Research Article

An Empirical Analysis of Grams of gold Funds and Macroeconomic Dynamics in the Context of Turkey's Private Pension System

Mehmet Mert TÜRK[1], Mahmut Şenol AKGÜL[2]

[1] Assist. Prof. Dr., Tokat Gaziosmanpaşa University, mehmetmert.turk@gop.edu.tr, ORCID: 0000-0002-0164-2131
[2] Graduate Student, Tokat Gaziosmanpaşa University, akgulmsenol@gmail.com, ORCID: 0009-0007-4171-3081

Abstract: This research investigates the long-term correlation between macroeconomic variables and the growth of private pension system (PPS) grams of gold funds in Turkey, employing Fourier ADL and FMOLS methodologies. The results indicate that grams of gold prices exert a substantial and considerable influence on the size of the PPS grams of gold fund. A 1% rise in grams of gold prices results in a 0.9% increase in the size of PPS grams of gold funds. Conversely, fluctuations in the BIST 100 index and exchange rates exert minimal influence on PPS grams of gold funds. The Fourier ADL test results demonstrate a long-term cointegration link between the series, notwithstanding structural breakdowns. This indicates that investors seek grams of gold as a refuge during financial instability and that grams of gold prices significantly influence PPS grams of gold funds. The results highlight the vulnerability of grams of gold investments in Turkey and the increasing significance of PPS grams of gold funds.

Keywords: Private Pension System, Grams of gold Funds, Individual Investor
Jel Codes: G11, E44, C32

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Altın Fonları ve Makroekonomik Dinamikler: Türkiye'de Bireysel Emeklilik Sistemi Perspektifinden Ampirik Bir Analiz

Öz: Bu araştırma, Fourier ADL ve FMOLS metodolojilerini kullanarak Türkiye'deki makroekonomik değişkenler ile bireysel emeklilik sistemi (BES) altın fonlarının büyümesi arasındaki uzun vadeli ilişkiyi araştırmaktadır. Sonuçlar, altın fiyatlarının BES altın fonunun büyüklüğü üzerinde önemli ve kayda değer bir etkiye sahip olduğunu göstermektedir. Altın fiyatlarındaki %1'lik bir artış BES altın fonlarının büyüklüğünde %0,9'luk bir artışa yol açmaktadır. Buna karşılık, BIST 100 endeksindeki ve döviz kurlarındaki dalgalanmalar BES altın fonları üzerinde minimum etkiye sahiptir. Fourier ADL test sonuçları, yapısal kırılmalara rağmen seriler arasında uzun dönemli bir eşbütünleşme ilişkisi olduğunu göstermektedir. Bu durum, yatırımcıların finansal istikrarsızlık dönemlerinde sığınacak bir liman olarak altın aradıklarını ve altın fiyatlarının BES altın fonlarını önemli ölçüde etkilediğini göstermektedir. Sonuçlar, Türkiye'deki altın yatırımlarının kırılganlığını ve BES altın fonlarının artan önemini vurgulamaktadır.

Anahtar Kelimeler: Bireysel Emeklilik Sistemi, Altın Fonları, Bireysel Yatırımcı
Jel Kodları: G11, E44, C32

1. Introduction

Grams of gold has been recognized as one of the most precious metals throughout human history. Until recently, it functioned as both a medium of trade and a component of the international monetary system (Menase, 2009, p. 8). For example, the Ottoman In

1881, the state employed one Ottoman grams of gold lira as its currency, valued at 7,216 kilograms of grams of gold, 18 British shillings, or 4.40 US dollars (Kepenk & Yentürk, 1983, p. 10). Currently, they are predominantly valued for their economical transportation and decorative purposes. Additionally, in conjunction with technical aspects such as electronics and medical gadgets. Individuals save them as a protection against inflation. Geopolitical dangers, conflicts, and economic disasters, including pandemics, are perceived as secure investments during times of upheaval (Nagayev & Dinç, 2018, p. 11).

Grams of gold is a universally traded investment asset. The grams of gold price, as reported by the London Bullion Market Association (LBMA), is utilized as a reference by all sectors and central banks globally. The price of a gram of grams of gold is officially determined twice daily, at 13:00 and 17:00 London time, in US dollars. This price represents the grams of gold futures delivery price, as well as the transaction and delivery charges. Various data-driven grams of gold exchanges and marketplaces exist globally, including the Borsa Istanbul Precious Metals Market (formerly known as the Istanbul Grams of gold Exchange). Global transactions in these marketplaces constitute a significant aspect of grams of gold trading, with central banks and financial institutions engaging in grams of gold trade globally. Grams of gold prices vary based on demand, supply, and economic conditions; thus, variations in the grams of gold markets are vital to global economies and financial markets, beyond just safekeeping. The price of grams of gold is dictated by the market supply and demand among all buyers and sellers (Küçükaksoy & Yalçın, 2017, p. 4). The majority of grams of gold prices are exclusively set in US dollars. An ounce is a derivative of the English term "ounce," with one ounce equating to 31.10 grams, which is predominantly exchanged by ranges, central banks, and international markets globally. Conversely, gram grams of gold prices are determined on local markets.

