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# Macroeconomic factors affecting honey exports of Türkiye

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## Abstract

This research aims to examine the macro determinants of honey exports in Türkiye using monthly data from 2016 to 2025. The methodology used is the ARDL bounds testing approach. The dependent variable is the volume of honey exports. The macroeconomic variables include the real effective exchange rate, the deposit interest rate, the producer price index, and the industrial production index. The results indicate long-run cointegration between Türkiye's honey exports and these macroeconomic determinants. The results show that, in the long run, the real effective exchange rate and the industrial production index are statistically significant and positively associated with honey exports. This indicates that these macroeconomic determinants play a significant role in determining exports. The results, however, show a negative relationship between the producer price index and honey exports. This indicates that exports are constrained by price levels. The interest rate is found to have a positive effect on honey exports, indicating that financial conditions, not just interest rates, influence exports. The short-run results show that honey exports are determined by their own lag, indicating convergence over time. The results indicate that honey exports are influenced by factors beyond volume alone.

**Keywords:** International Trade, ARDL model, Honey exports, Interest rate, Producer price index

## INTRODUCTION

Global trade in agricultural and food products has emerged as a strategic issue, driven by factors such as population growth, changing consumer behavior, and rising food security concerns. In this context, honey and bee products have emerged as an important set of products with strategic significance for global trade in agricultural and food products, as they offer significant value addition and are produced naturally. In many countries, beekeeping has emerged as an important segment of agriculture, with strategic importance due to its low startup costs and compatibility with rural livelihoods. Global data on honey production across countries indicate that countries exhibit varying levels of production capacity, reflecting uneven competitiveness in the global market. According to data provided by the FAO (2025),

China is by far the largest honey-producing country, while Türkiye ranks second globally. Recent data indicate that Türkiye produces several times more honey than many developed and developing countries To provide a clearer picture of global honey production patterns, the leading honey-producing countries and their production volumes for the period 2019–2023 are presented in Table 1.

While Table 1 highlights Türkiye's strong production capacity in global honey markets, production alone does not necessarily translate into export performance. However, as discussed in TEPGE (2025), the link between production capacity and export potential is not as simple as it may seem. The low share of exports in total production is due to the fact that only a small amount of the honey made in Türkiye can be sold abroad. In other words, a large portion of the honey produced in Türkiye is consumed domestically. This situation shows that Türkiye's honey export performance can't be explained solely by supply-side factors. Exports should be considered alongside macroeconomic conditions, cost structures, financing opportunities, and price competition dynamics.

Annual data on Türkiye's honey exports show that the volume exported has changed significantly over time. The rapid rise in export volume, especially between 2021 and 2022, followed by a subsequent downward trend, suggests that honey exports are sensitive to macroeconomic and external shocks. To better illustrate the temporal evolution of Türkiye's honey export performance, annual export volumes for the period 2016–2024 are presented in Figure 1.

**Table-1 Leading honey-producing countries and their production volumes (2019–2023)**

| Countries | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| China | 444.054 | 458.1 | 472.7 | 461.9 | 463.5 |
| Türkiye | 109.33 | 104.077 | 96.344 | 118.297 | 114.886 |
| Ethiopia | 150.258 | 129.301 | 52.034 | 73.12 | 84.591 |
| Iran | 72.424 | 74.015 | 76.484 | 78.386 | 80.389 |
| Argentina | 71.195 | 73.539 | 72.919 | 73.047 | 73.395 |
| India | 67.961 | 70.546 | 74 | 75.732 | 70.85 |
| Russian Federation | 63.526 | 66.368 | 64.533 | 67.014 | 64.511 |
| Brazil | 45.801 | 52.493 | 55.679 | 62.494 | 64.189 |
| USA | 71.179 | 66.948 | 57.49 | 56.849 | 62.855 |
| Mexico | 61.986 | 54.165 | 62.079 | 64.32 | 58.033 |
| Ukrainian | 69.937 | 68.028 | 68.558 | 63.079 | 57.919 |
| Canada | 39.295 | 37.723 | 39.976 | 33.753 | 41.643 |

