

Robust Macroeconomic Determinants of Domestic Spot Gold Return in Türkiye

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Türkiye'de Yurtiçi Spot Altın Getirisinin Sağlam Makroekonomik Belirleyicileri

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Öz

Bu çalışmanın amacı, Türkiye'deki altın getirilerinin sağlam belirleyicilerini Aşırı Sınırlar Analizi (Extreme Bounds Analysis - EBA) yöntemiyle incelemektir. Bulgulara göre, ekonomik politika belirsizliği, döviz kuru, para arzı ve enflasyon hem Leamer hem de Sala-i-Martin modellerine göre yüksek derecede sağlam dört değişken olarak tespit edilmiştir. Buna ek olarak, konut fiyatları da Sala-i-Martin yaklaşımına göre altın fiyatlarının sağlam bir belirleyicisi olarak raporlanmıştır. Bu sonuçlardan, yukarıda belirtilen faktörlerin Türkiye'deki altın fiyatlarının sağlam belirleyicileri olduğu ortaya çıkmaktadır. Çalışmanın sonuçları ayrıca göstermektedir ki, spot altın getirileri küresel faktörlerden ziyade yerel değişkenler tarafından yönlendirilmektedir. Bu yerel faktörler ise çoğunlukla para politikasının duruşu ve sonuçları ile ilişkilidir.

Abstract

The aim of this study is to investigate the robust drivers of gold return in Türkiye by using the extreme bounds analysis (EBA). According to findings, economic policy uncertainty, exchange rate, money supply and inflation are found four variables that are highly robust based on both Leamer and Sala-i-Martin models. In addition, house price is robust determinants of gold price as reported by Sala-i-Martin approach. From these results, it emerges that factors mentioned above are robust determinants of gold prices in Türkiye. The results of the study are also clear that spot gold return is driven by local variable more than global factors. This local factors are mostly related to the stance of monetary policy and the outcomes of monetary policy.

Anahtar Kelimeler: Altın Getirisi, Aşırı Sınırlar Analizi, Para Politikası Duruşu

Keywords: Gold Return, Extreme Bounds Analysis, Monetary Policy Stance

Makale Türü: Araştırma Makalesi

Paper Type: Research Article

1. Introduction

After the fall of the Bretton Woods system in 1973, all major currencies and gold were allowed to fluctuate against each other. With the Jamaica Treaty coming into force in 1976, central banks officially abandoned their obligation to hold gold reserves. Thus, gold prices began to be determined according to market supply and demand forces (Eun and Resnick, 2007). Gold supply is provided by mine production, reserve sales of central banks, scrap gold supply and forward sales. However, it does not

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seem possible to increase gold supply production in the short term due to physical constraints, so prices are determined by demand predominantly. The reason for gold being in such strong demand is arises from used as a raw material in the dentistry and electronics sectors (O'Connor et al., 2015).

When one looks at the literature on gold and precious metals, it is noted that there exists relationship between many economic variables and precious metals. For example, Elfakhani et al. (2009) documented that gold prices were determined by the gold reserves of the central banks, US capital market and US trade weighted dollar index throughout the 1990s. Arslanalp et al. (2023) examined that developing countries increases the share of gold-denominated reserves held in their central banks in response to sanctions risk. Lucey et al. (2017) argued that excess money supply leads to stimulate consumption and investments preferences of household. Therefore, money growth is expected to exercise upward pressure on gold prices.

One hand unemployment rate reflects the health of economy; on other hand it is related to consumer confidence. Because politicians closely monitor the number of unemployed people and they do not hesitate to make every effort to reduce unemployment in order to win upcoming the next elections. Eventually, an indirect relationship arises between unemployment rates and gold prices. Accordingly, in an economy with higher unemployment, the demand for gold is expected to increase as there will be a crisis of confidence (Thaver and Lopez, 2016; Christie–David et al., 2000).

According to Hillier et al. (2006), since gold is used as an input in various sectors such as the IT sector, construction sector, healthcare sector, they argued that there is a strong and positive relationship between gold prices and a well-functioning economy. Therefore, gold price is expected to rise, if the industrial production increases.

Market participants closely monitor the volatility index (VIX) derived from stock options on the S&P 500. The VIX represents investors' expectation of the stock market volatility over the next 30 days. Considering the VIX is accepted as a fear index in the literature, if the VIX raises, capital markets become more fearful and funds are directed to gold, which is seen as a safe haven. Conversely, when there is a decline in the VIX, investors perceive less uncertainty in the market and are encouraged to purchase stocks (Basher and Sadorsky, 2016).

The interest rate is reward for fixed income investment and also one of significant variable which influence the investor's expectation. While high levels of short-term interest rates increase the opportunity costs of investments, long-term interest rates vary according to inflation expectations. As a result, since interest rates will cause an increase in the return on monetary assets, it is inevitable that the demand for gold will drops (Qian et al., 2019).

