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Effectiveness of the Zero Interest Rate Policy for Financial Markets in Japan: Principal Components Analysis

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Abstract

The zero interest policy was introduced by the Bank of Japan (BOJ) and kept in force from February 12, 1999 through August 11, 2000, after which the BOJ introduced the quantitative easing policy in March 19, 2001. On March 9, 2006, the BOJ exited quantitative easing amid signs that deflation was ending and the recession had disappeared. After that, the zero interest rate policy again was introduced. Quantitative easing policies has been examined a lot in the literature; however, the BOJ introduced Abenomics, an unprecedented, aggressive monetary policy, on April 4, 2013. The effectiveness of the monetary policy during the zero interest rate policy era has not been adequately discussed. This article focuses on daily Japanese stock prices during the zero interest rate era; employs a principal components analysis to determine the effectiveness of the policy; and shows domestic interest rates, US interest rates, US and China stock prices, and the exchange rate of yen/US dollar influence Japanese stock prices but that the yen/Euro exchange rate does not.

Keywords: central bank; monetary policy; stock price, zero interest rate policy

1. Introducation

Deflationary pressure has had a serious impact on some developed countries since the 1990s. Worldwide financial shocks impacted the world economy and affected many countries, including both developing and newly industrializing economies. Policymakers, namely central banks, have tried to overcome the situation; however, most developed countries suffered recession. In response to this situation, on February 12, 1999, the Bank of Japan (BOJ), the Japanese central bank, implemented the unprecedented zero interest rate policy to combat deflation and to boost the economy. This tactic can be understood as sending money to the economy, promoting increases in asset prices, and removing deflationary pressures. On August 11, 2000, the zero interest rate policy in Japan was rescinded, as the economic situation showed signs of recovery. However, as Japan recovery had been less than adequate, after a long trial under the low interest rate policy, the BOJ changed the policy and conducted a more drastic monetary policy known as *quantitative monetary easing*,. The unprecedented policy started on March 19, 2001, and ended on March 9, 2006.

After the subprime problems in 2007 and the Lehman shock in 2008, a huge amount of capital flowed into the Japanese financial markets in spite of the fact that the Japanese economy still was not in good condition. Not only Japan but also Switzerland had to accept a lot of money all over the world. The Japanese yen appreciated against other currencies, which hit the Japanese economy as the strong yen dampened exports. In October 2010, the BOJ introduced its comprehensive monetary easing policy to respond to the re-emergence of deflation and a slowing recovery. One key measure was an asset purchase program that involved government bonds as well as private assets. After that, the Japanese government changed and more aggressive fiscal policy was strongly demanded. The zero interest rate policy was in effect beginning in October 2010 and continues in force now.

In Japan, a drastic new policy, called *Abenomics* (for Abe, the prime minister), was adopted in 2013. The Japanese government not only implemented drastic fiscal policy but also took measures to strengthen competitiveness and economic growth. Japan has been under severe economic conditions, namely, deflation. These measures included possible policy actions to reform the economic structure, such as concentrating resources on innovative research and development, strengthening the foundation for innovation, performing regulatory and institutional reforms, and changing the tax system (increasing the consumption tax and reducing the corporate tax). Moreover, by strengthening coordination between the BOJ and the government, since 2013, the Japanese government has implemented measures to achieve a new fiscal structure to ensure the credibility of the fiscal condition. The BOJ introduced Abenomics, an unprecedented aggressive monetary policy, on April 4, 2013. Much discussion has taken place about Abenomics; however, few studies have examined the zero interest rate policy and stock prices in spite of its importance. The so-called *Abenomics* have been highly evaluated in Japan. Asset prices, especially stock prices, have risen sharply since the beginning of 2013. Export industries, including Toyota (automobile company), have announced record high profits as the yen has depreciated against other currencies. However, the Japanese economy still remains weak. Exports and industrial production have decreased, reflecting worse overseas economies. Fixed investments also have shown some weakness. Consumption has remained resilient. The year-on-year rate of change in the CPI is still about 0%.