**Source:** FAO (2025), FAOSTAT database.

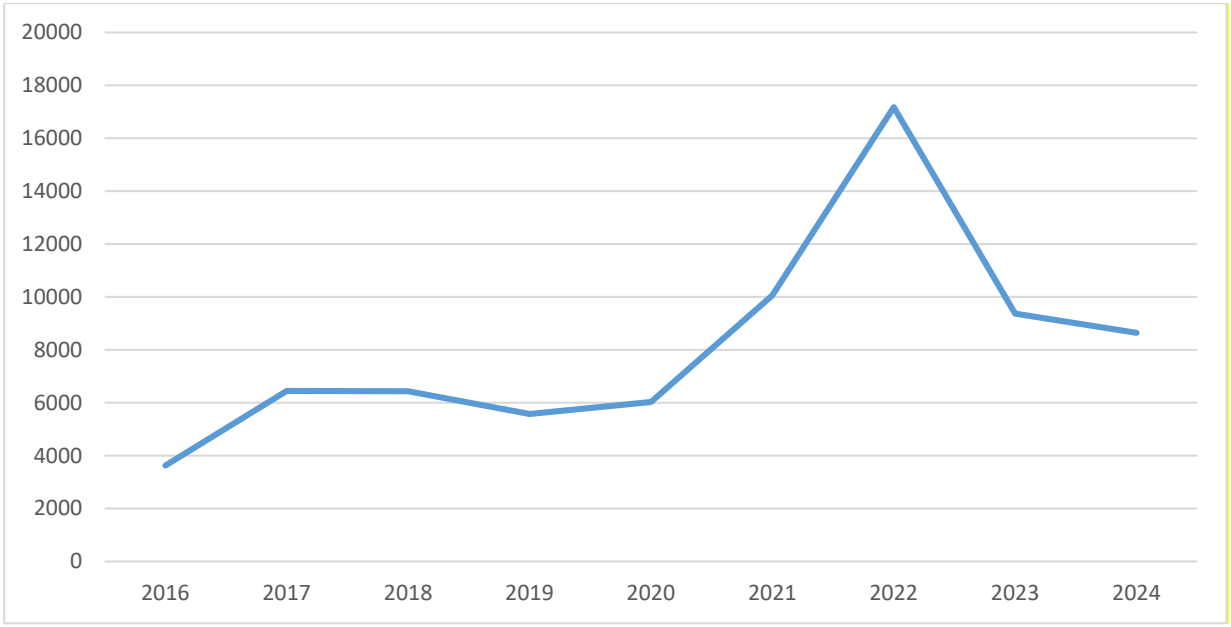


**Figure-1. Türkiye's annual honey exports 2016-2024 (Tons)**

As illustrated in Figure 1, Türkiye's honey exports exhibit a fluctuating but overall upward trend over the analyzed period. Export volumes increased steadily from 2016 to 2018, then declined slightly in 2019 and recovered in 2020. A sharp increase is observed in 2021, particularly in 2022, when exports reached their peak. However, this surge was not sustained, as export volumes declined again in 2023 and 2024. This pattern indicates that while Türkiye has the production capacity to expand exports, export performance remains highly sensitive to external conditions. The post-2022 decline may reflect tightening international demand conditions, rising logistics costs, exchange rate volatility, or regulatory constraints in target markets. Overall, the figure suggests that export growth is not linear but cyclical and influenced by both domestic production dynamics and global market factors.

While annual data provide a general overview of export trends, they may conceal short-term fluctuations and volatility. Therefore, examining monthly export data offers deeper insights into the dynamics of Türkiye's honey exports. The pronounced volatility in monthly export volumes suggests that export performance is highly sensitive to short-term changes in producer prices, exchange rates, and financing conditions, as shown in Figure 2.

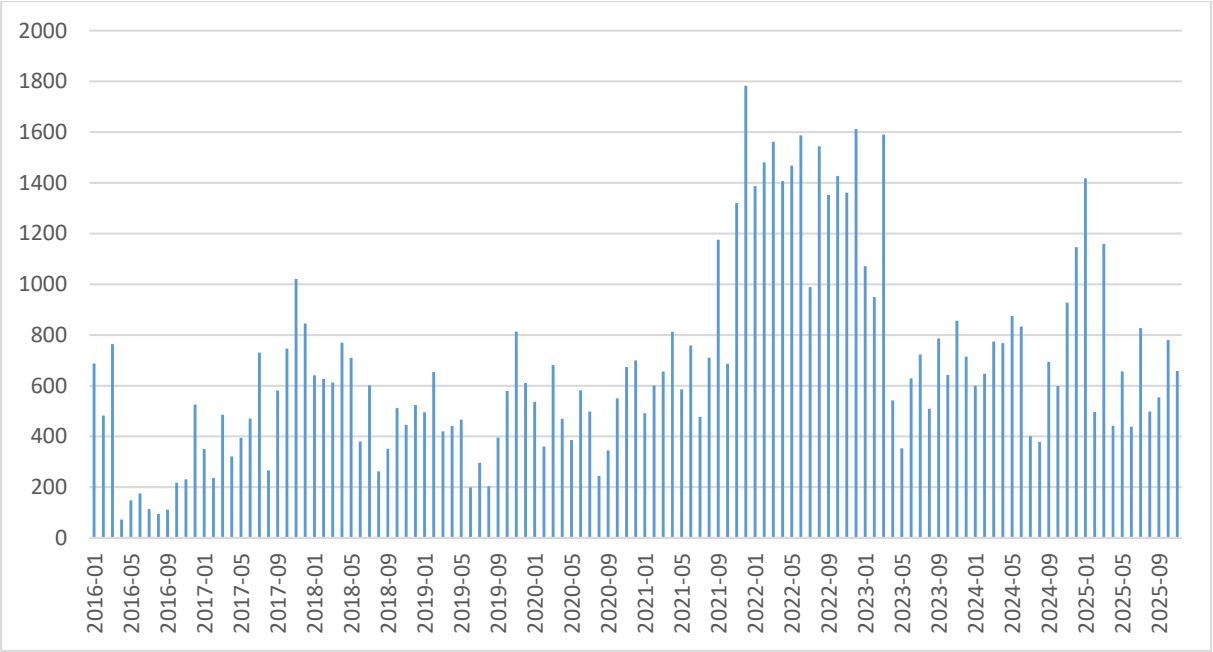


**Figure-2. Monthly honey exports from Türkiye 2016-2025 (Tons)**

Figure 2 reveals a high degree of volatility in Türkiye's monthly honey export volumes, with significant fluctuations both within and across years. In particular, export volumes display sharp spikes during certain periods—most notably in 2021 and 2022—followed by noticeable contractions. This pattern indicates that honey exports follow a volatile short-term trajectory rather than a stable monthly course. While this volatility suggests that export performance may be influenced by factors beyond production alone, identifying these determinants requires further empirical analysis.

Building on this observation, the present study aims to empirically investigate Türkiye's honey exports from a macroeconomic perspective by identifying the key economic factors that shape export performance in both the short and long term. To this end, the study examines the linkages between honey exports and the real effective exchange rate, interest rates, the producer price index, and the industrial production index, using monthly data from 2016 to 2025 within the ARDL bounds testing framework.