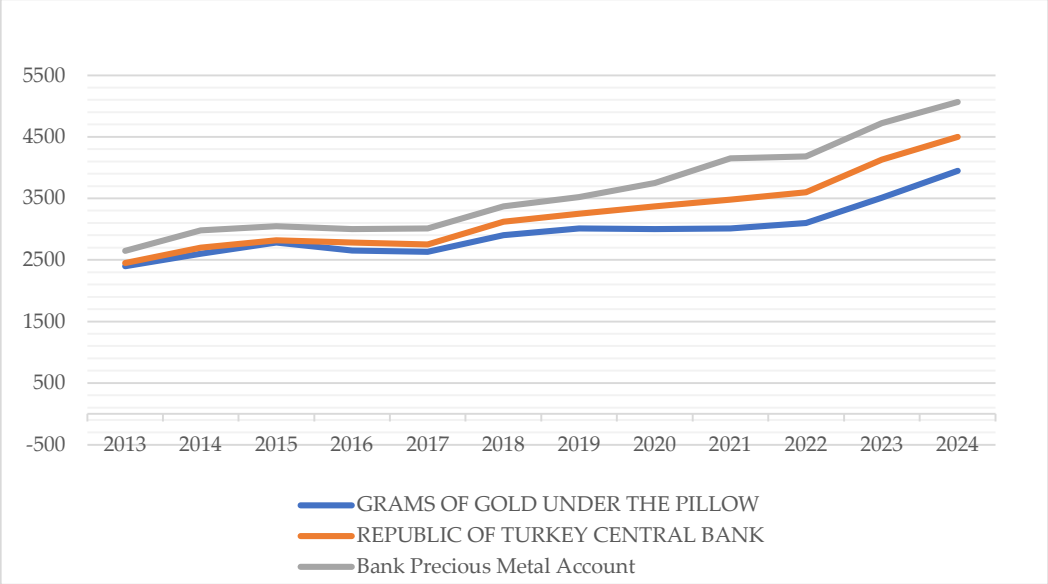

Figure 1. Total Ownership of Grams of gold Reserves (Tons) **Source:** (TÜİK, 2024)

The World Grams of gold Council estimates that Turkey possesses around 3,500 tons of grams of gold categorized as "under the mattress" (World Grams of gold Council, 2024, p. 2).

It is noted that 60% of savers typically allocate their resources to conventional investment vehicles, including grams of gold, foreign exchange, and interest rates. The long-term analysis of 5-year savings trends indicates that the BIST Banking index is statistically considerably and negatively influenced by interest rates and grams of gold prices, but it is strongly and positively influenced by the exchange rate (Tuna, 2019, p. 7).

The overall fund size in the private pension system is around TL 550 billion, with roughly 25% consisting of grams of gold funds. Furthermore, around TL 700 million is injected into the system monthly, with an additional 30% state contribution applied to this sum. Grams of gold investments are conducted through grams of gold mutual funds, grams of gold pension mutual funds, and grams of gold exchange-traded funds. Grams of gold funds typically commit 80% of their portfolios to grams of gold and precious metals, but some other traded funds may designate a portion of their portfolios to grams of gold and precious metals.

This means a long-term relationship between private pension system (PPS) funds and gram grams of gold prices is anticipated. Overall, the assets inside the private pension system exert a favorable influence on gram grams of gold prices. This possibility provided by the private pension system establishes a secure refuge for investors seeking protection from political instability and geopolitical threats. Implementing strategies to encourage the allocation of PPS funds to both investors and the national economy, by increasing state contributions to those investing in grams of gold and precious metal funds and exempting them from deductions, will diminish cash hoarding, limit new investors engaging in cash hoarding, and ensure that these funds are effectively utilized within the economy. Private pension grams of gold funds provide investors the chance to invest in grams of gold, regarded as a secure asset. This study aims to analyze and elucidate the impact of private pension grams of gold funds on macroeconomic indicators. The impact of the funds on the Consumer Price Index (CPI), gram grams of gold price, USD/TL exchange rate, and BIST100 index is examined. The current literature demonstrates the correlation between these funds and economic indicators, as well as the impact of these correlations on market dynamics.

2. Theoretical Framework

2.1. Private Pension Scheme (PPS)

The Private Pension System (PPS) is a voluntary savings and investing framework designed to secure financial stability in retirement. This method promotes consistent savings to secure financial stability for retirement and permits the deployment of these savings in many financial instruments (Yılmaz H., 2017, p. 52). The PPS, launched in Turkey in 2003, is founded on two primary objectives: enhancing individual savings and supporting capital markets (Tosun, 2015, p. 17). The PPS simultaneously fosters long-term economic growth by enhancing individual savings. The system's expansion in Turkey fosters sustainable economic growth by enhancing long-term savings rates. In this setting, individuals utilize the PPS to avert income loss and sustain their living standards in retirement. Consequently, whereas the PPS ensures individual financial stability, it also substantially enhances national savings rates (Çetin, 2020, p. 45).

The PPS serves as both a personal savings tool and a significant source of funding for the national economy. Participants' invested monies are allocated to capital markets, hence facilitating liquidity within the economy. The aim of the PPS is to enhance individual retirement income while ensuring the efficient utilization of savings nationwide. Participants may select from several fund types and favor investments aligned with their risk profiles, so ensuring financial security throughout retirement (Güven, 2018, p. 63). Participants allocate a specific percentage of their income to professional pension firms, intended for retirement, while augmenting their savings through regular contributions over a self-determined duration. Upon retirement, these savings may be withdrawn either as a lump payment or in installments, based on the participant's preference. Moreover, members may allocate their savings to other investment funds. These funds encompass several investment vehicles, including equities, fixed-income securities, foreign currencies, and real estate (Arslan & Kara, 2016, p. 99).

2.2. Grams of gold and the Financial System

Grams of gold has always served as a good investment vehicle and maintains a significant role in contemporary financial markets. Grams of gold serves as a repository of value and a refuge during economic instability, significantly contributing to portfolio diversification owing to its minimal association with other financial assets (Gültekin, 2019, p. 35). Grams of gold investments can be executed using many instruments. Grams of gold coins, bars, mining equities, and grams of gold funds are among these instruments. In recent years, grams of gold funds have emerged as a favored option that enables investors to invest without possessing real grams of gold (Yılmaz & Arslan, 2018, p. 112).

The price of grams of gold is influenced by multiple factors, including supply-demand equilibrium, exchange rates, interest rates, and geopolitical considerations. The demand for grams of gold rises particularly during times of economic uncertainty, thus driving up prices (Güzel, 2020, p. 79). Grams of gold's role as a safeguard against inflation and its perception as a low-risk investment are significant determinants of investor behavior (Yılmaz & Arslan, 2018, p. 130). Fluctuations in grams of gold prices can influence the overall economic landscape by impacting liquidity in financial markets. During crises, the pursuit of a safe haven heightens the demand for grams of gold, influencing economic equilibrium (Smith & Jones, 2021, p. 45).

