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Could Gold Serve as an Exchange Rate Hedge in Japan?

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Gold is the asset that has attracted people for thousands of years and this attraction continues to the present day because, according to Worthington and Pahlavani (2006), unlike most commodities, gold is durable, relatively transportable, universally acceptable and easily authenticated. The demand for gold is ever increasing, not only for jewelry, coins, and bars but also for many industries, such as electronics, space, as well as medical technology. Especially gold is still a form of currency in many countries after the collapse of the Bretton Woods system in 1971.

Many economic analysts suggest that gold prices are determined and influenced by a number of factors, such as mine production, fabrication demand, and the recovery of gold from scrap. Much greater influence is exerted by trends in central bank sales and purchases. Most important of all is trend in investment demand. Investors buy gold for a number of reasons. They buy gold as a hedge against any economic, political, or currency crises. They also buy gold for diversification and financial arbitrage when investment confidence is increasing because they have the common sense that physical assets, unlike financial assets, are the best way to hedge against recession and inflation. The developments of the gold market are followed closely by financial analysts and monetary policy makers and gold price is regarded as a good criterion of the inflationary trend in the future for it moves earlier than official measures of inflation.

Fisher (1930), the economist who first pointed out the relationship between expected inflation and interest rate, provides the theoretical basis for this study. Fisher (1930) concludes that expected nominal asset return comprises expected return and expected inflation rate. In other words, when expected inflation rises, asset return will rise. Later, the primary empirical test on inflation hedge of assets including U.S government bonds and bills, real estate, labor income, and stock returns was done by Fama and Schwert (1977). Ghosh et al. (2004) point out that people buy gold for two purposes. The first is the "use demand", where gold is used directly in the production of jewelry, medals, coins, electrical components, and so on. The second is the "asset demand" for gold, where it is used by governments, fund managers and individuals as an investment. The asset demand for gold is traditionally associated with the view that gold provides an effective "hedge" against inflation and domestic currency depreciation.

When it comes to inflation, the value of gold is considered to be preserved, for its price will increase along with the rise in the general level of prices. In other words, it is believed that a higher inflation rate is what gold prices said should be happening. However, the question is that how well gold hedge really works. Each country has its own economic conditions or characteristics. This issue is worth examining and verifying with non-linear model which might discover the key reasons that the linear model is unable to do.In this article, we attempt to examine whether gold could be an exchange rate hedge in Japan using data from 1986 to 2007. In the literature of this area, most research has focused on a linear relationship—rather than a nonlinear one—between returns on gold and the exchange rate of the Japanese yen. In the present paper, we used the depreciation rate of the yen as a threshold variable to distinguish between a high depreciation regime and a low depreciation (or appreciation) regime. With this setting, we build a threshold vector autoregressive model to investigate the causality between the gold return and the yen depreciation rate. We found that when the yen depreciation rate is greater than 2.62%, investing in gold could avoid the depreciation loss. This finding, that the effectiveness of gold as an exchange rate hedge depends on the depreciation rate of the yen, could be beneficial to Japanese government monetary policy and to investors with Japanese yen in their portfolios.

JEL classification: C32; F31; F33

Keywords: *Gold return, exchange rate hedge, threshold model, asymmetric causality, TVAR model.*

Introduction

Scientific problem. For most investors, the main purpose of diversifying a portfolio is to reduce the volatility of the return rates of the assets and to hedge risk. Particularly when the market information varies a lot, this behavior helps keep a positive return rate. Portfolio allocation guidelines suggest that the asset composition of a portfolio that could reduce risks and maintain a sound return rate is one in which the assets have low correlation or even negative correlation. In addition, the financial system development (e.g. capital and money markets) and economy growth have a big impact on investment decisions.[1] In the past research for assets portfolio, foreign market, stock market, and other real assets are the major aim. For example, Snieska *et al*. (2008) investigates the relationship between domestic macroeconomic variables and surplus returns of stocks in Lithuanian stock market. This research finding disclosed, that during the considered period most of Lithuania's macroeconomic factors were correlating with shares prices fairly strong, and it is possible to forecast the direction of these effects. Jarrett and Schilling (2008) indicate the Frankfurt stock market behaves in similar ways to North American, other European and Asian markets previously studied in the same manner. Hsing and Sergi (2009) analyze the behaviour of the USD/EUR exchange rate based on four major models. Ginevicius & Zubrecovas (2009) thought that investment in real estate has great influence on regional economics development, it is important to evaluate real estate investment processes as a whole. Pilinkus & Boguslauskas (2009) define the short-run relationship between Lithuanian stock market prices and macroeconomic variables by employing the impulse response function. For the risk management of a portfolio, Voronova (2008) considers the problems of analysis and assessment of risks at the enterprises of non-financial sphere basing on tactical standards of risk management and discusses how variety of scope methods may be applied for assessment of the profile of risks at the enterprise.

Related to the application of research methods, Pranevicius and Sutiene (2008) explore the copula effect on the investment portfolio of the insurance company, the insurance business is influenced by a large number of stochastic parameters, and decisions concerning the assets that must be invested over time to cover liabilities and to achieve goals subject to various uncertainties and various constraints are considered. Aniunas et al. (2009) construct a variance – covariance currency rate risk management model. Teresiene (2009) analyses the main factors that influence stock price volatility. In our study, we discuss the gold return for hedging characteristics of the Japanese yen with nonlinear model.

The reason that investors include gold in their portfolio is because gold is a precious metal, which works in the same way as a currency, and, therefore, each has its own purchasing power. When the hedging ability or the value-preserving ability of other financial assets, such as local currency-denominated stocks and bonds, decreases due to the depreciation of the local currency, the local market gold price would still be the same as the international gold price. In other words, the gold price is less susceptible to the fluctuations of a local currency exchange rate. Therefore, if we can prove that gold could serve as an exchange rate hedge, then it is more meaningful to add gold to a portfolio as a measure of asset value protection.

What does it mean that gold could be a hedge against an exchange rate? It means that gold has the ability to resist changes in the internal and external purchasing power of a domestic currency. That is, essentially, when the domestic price index raises, the domestic currency price of gold rises at the same time and rate; and when the domestic currency depreciates against a foreign currency, the domestic currency price of gold would reduce at exactly the same time and rate. In this article, we investigate to what extent gold is an internal domestic currency hedge.