This study contributes to the literature in several important ways. First, unlike most existing studies that rely on cross-country analyses or annual data, it uses high-frequency (monthly) time-series data, enabling a more precise analysis of short-term dynamics. Second, while previous research on honey exports has predominantly focused on structural and institutional factors, this study provides a comprehensive macroeconomic perspective by integrating key transmission channels such as price competitiveness, cost pressures, financial conditions, and economic capacity into a unified empirical framework. Third, by focusing specifically on Türkiye, the study offers country- and product-specific insights into the determinants of export performance, thereby enriching the existing literature with a more detailed, context-driven analysis. Section 2 of the article discusses the empirical literature and the relevant theoretical framework, mainly from an agricultural and honey export perspective, while Section 3 describes the data and the empirical approach employed in the study, and the empirical findings are presented in Section 4, followed by the concluding section, where the findings are interpreted in the context of the literature, the policy implications are discussed, and the limitations of the study are examined.

## Empirical Studies on Agricultural and Food Product Exports

Empirical studies on the export of agricultural and food products have shown that export activity is regulated by intricate dynamics that vary by exporting country and the specific products being exported. The factors that influence export activity include trade regimes and regulatory systems to which countries are subject, the structure of competition in specific markets, and the nature of technology (Curzi et al., 2018). The fundamental studies conducted in this specific domain, as indicated by literature, reveal that non-tariff measures of agricultural trade act as significant hurdles, especially for developing and transitioning countries (Kee et al. 2009).

Regulations, sanctions, and compliance may either enhance or impede export capacity, depending on their structure. Another major thread in the empirical research focuses on the interplay among trade liberalization, export performance, and agricultural production capacity. According to the research results, the effects of trade agreements and export growth differ across countries and commodities (Anderson & Martin 2005). Studies examining the product composition of agricultural exports reveal that certain agricultural product groups play a

dominant role in export structures and decisively shape national export strategies (Long 2021, Matkovski et al. 2021; Moral-Pajares et al. 2024).

Recent research has emphasized the growing importance of digitalization in agricultural trade. It argues that digital technologies and applications created to facilitate trade not only increase market access and logistics efficiency, but also enhance international competitiveness in the context of regional trade integration (Bueno Rezende de Castro & Kornher, 2023). However, research focusing on macroeconomic factors influencing agricultural and food product exports has emphasized the importance of fluctuations in real exchange rates and the impact of price competition on these exports. According to research evidence, it has been found that appreciation in the real exchange rate reduces agricultural product exports, and the volatility in the exchange rate increases uncertainty in export revenues and consequently impacts foreign trade volume (Bahmani-Oskooee & Hegerty 2007, Bleaney & Greenaway 2001).

In these research contexts, the primary implication is that macroeconomic stability and exchange rate policy directly affect the competitiveness of agricultural and food product exports, especially for price-sensitive product groups. When analyzed in the context of the entire macroeconomic structure, research focusing on the macroeconomic factors influencing agricultural and food product exports has emphasized the importance of economic growth, production potential, and agricultural and food product exports. Research evidence indicates that, in the long term, increases in production potential and factor productivity would positively impact export growth (Fugazza, 2004; Hatzichronoglou, 1997). Under the context of developing countries, it has been found that macroeconomic stability and production potential would positively impact agricultural and food product exports.

**Studies on the Export of Honey and Beekeeping Products**

However, the existing literature suggests that the export of honey depends not only on the potential for agricultural production of the commodity but also on sustainability, accessibility, institutional capacity, and international competitiveness. For instance, the export of honey has been cited as an important strategy for rural development, income diversification, and food security, particularly in developing and transition economies (Gebewo et al. 2023). For instance, organic farming, environmental standards, and certification processes have been cited as key factors that have enhanced the competitiveness of honey in the export market. Moreover, the existing literature suggests that the export strategy for processed and finished products has greater income potential than exporting raw honey (Bogale et al. 2023).

On the other hand, the increased demand for organically certified bee products has been cited as an important strategy for expanding market share for exporting countries (Lowore, 2020). The literature has also emphasized the importance of cooperatives and technology in institutional support for the export of honey. Cooperatives and unions of cooperatives collect honey from members, then process and market it, with some unions directly engaging in its export (Bayissa et al. 2025). This underscores the significance of the structure and manner in which the value chain is organized for export performance. However, growing concerns about consumer health and well-being, along with the potential market impacts of fraudulent practices, have made quality assurance an essential component of honey exports. Regulatory standards and analytical verification mechanisms, intended to ensure the authenticity and safety of the product, are the foundational mechanisms for establishing trust in the global market for exporting the product (Fakhlaei et al. 2020). The export of honey therefore presents a complex structure, ranging from cooperatives to consumers, in which competitiveness is driven by natural resource advantages, quality assurance, and the level of institutional coordination.

**Macroeconomic Determinants and Theoretical Approaches to Agricultural Exports**

Agricultural exports are an important strategic driver of economic development, hard-currency earnings, and rural development, particularly in developing countries. Given the significance of agricultural exports, the macro factors affecting the performance of agricultural exports have been an area of interest for many researchers. Normally, the factors considered include exchange rate, economic growth, monetary policy, and the degree of openness of the economies. According to the World Trade Organization, reducing tariffs and removing non-tariff barriers are normally considered to have a positive effect on the volume of agricultural trade (Anderson & Martin 2005). Studies have also considered exchange rate movements and energy prices as significant factors affecting agricultural exports (Ogundipe et al. 2019; Oyetade et al., 2020). In the context of exchange rate volatility, the pricing and competitiveness of the exporting countries are adversely affected, particularly in the context where price stability is difficult to attain (Kassem & Awad 2012, Uremadu et al. 2017).