Ruge-Murcia (2006) indicated that when zero low bound is considered in the markets, the hypothesis of expectations for the yield spread creates a nonlinear relationship between changes in short-term and long-term interest rates. As the short-term interest rate becomes zero, the sensitivity of long-term interest rates with regard to short-term interest rates declines. This response becomes asymmetric with short-term rate increases along with larger absolute long-term interest rate movement rather than decreases in the short-term. Grisse (2015) found that the extent to which these nonlinearities is informative about the transmission of short-term rates changes to long-term ones.

As the exchange rate premium model or portfolio approach model for exchange rate determination models has prevailed, the existence of premium foreign exchange markets has been analyzed. It is of course related strongly to interest rates. Bhar, Chiarella, and Pham (2001) provided evidence that the forward risk is stationary and has substantial time variation. Wu (2007) showed empirical results that reject the restrictions on the exchange rate and interest rate imposed by the term structure of interest rates. Azouzi, Kumar, and Aloui (2011) found that the forward premium is crucial for short-term calculations. Using data from six countries, Kim (2013) indicated that pricing revision errors exist in the exchange rate risk premium.

Recently, expansion of the traditional premium models has been ongoing. Arminio (1986) provided a theoretical model for how the risk premium relates to international shares of foreign assets and wealth, as well as the variance-covariance matrix of prices and exchange rates. Beng and Siong (1993) showed that forward discounts of exchange rates reflect expectations of future changes in exchange rates, and expectations of the financial market are not rational. Basurto and Ghosh (2001) indicated that there is little evidence that real interest rates contribute to a large risk premium. Landcon and Smith (2003) denied the rational expectations hypothesis and found the existence of a time-varying risk premium. Corte and Tsiakas (2009) showed that risk-averse market participants prefer to pay a high fee to switch from a dynamic portfolio decision based on the random walk model to the decision that hinges on the forward premium with stochastic volatility model. Alain and Carmelo (2015) found that pricing errors from ignoring the term structure of interest rates is smaller than the error that results from omission of the foreign exchange risk. Breoll, Welzel, and Wong (2015) showed that uncovered interest rate parity did not hold when international firms had a risk-averse attitude.

Estrella and Mishkin (1996) showed that empirical results depend on macroeconomic variables. Also, Kim and Singleton (2012) showed that a variety of non-negative symmetric term structure models lead to various predictions regarding the behavior of longer-term yields around the zero or low bound. De Pace (2013) showed that the term structure is not a credible predictor of economic growth.

The relationship between stock prices and macroeconomic variables has been discussed all over the world. Campbell (1987, 1991), Campbell and Shiller (1998), Cutler, James, and Summers (1989), Fama and Schwert (1997), Hodrick (1992), and Keim and Stambaugh (1986) showed that short- and long-term interest rates have a modest degree of forecasting power for excess stock returns. Similarly, other studies, such as Campbell and Shiller (1991) and Fama (1984), have shown that the slope of the term structure of interest rates makes it possible to forecast excess stock returns.

On the other hand, Campbell and Ammer (1993) and Hamori and Honda (1996) showed that short-term interest rates impact stock prices. During the 1980s and 1990s, many researchers analyzed the relationship between stock prices and interest rates.

Black Monday occurred in 1987 in the United States. At that time, international interdependence of stock prices received much attention, which prompted studies by Eun and Shim (1989), Jeon and Chiang (1991), Lai, Lai, and Fang (1993), Chowdhury (1994), and Hirayama and Tsutsui (1998). Liow, Muhammad, and Huang (2006) showed that the expected risk premium and the conditional volatilities of the risk premia on property stock are time-varying and dynamically related to the conditional volatilities of macroeconomic determinants. However, few recent studies have examined this topic. Meric (2012) showed that US stock markets have large impacts on the European and Australian stock markets. Also, Meric, Kimb, Geng, and Meric (2012) indicated that Singapore, Indian, and Japanese stock markets are the most influential markets and the Philippine and South Korean stock markets are the least influential stock markets in Asia. Mazuruse (2014) found that stock returns in Zimbabwe are most largely influenced by changes in consumer prices, money stocks, exchange rates, and treasury bills. Pradhan, Arvin, Norman, and Hall (2014) showed that banking sector maturity and stock market maturity are linked.