Generally speaking, research methods employed by previous studies in the field of gold price modeling can be categorized into three groups. The first group (e.g. Ariovich, 1983; Fortune, 1987; Dooley et al., 1995; Sherman, 1982, 1983, 1986; Sjaastad and Scacciallani, 1996) proxies the variation in gold price with variations in macroeconomic variables such as exchange rates, interest rates, world income etc. The second group (e.g. Baker and Van Tassel, 1985; Diba and Grossman, 1984; Koutsoyiannis, 1983; Pindyck, 1993) focuses on discussion of the factors that contribute to fluctuations in the gold price. The third group (e.g. Chappell and Dowd, 1997; Kolluri, 1981; Laurent, 1994; Mahdavi and Zhou, 1997; Moore, 1990) emphasizes the short-run and long-run relationships between the gold price and the general price level to investigate the ability of gold as a hedge against inflation. However, when discussing the relationship between gold price and other macroeconomic or financial variables, all these studies only focus on symmetric information in empirical studies, that is, employment of a linear model.

Moreover, few studies have discussed the hedging relationship between gold and the domestic currency exchange rate; and most of those use a linear model to investigate the relationship (e.g. Sjaastad & Scacciavillani, 1996; Twite, 2002; Capie et al., 2005). The disadvantage of employing a linear model is that one cannot use the estimated results from the linear model to infer what will happen under various conditions, such as in the case of exchange rate fluctuation. As globalization continues, the market becomes freer, which enhances the circulation and innovation of financial products. Under this circumstance, gold not only is a physical asset, but also has the properties of a general financial product. Because of this characteristic of gold, many financial products are related to spot gold and there are lots of gold derivative financial products such as gold futures, gold options etc., since financial data have the property of volatility clusters, which may lead to nonlinear phenomena like jumps or cycles in some periods. If one does not take into account this problem when specifying an econometric model, then the empirical findings may be biased.

In general, there are many factors contributing to the depreciation of a currency. For instance, inflation often leads to the depreciation of a domestic currency, which in its turn, brings down the nominal prices of domestic assets. Under this circumstance, only gold, compared to other financial assets, has value-preserving ability. The reason why gold has this characteristic is that the gold price has the ability to rapidly adjust to inflation. However, the price of gold may not always reveal the true value of gold due to

[1] Recently references; e.g. Lakstutiene (2008) analyzes correlation between financial system development indicators and economy growth indicator - Gross Domestic Product, in European Union countries, distinguishing those financial sector indicators, which have the strongest relation with GDP per capita. Rutkauskas et al. (2008) development of the conception of sustainable return investment decisions strategy in capital and money markets and modeling of investment decisions along sustainable development concept in capital and money markets.

special economic conditions or country-specified characteristics, such as unique market competition conditions, transaction costs etc. Because of these characteristics of gold, we believe it is worth examining the relationship between the gold price and exchange rate fluctuations. Furthermore, we would like to go one step further to see whether using a nonlinear model could reveal further aspects of exchange rate hedging.

Japan is one of the three largest economies in the world and is the largest economy in Asia; Japan is also a member of the G7 group. The Japanese, like most Asian people, love gold. Therefore, investigating the relationship between the gold price and yen exchange rate fluctuations in Japan is helpful for us to understand the fluctuations of these two variables in other countries.

The aim of the paper – to examine whether investment in gold could serve as a hedge against yen depreciation, or in other words, whether investment in gold could prevent the value of personal or company wealth from decreasing due to depreciation of the domestic currency. Because of imperfect competition of the market and the existence of transaction costs, there exists asymmetric information in the spot gold physical market and gold product market. Compared with recent studies such as Ghosh et al. (2002), Twite (2002), Capie et al. (2005), and Worthington and Pahlavani (2006), this paper focuses more on the relationship between exchange rate fluctuation and the ability of gold to hedge against it.

Research object – we argue that this relationship should be a nonlinear one, not a linear one such as has been assumed in most previous researches.

Research methods. Based on this belief, we construct a nonlinear threshold vector autoregressive (TVAR) model for our empirical study. We use the yen's exchange rate fluctuation as the threshold variable to construct a high depreciation regime and a low depreciation (or an appreciation) regime. The empirical results show that when the yen depreciates against the United States (US) dollar by more than 2.62%, investing in gold could avoid losses from the depreciation; otherwise, gold does not serve as a hedge against the yen's depreciation. We believe this finding could be a useful reference for Japanese government monetary policy and a guide for investors who would like to use gold as a hedge against depreciation of domestic currency.

The remainder of this paper is organized as follows. Section 2 discusses the model and the research methodology. Section 3 reports the empirical results. The conclusion follows in Section 4.

The model and research methodology

1. The model

Our purpose is to examine to what extent gold could serve as an internal domestic currency hedge. To reach this goal, we specify the model as follows:

$$\Delta g_t = f(\Delta e_t), \tag{1}$$

where e_t is the yen/dollar exchange rate; g_t is the gold price in yen; $\Delta e_t = \ln(e_t / e_{t-1}) \times 100$ denotes the change rate of e_t; and $\Delta g_t = \ln(g_t / g_{t-1}) \times 100$ denotes the gold return. When $f' > 0$, this indicates that the gold return is large enough to cover the loss from the changes in the internal purchasing power of a domestic currency. Depending on the status of Δe_t, equation (1) is as follows:

$$\Delta g_t = \begin{cases} f_1(\Delta e_t) & \Delta e_{t-d} > \gamma \\ f_2(\Delta e_t) & \Delta e_{t-d} \le \gamma \end{cases} \tag{2}$$

where γ is the threshold value of the exchange rate fluctuation rate; therefore, γ could be used to divide the regimes in this threshold model.