Oil market influences the real economy directly through several channels. Primarily, the oil price increases may cause the uncertainty about future so that, it would not be a surprise if consumption of households disrupted. Second, increases in oil prices make it costlier for the firm to produce. In cases, lower demand and production is observed simultaneously, which means: economic growth will slow down very soon (Sill, 2007). In the event of an increase in international oil prices, inflation rates in oil importing countries tend to be soared because of rising production costs. In addition, rising oil prices cause imbalances in the balance of payments and the foreign trade deficit widens. If the governments compensated deficits by printing money, then the demand for gold will shine as there appears to be inflation pressure on the eye of investors. On the grounds that gold is a unique hedging in inflationary periods, it is expected that there is positive relationship between oil and gold demand (Tiwari and Sahadudheen, 2015).

Uncertainties due to political turmoil in the world cause investors to lessen their transactions in stock or bond markets. Since gold investors are instilled with a sense of confidence in turbulent times,

there is a negative relationship between uncertainty indices and gold demand. In addition, as global uncertainties cause investors to seek a safe haven, portfolio owners trying to protect the relative returns of their investments continue to hold gold (Baur and McDermott, 2010).

Gold is the lifeblood of the Turkish investors. Turkish people are accustomed to using gold as a store of value. Concretely, there are both economic and traditional reasons why Turkish people are so fond of gold. First of all, the use of gold as currency during the Ottoman period has a place in the memory of the Turkish people as a tradition from the past. Besides, gold is the first jewelry preferred for gifts at weddings in Turkey. Economically, Türkiye has been living with high and volatility inflation rates for many years. To protect themselves from inflation hampered purchasing power, people keep gold under their pillows outside the financial system. Especially before 1980, strict exchange rate controls, fixed exchange rate regime and frequent devaluations, alienated households from domestic currency (Vural, 2003; Gülseven and Ekici, 2016). Real estate investments, just like gold, are among the financial options expected to protect investors against inflation. Yunus (2020) revealed that gold is integrated with real estate investments in the long-run by using many different econometric techniques. According to the study of Gülseven and Ekici (2021), Turkish investors have recently turned their attention to gold and real estate. In fact, housing sales were realized beyond the population growth rate. Indeed, accumulating gold for purchasing real estate is a common manner due to the Turkish people's sensitivity to interest. In a nutshell, one assumes positive correlation between gold and house prices in Turkey, as investors who refrain interest income as a result of their religious sensitivities shares their portfolios within gold and real estate holdings.

We can answer the question of why gold is a safe haven against inflation as an investment tool in two ways. First, the fact that the gold supply cannot be arbitrarily determined by any authority makes gold a hard currency. In fact, a situation like governments printing money to fund budget deficits is out of the question for gold (O'Connor et al., 2015). Secondly, mining companies that are engaged in gold mining reflect the costs caused by inflation into gold prices, causing gold to appreciate as much as inflation (Levin et al., 2006).

The perception of safe haven raises the question on what determine gold return over time. There is no doubt that understanding the factors affecting the value of gold will serve to risk minimization of portfolio allocation. More explicitly, gold cannot be deemed like a company that provides cash flow; it is not possible to explain gold prices with cash flow models or other financial theories. Therefore, the most logical approach is to identify the macroeconomic forces that drive gold return.

Taking into account the studies mentioned above, to explain the domestic spot gold return in Türkiye, this paper addresses the impact of macroeconomic factors on domestic gold prices by using Extreme Bounds Analysis (EBA) and chooses the house price, VIX index, oil prices, interest rate, economic policy uncertainty index, inflation rate, US dollar, Borsa Istanbul stock exchange, industrial production, unemployment rate, money supply defined by M2 and central bank gold reserves as potential economic drivers.

In the following sections of the study, the empirical literature on the macroeconomic variables affecting gold prices will be reviewed. Subsequently, the dataset, variables, and models used in the analysis will be introduced. In the empirical analysis, the effects of the selected variables on domestic spot gold returns will be examined using the EBA method. Finally, based on the findings, implications for policymakers and investors will be presented, along with suggestions for future research.

2. Literature Review

The earlier study by Cai et al. (2001) underscores the significant impact of intraday behaviors on the volatility of gold returns, highlighting unemployment, GDP, CPI, and personal income

announcements as the most influential factors. They provided evidence that massive gold selling's of major centrals cause the drop of gold price rather than macroeconomic announcement related to US economy.

In a similar line of inquiry focusing on macroeconomic and monetary conditions, Batten et al. (2010) examine the effects of the business cycle, monetary environment, and financial market sentiment on gold volatility. Their findings reveal that gold is largely explained by monetary variables. Murach (2019) also investigates the impact of fluctuations in global liquidity conditions on gold prices, concluding that increased monetary liquidity leads to higher global inflation and the demand for gold. Adding to the discussion of uncertainty and its impact on investor behavior, Jones and Sackley (2016) focus on the short-term effects of economic policy uncertainty on gold price movements in the US and the EU, and conclude that gold is not only used as a hedge against inflation, but also attracts demand during periods of economic policy uncertainty. According to Malliaris and Malliaris (2015), while gold returns do not outperform equities over the long term—such as over several decades—gold demand can rise sharply in the short term due to financial instability, currency crises, stock market corrections, and fears of inflation.