2.3. Private Pension Schemes and Grams of gold Investment Funds

The PPS is a system that facilitates retirement savings and provides long-term investment alternatives appropriate for diverse risk profiles (Yazar, 2023, p. 12). PPS grams of gold funds allow investors to mitigate inflation risks and enhance portfolio diversity. These funds obviate the necessity of storing real grams of gold, enabling investors to directly capitalize on grams of gold prices.

PPS grams of gold funds give investors the benefits of portfolio diversification and serve as a safeguard against inflation. Furthermore, selecting these funds versus purchasing actual grams of gold offers reduced expenses and enhanced liquidity. Grams of gold funds enable individuals to capitalize on value appreciation during retirement (Doe, 2020, p. 18). The trajectory of PPS grams of gold funds will be influenced by advancements in financial technologies and the establishment of regulatory frameworks. The expansion of digital platforms will provide investors convenient access to grams of gold funds, while adherence to environmental and social responsibility criteria may enhance their appeal (Güzel, 2020, p. 119). The actions of central banks regarding grams of gold reserves and the economic impacts of PPS money significantly influence grams of gold market trends. PPS grams of gold funds that promote economic stability are expected to influence investor behavior (Yavuz & Demir, 2020, p. 88). Grams of gold continues to be a compelling asset for both individual and institutional investors, appealing to diverse investor profiles via PPS grams of gold funds. These funds offer safeguards against economic crises and bolster individual savings, so fostering long-term economic growth and financial stability. Future advancements will augment the sustainability and efficacy of PPS grams of gold funds. This necessitates grams of gold funds to engage with many macroeconomic variables within an economy.

3. Literature Review

Research on the impact of the private pension system on financial markets yields significant insights both in Turkey and beyond. In Turkey, Budak (2021) identified a reciprocal causation between private pension funds and the stock market, whilst Bayar (2020) highlighted the long-term beneficial impacts of pension funds on both the stock and debt markets. Arslan (2006) highlights the role of private pension funds in the advancement of capital markets, but Meriç (2018) contends that the private pension system mostly allocates its assets to fixed-income instruments, resulting in a constrained contribution to capital markets. Verberi (2019) demonstrates that private pension funds have a beneficial impact on corporate bonds and stock markets over the long term,

although a one-way causal relationship exists in the near term. Meng & Pfau (2010) identify that pension funds enhance stock market value, stock volume, and bond market value at the worldwide level, whereas Gürbüz (2003) highlights their role in diminishing market volatility and cutting real interest rates in OECD nations.

The impact of grams of gold ETFs on inflation and market dynamics also uncovers significant insights. Kurtuluş & Yılmaz (2017) demonstrate that the demand for grams of gold funds rises during high inflation times, as investors want to safeguard their purchasing power. Cunningham (2016) and Gürkaynak, Sack & Swanson (2008) analyze the impact of inflation predictions on precious metals, highlighting that grams of gold serves as a strong hedge against inflation. Büyükşahin (2018) and Wang & Zhang (2015) demonstrate that the performance of private pension grams of gold funds is directly correlated with gram grams of gold prices, whereas Yıldız (2019) elucidates the indirect impacts of grams of gold funds on exchange rate volatility.

The impact of exchange rates on commodity funds and financial market dynamics has been extensively researched. Borio & Disyatat (2011) highlight the impact of exchange rate fluctuations on private pension grams of gold funds, whereas Cheung & Rangel (2009) and Fratzscher & Mihaljek (2012) investigate the influence of exchange rates on commodity fund performance and pricing. Adrian & Shin (2010) underscore the impact of liquidity supplied by funds in mitigating price volatility in the markets.

The correlation between stock market indices and commodity funds yields significant insights into investor behavior and market dynamics. Kaya (2020) examines the impact of commodities funds on stock market volatility, whereas Baur & McDermott (2010) contend that investors seek refuge in safe haven assets like grams of gold during times of uncertainty. Kilian (2009) and Beckmann & Czudaj (2013) examine the influence of commodity prices on stock market indices and their ramifications for market dynamics. Research on investor behavior amid economic instability illustrates how these dynamics influence the demand for grams of gold funds. Arslan & Yılmaz (2018) contend that investors gravitate towards grams of gold funds amid economic difficulties due to the apprehension of loss, whereas Demirtaş & Korkmaz (2020) examine the rising demand for grams of gold funds as a refuge during crises. Çolak & Polat (2019) investigated the impact of investor behavior during crises on the performance of grams of gold ETFs. These studies offer a crucial framework for comprehending the impact of private pension funds on financial markets and for formulating corresponding investment strategies.

4. Data Sources and Methodology

The econometric model of the study utilizes monthly data from January 2014 to December 2023. The model seeks to ascertain the association between private pension grams of gold funds (befas) and specific macroeconomic factors, with BIST100, foreign exchange (usd), and gram grams of gold identified as independent variables representing alternative investment instruments. The study investigated a total of 120 observations for each variable. The model for analysis is shown in equation (1):

$$lnbefas_t = \beta_0 + \beta_1 lnusd_t + \beta_2 lngrgold_t + \beta_3 lnbist100_t + \varepsilon_t \quad (1)$$

In the econometric model presented in Equation (1), the symbols β_0 and ε_t denote the constant and the error term, respectively. The parameters $\beta_0$to β_3 are the coefficients of the explanatory variables incorporated in the function. All variables are transformed using natural logarithms to ensure that observation values with differing units convey equivalent significance. The notation "ln" signifies that the logarithm of the series is computed. The model's data descriptions are presented in Table 1;

Table 1. Data Set

Variable	Notation	Description	Application	Source
Befas	lnbefas	BEFAS grams of gold fund size (TL)	Logaritmik	Retirement Monitoring Center
Bist-100	lnbist	According to closing prices (2003=100)	Logaritmik	Electronic Data Distribution System (EVDS)
Grams of gold	lngrgold	Grams of gold bullion selling price (TL/Gr.)	Logaritmik	EVDS
usd	lnusd	USD/TL usa dollar exchange rate	Logaritmik	EVDS

In the study, as a starting point, the stationarity of the variables was examined through the Augmented Dickey-Fuller (1981) (ADF) and Phillips-Perron (1988) (PP) unit root tests. Subsequently, the Fourier ADL cointegration test developed by Banerjee, Arčabić & Lee (2017) has been used to reveal long-term relationships. In the final stage, the FMOLS (Fully Modified Ordinary Least Squares) method was applied to calculate the long-term parameter coefficients in the cointegrated series. Graphs showing the trends of the variables used in the analysis over time are provided in Figure 1:

Upon examination of the series graphs, it is noted that all series exhibit an upward tendency.

