanent adverse shift in Türkiye's food export revenues to the U.S. Since this break date coincides with the Global Financial Crisis, the result suggests that the crisis generated a persistent downward level effect over the sample period.

The asymmetry analysis further strengthens the interpretation of the main findings. The Wald test and cumulative dynamic multiplier graphs jointly indicate that U.S. trade policy uncertainty is the only variable producing statistically significant long-run asymmetry. For lustpu, the adjustment paths diverge substantially and the asymmetry plot falls outside the 95% confidence bounds. By contrast, for lusdispinc, lfpi and lreertr, the response curves remain close to each other and the asymmetry plots stay within the confidence intervals. Taken together, these results show that trade policy uncertainty is the primary driver of asymmetric adjustment in Türkiye's food export revenues to the U.S., whereas income, prices and exchange rates display symmetric long-run effects.

Conclusion

This study is conducted to investigate asymmetric effects of key macroeconomic variables on Türkiye's food exports to the United States by using the Nonlinear Autoregressive Distributed Lag (NARDL) model for the 2002: Q1-2024: Q4 period, employing the most recent available datasets. By decomposing the effects of independent variables into their positive and negative components, the analysis provides a comprehensive understanding of how these variables influence Türkiye's food export revenue performance to one of the sector's main export market.

According to the empirical results obtained from the analysis, there is a significant long-run asymmetry specifically in the U.S. trade policy variable, whereas other variables exhibit symmetric or insignificant long run behaviors. U.S. trade policy uncertainty is the most dynamic driver of Türkiye's food export revenues to this country. Both increases and decreases of the policy uncertainties boost Turkish exports, however, the positive shock effect is weakly significant and smaller in magnitude. A 1% decrease in uncertainty (greater stability) increases export revenues by .056% while a 1% increase in uncertainty (lower stability) raises them only by .025%. Both the Wald test results and the dynamic multiplier band jointly confirm that the magnitudes of these positive and negative shocks are different in the long-run. According to this result, while Türkiye benefits from trade diversion during the global trade wars as U.S. importers shift away from rivals like China, the main driver of the export growth is a stable trade environment, which is consistent with the Real Option Theory.

Contrary to the asymmetric effects of uncertainty, global food prices and disposable income levels display a different pattern. In the short run, price spikes boost revenues via the revenue effect, however, in the long-run, food price changes are statistically insignificant. This result indicates that long-term export revenues are not affected by changing price signals, possibly due to insulating trade policies and related policy interventions that sever the connection between international prices and export adjustments. The U.S. disposable income is also insignificant. It confirms the Engel's Law; thus, when U.S. income grows, it does not translate into higher demand for Turkish products automatically.

The real effective exchange rate (REER) reveals a crucial structural rigidity. A 1% appreciation of Türkiye's REER significantly hurts exports by decreasing the revenues by .18%. However, depreciations do not lead to a significant increase in exports. Export revenues are unresponsive to devaluations likely due to heavy reliance on imported inputs such as energy, fertilizers in the Turkish food sector. Rising costs offset the competitive price advantage via the exchange rate pass-through mechanism. The Wald test indicates that there is no long run asymmetry. Because of the structural constraints, such as input dependency and market competitiveness, the magnitudes are statistically indistinguishable, although the responses are not identical. The exchange rate mechanism is ineffective in generating a net positive outcome.

There are several policy takeaways that should be obtained from these results. Firstly, the institutionalization of market intelligence is very crucial. The results clearly show that uncertainty creates a dual opportunity. Stable policies bring organic growth and chaos brings trade diversion gains. Therefore, it is critically important to track the shifts in U.S. policies in real time so Türkiye can fill the supply gaps left by competitors during trade wars. Secondly, since stability generates higher returns, targeted agreements in the food sector are required to enhance these gains during both stable and unstable trade policy periods. Using different instruments such as mutual recognition of food standards or tailored preferential trade agreements will accelerate Türkiye's access to U.S. market even after episodes of elevated uncertainty. Thirdly, since income elasticity is low and price signals are ineffective in the long run, the strategies should focus on high-value differentiation instead of price competition. Exports should shift their focus to higher value-added products so demand is driven by quality rather than volume. Lastly, as the depreciation fails to boost export revenues, the resources should be allocated to reduce import dependency in agriculture.