A study conducted in the United States on the influence of monetary policy on agricultural exports, particularly soybeans, concluded that competitiveness is largely driven by the exchange rate channel (Thraen et al. 1992). Moreover, the gravity model provides a theoretical basis for the influence of trading partners' size and proximity, which normally drives export volume (Braha et al. 2017). The J-curve concept suggests the exchange rate devaluation would have an adverse effect on the trade balance but would have a positive effect in the

long run (Carter & Pick 1989). On the other hand, the structural cointegration suggests that the exchange rate volatility and the level of foreign income have long-lasting effects on agricultural exports (Jha & Roe, 2016).

Despite the extensive literature on agricultural and food product exports, several important gaps remain. First, a large portion of the existing studies relies on cross-country analyses or annual data, which may fail to capture short-term fluctuations and dynamic adjustments in export performance. Second, while the literature on honey exports emphasizes structural, institutional, and value-chain-related factors, the role of macroeconomic variables has not been sufficiently examined within a unified empirical framework. In particular, there is a lack of high-frequency (monthly) time-series analyses that jointly consider price competitiveness, cost pressures, financial conditions, and economic capacity. Moreover, existing studies often focus on either sector-specific characteristics or general agricultural exports, without providing a country-specific and product-specific macroeconomic perspective. In this context, the present study contributes to the literature by offering a comprehensive time-series analysis of Türkiye's honey exports using monthly data and the ARDL bounds testing approach. By integrating key macroeconomic channels into a single empirical framework, the study provides new insights into the short-run and long-run dynamics of export performance in a product-specific context.

## Conceptual Framework

### Price Competition Mechanism: The Role of Exchange Rates

In the context of international trade, exchange rate pass-through (ERPT) measures the extent to which exchange rate movements are reflected in export prices. The exchange rate pass-through, however, depends on the market structure, the level of product differentiation, and the extent of the firm's pricing power. In the context of imperfect competition, the exchange rate impact can, to some extent, be passed through to consumers through profit margins rather than prices. In addition, increased hedging, especially during episodes of significant exchange rate volatility, reduces exchange rate pass-through (Brahmasrene and Huang 2011). One of the main explanations for imperfect pass-through in the literature is that firms adjust prices through variable profit margins. At the firm level, market share and price complementarity determine the response to exchange rate changes; it has been shown that pass-through can exhibit a U-shaped or hump-shaped structure depending on the market structure (Auer & Schoenle, 2016). These findings reveal that intra-sector competition dynamics are decisive in pricing behavior. Exchange rate pass-through also varies by invoice currency. While higher pass-through is observed in the short term for goods priced in the producer's currency, pass-through may be more limited for goods priced in the importer's currency. Furthermore, high-performing firms tend to absorb exchange rate fluctuations more strongly through their profit margins (Fabling & Sanderson, 2014). This indicates that firm heterogeneity plays a significant role in ERPT. On the other hand, adapting pricing strategies to country conditions in export markets also has significant effects on performance. It has been shown that firms adapt their pricing and distribution strategies more in highly competitive markets, and this positively impacts export performance (Fuchs & Köstner 2016). Therefore, price competition is not merely a cost-based mechanism, but reflects a strategic decision-making process sensitive to market structure and the competitive environment.

### Cost and Financing Mechanism: Inflation and Interest Rates

The interaction between cost and financing mechanisms, and between inflation and interest rates, creates a multi-layered structure that shapes both macroeconomic stability and firm and household behavior at the micro level. This conceptual framework aims to explain the impact of inflation and interest rates on financing decisions based on theoretical and empirical literature. Financing mechanisms are significantly influenced by the cost structure and the macroeconomic expectations. Interest rates and inflation rates are the two macroeconomic variables that directly affect the firm's borrowing capacity. The impact of mortgage market finance on housing demand and economic activity is clearly demonstrated in Tse's (1996) study.

Similarly, the study by A'yun (2020) indicates that the supply of finance depends not only on internal variables but is also significantly influenced by external variables, including inflation and interest rates. In the context of the Islamic financial system, though equity finance is the focus, debt instruments are the most widely used instruments for financing (Effendi 2018). This further justifies the importance of interest rates in determining the cost of finance. Interest rates are not just limited to the role of determining the cost of finance but are an important indicator of the direction of the monetary policy of the central bank of the country. The central bank raises the interest rates to control the aggregate demand and inflation in the economy (Gavrovska 2022, Ullah & Asghar 2023). In this context, it is clear that the relationship between inflation and interest rates is predominantly unidirectional: higher inflation forces the central bank to raise interest rates (Kismawadi et al. 2023). The policy of raising interest rates to control inflation is considered the most important principle of modern financial theory (Rehman 2015). However, it is argued that high public debt can affect the effectiveness of the policy (Mitra 2007). At the sectoral level, inflation and interest rates have different effects on financial products. Empirical research on Islamic banking shows that inflation and

exchange rate movements have short- and long-term effects on different types of financing, according to Kismawadi et al. (2023). In addition, the relationship between inflation and nominal interest rates is discussed in terms of the Fisher Effect, which holds that real interest rates respond to inflation (Hochman & Palmon, 1983). In conclusion, interest rates, inflation, and costs are interrelated variables that affect each other. An in-depth analysis of these interrelations helps develop better financing strategies.

**Economic Capacity Mechanism: Industrial Production Index**

The link between economic capacity and industrial production provides an essential framework for macro-level economic performance. The Economic Capacity Mechanism (ECM) describes the degree and efficiency of the mobilization of factors of production, including labor, capital, and technology; conversely, the Industrial Production Index (IPI) measures changes in industrial sector output volume and is an essential indicator of overall economic activity. Economic capacity is determined not only by resource availability but also by effective resource allocation into production processes via financial intermediation mechanisms.