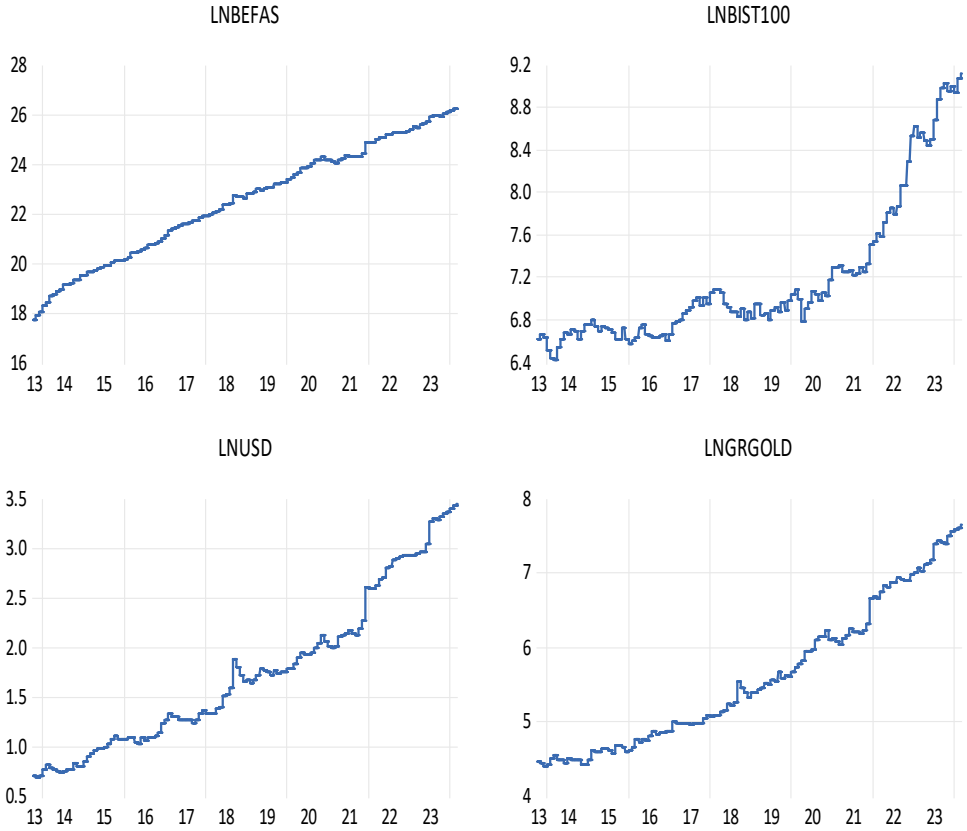

Figure 2. Graphs of variables

4.1 Augmented Dickey-Fuller (1981) and Phillips and Perron (1988) Unit Root Tests Tests

The Dickey-Fuller (1981) stationarity test is based on the examination of a first-order autoregressive (AR) process. The Augmented Dickey-Fuller (1981) test evaluates the null hypothesis based on an ARIMA(p,1,0) autoregressive integrated moving average process and the alternative hypothesis based on a stationary ARIMA(p+1,0,0) process (Cheung &

Lai, 1995, p. 277). Error terms are assumed to be discrete and identically distributed $[\varepsilon_t \sim WN(0, \sigma^2)]$.

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_t \quad (2)$$

$$\Delta y_t = c + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (3)$$

$$\Delta y_t = c + \gamma y_{t-1} + \delta_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (4)$$

The first of the three regression models mentioned above (Model 1) does not include the constant term and trend variable. The second model (Model 2) represents a regression including only the constant term. The third model (Model 3) represents a model that includes both a constant term and a trend variable. In these models, it is tested whether the coefficient 'γ' of y_(t-1), the value of the dependent variable in the previous period, is less than one. If the alternative hypothesis is confirmed, it is concluded that the series is stationary.

The Dickey-Fuller test assumes constant variances and independent error terms, which implies the absence of autocorrelation. Phillips and Perron (1988) modified these assumptions of the Dickey-Fuller (1979) test and introduced a new approach to random shocks (Sevüktekin & Nargeleçekenler, 2010, p. 366). The equations expressing the fixed and fixed-trend models in the PP test are as follows:

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \varepsilon_t \quad (5)$$

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 \left(t - \frac{T}{2}\right) + \varepsilon_t \quad (6)$$

Equations (4) and (5) above represent models with constant term and constant-trend, respectively. In these models, Y_t is the tested variable, α_0 is the constant term, t is the trend, T is the number of observations and the error term is the uncertainty component of the model. The coefficient to be tested is estimated by this method. As in the ADF test, the result obtained is compared with the MacKinnon critical table values and a decision is made about the stationarity of the series (Tarı, 2010).

4.2 Fourier ADL Cointegration Test

A. Banerjee, Dolado & Mestre (1998) were the first to propose the distributed lag (ADL) model for cointegration testing. In the method introduced in the literature in 2017, P. Banerjee et al. (2017) added Fourier functions, including sine and cosine functions, to the previous model. In the Fourier ADL model, the model is rearranged as follows by using deterministic components as the constant term:

$$\Delta y_t = d(t) + \beta_1 y_{t-1} + \gamma_1' x_{t-1} + \emptyset' \Delta x_t + u_t \quad (7)$$

$$d(t) = a_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) \quad (8)$$

In this model, (t) represents a deterministic component. To solve the autocorrelation problem, the revised model includes lagged values of the variables. The alternative hypothesis suggests that there is a long-term relationship between the variables. Therefore, in order to test the long-run relationship, equation (7) is run, the appropriate frequency value is obtained and the significance of the coefficient of the lagged value of the dependent variable is examined using the standard t-test.

$$H_0: \beta_1 = 0 \quad (9)$$

Although it is interpreted with the T test, the critical values in the article of P. Banerjee et al. (2017) are taken into account.