In terms of country-specific macroeconomic relationships, Rana & O'Connor (2023) examine the relationship between domestic macroeconomic factors and domestic gold prices from 1979 to 2020. The authors fail to identify a set of common determinants applicable across all countries. It is found long run co-integration between precious metals prices and CPI, industrial production, stock price, long-term and short-term interest rate in Australia, Japan and China but not in India, USA and UK.

A significant portion of the literature has focused specifically on the relationship between gold and inflation. Ghosh et al. (2004), McCown and Zimmerman (2006) and Worthington and Pahlavani (2007) find a statistically significant long-term cointegration between inflation and gold prices. Bruno and Chincarini (2010) emphasize that investors tend to include gold assets in their portfolios particularly during inflationary periods. Hoang (2011) and Bampinas and Panagiotidis (2015) indicate that gold serves as a hedge against inflation indicators in the US and the UK over the very long term, while Sharma (2016) extends these findings to 54 countries. Blose (2010), on the contrary, demonstrates that unexpected changes in the Consumer Price Index do not affect gold prices. According to the study's findings, in response to unexpected inflationary shifts, investors tend to engage in speculative movements in the bond market rather than the gold market. Tully and Lucey (2007) do not find a statistically significant relationship between inflation and gold prices.

According to Erb et al. (2020), since purchasing power remains constant, rising concern about high future price inflation should result in an escalating gold price. In addition, the same study emphasized that the price of commodities such as gold may increase as a result of financialization of gold with the help of exchange-traded funds (ETF).

Beyond inflation and macroeconomic indicators, other studies have explored the role of financial markets in shaping gold prices. Chirwa and Odhiambo (2020) identify significant short- and long-term effects of international stock and bond markets, as well as global variables, on gold prices. However, their findings indicate mixed results regarding the direction of these effects. The study concludes that bond and equity markets serve as important sources of information for understanding the movements in gold prices. Alongside financial markets, oil prices have also been examined for their potential influence on gold. Shahbaz et al. (2017) examine the mean and variance causality between oil prices and gold returns, and their findings suggest that the relationship is stronger at higher frequencies, such as weekly data, compared to exceptional periods characterized by extreme oil price movements.

Focusing more closely on the Turkish market, Poyraz and Didin (2008), in their regression analyses for the 1979–2016 period, find exchange rates, the Central Bank of Turkey's foreign exchange reserves, and oil prices as determinants of gold prices in Turkey. Soytaş et al. (2009) investigate the relationship between global oil prices, Turkey's interest rates, the USD/Turkish Lira exchange rate, and domestic gold and silver prices. While fluctuations in global oil prices causes temporary positive effects on gold and silver prices in the short term, gold is perceived as a safe haven in Turkey during periods when the Turkish Lira depreciates globally. Toraman et al. (2011), using the MGARCH model for the 1992–2010 period, find a positive relationship between gold prices and oil prices and a negative relationship with the US dollar exchange rate. Aksoy and Topçu (2013), based on a VECM model for the 2003–2011 period in Turkey, find a negative relationship between gold returns and stock returns, and a positive relationship with inflation based on the PPI. Additionally, they find causality from government securities, stock returns, and CPI to gold prices. Elmas and Polat (2014), based on time series regressions from 1988 to 2013, find that oil prices, silver prices, and inflation have a positive effect on gold prices, while exchange rates and the Dow Jones Index have a negative effect. Kırkulak Uludağ and Lkhamazhapov (2014) investigated the long memory properties and structural breaks of gold returns and volatility in Turkey by using ARFIMA–FIGARCH models between 2008–2013. They demonstrated that spot gold returns exhibit dual long memory, whereas futures gold returns do not have long memory. Moreover, the adjustment associated with the global financial crisis has led to a structural break in gold returns. Yüksel and Akkoç (2016), using a neural network model with daily data from 2002 to 2013, reveal that in Turkey, gold prices are most affected by silver and oil prices. Kocatepe and Yıldız (2016), using the same method, conclude that explanatory variables such as crude oil prices, the dollar index, the exchange rate, the S&P 500 index, the BIST100 index, Turkey's inflation, bond and interest rates, US inflation, bond and interest rates, and silver and copper prices can predict changes in gold prices with 75.24% accuracy. Elmastaş Gültekin and Aktürk Hayat (2016), based on VAR model findings for the 2005–2015 period, indicate that gold prices are strongly affected by international gold prices (ounce) and oil prices, whereas the impact of interest rates is quite limited. Doğanalp et al. (2016), based on causality analysis for the 1996–2014 period in Turkey, conclude that gold prices are affected by exchange rates, interest rates, oil imports, and the BIST 100 index. Küçükaksoy and Yalçın (2017), based on VAR model findings for the 1990–2015 period, reveal a causality from silver and oil prices to gold prices in Turkey. Cingoz and Kendirli (2019), through cointegration and causality analyses for the 2006–2018 period, suggest that while there may be a long-term relationship between gold prices, the BIST 100 index, and the exchange rate, these variables do not significantly affect gold prices in the short term. Gülhan (2020), based on Granger causality test results, based on weekly data from 2015 to 2019, there is a causal relationship between gold prices and the BIST 100, oil prices, and exchange rates. Kuzu (2022), for the 2013–2021 period in Turkey, inflation, interest rate differential, BIST100, and the VIX fear index are identified as determinants of gold prices. In the short term, inflation, oil prices, and the VIX index have a negative effect, while other variables have a positive effect. In the long term, oil prices and the BIST-100 index have a positive impact, whereas the interest rate differential has a negative impact on gold prices. İlkan et al. (2022), using Maki cointegration and ARDL bounds testing methods for the 1986–2021 period, find a long-term cointegration relationship between gold prices, the dollar exchange rate, and the BIST100 index.