Saleem et al. (2023) show that financing models directly affect industrial production capacity, and that risk-sharing and non-risk-sharing contracts have differential effects on it. In another study, Korgbeelo and Deekor (2021) demonstrate that industrial production has a long-term, stable relationship with economic growth; economic capacity is thus reflected in industrial production. However, economic capacity faces various constraints. Technological limitations, capital shortages, and regulatory frameworks can directly affect capacity utilization rates. Grifell-Tatjé and Lovell (2013) state that capacity constraints shape economic performance through inter-sectoral productivity differences. Furthermore, external factors such as macroeconomic uncertainties and security issues can limit production capacity by reducing capital inflows (Onyele et al. 2024).

The Industrial Production Index is considered a measurable output of this capacity utilization. Corrado et al. (1997) state that improvements in the index's calculation methods enable more accurate analysis of industrial activity. However, structural problems, such as sectoral overcapacity, can render index data misleading (Wang et al. 2021). The strong relationship between the Industrial Production Index and indicators such as GDP and employment shows that fluctuations in industrial production play a critical role in macroeconomic policy design (Ak 2021, Ishchuk 2025). In conclusion, there is a reciprocal and dynamic relationship between economic capacity and industrial production. Increasing production capacity boosts industrial output; increased production, in turn, supports economic growth and expands capacity again (Rakhimov & Eshonkulov, 2023). Therefore, capacity management and accurate measurement mechanisms are among the key components of sustainable economic performance.

## MATERIALS AND METHODS

This study explores the macroeconomic determinants of honey exports using monthly data from 2016 to 2025. The dependent variable will be the volume of honey exports, while the independent variables will include the interest rate, the real effective exchange rate, the domestic producer price index, and the industrial production index. The data used will be procured from the official databases of the Turkish Statistical Institute and the Central Bank of the Republic of Türkiye. Table-1 lists the symbols and the descriptive explanations for the variables used in this study. The variables used reflect the main macroeconomic linkages between the exports of agricultural and food products, as supported by the literature. The exchange rate reflects price competition, the interest rate reflects financing costs, the domestic producer price index reflects cost pressures, and the industrial production index reflects the economic conditions.

**Table-2. Description of Variables**

| Symbol | Variable Name | Description |
|---|---|---|
| HEX | Honey Exports (tons) | Export volume of honey measured in metric tons |
| IR | Deposit Interest Rate | Weighted average interest rate on short-term TRY deposits |
| REER | Real Effective Exchange Rate (CPI-based) | CPI-based real effective exchange rate index |
| PPI | Producer Price Index | Domestic producer price index (2003 = 100) |
| IPI | Industrial Production Index | Seasonally and calendar-adjusted industrial production index |

Table-2 presents the descriptive statistics for the variables used in the study. The findings show that honey exports exhibited significant fluctuations during the period examined and significant differences across periods. This is consistent with the sensitivity of agricultural exports to seasonality, external demand conditions, and macroeconomic developments. The wide range of values for interest

rate and real effective exchange rate indicators suggests that monetary policy conditions and exchange rate dynamics varied significantly during the analysis period. The producer price index's high volatility indicates that cost pressures have increased significantly, especially in recent years. Statistics on the industrial production index show that the general level of economic activity followed a relatively stable course with periodic fluctuations. In general, the descriptive statistics reveal that honey exports exhibit a dynamic, variable structure that necessitates analysis alongside macroeconomic indicators; this makes it meaningful to examine the short- and long-term relationships between variables using econometric methods.

**Table-3. Descriptive Statistics**

| | Mean | Median | Max | Min | Sd |
|---|---|---|---|---|---|
| HEXP | 683.03 | 610.69 | 1782.79 | 72.35 | 381.91 |
| IR | 21.62 | 17.09 | 50.21 | 8.66 | 12.87 |
| REER | 73.88 | 71.78 | 103.91 | 50.86 | 13.54 |
| PPI | 1426.76 | 568.27 | 4747.63 | 250.16 | 1404.78 |
| IPI | 93.69 | 94.40 | 112.50 | 58.60 | 12.67 |

In this article, the autoregressive distributed lag model (ARDL) developed by Pesaran, Shin, and Smith (2001) is preferred. The reason for using the ARDL model is that it allows working with series at different stationarity levels (I(0) and I(1)). In addition, the ARDL model also provides long-term elasticities and short-term dynamics. Furthermore, unlike univariate methods, it allows the estimation of multivariate models.

An ARDL(p_y,q_i) model with p_y lagged variable, q_i lagged variable, and i=1,2,…,k, is as follows:

$$y_t = \pi_0 + \sum_{j=1}^{p_y} \pi_j y_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{q_i} \alpha_{ij} x_{it-j} + \varepsilon_t \quad (1)$$

$\{\varepsilon_t\} \sim (0, \sigma^2)$ is an error process without autocorrelation. Its error correction mechanism

$$\Delta y_t = c + \lambda y_{t-1} + \sum_{i=1}^{k} \rho_i x_{it-1} + \sum_{j=1}^{p_y-1} \gamma_j \Delta y_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{q_i-1} \zeta_{ij} \Delta x_{it-j} + \epsilon_t \quad (2)$$