In conclusion, this study provides strong empirical support for the view that asymmetric responses to external economic shocks, especially those related to policy uncertainties, are critical in shaping Türkiye's food export performance. Türkiye must act strategically, quickly and structurally as global trade volatilities are rising again. It is important to turn temporary advantages into sustained economic gains. This includes deepening trade relations, upgrading export product variety towards high-value segments, enhancing supply chain competitiveness and institutionalizing market intelligence systems to support agile and informed policy responses.

Hakem Değerlendirmesi: *Dış bağımsız.*
Çıkar Çatışması: *Yazar, çıkar çatışması olmadığını beyan etmiştir.*
Finansal Destek: *Yazar, bu çalışma için finansal destek almadığını beyan etmiştir.*
Yapay Zekâ Kullanımı: *Yazar, bu çalışmada yapay zekâ araçlarının kullanılmadığını beyan etmiştir.*

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Appendices

Appendix A: Unit Root Test Results

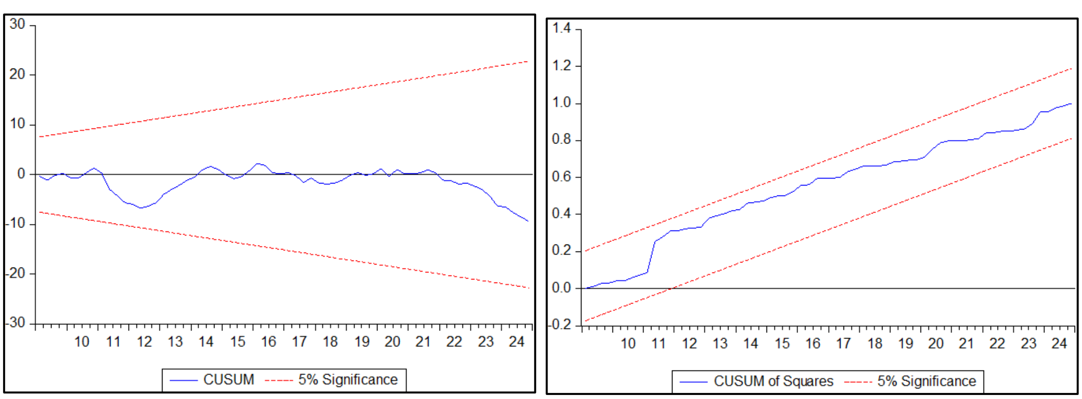
Table 1A.
ADF, PP, KSS and ZA Unit Root Test Results

		Level					First Difference	
		ADF	PP	KSS	ZA	ZA Break Date	ADF	PP
With Intercept								
lsusfexr1	**t-Stat.**	.045	.197	.038	-4.008***	2008: Q4	-13.459***	-16.159***
lusdispinc	**t-Stat.**	-.413	-.302	-1.552	-4.166***	2018: Q2	-4.922***	-14.377***
lfpi	**t-Stat.**	-2.598*	-2.102	-2.286	-4.344**	2014: Q3	-6.727***	-6.574***
lustpu	**t-Stat.**	-2.771*	-2.607*	-1.323	-4.218*	2016: Q2	-11.295***	-11.378***
lreertr	**t-Stat.**	-.855	-.806	-1.292	-3.316	2016:Q4	-10.181***	-10.181***
With Trend and Intercept								
lsusfexr1	**t-Stat.**	-3.397*	-3.077	-2.712	-4.272**	2008: Q4	-13.417***	-16.535***
lusdispinc	**t-Stat.**	-2.662	-3.531**	-5.039***	-4.287***	2020: Q2	-4.901***	-14.336***
lfpi	**t-Stat.**	-3.174*	-2.464	-3.820***	-4.251**	2014: Q3	-6.713***	-6.553***
lustpu	**t-Stat.**	-3.412*	-3.324*	-1.926	-4.383**	2016: Q2	-11.281***	-11.368***
lreertr	**t-Stat.**	-2.061	-2.021	-2.245	-3.354	2006: Q4	-10.211***	-10.224***

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

Appendix B: Model Stability Test

Figure 1B.
CUSUM and CUSUMSQ Test Graphs



Appendix C: Long-Run Asymmetry Test and Graph

Table 1C.
Wald Test Results

Variable	Restriction Tested	F-Statistic
LUSDISPINC	C(2) = C(3)	.038
LFPI	C(4) = C(5)	.070
LUSTPU	C(6) = C(7)	33.409***
LREERTR	C(8) = C(9)	.003

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

Figure 1C.
Dynamic Multipliers and Asymmetry Plots for Long-Run Effects