Little research exists on the effect of the exchange rate on stock prices. Hamao (1988) investigated this relationship and found that the exchange rate was not significant for Japan, but Choi, Hiraki, and Takezawa (1998) showed that the exchange rate is an important factor. Homma, Yoshiro, and Tsutsui (2005) stated that stock investors evaluate firms' foreign asset positions and respond to changes in the exchange rate. Demarzo and Duffie (1995), Barton (1996), Brown (2001), and Pincus and Rajgopal (2003) argued that hedging using financial derivatives can reduce the amount of noise in corporate earnings. Since the 1980s, capital movement across countries has been dramatic. In spite of the reduction in fluctuations of the exchange rate in the 1990s compared to the 1980s, the capital movement should not be ignored. Since the middle of the 2000s, exchange rate instability has been common. There is some possibility that exchange rates have been influencing Japanese stock prices.

In the fields of economics, few studies have employed principal components analysis. Moreover, few existing studies have analyzed monetary policy. On the other hand, this method can decompose the variables that examine economic phenomena into common and specific components.

This article examines whether or not the zero interest rate policy was effective. The sample period is from October 5, 2010, to April 3, 2013, namely, during the time of the zero interest rate policy. Japanese stock prices are focused to judge whether or not the zero interest rate policy was effective. Along with regression analysis, principle component analysis is used.

Empirical methods are explained in section 2. Section 3 show the empirical analyses and the results. Further empirical analyses are the performed and the results examined. Finally, this article ends with a brief summary.

2. **Theoretical Background and Empirical Method**

2.1 Theoretical background

Principal components analysis is a statistical method for clearing a smaller number of uncorrelated variables, namely, principal components, from a large set of data. The goal of this analysis is to check the maximum amount of variance with the fewest number of principal components. This method combines the techniques of principal component analysis to decompose the variables that examine economic phenomena into common and specific components. One can use this analysis to reduce the number of variables and avoid multicollinearity or when there are many variables relative to the number of observations.

2.2 Data and empirical method

The data used in this paper are interest rates (Japanese call rate, Japanese long-term rate [10 years], and FF), stock prices (Nikkei [Japan], S&P, DOW, DAX [Germany], and SHASHR [China]), exchange rates (yen/US dollar and yen/Euro), and oil prices (Japan). Daily data are used for estimation.

First, correlation of each variable is estimated and estimation of a country model is performed by reduced form with 11 endogenous variables, in addition to a constant and a linear trend is performed. The first principal component of variables that represent economic activity, the common component, is obtained and 80% of the variance, indicating the common existence of a common component, is employed.

3. Results and Implications

The empirical results are shown in Table 1 and Figure 1. For scree plots, order 2 is selected.

Table 1. *Eigenvalues, Eigenvectors, and Correlations*

Eigenvalues

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	5.032	1.181	0.457	5.032	0.457
2	3.851	2.732	0.350	8.883	0.800
3	1.118	0.597	0.101	10.008	0.909
4	0.520	0.287	0.047	10.525	0.956
5	0.233	0.104	0.021	10.755	0.977
6	0.128	0.070	0.011	10.883	0.989
7	0.058	0.032	0.005	10.942	0.994
8	0.025	0.006	0.002	10.967	0.997
9	0.018	0.007	0.001	10.986	0.998
10	0.011	0.009	0.001	10.998	0.999
11	0.001	---	0.000	11.000	1.000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10
_10YINT	-0.135	0.467	0.087	-0.013	0.029	0.484	0.616	0.207	0.282	0.126
CALL	0.119	0.444	0.266	-0.077	-0.136	-0.778	0.256	0.048	0.046	-0.127
DOW	0.359	-0.275	0.196	0.059	-0.171	-0.002	-0.030	0.175	0.511	0.107
DAX	0.376	-0.256	0.069	0.127	-0.013	0.014	0.402	0.380	-0.659	0.160
EXCEU	0.299	0.308	0.146	-0.380	0.545	0.122	-0.401	0.396	-0.057	-0.117
EXCUS	0.404	0.133	-0.196	-0.311	0.120	-0.027	0.080	-0.529	-0.011	0.617
OIL	-0.131	-0.118	0.865	0.107	0.218	0.111	-0.009	-0.355	-0.108	0.097
FF	0.177	0.419	0.167	0.091	-0.678	0.274	-0.399	0.004	-0.228	0.089
S_P	0.376	-0.258	0.142	0.011	-0.122	0.009	-0.006	0.180	0.383	0.055
STOCKJ	0.440	0.001	-0.038	-0.081	-0.029	0.230	0.226	-0.420	-0.038	-0.716
SHA	0.245	0.269	-0.139	0.840	0.338	-0.043	-0.110	-0.077	0.072	0.041