In Equation (2), λ is known as the adjustment rate parameter and y_(t-1) is the time-lagged measure of deviations from the long-term equilibrium condition.The ARDL (p, q) model can be defined as follows to determine the elasticities of long-term relationships between variables for multivariate time series, honey exports, interest rates, inflation, real exchange rate and production variables (Pesaran etc, 2001):

$$HEXP_t = \beta_0 + \Sigma\beta_1 IR_{t-i} + \Sigma\beta_2 REER_{t-i} + \Sigma\beta_3 PPI_{t-i} + \Sigma\beta_4 IPI_{t-i} + \varepsilon_{1t} \quad (3)$$

*To analyze the short-term relationships between the variables in Equation 3, the error correction model is presented below*:

$$\Delta HEXP_t = \delta_0 + \Sigma\delta_1 \Delta IR_{t-i} + \Sigma\delta_2 \Delta REER_{t-i} + \Sigma\delta_3 \Delta PPI_{t-i} + \Sigma\delta_4 \Delta IPI_{t-i} + \tau ECM_{t-1} + \epsilon_{1t} \quad (4)$$

In Equation 4, $\Delta$ represents the difference models. δ_0 is the model constant, and the δ_i coefficients are the parameter estimates. ECM is the error correction term. A bounds test was applied to determine whether there is a potential long-term relationship between the variables. In this context, the alternative hypothesis was tested against the null hypothesis of no cointegration. The calculated F-statistic values are compared with the critical values specified by Peseran et al. (2001). When the F-statistic is above the upper critical threshold, the null hypothesis that there is no cointegration is rejected. When the F-statistic is below the lower critical threshold, the null hypothesis that there is no cointegration cannot be rejected. This indicates that there is no long-term relationship between the variables. In addition, when the F-statistic value is between the lower and upper critical limits, a definitive conclusion cannot be reached from the analysis.

## RESULTS

The unit root test results presented in Table 3 were obtained using the ADF and Phillips–Perron (PP) tests to evaluate the stationarity of the variables used in the study. The findings show that the series exhibits different stationarity properties at the level, but all variables become stationary when first differences are taken. These results indicate that the variables included in the analysis generally have an I(1) integration degree. Therefore, it is understood that there is a risk of spurious regression between the series, but long-term relationships between variables can be reliably examined if appropriate econometric methods are used. In line with these findings, it is considered methodologically appropriate to use cointegration-based time-series methods that allow for the simultaneous consideration of short- and long-term dynamics in the continuation of the study.

**Table-4. Unit Root Test Results**

| | PP | | ADF | |
|---|---|---|---|---|
| | constant | cons+trend | cons | cons+trend |
| HEXP | -4.5772*** | -5.4075*** | -2.7264* | -2.7264 |
| IR | -0.6516 | -1.7601 | -1.1544 | -1.1544 |
| REER | -2.0272 | -0.9046 | -2.2465 | -2.2465 |
| PPI | 4.7128 | 0.0488 | 2.6650 | 2.6650 |
| IPI | -1.2721 | -3.8513** | -1.6526 | -1.6526** |
| ∆ HEXP | -19.2009*** | -19.1170*** | -11.3817*** | -11.3308*** |
| ∆ IR | -4.0737*** | -4.0904*** | -4.0191*** | -4.0251*** |
| ∆ REER | -7.2553*** | -8.4335*** | -9.0020*** | -9.2722*** |
| ∆ PPI | -3.6540*** | -5.4301*** | -3.8785*** | -5.4754*** |
| ∆ IPI | -17.7841*** | -17.6857*** | -12.3737*** | -12.3198*** |

Note: ∆ is the difference operator. *** p<0.01, ** p<0.05, * p<0.1

The ARDL bounds test results reported in Table-4 reveal a long-term cointegration relationship between honey exports and the macroeconomic variables included in the model. The fact that the calculated F-statistic exceeds the upper limit critical values at all significance levels allows for the rejection of the null hypothesis and the acceptance of a stable equilibrium relationship between the variables in the long term. This finding demonstrates that honey exports move within the framework of long-term dynamics alongside exchange rates, interest rates, price levels, and economic activity indicators; therefore, it necessitates an analysis of structural relationships beyond short-term fluctuations. The results obtained make the estimation of long- and short-term coefficients using the ARDL approach methodologically meaningful and consistent in the continuation of the study.

**Table-5. ARDL Bound Test**

| ***Dependent variable: HEXP*** | | | | | |
|---|---|---|---|---|---|
| F-ist. | df | Sig. | I(0) | I(1) | Result |
| 8.943 | (4, 108) | %1 | 2.20 | 3.09 | Cointegration |
| | | %2,5 | 2.56 | 3.49 | |
| | | %5 | 2.88 | 3.87 | |
| | | %10 | 3.29 | 4.37 | |

The long-term ARDL results reported in the first part of Table-5 reveal that honey exports have significant and structural relationships with macroeconomic variables. The positive and statistically significant long-term effect of the interest rate indicates that agricultural export decisions can be shaped through financial return channels and liquidity preferences.

The positive effect of the real effective exchange rate shows that the price competition mechanism is dominant in the long term and that movements in the real value of the national currency play a supportive role for honey exports. In contrast, the negative and significant coefficient for the producer price index indicates that cost pressures act as a limiting factor on export performance; it underscores the importance of price stability, especially for agricultural products sensitive to input costs. The positive effect of the industrial production index shows that improvements in general economic capacity and production conditions support honey exports, and that non-agricultural economic activities contribute to agricultural exports through indirect channels. The selected ARDL (10, 9, 1, 11, 9) model confirms that it captures the long-term effects of variables on honey exports across different lag structures and that the model's dynamic structure is consistent with the study's aim. The short-term ARDL results reported in Table 5 show that honey exports are significantly influenced by their own past dynamics and exhibit significant short-term inertia. The fact that the lagged differences of the dependent variable have positive, statistically significant coefficients indicates that exports in previous periods support current export performance in the short term.