3. Models and Data

3.1. Data

Considering the most common variable in the literature, this study employs monthly time series data on domestic spot gold price, house price index, deposit interest rate, inflation, economic policy uncertainty, unemployment, the M2 money growth, the Turkish lira/US dollar exchange rate, the VIX, the Brent oil price, Central Bank of Türkiye's gold reserves, the BIST-100 index, and the industrial

production. Data covers the period 2010-01 and 2024-03. Table 1 presents the definitions and sources of each variables.

Table 1: Variable and Definitions

Variables	Description
GOLD	The continuously compounded returns of bullion gold selling price (TL/Gr)
HOUSE	Logarithmic changes in residential property price index (2023=100)
VIX	VIX represents investors' expectation of the market volatility over the next 30 days.
OIL	Percentage change in Europe Brent Spot Price FOB (Dollars per Barrel)
INT	Return on monthly deposits
GEPU	Economic policy uncertainty reflecting the changes in World's economic tension
INF	Growth rate of consumer price index based on previous period.
USD	Logarithmic changes in monthly average USD/TL parity
BIST	The continuously compounded returns on the Borsa İstanbul-100 index
IND	Percentage change of seasonally adjusted industrial production index
UNEMP	Number of monthly total unemployed, denominated thousand person
M2	The continuously compounded growth rate of money supply in terms of M2
CBT	Ratio of gold in total reserves holding by Central Bank of Türkiye

Notes: Data for VIX and INF retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org>. Data for GOLD, INT, OIL, HOUSE, USD, BIST, M2 and CBT are obtained from EVDS (Electronic Data Delivery System of Central Bank of Türkiye), <https://evds2.tcmb.gov.tr/index.php?> Data for IND and UNEMP are retrieved from The Turkish Statistical Institute database, <https://data.tuik.gov.tr>. Global Economic Policy Uncertainty Index (GEPU) is collected from https://www.policyuncertainty.com/global_monthly.html, which is based on the study of Davis, S. (2016.) An Index of Global Economic Policy Uncertainty, Macroeconomic Review.

3.2. Models

In econometric models, the inclusion of different control variables can significantly alter the results—particularly the signs and statistical significance of the estimated coefficients. Because the choice of which variables to include is often left to the researcher's discretion, such decisions can increase model uncertainty and reduce the credibility of policy recommendations. Leamer (1985) addresses this prevalent issue in econometric analysis and underscores the importance of conducting extensive sensitivity tests to mitigate it. Within this framework, Extreme Bounds Analysis (EBA)³ was developed as a systematic method to assess model sensitivity and to examine whether the estimated effects of explanatory variables on the dependent variable are robust. This technique reveals whether economic relationships are sensitive to alternative model specifications. In other words, it tests whether the sign and significance of a variable's coefficient change when different combinations of control variables are included in the model.

The general regression form of the EBA model is as follows:

$$Y_i = \alpha + \beta Z_i + \sum_{j=1}^k \gamma_j X_{ji} + \varepsilon_i$$

Here, Y_i denotes the dependent variable, Z_i represents the hypothesized variable whose effect is to be tested, and X_{ji} refers to the alternative control variables. β and γ_j are the coefficients associated with the hypothesized and control variables, respectively, while ε_i denotes the error term.

For example, Z denote the key variable whose effect we wish to test, and X represent the set of all alternative control variables. In each regression, Z is held constant, while all possible combinations

³ For more econometric and technical details, see Leamer (1985) and Sala-i-Martin (1997).

of the control variables are included in the model sequentially. Subsequently, the equation is solved using ordinary least squares with a heteroscedasticity- and autocorrelation-consistent (HAC) covariance matrix estimator. For each specification, a coefficient $\hat{\beta}$ and its standard error $SE(\hat{\beta})$ are estimated for the variable Z . The extreme bounds for the coefficient of this variable are then calculated as follows:

$$\text{Lower Bound} = \min(\hat{\beta}) - 2 \cdot \max(SE(\hat{\beta}))$$

$$\text{Upper Bound} = \max(\hat{\beta}) + 2 \cdot \max(SE(\hat{\beta}))$$

These bounds correspond approximately to a 95% confidence interval. If all estimated $\hat{\beta}$ coefficients for the variable Z fall within these lower and upper bounds and are statistically significant, the estimates for this variable are considered robust. Otherwise, the estimates are deemed fragile. Leamer's (1985) model is significant in that it provides a systematic approach to evaluating model uncertainty. However, if the coefficient of the variable is found to be statistically insignificant in even a few of the estimated regressions, the variable is considered fragile, which may lead to the rejection of the entire model results. Moreover, when the number of control variables is large, the number of possible combinations increases dramatically, raising the likelihood of obtaining fragile results. In this respect, although Leamer's (1985) approach represents an important starting point, it is often considered excessively strict.