2. Research methodology

The threshold autoregressive (TAR) model developed by Tong (1978) and Tong and Lim (1980) uses an optimal threshold value to divide the short-run dynamic status of one economic indicator into two regimes. When there are multiple regimes, the TAR model could be transformed into a TVAR model thus:

$$Z_t = (A_1 + \Phi_1 Z_{t-i}) I(q_{t-d} > \gamma) + (A_2 + \Phi_{2,i} Z_{t-i})(1 - I(q_{t-d} > \gamma)) + \varepsilon,$$

$$Z_t = \begin{bmatrix} g_t \\ i_t \end{bmatrix}_{2\times 1}, A_1 = \begin{bmatrix} \alpha_{10} \\ \beta_{10} \end{bmatrix}_{2\times 1}, A_2 = \begin{bmatrix} \alpha_{20} \\ \beta_{20} \end{bmatrix}_{2\times 1},$$

$$\Phi_1 = \begin{bmatrix} \alpha_{1,11} \cdot\cdot \alpha_{1,1p}, \alpha_{1,21} \cdot\cdot \alpha_{1,2p} \\ \beta_{1,11} \cdot\cdot \beta_{1,1p}, \beta_{1,21} \cdot\cdot \beta_{1,2p} \end{bmatrix}_{2\times 2p} \quad \Phi_2 = \begin{bmatrix} \alpha_{2,11} \cdot\cdot \alpha_{2,1p}, \alpha_{2,21} \cdot\cdot \alpha_{2,2p} \\ \beta_{2,11} \cdot\cdot \beta_{2,1p}, \beta_{2,21} \cdot\cdot \beta_{2,2p} \end{bmatrix}_{2\times 2p}$$

where p is the lag length; q_{t-d} is the threshold variable, and d is the delay parameter; γ is the threshold value; and the error term ε has the properties such that $\varepsilon = (\varepsilon_1^* \ \varepsilon_2^*)' \sim iid$, $E(\varepsilon_t | \Omega_{t-1}) = 0$, and $E(\varepsilon_t^2 | \Omega_{t-1}) = \sigma^2$ where Ω_{t-1} is the information set in period t-1; $I(\cdot)$ are the indicator functions of regimes, and it is assumed that $I(q_{t-d} > \gamma) = 1$ if there exist regimes and $I(q_{t-d} \le \gamma) = 0$ otherwise.

We must examine the existence of the threshold effect in equation (3) before estimating the TVAR model. We follow the approach of Tsay (1998) to test the linearity of the model. The null hypothesis is that the model is linear—the VAR model—and the alternative hypothesis is that the model is nonlinear—the TVAR model. Tsay (1998) employs the recursive least squares method (RLS) to obtain the predictive residual of the arranged autoregression (ARR) to build the test statistic based on the standardized predictive residual. For detailed discussion of the Tsay linearity test, please refer to Tsay (1998).

If the null hypothesis is rejected, which indicates that the model is nonlinear, then the next step is to find the values of the two parameters, the delay parameter d and the threshold value γ. Suppose that p, q and the regimes are known. The threshold variable z_t

determines the appearance of the model in two regimes:

$$y_t = \begin{cases} X_t'\Phi_1 + \Sigma_1^{1/2} a_t & \text{If } z_{t-d} > \gamma \\ X_t'\Phi_2 + \Sigma_2^{1/2} a_t & \text{If } z_{t-d} \le \gamma \end{cases} . \quad (4)$$

If γ and d are given, then the above equation can be viewed as having two independent linear regressive models, where Φ_i and Σ are obtained as follows:

$$\hat{\Phi}_i(\gamma, d) = \left(\sum_t^{(i)} X_t X_t'\right)^{-1}\left(\sum_t^{(i)} X_t y_t'\right),$$
$$\hat{\Sigma}_i(\gamma, d) = \sum_t^{(i)} (y_t - X_t'\hat{\phi}_i^*)(y_t - X_t'\hat{\phi}_i^*)'/(n_i - k) \quad (5)$$

where $\Phi_i^* = \hat{\Phi}_i(\gamma, d)$; n_i denotes the observations in regime i; and k indicates the dimension of X_t and $k < n$. The residual sum of squares is:

$$S(\gamma, d) = S_1(\gamma, d) + S_2(\gamma, d),$$
$$S_i(\gamma, d) = trace\ [(n_i - k)\hat{\Sigma}_i(\gamma, d)] \quad (6)$$

where γ and d are obtained from the following equation:

$$\arg\min_{\gamma, d} S(\gamma, d),\ 1 \le d \le d_0\ and\ \gamma \in R_0.$$

After attaining the optimal threshold value (γ) and the delay parameter (d), the best fit TVAR model can be built.

In our case of the gold return and exchange rate fluctuations, equation (3) is re-written as follows:

$$\Delta g_t = \begin{cases} \alpha_{10} + \sum_{i=1}^{p} \alpha_{1,1i}\Delta g_{t-i} + \sum_{i=1}^{p} \alpha_{1,2i}\Delta e_{t-i} + \varepsilon_{g1t},\ \Delta e_{t\text{-}d} > \gamma \\ \alpha_{20} + \sum_{i=1}^{p} \alpha_{2,1i}\Delta g_{t-i} + \sum_{i=1}^{p} \alpha_{2,2i}\Delta e_{t-i} + \varepsilon_{g2t},\ \Delta e_{t\text{-}d} \le \gamma \end{cases} \quad (7)$$

$$\Delta e_t = \begin{cases} \beta_{10} + \sum_{i=1}^{p} \beta_{1,1i}\Delta g_{t-i} + \sum_{i=1}^{p} \beta_{1,2i}\Delta e_{t-i} + \varepsilon_{e1t},\ \Delta e_{t\text{-}d} > \gamma \\ \beta_{20} + \sum_{i=1}^{p} \beta_{2,1i}\Delta g_{t-i} + \sum_{i=1}^{p} \beta_{2,2i}\Delta e_{t-i} + \varepsilon_{e2t},\ \Delta e_{t\text{-}d} \le \gamma \end{cases} \quad (8)$$

where α and β are parameters; and ε_{1t} and ε_{2t} indicate the error terms in the two different regimes, respectively.

In equations (7) and (8), when $\Delta e_{t\text{-}d} > \gamma$, this indicates that the fluctuation rate of the yen/dollar exchange rate is larger than the threshold value. We name this "regime 1"; otherwise, we call it "regime 2."