4.3 Estimation of Long Run Cointegration Coefficients (Fully Modified Ordinary Least Squares-FMOLS)

In this study, long-run cointegration coefficients are analysed by FMOLS (Fully Modified Ordinary Least Squares) method. FMOLS (Fully Modified Ordinary Least Squares) method was developed to obtain reliable estimates by correcting autocorrelation and endogeneity problems in cointegration analyses. The method provides more accurate estimation of long-run relationships by removing possible relationships between independent variables and error terms. FMOLS, which provides efficient forecasts even in small sample sizes, provides a more robust basis for long-run cointegration relationships between time series by correcting autocorrelation. This method tests long-run equilibrium relationships using conventional cointegration tests and is sensitive to simultaneous relationships between variables. Therefore, it is frequently preferred to analyse the dynamics between macroeconomic variables and financial markets in developing countries such as Turkey (Phillips & Hansen, 1990). The FMOLS method has become an important tool in the analysis of long-run relationships in both small and large samples by providing a flexible approach that minimises problems such as autocorrelation and endogeneity.

5. Results and Discussion

In the time series analysis, the initial step is to ascertain the stationarity of the series. Regression estimations derived from non-stationary data are unreliable. If the d-th difference in a time series attains stationarity, the series is classified as d-th degree integrated, designated as I(d). Consequently, this study assesses the stationarity of the variables in the initial phase. The ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) tests were employed for stationarity assessments. The ADF test assesses the presence of unit roots in a series, but the PP test provides a more adaptable solution to issues of autocorrelation and heteroskedasticity within the series. The results of these two tests offer significant insights into the long-term equilibrium relationships of the series. The outcomes of the stationarity test are presented in Table 2;

Table 2. PP and ADF Unit Root Test Results

PP Testi				
Variables		Constant	Constant-Trending	Constant-No trend
Lnbefas	level	-1.869 (0.345)	-3.438* (0.051)	9.126 (1.000)
Lnbist100		3.062 (1.0000)	0.433 (1.0000)	3.009 (0.999)
Lnusd		2.097 (0.999)	-1.211 (0.903)	5.920 (1.000)
lngrgold		3.343 (1.000)	-1.155 (1.000)	5.963 (1.000)
ΔLnbefas	first differences	-10.579*** (0.0000)	-10.724*** (0.0000)	-7.397*** (0.0000)
ΔLnbist100		-9.648*** (0.0000)	-9.996*** (0.0000)	-9.079*** (0.0000)
ΔLnusd		-9.501*** (0.0000)	-9.985*** (0.0000)	-8.639*** (0.0000)
Δlngrgold		-11.205*** (0.0000)	-13.165*** (0.0000)	-9.953*** (0.0000)
ADF Testi				
Variables		Sabit	Sabitli–Trendli	Sabit-Trend yok
Lnbefas	level	-1.726 (0.415)	-3.409* (0.055)	9.428 (1.0000)
Lnbist100		2.143 (0.999)	0.142 (0.997)	3.096 (0.999)

Lnusd		1.460 (0.999)	-1.350 (0.870)	4.478 (1.000)
lngrgold		1.639 (0.999)	-1.525 (0.815)	4.705 (1.000)
ΔLnbefas	first differences	-10.546*** (0.0000)	-10.653*** (0.0000)	-3.373*** (0.0000)
ΔLnbist100		-9.668*** (0.0000)	-10.020*** (0.0000)	-9.086*** (0.0000)
ΔLnusd		-9.576*** (0.0000)	-9.816*** (0.0000)	-8.573*** (0.0000)
Δlngrgold		-11.148*** (0.0000)	-11.580*** (0.0000)	-9.691*** (0.0000)

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

The findings of the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests indicate that a substantial number of variables are non-stationary at the level. The test statistics for the Lnbefas, Lnbist100, Lnusd, and Lngrams of grams of gold variables from level tests in both constant and trend models failed to demonstrate stationarity at the significance level, as the p-values exceeded 0.05. This scenario suggests that the series possesses a unit root at the level and is non-stationary. Upon examining the first difference findings of both tests, it was determined that all variables achieved stationarity in their first differences. The first differences of the variables Lnbefas, Lnbist100, Lnusd, and Lngrams of grams of gold exhibit very significant test statistics across models with constant, trend, and without constant-trend, with p-values at the 0.000 level. The results demonstrate that the series are stationary in their first differences and are classified as I(1) integrated series.

At this juncture, following the identification of the series' stationarity structures, the ADL model will be approximated utilizing the Fourier method to investigate potential long-term correlations among the series. The Fourier ADL cointegration test provides enhanced flexibility and reliability by accommodating structural interruptions within the series. The results of the Fourier ADL test are displayed in Table 3:

Table 3. Fourier ADL Cointegration Test Results

Min AIC	**Frequency(k)**	**Fourier ADL Test Statistic**	**Result**
2.283	5	-4.244*	There is a merger.
	Postponement Figures		
Lnbefas	Lnbist100	Lnusd	lngrams of gold
1	1	1	1
	Critical Values		
	%1	%5	%10
Fourier ADL	-5.08	-4.38	-4.01

Note: *, ** and *** indicate significance level at 10%, 5% and 1%.

The Fourier ADL test results indicate that the ideal model frequency value, based on the Min AIC criterion, is 5. This indicates that variations in the model are more effectively caught at this frequency, and that structural fractures are more accurately reflected. The Fourier ADL test statistic was computed as -4.244, surpassing the threshold value of -4.01 at the 10% significance level, hence indicating a cointegration relationship between the series at this significance level. Nonetheless, a result proximate to the crucial value of -4.38 established at the 5% significance level has been attained; thus, it may be inferred that a cointegration connection may also significantly exist at the 5% significance level. The crucial value of -5.08 at the 1% level is not surpassed, indicating a lack of evidence for cointegration at this level.