However, it is difficult to meet conditions of Leamer's (1985) approach. To overcome the rigidity of Leamer's approach and make it more flexible, Sala-i-Martin (1997) proposed a model that evaluates the robustness of variables by considering the probability distribution of the estimated coefficients across all regressions. This model facilitates more tolerant decisions regarding the magnitude and sign of the effect variable's coefficient by taking into account its distribution across all model specifications. Similar to Leamer's approach, Sala-i-Martin (1997) estimates numerous regressions with all possible alternative combinations of control variables; however, instead of relying on extreme bounds, it uses the distribution of the estimated $\hat{\beta}$ coefficients from each regression to make statistical inferences. Using the $\hat{\beta}$ and $SE(\hat{\beta})$ values obtained from each regression model, a density function is constructed based on the normal distribution. First, the mean of the M different $\hat{\beta}$ estimates is calculated:

$$\bar{\beta} = \frac{1}{M} \sum_{j=1}^M \hat{\beta}_j$$

Here, the average effect of the variable is calculated. To observe the variation in the coefficients, the standard deviation is computed.

$$\sigma_{\beta} = \sqrt{\frac{1}{M-1} \sum_{j=1}^M (\hat{\beta}_j - \bar{\beta})^2}$$

A small standard deviation implies that the coefficient is approximately the same across all models, indicating that the effect of the explanatory variable is consistent and robust. Conversely, a large standard deviation suggests the opposite. The approach proposed by Sala-i-Martin (1997) assumes that the coefficients are approximately normally distributed, i.e., $\beta \sim N(\bar{\beta}, \sigma_{\beta}^2)$. In a normal distribution, the probability density function (PDF) for a given β value is calculated as follows:

$$f(\beta) = \frac{1}{\sigma_{\beta} \sqrt{2\pi}} \exp\left(-\frac{(\beta - \bar{\beta})^2}{2\sigma_{\beta}^2}\right)$$

The cumulative distribution function (CDF), which is the integral of the probability density function (PDF), is used to calculate the probability that the coefficient of the variable is less than zero, as shown below:

$$P(\beta < 0) = \int_{-\infty}^0 f(\beta) d(\beta) = \Phi\left(\frac{0 - \bar{\beta}}{\sigma_{\beta}}\right)$$

Here, $P(\beta < 0)$ denotes the probability that the coefficient takes a negative value, and $\Phi\left(\frac{0 - \bar{\beta}}{\sigma_{\beta}}\right)$ represents the cumulative distribution function (CDF) of the standard normal distribution. Similarly, the probability that the coefficient is greater than zero is calculated as follows:

$$P(\beta > 0) = \int_0^{\infty} f(\beta) d(\beta) = 1 - \Phi\left(\frac{0 - \bar{\beta}}{\sigma_{\beta}}\right)$$

Here, $P(\beta > 0)$ represents the probability that the coefficient is positive, and $1 - \Phi\left(\frac{0 - \bar{\beta}}{\sigma_{\beta}}\right)$ is the complement of the CDF. Consequently, if $P(\beta > 0) > 0.95$, it is concluded that the coefficient of the estimated variable is positive and robust; similarly, if $P(\beta < 0) > 0.95$, it is concluded that the coefficient is negative and robust. Therefore, more flexible inferences can be made using the Sala-i-Martin (1997) approach.

4. Results

First of all, in the name of proper time series analysis, logarithmic first-difference forms were performed to ensure stationary properties except for the inflation. Table 2 provides statistical properties of the individual time series. With regard to descriptive statistics, Gold has the highest average monthly return of 2%, whereas BIST stands out as one of the most volatile investments with a monthly standard deviation of 7%. The Jarque-Bera probability shows that the null hypothesis of normality is rejected for all series except for the BIST and unemployment.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Skewness	Kurtosis	JB test	ADF
GOLD	0.022	0.050	1.233	6.320	0.000	-9.905***
HOUSE	0.019	0.025	2.342	8.717	0.000	-3.954***
VIX	-0.002	0.189	1.688	9.753	0.000	-13.706***
OIL	0.001	0.140	-3.535	39.652	0.000	-10.499***
INT	0.010	0.070	0.837	6.049	0.000	-7.622***
GEPU	0.002	0.179	0.457	4.215	0.000	-10.932***
INF	0.015	0.020	2.814	13.435	0.000	-3.668***
USD	0.018	0.041	1.760	10.139	0.000	-9.087***
BIST	0.016	0.074	0.265	3.031	0.367	-12.029***
IND	0.005	0.040	-3.321	38.477	0.000	-10.246***
UNEMP	0.000	0.063	0.077	2.580	0.390	-2.802**
M2	0.019	0.025	2.177	12.851	0.000	-10.771***
CBT	0.013	0.063	0.358	4.966	0.000	-6.970***

Note: ADF Test critical values: 1% level: -3.463; 5% level: -2.878; 10% level: -2.575

All series satisfy the stationary, as reported by augmented Dickey-Fuller tests (Dickey & Fuller, 1981). Regarding skewness and kurtosis, for all variables except BIST and unemployment, distributions of the series dominated by long and fat tails.