Ordinary Correlations:

	_10YINT	CALL	DOW	DAX	EXCEU	EXCUS	OIL	FF	S_P	STOCKJ
_10YINT	1.000									
CALL	0.705	1.000								
DOW	-0.721	-0.193	1.000							
DAX	-0.699	-0.193	0.965	1.000						
EXCEU	0.366	0.730	0.214	0.241	1.000					
EXCUS	-0.052	0.423	0.529	0.594	0.803	1.000				
OIL	-0.033	-0.046	0.070	-0.060	-0.190	-0.524	1.000			
FF	0.648	0.858	-0.059	-0.063	0.701	0.503	-0.170	1.000		
S_P	-0.705	-0.170	0.994	0.975	0.267	0.593	-0.001	-0.036	1.000	
STOCKJ	-0.282	0.240	0.780	0.823	0.665	0.917	-0.328	0.390	0.823	1.000
SHA	0.293	0.524	0.140	0.238	0.544	0.543	-0.355	0.615	0.170	0.511

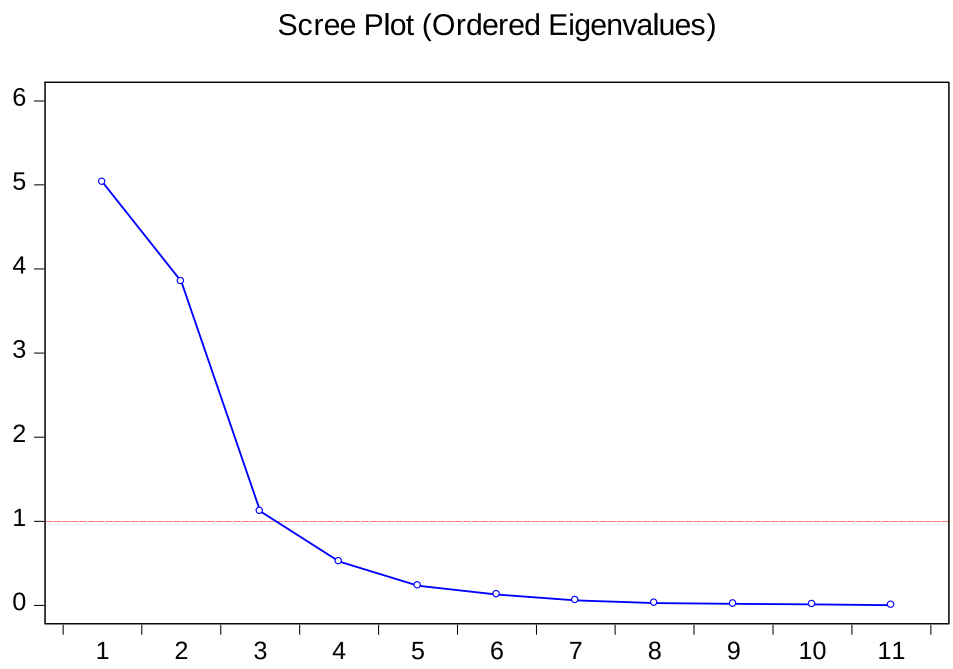

Figure 1. Scree plot.