The results suggest that the series exhibit a long-term equilibrium connection, indicating that the variables co-vary. This scenario is crucial for examining the presence of long-term linkages in economic and financial time series. Furthermore, the optimal amount of lags for all variables in the model has been established as 1. The values of the Lnbefas, Lnbist100, Lnusd, and lngrams of grams of gold series from the preceding era adequately account for the current period. A minimal number of delays signifies that the model is more straightforward and efficient, necessitating no undue complication. The Fourier ADL test results demonstrate a long-term cointegration link between the series, and employing a model that accommodates structural breaks produces more trustworthy outcomes. These data indicate that the variables are correlated and interrelated over the long run.

A long-term link between the series has been identified using the Fourier ADL test. To do a comprehensive analysis of this relationship and get more precise parameter estimations, the FMOLS (Fully Modified Ordinary Least Squares) method will be utilized. This strategy yields dependable outcomes by adjusting the cointegration relationship in the series for autocorrelation and variance discrepancies. Table 4 presents the results of the coefficient estimations:

Table 4. Estimation of Long-Term Coefficients (FMOLS)

Dependent variable:	Lnbefas			
Independent variables	β	Std. Err.	T-Stats.	Prob.
Lnbist100	-0.886	0.696	-1.271	0.206
Lnusd	-0.012	0.153	-0.080	0.936
lngrgold	0.895***	0.134	6.655	0.000
C	0.043***	0.006	7.209	0.000

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

The table indicates that only fluctuations in grams of gold prices (lngrams of grams of gold) exert a statistically significant and positive influence on the dependent variable Lnbefas. The coefficient for changes in grams of gold prices is 0.895, accompanied by a t-statistic of 6.655 and a p-value of 0.000, signifying a robust positive influence at the 1% significance level. Conversely, although the coefficients for the BIST 100 index changes (Lnbist100) and exchange rate changes (Lnusd) are -0.886 and -0.012 respectively, the t-statistics and p-values suggest that these factors do not significantly influence Lnbefas. The constant term coefficient is 0.043, with a t-statistic of 7.209 and a p-value of 0.000, indicating strong significance and suggesting the potential influence of unaccounted factors in the model.

The Fourier ADL test findings indicate a long-term cointegration link between the series. This indicates that the series have co-moved throughout time, notwithstanding structural breakdowns, and have attained long-term equilibrium. The Fourier ADL test statistic has specifically validated the long-term associations between the series by surpassing the critical values at the 10% significance level. The findings were corroborated by FMOLS and regression analyses performed in the subsequent phase.

The FMOLS results unequivocally indicate that the most substantial and significant impact on the dependent variable Lnbefas arises from fluctuations in grams of gold prices (lngrams of grams of gold). The coefficient for grams of gold prices is 0.895, accompanied by a t-statistic of 6.655 and a p-value of 0.000, signifying a robust positive impact at the 1% significance threshold. This outcome demonstrates that rising grams of gold prices significantly enhance Lnbefas (the variation in the amount of the BES grams of gold fund) and that investors exhibit sensitivity to fluctuations in grams of gold prices. Conversely, despite the coefficients for the fluctuations in the BIST 100 index (Lnbist100) and the exchange rate variations (Lnusd) being -0.886 and -0.012 respectively, it has been ascertained that these variables exert no substantial influence on Lnbefas. The p-values for the BIST 100 index and exchange rate fluctuations are 0.206 and 0.936, respectively,

indicating a lack of statistical significance. This data suggests that movements in the BIST 100 and exchange rates do not significantly affect the size of the BES grams of gold fund. The coefficient for the constant term in the model is 0.043, accompanied by a t-statistic of 7.209 and a p-value of 0.000, signifying statistical significance. The importance of the constant term indicates that additional macroeconomic or financial factors not incorporated in the model may also influence the magnitude of the pension grams of gold fund. This indicates that variables not incorporated in the model may further elucidate the fluctuations in the BES grams of gold fund.

In conclusion, the combined evaluation of the Fourier ADL and FMOLS studies indicates a long-term cointegration relationship between the series, with fluctuations in grams of gold prices significantly influencing the magnitude of the private pension grams of gold fund. It has been established that the BIST 100 index and exchange rate variations do not significantly influence this relationship. The significant influence of grams of gold prices reflects investors' risk assessment and their demand for grams of gold as a secure investment option.

6. Conclusion and Policy Implication

This study analyzed the long-term correlations between the magnitude of the grams of gold fund in Turkey's individual retirement system (BES) and the BIST 100 index, currency rates, and grams of gold prices utilizing the Fourier ADL and FMOLS methodologies. The stationarity tests performed on the time series data revealed that none of the series were stationary at the level, albeit their first differences exhibited stationarity.

This conclusion suggests that the series are I(1) integrated, necessitating the use of their initial differences in subsequent analysis. The Fourier ADL test findings demonstrate a long-term cointegration link between the series. This discovery suggests a sustained equilibrium relationship among the magnitude of the private pension system's grams of gold fund, the BIST 100 index, exchange rates, and grams of gold prices. The Fourier ADL test statistic indicates that, even amidst structural breaks, the series exhibit long-term coherence. Consequently, it is understood that economic and financial shocks occurring at different intervals do not disturb the long-term cointegration relationship, allowing the series to attain equilibrium over time. A comprehensive analysis of the impact of macroeconomic variables in Turkey on the magnitude of the BES grams of gold fund has been established.

The results derived from the Fourier ADL test are corroborated by the estimates produced by the FMOLS approach. The FMOLS research indicates that fluctuations in grams of gold prices exert a substantial and statistically significant influence on the magnitude of the BES grams of gold reserve. The coefficient for grams of gold prices is 0.895, accompanied by a t-statistic of 6.655 and a p-value of 0.000, signifying a robust positive impact at the 1% significance level. This outcome indicates that the rise in grams of gold prices has resulted in a surge in grams of gold-based investments inside the individual pension system. Investors, particularly in times of financial instability, favor this investment instrument, viewing it as a safe haven by investing in grams of gold.