4.1. EBA Results

Table 3 shows the mean and standard error of the coefficients, as well as the lower and upper limits of the coefficients calculated according to the Leamer method. The first point that draws attention in the table is that the BIST Index and industrial production index have a negative effect on gold prices. The rest of the variables have a positive effect on gold prices. Forefronts, the variables that have the greatest impact on gold prices are money supply, dollar exchange rate and inflation rates, respectively. The Leamer approach considers variables whose coefficients are statistically significant and have the same sign across all regressions as robust. Therefore, the coefficients of geopolitical risks, the dollar exchange rate, money supply, and inflation rate are considered robust, as they are statistically significant and have a positive sign across all regressions. This finding implies that increases in geopolitical risks, the dollar exchange rate, money supply, and inflation rates are expected to raise domestic gold prices in Turkey. The remaining variables are fragile because their coefficients are different signs or insignificant in at least one model during the model generating process.

Table 3: Leamer's Extreme Bounds Analysis

Variables	Coefficient Mean	Std. Dev.	Lower Bound	Upper Bound	Robust/Fragile
C	0.008	0.003	-0.005	0.031	fragile
VIX	0.018	0.018	-0.028	0.092	fragile
GEPU	0.046	0.021	0.003	0.090	robust
OIL	0.027	0.032	-0.043	0.089	fragile
BIST	-0.017	0.063	-0.153	0.114	fragile
USD	0.861	0.080	0.704	1.020	robust
M2	0.958	0.166	0.632	1.286	robust
INF	0.784	0.317	0.162	1.411	robust
IND	-0.071	0.117	-0.304	0.161	fragile
INT	0.043	0.053	-0.063	0.148	fragile
HOUSE	0.446	0.247	-0.041	0.937	fragile
CBT	0.088	0.083	-0.077	0.256	fragile
UNEMP	0.010	0.052	-0.096	0.112	fragile

Note: The estimated coefficients are based on heteroskedasticity-robust standard errors.

According to Sala-i-Martin interpretation, if the least 0.95 of the density function of a given focus variable is on the right or left side of zero, it becomes clear that the variable is robust. It is clearly seen from Table 4, which contains the results of the Sala-i-Martin 's model, the probability that the coefficients of geopolitical risks, the dollar exchange rate, money supply, inflation, and house price variables are positive is greater than 95%. Therefore, we can say that the coefficients representing the effects of these variables on gold prices are positive and robust. The returns of gold in Türkiye are concretely effected by geopolitical risks, dollar exchange rate, money supply, inflation and house price. Since the distributions of the variables in regression are concentrated on the right side, increases in these variables will drive gold prices up in Turkey. Since the probability of negative coefficients does not exceed 95% for any of the explanatory variables, no variable can be considered to have a robust negative effect on gold prices. In line with the Leamer results, only the coefficients of the BIST Index and the industrial production index have a higher probability of being negative than positive; however, since these probabilities do not exceed 95%, they are not regarded as robust.

The findings of our study align with several previous works in terms of key explanatory variables. In Turkey, the positive relationship between the exchange rate and gold prices is consistent with the findings of Doğanalp et al. (2016), Kocatepe and Yıldız (2016), and İlkan et al. (2022). Similarly, the positive effect of inflation on gold prices parallels the results of Aksoy and Topçu (2013), Elmas and Polat (2014), and Kuzu (2022). On the other hand, our study differs from previous research by

estimating the positive and robust effects of geopolitical risks, money supply, and house prices on gold prices in Turkey.

Table 4: Sala-i-Martin's Extreme Bounds Analysis

Variables	CDF < 0	CDF > 0	Decision
C	1.456	98.544	robust
VIX	16.285	83.715	fragile
GEPU	1.493	98.507	robust
OIL	20.228	79.772	fragile
BIST	60.388	39.612	fragile
USD	0.000	100.000	robust
M2	0.000	100.000	robust
INF	0.670	99.330	robust
IND	72.897	27.103	fragile
INT	20.906	79.094	fragile
HOUSE	3.560	96.440	robust
CBT	14.394	85.606	fragile
UNEMP	40.181	59.819	fragile

If we interpret the findings as a whole and taking into account the economic fundamentals, the following topics come to the fore. To sum up, gold is one of the most liquid, globally traded and portable precious metals around, general investors tend to view gold as “investment of last resort” in times of escalating economic uncertainty and tension. This is why the coefficient of GEPU is positive. The average effect of US dollar on gold is positive. Because, the ounce price of gold in the world is denominated in dollars, as the dollar gains value, gold prices which is denominated Turkish Lira, also increase in Türkiye. The growth rate of nominal M2 is highly significant determinant of gold price. The reason we came to such a result is that the idle money in the market is directed to gold for investment purposes. Gold returns are driven by an increase in inflation. Because highly inflationary processes deteriorate the purchasing power, economic agents often prefer gold to protect themselves from losses in domestic assets. Rising house price also translates into increase of gold return. Likely, the positive correlation between the two variables is that both houses and gold are preferred by investors who do not like the interest income for religious reasons. Thus, savers who do not invest their money in deposits and bonds simultaneously turn to the gold and real estate markets.