We employ the Wald coefficient test to examine the causality between the variables (i.e. strong exogeneity) to confirm the causality of the short-run dynamic effect. Using the notations of equation (7), the null hypothesis of the causality test can be expressed as $H_0 : \alpha_{1,2i} = 0$, $i = 1,..., p$ ($H_0 : \alpha_{2,2i} = 0$), along with regime 1 (regime 2). If the null hypothesis holds, it indicates that Δe does not Granger cause Δg. The rejection of this null hypothesis means that exchange rate fluctuations do Granger cause gold returns (Δg), indicating the exchange rate effectively hedges the gold returns. In addition to directly testing the hypothesis, observing coefficients of the lag variables (i.e. $\sum_{i=1}^{p} \alpha_{1,2i}$ and $\sum_{i=1}^{p} \alpha_{2,2i}$) could also provide indication of the causality between Δe and Δg. When the null hypothesis is rejected and the coefficient sum is positive, this indicates that gold could be an effective hedge against exchange rate fluctuation. Besides the causality between Δe and Δg, we can examine the reverse causality between Δg and Δe. If the null hypothesis $H_0 : \beta_{1,1i} = 0$, $i = 1,..., p$ ($H_0 : \beta_{2,1i} = 0$) holds, it means that Δg does not Granger cause Δe. The rejection of this null hypothesis indicates that the gold return does not Granger cause exchange rate fluctuation. Based on the coefficients of the lag variables ($\sum_{i=1}^{p} \beta_{1,1i}$ and $\sum_{i=1}^{p} \beta_{2,1i}$), we can ascertain the direction of the short-term effects of the gold return on exchange rate fluctuation in regime 1 (regime 2). With the results of the causality test and the lag parameter analyses, we then can examine whether investing in gold can avoid the changes in the *internal* or domestic purchasing power of a domestic currency.

Empirical study

1. Data description

We used the monthly data of gold price per ounce in yen based on the London PM Fix and yen/dollar exchange rates. The gold price data come from the World Gold Council Value Research & Statistics Database and the yen/dollar exchange rate data are obtained from the International Financial Statistics (IFS) data base of the International Monetary Fund (IMF).[2] Our sample period is from April 1986 to March 2007, which gives us 252 observations. Figure 1 shows the time trends of the yen gold price and the yen/dollar exchange rate. Generally, the yen was appreciating against the US dollar during the sample period, reaching a peak in 1995. After that, the yen depreciated.[3] The yen gold price started going up in the year 2000 and reached a recorded high in 2007. As one can see from the graph, these two variables walk in opposite directions before 1990 and it is the exchange rate that seems to lead to a change of direction. From 1990 to 1997, the two variables walk in similar patterns. From 1997, the start year of the Asian financial crisis, the two variables walk in opposite directions again; after 2005, the two variables behave the same way once more. From this analysis we can conclude that the behavior of the gold return and yen/dollar exchange rate fluctuation is more nonlinear than linear; therefore, it is more suitable to use a nonlinear model to explain the relationship.

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[2] The URL of the World Gold Council Value Research & Statistics Database is http://www.gold.org/value/stats/statistics/monthlysince1971.html.

[3] Because of the ongoing trade surplus during this period, the yen kept appreciating and was priced at ¥79.75 per dollar as one of the recorded highs on April 19, 1995.

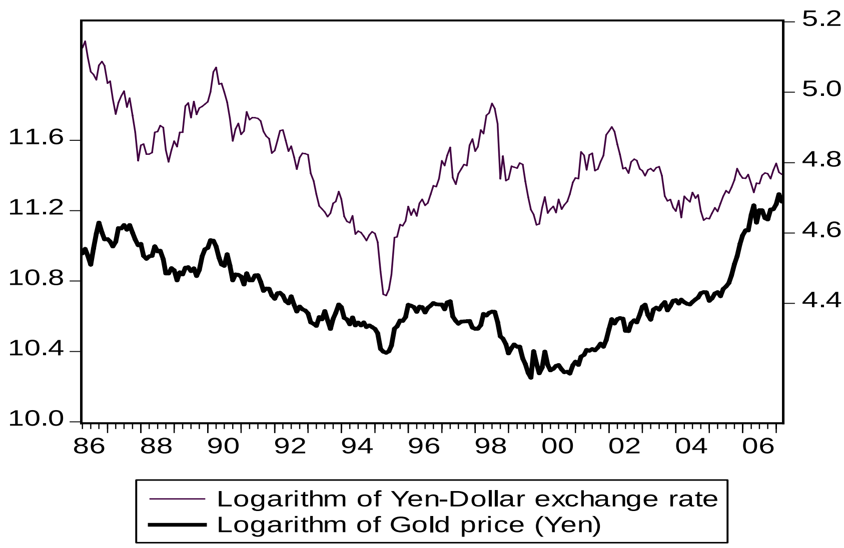


Figure 1. Behavior of yen/dollar exchange rate and gold price from April 1986 to March 2007

2. Unit root test

Nelson and Plosser (1982) indicate that many macroeconomic variables have a nonstationary characteristic. Since nonstationary variables do not fit the traditional requirement of regression analyses, directly using them in an ordinary least squares (OLS) estimation would cause OLS estimators to have biased asymptotic distributions and lead to the so-called spurious regression problem. The purpose of the unit root test is to determine the integration orders of time series so that we can know whether we have to difference a certain time series. In this paper, we utilize four different methods to conduct the unit root test: the Augmented Dickey-Fuller test (Dickey and Fuller, 1979), the Phillips-Perron test (Phillips and Perron, 1988), the Dickey-Fuller generalized least squares (DF-GLS) test (Elliott et al., 1996), and the Ng and Perron MZ_a (NP-MZ_a) test (Ng and Perron, 2001). The constant term and the time trend are added when we conduct the test. Table 1 shows that the yen gold price and the yen/dollar exchange are both I(1) variables, that is, two variables will be stationary after being first differenced.

Table 1

Unit root tests

	Gold price		Yen/dollar exchange rate	
	Constant	Constant & time trend	Constant	Constant & time trend
Level				
ADF	-0.771 [4]	0.497 [2]	-2.570 [11]	-2.648 [11]
PP	-0.564 [5]	0.291 [3]	-2.793 [0]	-2.614 [2]
DF-GLS	-0.812 [4]	-0.423 [4]	-0.653 [11]	-1.831 [11]
NP-MZ_a	-1.812 [4]	-1.345 [4]	-1.421 [3]	-8.324 [11]
First difference				
ADF	-7.035 [3]***	-12.55 [1]***	-4.087 [10]***	-4.115 [10]***
PP	-14.65 [5]***	-14.93 [3]***	-14.84 [3]***	-14.86 [4]***
DF-GLS	-2.843 [7]***	-3.720 [6]***	-2.176 [10]**	-3.163 [10]**
NP-MZ_a	-20.31 [3]***	-39.83 [3]***	-36.96 [2]***	-56.61 [2]***

Notes: The maximum lagged period is 12. The numbers in square brackets are the appropriate lag lengths selected by the Akaike information criterion in the ADF: Augmented Dickey-Fuller test, PP: Phillips-Perron test, DF-GLS: Dickey-Fuller generalized least squares test, NP-MZ_a: Ng and Perron MZ_a test. For the PP test, the bandwidth was determined using the Newey-West correction.