This finding suggests that factors such as order contracts, inventory management, and the continuity of external demand shape short-term behavior in honey exports. The fact that the short-term interest rate coefficients are significant in different directions and span only a limited number of lags indicates that the impact of financial conditions on honey exports does not exhibit a stable, unidirectional structure in the short term. On the other hand, the short-term results for the producer price index and the industrial production index show that cost and capacity channels are more prominent in the short term. The fact that changes in the producer price index are significant at some lags suggests that cost shocks are reflected in honey exports with delayed and temporary effects. The industrial production index having predominantly negative and significant

coefficients in the short term indicates that fluctuations in general economic activity can have suppressive effects on agricultural exports in the short term.

**Table-6. ARDL Results**

| ***Dependent variable: HEXP*** | | |
|---|---|---|
| Variables | Coefficient | Std. Error |
| Long-run | | |
| IR | 25.4088*** | 7.0850 |
| REER | 8.6022** | 3.2489 |
| PPI | -0.5902*** | 0.0975 |
| IPI | 38.9660*** | 6.5063 |
| C | -3637.54*** | 766.0175 |
| Short-run | | |
| D(HEXP(-1)) | 0.3548** | 0.1437 |
| D(HEXP(-2)) | 0.5859*** | 0.1402 |
| D(HEXP(-3)) | 0.5272*** | 0.1484 |
| D(HEXP(-4)) | 0.5231*** | 0.1434 |
| D(HEXP(-5)) | 0.2743** | 0.1275 |
| D(HEXP(-6)) | 0.2880** | 0.1275 |
| D(HEXP(-7)) | 0.4059*** | 0.1249 |
| D(HEXP(-8)) | 0.1626 | 0.1085 |
| D(HEXP(-9)) | 0.2216** | 0.0930 |
| D(IR) | 14.0834 | 29.7137 |
| D(IR(-1)) | 8.9754 | 32.2617 |
| D(IR(-2)) | -26.5238 | 31.8549 |
| D(IR(-3)) | 9.4593 | 32.7976 |
| D(IR(-4)) | 22.3237 | 33.7978 |
| D(IR(-5)) | -85.6327** | 33.4242 |
| D(IR(-6)) | -73.5866** | 33.5993 |
| D(IR(-7)) | -55.1904 | 34.1842 |
| D(IR(-8)) | -59.9577** | 26.8735 |
| D(REER) | -8.0621 | 8.2897 |
| D(PPI) | 1.4360* | 0.8059 |
| D(PPI(-1)) | -0.8814 | 1.0624 |
| D(PPI(-2)) | 4.4648*** | 1.0529 |
| D(PPI(-3)) | -1.5446 | 1.0822 |
| D(PPI(-4)) | 0.6570 | 1.0928 |
| D(PPI(-5)) | 1.2193 | 1.0781 |
| D(PPI(-6)) | 2.1124* | 1.1866 |
| D(PPI(-7)) | -2.0298* | 1.1915 |
| D(PPI(-8)) | 4.1268*** | 1.2102 |
| D(PPI(-9)) | 1.0742 | 1.2048 |
| D(PPI(-10)) | 4.6375*** | 1.1242 |
| D(IPI) | 6.4077 | 6.0554 |
| D(IPI(-1)) | -28.5881*** | 7.6545 |
| D(IPI(-2)) | -28.8115*** | 7.3334 |
| D(IPI(-3)) | -25.1384*** | 7.0731 |
| D(IPI(-4)) | -10.5578 | 7.1834 |
| D(IPI(-5)) | -15.3156** | 6.7106 |
| D(IPI(-6)) | -15.3296** | 6.2020 |
| D(IPI(-7)) | -14.8130** | 6.1292 |
| D(IPI(-8)) | -12.4921** | 6.1346 |
| CointEq(-1)* | -1.2473*** | 0.1639 |
| *Diagnostic Tests* | *p-value* | |
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | 0.674 | |
| Breusch-Godfrey Serial Correlation LM Test | 0.1247 | |
| Jarque-Bera | 0.074 | |
| RESET | 0.0579 | |

The negative and statistically significant error correction term shows that short-term deviations are corrected quickly and stably towards the long-term equilibrium relationship; confirming that the model successfully captures the dynamic adjustment process. The diagnostic tests and structural stability analyses performed show that the established ARDL model is econometrically reliable and consistent. While the Breusch–Pagan–Godfrey test results do not indicate heteroskedasticity in the error terms, the Breusch–Godfrey serial correlation LM test indicates no autocorrelation in the model. The Jarque–Bera test indicates that the error terms are approximately normally distributed, while the RESET test confirms that the model's functional form has been correctly specified. In addition, the fact that the test statistics in the CUSUM and CUSUM of Squares plots remain within the 5% significance limits, as shown in Figure 3, indicates that the model coefficients are temporally stable during the analysis period and that no structural break dominates the model. When these findings are considered together, it can be said that the short- and long-term ARDL results satisfy the statistical assumptions and are supported by a solid analytical foundation for policy interpretation.