5. Conclusion

Türkiye still faces many challenges as a high-inflation country, and gold investors have first-hand experience with this issue. Therefore, it is widely accepted that households in Türkiye protect their financial position against inflation by holding gold. This study aims to identify which robust factors determine gold prices in Türkiye. According to the findings, GEPU, USD, money supply, and inflation are identified as four highly robust variables based on both Leamer and Sala-i-Martin models. In addition, house price is identified as a robust determinant of gold prices according to the Sala-i-Martin approach. These results indicate that the aforementioned factors are robust determinants of gold prices in Türkiye. The study also clearly shows that spot gold returns are driven more by local variables than by global factors. This is because variables such as oil prices and the VIX are found to be fragile under both models, indicating that they are not significantly related to gold prices in Türkiye. The insignificant impact of global factors such as oil prices and the VIX on gold demand suggests that Turkish investors are not particularly sensitive to external economic shocks.

These findings highlight the prominent role of monetary policy and its outcomes in ensuring more stable gold prices in Türkiye. Accordingly, tighter control over the money supply, along with a

transparent, accountable, and consistent monetary policy, can help prevent the depreciation of the Turkish lira and sudden exchange rate fluctuations, thereby reducing inflationary pressures. On the other hand, the development of inflation-indexed financial instruments in the capital markets could help absorb part of the demand for gold during inflationary periods.

Araştırma ve Yayın Etiği Beyanı

Bu çalışma bilimsel araştırma ve yayın etiği kurallarına uygun olarak hazırlanmıştır.

Yazarların Makaleye Olan Katkısı

Yazar 1'in makaleye katkısı % 50, Yazar 2'nin makaleye katkısı % 50'dir.

Çıkar Beyanı

Yazarların hiçbir kimse ya da kurum ile çıkar çatışması bulunmamaktadır.

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Extended Summary

Gold is one of the most fundamental investment instruments for Turkish investors. Turkish people are accustomed to using gold as a store of value. Concretely, there are both economic and traditional reasons why Turkish people are so fond of gold. First of all, the use of gold as currency during the Ottoman period has a place in the memory of the Turkish people as a tradition from the past. Besides, gold is the first jewelry preferred for gifts at weddings in Turkey. Economically, Türkiye has been living with high and volatility inflation rates for many years. To protect themselves from inflation hampered purchasing power, people keep gold under their pillows outside the financial system. Especially before 1980, strict exchange rate controls, fixed exchange rate regime and frequent devaluations, alienated households from domestic currency (Vural, 2003; Gulseven & Ekici, 2016).

In this study, we try to explain the domestic spot gold return in Türkiye. Therefore, this paper investigates the impact of macroeconomic factors on domestic gold prices by using Extreme Bounds Analysis (EBA). It chooses the house price, VIX index, oil prices, interest rate, economic policy uncertainty index, inflation rate, US dollar, Borsa Istanbul stock exchange, industrial production, unemployment rate, money supply defined by M2 and central bank gold reserves as potential economic drivers.

The relationship between gold prices and macroeconomic, monetary, and financial variables has been extensively studied in the literature due to gold's unique role as both an investment asset and a store of value. Researchers have explored a wide range of factors influencing gold prices, including inflation dynamics, monetary policy conditions, financial market sentiment, and global uncertainty. While some studies emphasize the importance of macroeconomic indicators such as CPI, GDP, and interest rates, others highlight the role of investor behavior, liquidity conditions, and geopolitical events. Additionally, gold's effectiveness as an inflation hedge and its safe-haven characteristics during periods of economic instability remain central themes. The following review summarizes key empirical findings from prior studies, shedding light on the diverse determinants of gold price movements across different time periods and geographic contexts.

Cai et al. (2001) found that intraday trading behaviors significantly influence gold price volatility, and that major central bank gold sales, rather than U.S. macroeconomic announcements, are the primary drivers of price declines. Batten et al. (2010) concluded that gold price volatility is largely explained by monetary factors. Murach (2019) demonstrated that rising global liquidity leads to higher inflation and increases the demand for gold. Jones and Sackley (2016) showed that economic policy uncertainty raises short-term demand for gold, as it serves not only as an inflation hedge but also as a safe haven during uncertain periods. Malliaris and Malliaris (2015) found that while gold underperforms equities over the long term, demand for gold spikes during financial crises, inflation fears, currency devaluations, and stock market downturns. Rana and O'Connor (2023) identified long-run cointegration between precious metal prices and variables such as CPI, industrial production, stock prices, and interest rates in Australia, Japan, and China, but not in India, the U.S., or the U.K.