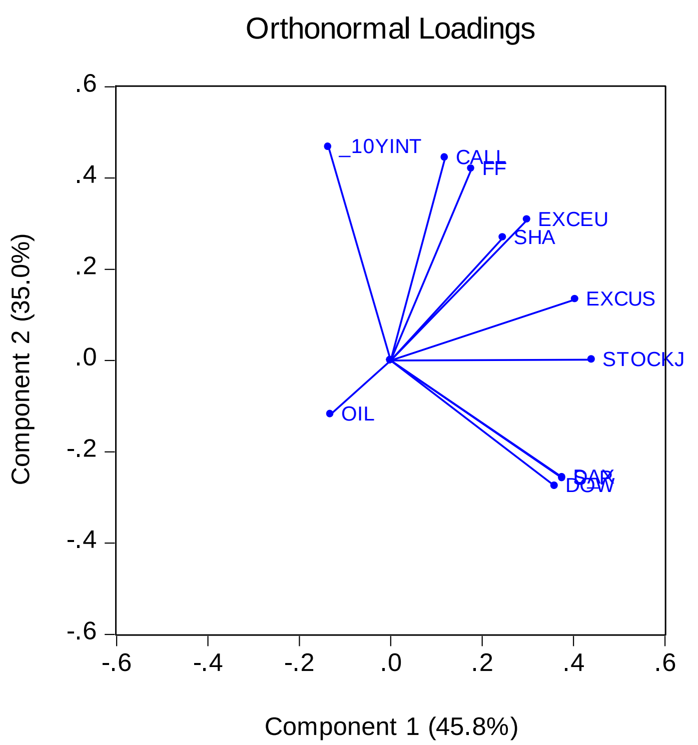

Figure 2. Orthonormal loadings.

The results show that Japanese stock prices are linked to domestic interest rates, US interest rates, US and Chinese stock prices, and exchange rate of yen/US dollar.

Moreover, regression analyses are performed. Adding to the standard OLS method, GMM (generalized method of moments) and robust estimation are also used for estimation. The GMM estimators are known to be consistent, asymptotically normal, and efficient among all estimators that do not use any extra information aside from that contained in the moment conditions. Robust estimation is unlike maximum likelihood estimation. OLS estimates for regression are sensitive to the observations that do not follow the pattern of the other observations. This is not a problem if the outlier is simply an extreme observation from the tail of a normal distribution; however, if the outlier is from non-normal measurement error or some other violation of standard OLS, it compromises the validity of the regression results if a nonrobust regression method is employed.

The results are shown in Table 2.

Table 2. Regression Analysis

	OLS	OLS	GMM	Robust estimation
	-11265.63	-11373.363	-12203.35	-11656.65
C	(-38.880)	(-62.040)	(-25.593)	(-61.482)
	1417.263	1452.211	1735.536	1560.734
_10YINT	(14.104)	(17.277)	(7.736)	(17.954)
	-2650.222	-2613.205	-2686.362	-2675.853
CALL	(-14.802)	(-17.420)	(-8.281)	(-17.247)
	-0.078			
DOW	(-1.274)			
	0.448	0.451	0.523	0.463
DAX	(12.674)	(13.172)	(6.498)	(13.079)
	-1.235			
EXCEU	(-0.585)			
	136.550	134.669	138.511	135.521
EXCUS	(32.577)	(97.348)	(32.885)	(94.723)
	1.352			
OIL	(1.008)			
	270.726	262.689	119.714**	220.637
FF	(13.480)	(14.428)	(2.436)	(11.717)
	4.503	3.941	3.585	3.911
S_P	(8.315)	(21.085)	(8.022)	(20.232)
	0.196	0.188	0.281	0.217
SHA	(8.827)	(8.982)	(4.785)	(10.027)
Adj.R2	0.981	0.981	0.979	
Rw-squared				0.984
F-statistic	10268.36	14676.01		
	(0.000)	(0.000)		
Rn-squared				95606.47
statistic				(0.000)
Durbin-Watson	0.128	0.128	0.118	
stat				
J-statistic			107.848	
			(0.000)	

Note. Figures in parentheses are t-statistic, except for the z-statistic for robust estimation and probability for F- and J-statistics.

The results coincide with the results of the principle component analysis. Moreover, the impulse response function is calculated.