*** and ** indicate significance at the 1% and 5% levels, respectively. Critical values of the ADF, PP, and DF-GLS tests are from MacKinnon (1991). Critical values of the NP-MZ_a test are from Ng and Perron (2001).

Because of this, in the rest of the paper, we use the rates of return of the gold return and yen/dollar exchange rate fluctuations to construct our TVAR model.[4]

[4] We also conducted a cointegration test using the Engle and Granger test (Engle and Granger, 1987), the TAR and momentum threshold autoregressive (MTAR) test (Enders and Siklos, 2001), and the Johansen test (Johansen, 1991). The test results show that there is no cointegration relationship between these two variables; therefore, we directly estimate the TVAR model. Please contact the author for the cointegration test results.

3. Linearity test

Before constructing the TVAR model, we have to make sure whether there exists a nonlinear relationship among the variables. We employ the linear test suggested in Tsay (1998) and use Δe_{t-d} as the threshold variable. The first step to conduct the test is to decide the optimum lagged periods. Table 2 shows the selection results of lagged periods, based on four criteria: the final prediction error criterion (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ). One can see that the proper lagged number is 2 (p = 2). Applying this result in the linear test, we find that when p = 2 and d = 1, the null hypothesis of linearity should be rejected. The test result is reported in Table 3.

Table 2

Optimum lags of the VAR model

Lags(p)	FPE	AIC	SC	HQ
1	0.00	-7.94	-7.85**	-7.90**
2	1.22e-06**	-7.94**	-7.78	-7.88
3	0.00	-7.94	-7.72	-7.85
4	0.00	-7.92	-7.64	-7.81
5	0.00	-7.91	-7.56	-7.77
6	0.00	-7.92	-7.50	-7.75
7	0.00	-7.91	-7.43	-7.71
8	0.00	-7.89	-7.35	-7.67
9	0.00	-7.88	-7.28	-7.64
10	0.00	-7.86	-7.19	-7.59
11	0.00	-7.84	-7.10	-7.54
12	0.00	-7.81	-7.02	-7.49

Notes: FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.
** denotes significance at the 5% level.

Table 3

Linearity test

d \ p	1	**2**	3	4	5	6
1	0.12	**0.03**	0.12	0.23	0.08	0.06
2		0.10	0.27	0.33	0.11	0.14
3			0.81	0.44	0.65	0.25
4				0.11	0.35	0.23
5					0.07	0.19
6						0.44

Note: The above values are the p-values of the chi-square linearity test.

Table 4

Causality test

Dependent Variable	Null Hypothesis H_0:	Regime 1 $\Delta e_{t-1} > 2.62\%$		Regime 2 $\Delta e_{t-1} \leq 2.62\%$	
		Sum of coefficients	Chi-square test	Sum of coefficients	Chi-square test
Δg	$\Delta e \times\!\!\rightarrow \Delta g$	$\sum_{i=1}^{2} \hat{\alpha}_{1,2i} = 0.42$	**6.49**** **(0.04)**	$\sum_{i=1}^{2} \hat{\alpha}_{2,2i} = 0.16$	2.21 (0.33)
Δe	$\Delta g \times\!\!\rightarrow \Delta e$	$\sum_{i=1}^{2} \hat{\beta}_{1,1i} = -0.04$	0.28 (0.87)	$\sum_{i=1}^{2} \hat{\beta}_{2,1i} = 0.09$	1.4 (0.50)

Notes: Exchange rate fluctuation is used as the threshold variable. The optimal threshold value (γ) = 2.62%; the lag length of the TVAR model (p) = 2; the optimal lag of the threshold variable (d) = 1.
The notation $\Delta e \times\!\!\rightarrow \Delta g$ indicates the null hypothesis that the (lagged) change of exchange rate cannot explain the (current) gold returns; $\Delta g \times\!\!\rightarrow \Delta e$ denotes the null hypothesis that the (lagged) gold returns cannot explain the (current) change of exchange rate.
The values in parentheses are the p-values of the chi-square statistics of the join test. ** denote significance at the 5% level.

4. Asymmetric causality test

Based on the results of the linear test, we use Δe_{t-1} as the threshold variable and estimate the TVAR model. Table 4 shows the estimation results. The threshold value equals 2.62%, and we define regime 1 as the case that $\Delta e_{t-1} > 2.62\%$ and regime 2 as the case that $\Delta e_{t-1} \leq 2.62\%$. Regime 1 corresponds to the situation in which the yen fluctuates more. Since the threshold value is positive, it means that regime 1 represents a high depreciation period. On the other hand, regime 2 corresponds to a situation in which the yen depreciates less or even appreciates. We plot the correspondence of the threshold value and the exchange rate fluctuation in Figure 2. About 18% of the data lie in regime 1 and the rest in regime 2. From Figures 1 and 2, we can conclude that from April 1986 to March 2007, there was not much significant depreciation of the yen. Moreover, from Figure 2 we can see that in both regimes, there exists a nonlinear relationship between the gold price and the yen/dollar exchange rate. Therefore, if one simply uses the actual appreciation and depreciation rates to specify the two regimes, rather than let the model endogenously determine the threshold value to specify the regimes, then the estimation results will be biased. This is the major reason for us to use the more complicated nonlinear TVAR model.