The expansion of the BES grams of gold fund underscores Turkish investors' sensitivity to grams of gold prices and their pronounced interest in the commodity. It has been determined that fluctuations in the BIST 100 index and currency rates do not significantly affect the size of the BES grams of gold fund. FMOLS data indicate that the coefficient for fluctuations in the BIST 100 index is -0.886, whilst the coefficient for variations in the exchange rate is -0.012. Both variables had low t-statistics and elevated p-values, suggesting that variations in the BIST 100 and exchange rates do not significantly influence BES grams of gold funds. This data suggests that variations in the stock market and currency rates are not substantial determinants for individual retiree grams of gold funds. The investors' preference for BES grams of gold funds is mostly influenced by fluctuations in grams of gold prices, whilst other financial market indicators, such the stock market index and exchange rates, exert minimal impact.

The constant term coefficient of 0.043 and the t-statistic of 7.209 in the model demonstrate that the constant term is relevant for the amount of the BES grams of gold fund. This outcome indicates that certain macroeconomic or financial variables excluded from the model may also influence the magnitude of the pension grams of gold fund. The positive and substantial character of the constant term may suggest the impact of additional structural and external factors on the magnitude of the pension grams of gold funds, which are not examined in this analysis. The results indicate that fluctuations in grams of gold prices are the primary determinant of the pension grams of gold fund's size. Grams of gold is regarded as a secure asset during times of uncertainty, hence augmenting the demand for grams of gold funds inside individual retirement accounts. The BIST 100 index and currency exchange rate variations do not substantially influence the magnitude of this fund. The data suggest that grams of gold prices in Turkey significantly influence BES grams of gold funds and that individual investors highly perceive grams of gold's safe-haven function. Future research addressing additional macroeconomic variables and investor behaviors about the magnitude of pension funds may yield a more comprehensive understanding of the individual retirement system.

References

Adrian, T. & Shin, H. (2010). Liquidity and leverage. *Journal of Financial Indermetiation, 19*(3), 418-437.

Arslan, A. & Kara, H. (2016). Bireysel emeklilik sistemi ve Türkiye ekonomisi üzerindeki etkileri. 99.

Arslan, F. (2006). *Türkiye'de bireysel emeklilik sistemi fon yaratma kapasitesi ve sermaye piyasaları üzerine etkisi.* İstanbul: Yıldız Teknik Üniversitesi.

Banerjee, A. D. & Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis, 19*(3), 114-124.

Başar, R. (2015). *Global Altın fiyatlarının modellenmesi ve tahmini.* Sakarya: Sakarya Üniversitesi.

Baur, D. & McDermott, J. (2010). Is grams of gold a safe haven? *Journal of Banking&Finance, 34*(8), 1886-1898.

Bayar, Y. (2017). Yükselen Piyasa ekonomilerinde emeklilik fonları, finansal gelişme ve ekonomik büyüme. *BDDK Bankacılık ve Finansal Piyasalar Dergisi, 11*(1), 51-64.

Beckmann, J. & Czudaj, R. (2013). The impact of stock indices on commodity prices: Evidence from a volatility perspective. *Journal of International Financial Markets, 26*, 132-144.

Bekaert, G. & Harvey, C. (2002). Research in emerging markets finance: An overview. *Journal of emprical finance, 3*(2), 429-448.

Borio, C. & Disyatat, P. (2011). Global imbalances and the financial crisis: Linkages and policy implications. *Journal of International Money and Finance, 30*(8), 1135-1163.

Budak, S. (2021). Türkiye' de bireysel emeklilik sistemi ile BİST Tüm endeksi arasındaki ilişki. *EKEV Akademi Dergisi, 25*(86).

Büyükşahin, B. (2018). Grams of gold market dynamics and investment fund impact. *Journal of Commodity Markets*(11).

Cheung, Y. & Rangel, J. (2009). The effects of exchange rate movements on commodity prices. *Journal of International Money and Finance, 28*(3), 340-357.

Cheung, Y.-W. & Lai, K. S. (1995). Lag order and critical values of the augmented Dickey-Fuller test. *Journal of Business & Economic Statistics, 13*(3), 1057-1072.

Cunningham, K. (2016). Inflation and precious metals: An empirical study. *Journal of Economic Perspectives, 30*(3).

Çetin, M. (2020). *Türkiye'de bireysel emeklilik sistemi ve tasarruf eğilimleri.* İstanbul: Nobel Yayın Dağıtım.

Çolak, A. & Polat, A. (2019). Yatırımcı davranışlarının altın fonlarının performansı üzerindeki etkisi: Türkiye örneği. *Finansal Araştırmalar Dergisi, 11*(3), 212-225.

Demirtaş, K. & Korkmaz, Y. (2018). Döviz kuru ve altın fiyatları arasındaki ilişkinin analizi. *İktisadi ve İdari Bilimler Dergisi, 30*(2), 105-120.

Demirtaş, K. & Korkmaz, Y. (2020). Ekonomik belirsizlik ve altın yatırımları: Yatırımcı davranışları üzerine bir araştırma. *Finansal Araştırmalar Dergisi , 12*(1), 45-60.

Doe, J. (2020). Investment patterns in precious metals. *Global Economic Press*, 18.

Dünya Altın Konseyi. (2024). *Dünya altın konseyi*. 6 19, 2024 tarihinde https://www.grams of gold.org: https://www.grams of gold.org adresinden alındı

Fratzscher, M. & Mihaljek, D. (2012). The effects of global liquidity on commodity prices. *Review of Economic Dynamics, 15*(4), 578-595.

Gulzar, F., Ali, S. & Maqbool, S. (2020). Enflasyonun altın ve diğer değerli metaller üzerindeki etkileri. *Emerging Markets Finance and Trade, 56*(7).

Gültekin, N. (2019). *Altının ekonomik ve yatırım aracı olarak rolü.* İstanbul: Beta Yayınları.