Regarding the gold-inflation relationship, Ghosh et al. (2004), McCown and Zimmerman (2006), and Worthington and Pahlavani (2007) found significant long-term cointegration between gold prices and inflation. Bruno and Chincarini (2010) noted that investors are more likely to add gold to their portfolios during inflationary periods. Hoang (2011) and Bampinas and Panagiotidis (2015) confirmed gold's role as an inflation hedge in the U.S. and U.K. over the long term, and Sharma (2016) extended these results to 54 countries. In contrast, Blose (2010) found that unexpected changes in inflation do not significantly impact gold prices, with investors turning to bond markets instead. Similarly, Tully and Lucey (2007) did not observe a statistically significant relationship between gold and inflation. Erb et al. (2020) argued that rising inflation expectations should lead to higher gold prices and that

financialization through ETFs has also contributed to price increases. Chirwa and Odhiambo (2020) identified both short- and long-term impacts of international stock and bond markets and global variables on gold prices, though the direction of these effects varied. Shahbaz et al. (2017) found a stronger relationship between oil prices and gold returns at higher data frequencies, particularly weekly.

Focusing on the Turkish market, Soytaş et al. (2009) observed that global oil prices have a temporary positive impact on domestic gold and silver prices, and that gold serves as a safe haven during periods of Turkish Lira depreciation. Kırkulak Uludağ and Lkhamazhapov (2014) found that spot gold returns in Turkey exhibit long memory properties and that the global financial crisis introduced structural breaks in gold return patterns.

Considering the most common variable in the literature, this study employs monthly time series data on domestic spot gold price, house price index, deposit interest rate, inflation, economic policy uncertainty, unemployment, the M2 money growth, the Turkish lira/US dollar exchange rate, the VIX, the Brent oil price, Central Bank of Türkiye's gold reserves, the BIST-100 index, and the industrial production. Data covers the period 2010-01 and 2024-03.

The Extreme Bounds Analysis (EBA) model attempts to capture the strongest statistical relationship between predictor and predicted by trying all combinations of a number of independent variable candidates that are likely to explain changes in the dependent variable (Kim et al., 2019). At its core, EBA is an econometric technique preferred to reduce uncertainty in multiple linear regression models. There are two different approaches in this type modeling method: Leamer (1985) and Sala-i-Martin (1997). According to the Leamer approach, the coefficients determined whether they are statistically robust or fragile with the help of upper and lower extreme limits. If the coefficient has the same sign within the upper and lower extreme limits, it is considered strong, and otherwise it is considered weak. According to the Sala-i-Martin calculation method, the more values of the coefficient are in the same region of zero, the coefficients are considered to be more robust (Hlavac, 2016).

According to the Leamer approach, it is concluded that as geopolitical risks, exchange rates, money supply, and inflation rates increase over time, gold prices in Türkiye also rise. The remaining variables are considered fragile. According to the Sala-i-Martin interpretation, gold returns in Turkey are significantly affected by geopolitical risks, exchange rates, money supply, inflation, and housing prices. Increases in these variables will drive gold prices upward in Turkey. Our results bring the following findings to the forefront. To sum up, gold is one of the most liquid, globally traded and portable precious metals around, general investors tend to view gold as "investment of last resort" in times of escalating economic uncertainty and tension. This is why the coefficient of GEPU is positive. The average effect of US dollar on gold is positive. Because, the ounce price of gold in the world is denominated in dollars, as the dollar gains value, gold prices which is denominated Turkish Lira, also increase in Türkiye. Growth rate of nominal M2 is highly significant determinant of gold price. The reason we came to such a result is that the idle money in the market is directed to gold for investment purposes. Gold returns are driven by an increase in inflation. Because highly inflationary processes deteriorate the purchasing power, economic agents often prefer gold to protect themselves from losses in domestic assets. Rising house price translates into increase of gold return. Likely, the positive correlation between the two variables is that both houses and gold are preferred by investors who do not like the interest income for religious reasons. Thus, savers who do not invest their money in deposits and bonds simultaneously turn to the gold and real estate markets.

Türkiye still faces many challenges as a high-inflation country, and gold investors have first-hand experience with this issue. Therefore, it is widely accepted that households in Türkiye protect their financial position against inflation by holding gold. This study aims to identify which robust factors

determine gold prices in Türkiye. According to the findings, GEPU, USD, money supply, and inflation are identified as four highly robust variables based on both Leamer and Sala-i-Martin models. In addition, house price is identified as a robust determinant of gold prices according to the Sala-i-Martin approach. These results indicate that the aforementioned factors are robust determinants of gold prices in Türkiye. The study also clearly shows that spot gold returns are driven more by local variables than by global factors. This is because variables such as oil prices and the VIX are found to be fragile under both models, indicating that they are not significantly related to gold prices in Türkiye. The insignificant impact of global factors such as oil prices and the VIX on gold demand suggests that Turkish investors are not particularly sensitive to external economic shocks. These findings highlight the prominent role of monetary policy and its outcomes in ensuring more stable gold prices in Türkiye. Accordingly, tighter control over the money supply, along with a transparent, accountable, and consistent monetary policy, can help prevent the depreciation of the Turkish lira and sudden exchange rate fluctuations, thereby reducing inflationary pressures. On the other hand, the development of inflation-indexed financial instruments in the capital markets could help absorb part of the demand for gold during inflationary periods.