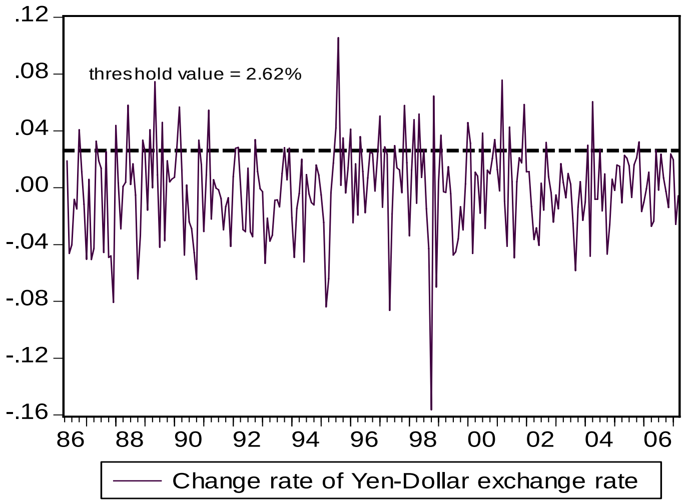
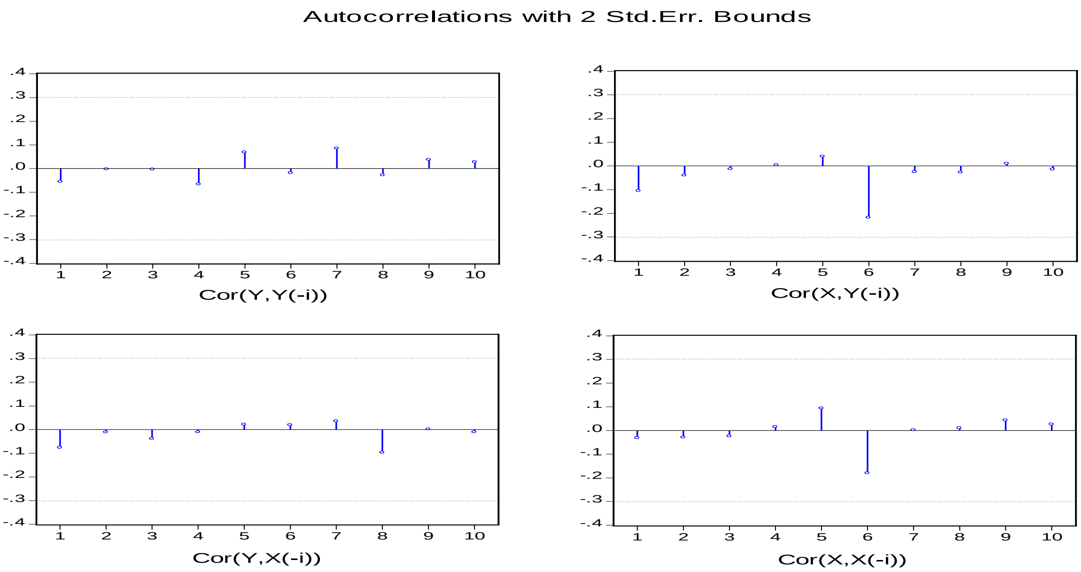


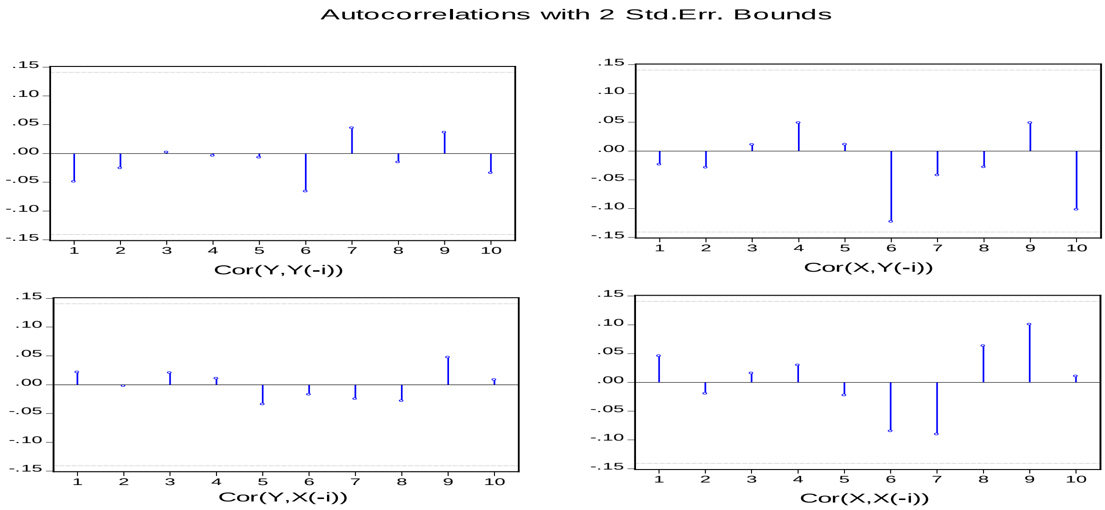
Figure 2. Change in yen/dollar exchange rate and threshold value from April 1986 to March 2007

In addition, most of the time exchange rate fluctuations can reveal the productivity cycles of a country. Generally speaking, when a country is located in the high productivity area of a cycle, the country could export more, which in its turn, creates a larger demand for its currency and leads to an appreciation of the currency—otherwise, a depreciation. In Japan, the economic bubble burst in 1990, followed by a long recession of more than 10 years. In 1997, the already harsh economic situation faced another challenge—the Asian financial crisis. Because of its strong and solid economic foundations, the Japan economy survived these threats. Even though the yen fluctuated a lot at times, the yen/dollar exchange to the value matching the productivity of Japan within a short time.

To make sure that the estimation results of the TVAR model would not violate basic statistic assumptions, we examined the autocorrelation and the cross-correlation of the residuals in the two regimes. The charts are shown in Figure 3. It is obvious that the residuals fit the requirements of no autocorrelation, indicating that the specification of our TVAR model is appropriate.



Y= e_{g1t} , X= e_{e1t} , $\Delta e_{t\text{-}1} > 2.62\%$



$Y = e_{g1t}$, $X = e_{e1t}$, $\Delta e_{t-1} \leq 2.62\%$

Figure 3. Autocorrelation and cross-correlation analysis using residuals of the TVAR model

Table 4 reports the results of the causality test. The strong exogenity of $\hat{\alpha}_{1,2i}$ and the positive value of $\sum \hat{\alpha}_{1,2i}$ (0.42) indicate that in regime 1, the exchange rate fluctuation positively affects the gold returns, which tells us that gold could serve as a hedge against yen depreciation. In regime 2, since we could not reject the null hypothesis, we cannot say that there is a strong exogenity associated with $\hat{\alpha}_{2,2i}$, which tells us that gold could not serve as hedge for yen depreciation. In the meantime, we also test the causality between the gold return and yen exchange rate fluctuation. The results of a strong exogenity of $\hat{\beta}_{1,1i}$ and $\hat{\beta}_{2,1i}$ show that in both regimes, the gold return does not affect the fluctuation rate of the exchange rate. From these test results, we can conclude that only when the yen depreciates more than 2.62%, would it be possible for investors to invest in gold to prevent a loss in purchasing power from the depreciation of the yen.