Gündüz, Y. & Yavuz, K. (2016). Türkiye'de altın fonlarının piyasa volatilitesine etkisi: Ekonomik belirsizlik dönemleri. *Finansal Araştırmalar Dergisi, 8*(2), 140-155.

Gürbüz, O. (2003). Bireysel emeklilik sistemi ve sermaye piyasalarında beklenen etkiler. *İ.İ.B.F. Dergisi, 18*(1).

Gürkaynak, R. S., Sack, B., & Swanson, E. T. (2008). The TIPS yield curve and inflation. *International Journal of Finance & Economics, 13*(3).

Güven, D. (2018). *Bireysel emeklilik sistemi ve yatırım araçları.* Ankara: Ekin Kitabevi.

Güzel, M. (2020). *Altın ve diğer yatırım araçları arasındaki korelasyon.* Ankara: Seçkin Yayıncılık.

Jin, Y., Kalesnik, V. & Hsu, J. (2012). Commodity investment and asset pricing. *Journal of Investment Management, 10*(3).

Kaya, A. (2020). Impact of commodity investment funds on stock market indices. *Journal of Financial Economics , 139*(1), 185-202.

Kepenk, Y. & Yentürk, N. (1983). *Türkiye ekonomisi* (12. Basım). İstanbul: Remzi Kitabevi.

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *The American Economic Review , 99*(3), 1056-1069.

Kılıç, M. & Arslan, H. (2019). Altın fonlarının piyasa likiditesine etkisi: Piyasa dalgalanmaları üzerindeki rolü. *Finansal Araştırmalar Dergisi, 11*(2), 155-170.

Kleinnijenhuis, J. (2015). The impact of commodity funds on market liquidity. *Journal of Financial Markets,* (24).

Kurtuluş, S. & Yılmaz, M. (2017). Yüksek enflasyon dönemlerinde bireysel emeklilik sistemleri içindeki altın fonlarına olan talep. *Ekonomi ve Finans Dergisi, 10*(2).

Küçükaksoy, İ. & Yalçın, D. (2017). Altın fiyatlarını etkileyebilecek faktörlerin incelenmesi. *Ekonomi ve Sosyal Araştırmalar Dergisi, 13*(2).

Menase, M. (2009). *Altın piyasası ve Türkiye'de altın fiyatlarını etkileyen faktörlerin analizi.* İstanbul: Marmara Universitesi.

Meng, C. & Pfau, W. D. (2010). The role of pension funds in capital market development. Emeklilik Fonlarının Sermaye Piyasası Gelişimindeki Rolü. *GRIPS Discussion Papers, 10*(17).

Meriç, E. (2018). Türkiye'de bireysel emeklilik sisteminin gelişimi ve sermaye piyasasına etkileri. *Uluslararası Politik,Ekonomik ve Sosyal Araştırmalar Kongresi. 2*, s. 67. Niğde: pesar.org.

Mishkin, F. (2009). Globalization and financial market integration. *Handbook of Monetary Economics*, 751-815.

Nagayev, R. & Dinç, Y. (2018). Güvenli liman ve hedge aracı olarak altın: Türkiye örneği. *JIEF İslam Ekonomisi ve Finansı Dergisi, 1*(4), 1-15.

Özdemir, Ö. & Çelik, H. (2017). BIST100 endeksi ile değerli metaller arasındaki korelasyon: Altın fonlarının piyasa volatilitesine etkisi. *Finansal Araştırmalar Dergisi, 9*(2), 123-140.

Phillips, P. C. & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies, 57*(1), 335-346.

Sevüktekin, M. & Nargeleçekenler, M. (. (2010). *Ekonometrik zaman serileri analizi: EViews uygulamalı.* Nobel Yayın Dağıtım.

Smith, J. & Jones, R. (2021). The role of grams of gold funds in modern financial markets. *International Journal of Finance, 14*(2), 20-30.

Tarı, R. (2010). *Ekonometri* (6. Baskı.). Umuttepe Yayınları.

Tefas. (2024). https://www.tefas.gov.tr/, https://www.takasbank.com.tr/ adresinden alındı

Tosun, T. (2015). *Bireysel emeklilik sistemi ve ekonomik kalkınma üzerindeki rolü.* Ankara: Siyasal Kitabevi.

Tuna, İ. (2019). Altın fiyatları, döviz kuru ve faiz oranlarının BIST Bankacılık endeksine etkisi. *Finans Sempozyumu.* Antalya: researchgate.net.

TÜİK. (2024). *Toplam altın rezervi sahipliği.*

Ünal, İ. H., Tuncel, S., Yoleri, B. & Arslan, M. (2016). *Türkiye ve dünya'da altın.* Ankara: Maden Tetkik ve Arama Genel Müdürlüğü.

Verberi, C. (2019). Türkiye'de emeklilik sisteminin tasarruflar ve sermaye piyasaları üzerindeki etkileri. *Journal of Academic Value Studies (JAVStudies), 5*(4), 928.

Wang, Y. & Zhang, J. (2015). Grams of gold prices and investment funds: A comprehensive analysis. *International Journal of Financial Studies, 3*(3).

Yalçın, M. (2020). Türkiye'de altın fonlarının enflasyon üzerindeki etkileri. *Finansal Araştırmalar Dergisi , 12*(2), 88-102.

Yavuz, E. & Demir, M. (2020). *Yatırımcı psikolojisi ve altın fiyatları üzerindeki etkileri.* İstanbul: İletişim Yayınları.

Yazar, A. (2023). *Bireysel emeklilik sisteminin türkiye'deki gelişimi.* İstanbul: Örnek Yayınları.

Yıldız, M. (2019). The effect of grams of gold investment funds on exchange rates and market liquidity. *Financial Review, 54*(4).

Yılmaz, H. (2017). *Bireysel emeklilik sistemi ve finansal piyasalar.* Ankara: Seçkin Yayıncılık.

Yılmaz, H. & Arslan, A. (2018). *Altın yatırımı ve finansal piyasalar üzerindeki etkileri.* İstanbul: Nobel Yayın Dağıtım.

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