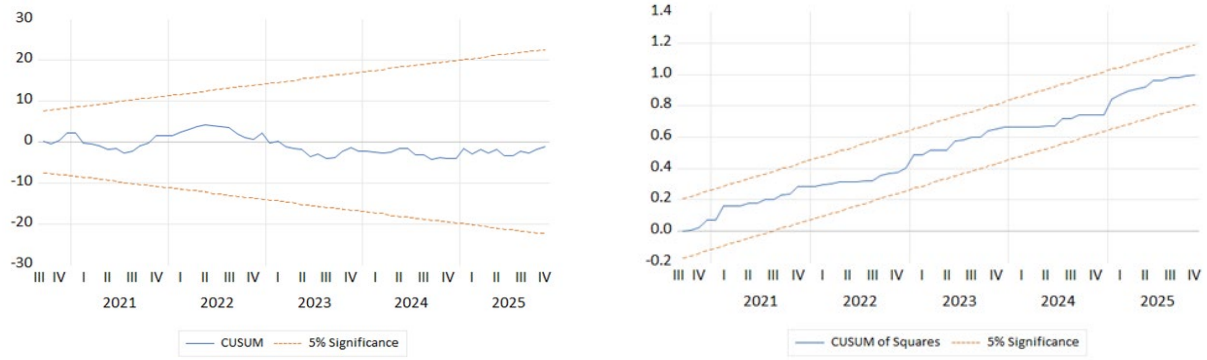


**Figure-3. CUSUM and CUSUM Square**

Overall, these findings validate the model's econometric soundness and establish a solid foundation for interpreting the empirical results discussed in the next section.

## DISCUSSION

In this study, the macroeconomic determinants of honey exports in Türkiye were analyzed using monthly data from 2016–2025 within the framework of the ARDL approach. The unit root and bounds test results indicate the existence of a long-term cointegration relationship between honey exports and the interest rate, the real effective exchange rate, the producer price index, and the industrial production index. This finding shows that honey exports move within a long-term structural equilibrium with macroeconomic conditions, rather than short-term fluctuations. The long-term estimation results reveal that honey exports are shaped particularly through price competitiveness, cost structure, and economic capacity channels.

The positive, statistically significant effect of the real effective exchange rate on honey exports indicates that changes in the real value of the national currency support export performance by enhancing price competitiveness in the long run. This result is consistent with previous studies emphasizing the determinant role of the exchange rate channel in agricultural and food product exports (Bahmani-Oskooee & Hegerty 2007, Bleaney & Greenaway 2001).

The findings are consistent with the long-term adjustment mechanisms highlighted in the J-curve approach and exchange rate pass-through literature. The negative and significant long-term coefficient for the producer price index indicates that cost pressures act as a limiting factor on honey exports. This finding aligns with the literature highlighting the role of input costs and price stability on competitiveness in agricultural exports (Fugazza 2004, Ogundipe et al. 2019). The findings of this study support the idea that cost increases, particularly in labor- and natural input-intensive products like honey, can weaken export capacity. The positive long-term impact of the industrial production index on honey exports shows that improvements in overall economic capacity and production conditions support agricultural exports through indirect channels. This result is consistent with previous studies showing that industrial production and economic growth indicators enhance export performance (Hatzichronoglou 1997, Korgbeelo & Deekor 2021).

Expansion of production capacity in non-agricultural sectors can also positively impact honey exports through improvements in logistics infrastructure, access to finance, and organizational efficiency. The fact that interest rates exhibit a positive, significant long-term effect indicates that the impact of financial conditions on honey exports cannot be explained directly and unidirectionally through a cost channel. This finding is consistent with the literature, which holds that interest rates are indicators not only of the cost of borrowing but also of macroeconomic stability, saving behavior, and financial return

expectations (Rehman 2015, Mitra 2007). Therefore, it can be said that honey export decisions are shaped by perceptions of long-term financial stability. Short-term results reveal that honey exports are significantly affected by their own lagged values and exhibit a distinct continuity structure. This indicates that factors such as export contracts, inventory management, and the continuity of external demand are decisive in short-term export dynamics.

The fact that short-term coefficients for the producer price index and the industrial production index produce temporary effects in opposite directions due to lags indicates that cost and capacity shocks have unstable but limited effects in the short term. The fact that the error correction term is negative and statistically significant confirms that short-term deviations are rapidly corrected towards the long-term equilibrium relationship, and that the model has a strong adjustment mechanism. Based on these findings, several important policy implications emerge. Firstly, maintaining macroeconomic stability, with a focus on exchange rate and price stability, is a prerequisite for sustained growth in honey exports. Secondly, the alleviation of producer costs should be viewed as a vital tool for enhancing the competitive position of honey exports. Thirdly, implementing measures that increase the overall capacity of the economy could be viewed as a means of indirectly supporting honey exports, insofar as these measures affect the broader production infrastructure. However, these policy recommendations should be viewed as within the scope of the possibilities suggested by the empirical findings. Lastly, the study acknowledges several limitations that should be considered when interpreting the findings.

First, the analysis is based on a macroeconomic framework and does not incorporate micro-level or institutional factors specific to the honey export sector, such as firm behavior, quality standards, or value-chain dynamics. Second, due to monthly data availability constraints, the model is limited to a parsimonious set of core macroeconomic variables and does not explicitly include potentially relevant indicators, such as global honey prices or export price indices, which may also influence export performance. Third, although the ARDL framework partially mitigates endogeneity concerns through its lag structure, the potential for reverse causality and omitted variable bias cannot be fully ruled out. Fourth, the use of high-frequency (monthly) data, while providing richer short-term dynamics, may also increase volatility and contribute to relatively higher lag lengths in the model specification. Finally, although structural stability tests suggest that the model remains stable over the sample period, noticeable fluctuations—particularly the sharp increase in exports observed in recent years—may indicate structural shifts associated with major economic developments, such as exchange rate movements and the COVID-19 pandemic. However, explicitly modeling structural breaks could not be incorporated without compromising model diagnostics and overall stability within the ARDL framework.

Future research could address these limitations by employing alternative methodologies that explicitly account for structural breaks, incorporating additional variables as higher-frequency data become available, and combining macro-level analysis with micro-level evidence.

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