The economic significance of our empirical study can be summarized as follows. The distribution of the observations between the two regimes is very asymmetric: 18% of the sample lies in regime 1, high depreciation periods, and the rest in regime 2, low depreciation or appreciation periods. From the causality tests we know that the gold return could serve as a hedge for yen/dollar depreciation only in regime 1. This implies that in Japan, high investment risks only exist in a high depreciation regime (regime 1). Let us give an example. Japan is short of natural resources. Most of its petroleum is imported so there are huge costs expended purchasing petroleum abroad. If the yen depreciates a lot, there might be imported inflation associated with petroleum purchase, which in turn, will further raise the Japanese inflation rate. To investors, they are already in a high depreciation regime. If they suspect that the inflation rate might rise, then they would relocate their asset portfolio to minimize the damage caused by the inflation. In this case, gold and its derivates become popular candidates for investors as a measure to preserve the value of their assets. Therefore, the demand for gold and gold derivatives increase, which in turn enhances the gold price and gold returns. This is the reason why the gold return and the exchange rate fluctuation are positively correlated. However, in a low depreciation or appreciation regime (regime 2), since there is no need for investors to put gold into their asset portfolio, the demand for gold and gold derivatives does not significantly increase. Hence, in regime 2, although the gold return and the exchange rate fluctuation are positively correlated, this correlation is not statistically significant.

Conclusion remarks

In the literature of exchange rate hedging, the hedging relationship between gold and the domestic currency exchange rate has been little discussed. Moreover, most of this research has used linear models to investigate the relationship. However, it is inappropriate to use a linear model to investigate this hedging relationship under different levels of exchange rate fluctuation. The purpose of this study is to examine whether the gold price adjusts to the exchange rate fluctuation and whether the gold return reflects the exchange rate fluctuation. If the answer is yes, then the gold return could serve as a hedge against the exchange rate depreciation of a domestic currency. In this paper, we found that the hedging relationship between the gold price and the yen/dollar exchange rate is nonlinear, which validates our employment of a TVAR model to investigate the causality between the gold return and the exchange rate fluctuation of the yen.[5]

This paper contributes to the field of exchange rate hedging in the following ways. As far as we know, we are the first to examine the hedging relationship between gold return and yen exchange rate fluctuation in Japan from the viewpoint that there exist threshold effects in the

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[5] In the future, we will use the methods that proposed by Pilinkienė (2008a, 2008b) to construct forecast methods for gold return and the exchange rate fluctuation of the yen.

exchange rate fluctuation. In addition, we employ a nonlinear TVAR model to investigate the causality. To our knowledge, this paper is also the first to use such a complicated model to examine exchange rate hedging. Finally, we found that different fluctuation levels of the yen have different effects on the effectiveness of gold as a hedge against exchange rate depreciation. Our paper initiates the use of a nonlinear TVAR model in examining exchange rate hedging. The robustness of our conclusion could be further examined by multicurrency studies.

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Ar galėtų auksas tarnauti kaip valiutos kurso apsauga Japonijoje?

Santrauka

Remiantis istorija, tik auksas išlaiko savo vertę per karus, pakilimus, krizių laikotarpius, imperijų ir vyriausybių pasikeitimus. Pinigų rinka rodo, kad auksas yra ideali portfelio nuosavybė ir vidaus valiutos kritimo rodiklis ekonomikos netikrumo sąlygomis. Daugelis centrinių bankų auksą įtraukia į valiutos krepšį, kuris naudojamas valiutos kursui valdyti ir kaip rezervas to turto, kuris skirtas nepastovumui sumažinti ir rizikos / grąžos balansui

sustiprinti. Auksas ilgą laiką buvo laikomas kaip gera apsauga nuo infliacijos ir valiutos nuvertėjimo. Nors tuo buvo tikima, tačiau tam buvo paskirta labai mažai statistinių tyrimų. Be abejo, auksas yra gera apsauga nuo valiutos kurso svyravimų, tačiau to negalima suabsoliutinti. Gilesnės studijos galėtų būti naudingos tiek akademinio rato specialistams, tiek investuotojams. Šis straipsnis padeda geriau suprasti, kada ir kur auksas gali apsaugoti valiutos kursą naujame jenos ir dolerio modelyje. Investitorių požiūriu šis straipsnis suteikia informacijos, kaip geriau paskirstyti savo turtą.

Auksas yra brangus metalas, kuris veikia taip pat kaip ir valiuta ir todėl turi savo perkamąją galią. Kai vertės išsaugojimo galimybės sumažėja dėl vietinės valiutos vertės kritimo, vietinės rinkos aukso vertė išlieka ta pati kaip ir tarptautinė aukso kaina. Taigi aukso kaina nėra tokia jautri vietinės valiutos kurso svyravimams. Jeigu mes galime įrodyti, kad auksas gali apsaugoti valiutos kursą nuo jo kritimo, tada svarbu panaudoti auksą kaip valiutos kurso apsaugą. Ką tai reiškia? Tai reiškia, kad auksas turi savybę atsispirti pokyčiams vidaus valiutos perkamosios galios kritimui. Tai labai svarbu, nes kylant vidaus kainų indeksui, kyla ir aukso valiutos vertė, krintant vidaus valiutos kursui palyginti su užsienio valiuta, vidaus aukso kaina taip pat mažėja. Šiame straipsnyje nagrinėjama, iki kokio lygio auksas padeda apsaugoti vidaus valiutos kurso svyravimą.

Nedaug yra tyrimų, susijusių su priklausomybės tarp aukso ir vidaus valiutos kurso svyravimų. Tuose tyrimuose paprastai taikomas linijinis metodas, kurio trūkumas yra tas, kad šiuo metodu gautus rezultatus sunku pritaikyti ten, kur sąlygos kinta, pvz., keičiantis valiutų kursams. Vykstant globalizacijos procesams, rinkos sąlygos laisvėja ir auksas tampa ne tik fizine vertybe, bet įgyja ir finansinio produkto vaidmenį. Taigi daugelis finansinių produktų yra susiję su auksu (aukso operacijos ir t. t.). Į tai reikia atsižvelgti sudarant ekonominį modelį, nes priešingu atveju empiriniai duomenys bus iškreipti.

Japonija yra viena iš trijų stambiausių ekonomikų pasaulyje ir didžiausia Azijoje. Japonija yra G 7 grupės narė. Japonai, kaip ir daugelis Azijos žmonių, mėgsta auksą. Todėl santykio tarp aukso kainos ir jenos kurso kitimo Japonijoje tyrimas padeda suprasti šių dviejų kintamųjų priklausomybę.

Šio straipsnio tikslas yra ištirti, ar investavimas į auksą galėtų apsaugoti jenos kurso kitimą, t. y. ar investavimas į auksą galėtų apsaugoti asmeninį ir kompanijų turtą nuo smukimo. Dėl rinkos konkurencijos, operacijų kaštų svyravimo egzistuoja asimetriška informacija apie aukso fizinę rinką ir aukso produktų rinką. Palyginus kitus tyrimus, šis darbas remiasi daugiau santykiui tarp valiutos kurso svyravimo ir aukso kaip apsaugos priemonės atskleisti. Straipsnio autoriai tvirtina, kad šis santykis turėtų būti nelinijinis. Taip teigia ir daugelis tyrėjų. Remdamiesi šiuo teiginiu, sukuriamas nelijinis modelis empiriniam tyrimui.

Straipsnio autoriai savo tyrimuose vadovaujasi Tsay (1998) požiūriu į modelio linijiškumą. Pirmoji hipotezė – modelis yra linijinis – VAR modelis. Alternatyvi hipotezė – modelis nėra linijinis – TVAR modelis. Autoriai panaudojo jenos kurso svyravimą kaip kintamąjį kuriant aukšto nuvertėjimo ir žemo nuvertėjimo (arba įvertinimo) režimą. Wald koeficiento testas yra naudojamas tiriant kintamųjų priežastingumą tam, kad būtų patvirtintas trumpo dinamiško efekto priežastingumas. Gavus šiuos priežastingumo testo rezultatus ir atlikę vėlavimo parametrų analizes, galima tirti, ar investavimas į auksą gali padėti išvengti vietinės valiutos perkamosios galios pasikeitimų. Tyrime naudojami aukso uncijos kainos mėnesio duomenys pagal jenos kurso pasikeitimą. Aukso kainos duomenys imami iš Pasaulinės aukso vertės tyrimo tarybos ir statistikos duomenų bazės bei iš jenos ir dolerio kurso duomenų, kurie pateikti Tarptautinio valiutų fondo tarptautinės finansinės statistikos duomenų bazėje. Tyrimo periodas – nuo 1986 m. balandžio mėn. iki 2007 m. kovo mėn. Buvo užfiksuoti 252 pastebėjimai. Lentelėse pateikti duomenys rodo, kad jenos aukso kaina ir jenos ir dolerio kursas yra: 1) kintamieji, t. y. du kintamieji bus pastovūs diferencijuojant; 2) pirmoji hipotezė apie linijiškumą tarp jenos aukso kainos ir jenos ir dolerio kurso turi būti atmesta; 3) remiantis linijinio testo rezultatais, panaudojome Δe_{t-1} kaip pradinį kintamąjį ir apskaičiavome TVAR modelį. 4 lentelė rodo šio skaičiavimo rezultatus. Pereinamoji vertė lygi 2,62 proc. Galima apibrėžti pirmąjį režimą kaip atvejį, kad $\Delta e_{t-1} > 2{,}62\%$, ir antrąjį režimą kaip atvejį, kad $\Delta e_{t-1} \le 2{,}62\%$. Pirmasis režimas atitinka situaciją, kurioje jenos svyravimas yra didesnis. Antrasis režimas rodo, kad jenos valiutos kursas yra žemesnis. Kai jenos vertė, palyginti su JAV doleriu, krinta daugiau nei 2,62 proc., investavimas į auksą galėtų padėti išvengti nuostolių, kitaip auksas neapsaugos jenos kursą nuo jo kritimo.

Empirinis tyrimas turi ekonominę reikšmę, kurią galima apibendrinti šiomis išvadomis: 18 proc. pastebėjimų priklauso pirmajam režimui, t. y. aukšto kritimo periodai, o kiti pastebėjimai priklauso antrajam režimui, t. y. žemo kritimo periodai. Atsitiktinumo testas parodė, kad auksas gali apsaugoti jenos ir dolerio kursą jam krintant tik pirmame režime. Tai rodo, kad Japonijoje didelių investicijų rizika egzistuoja tiktai esant didelio kritimo režimui. Pavyzdžiui, tarkime, kad Japonijai trūksta gamtinių išteklių. Didžioji naftos dalis importuojama, todėl išleidžiami didžiuliai kaštai perkant naftą užsienyje. Jeigu jenos kursas krinta laba žemai, su naftos kaina gali būti importuota ir infliacija, o pastaroji toliau kelia visą Japonijos infliacijos lygį. Investuotojai atsiduria aukštame kritimo režime. Jeigu jie įtaria, kad infliacijos mastai gali augti, jie nukreipia savo kapitalą kitur, kad sumažintų infliacijos nuostolius. Tokiu atveju auksas ir jo vediniai tampa patrauklūs investuotojams kaip matas, pagal kurį stengiamasi išsaugoti savo turto vertę. Todėl aukso reikalavimas auga, o tai stiprina aukso kainą. Tai ir yra priežastis, kodėl aukso grąža ir kurso kitimo svyravimai yra teigiamai koreliuojami. Tačiau, esant antrajam režimui, aukso poreikis labai nedidėja. Taigi, nors esant antrajam režimui aukso ir kurso kitimo svyravimai yra teigiamai koreliuojami, ši koreliacija nėra statiškai reikšminga.

Šis tyrimas turėtų būti naudingas Japonijos piniginei politikai ir padėtų investuotojams, kurie norėtų panaudoti auksą apsaugoti vidaus valiutos kursą nuo jo kritimo.

Raktažodžiai: *aukso grąža, valiutos kurso kritimo apsauga, ribinis modelis, asimetriškas atsitiktinumas, TVAR modelis.*

The article has been reviewed.

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