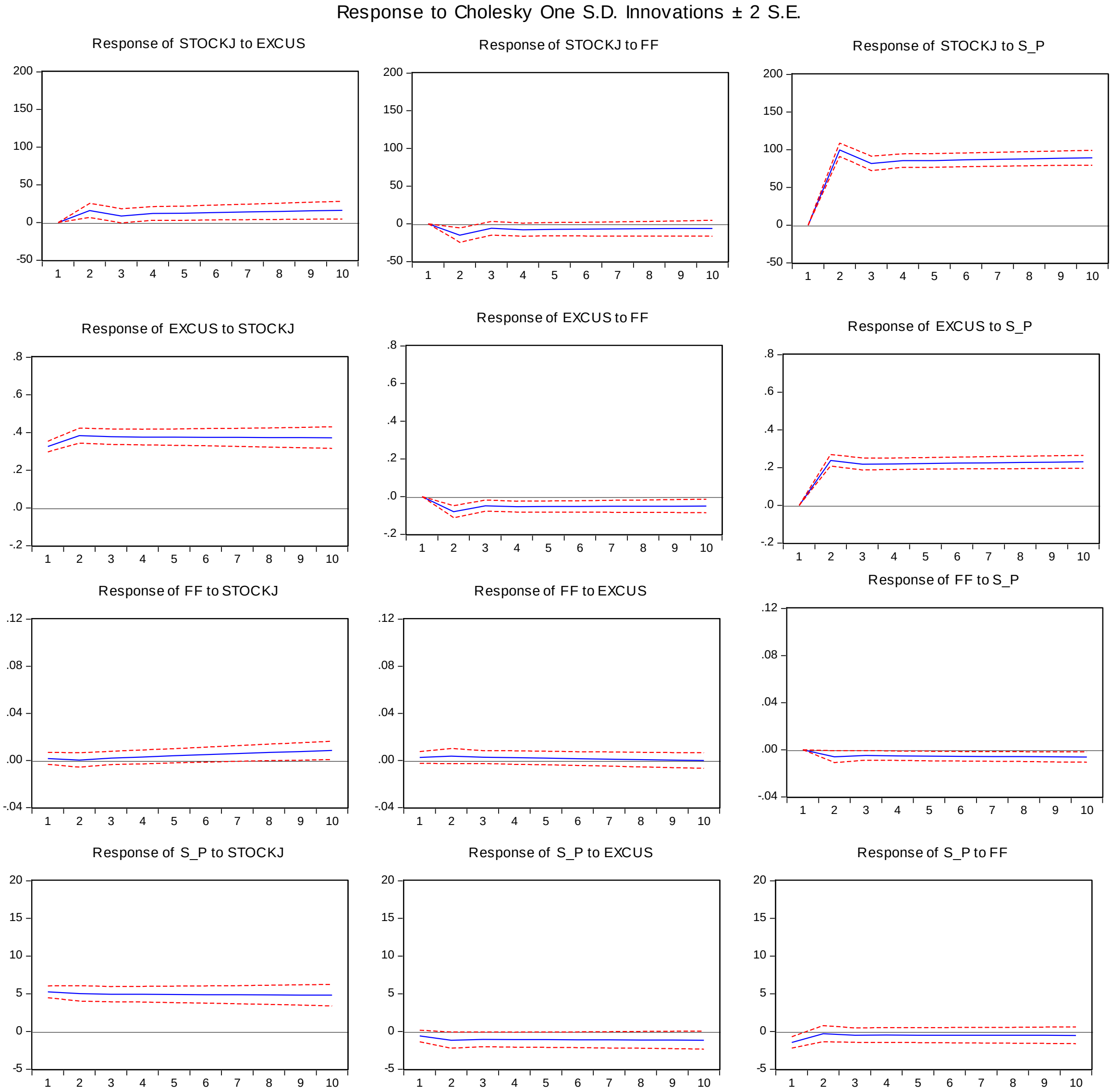

Figure 2. Impluse resonse function.

The US stock prices rose, Japanese stock prices increased the next day, and the influence continues for some time. The effect on Japanese stock prices is similar to that in the exchange rate of yen/US dollar. Depreciation of the yen and increases other countries' stock prices make Japanese stock rises rise and the effect continues for some time.

For interest rates, domestic short-term interest rates impact stock prices negatively as expected; however, domestic long-term interest rates and foreign interest rates positively impact Japanese stock prices. Also the effects continue for some time as in the regression analyses.

4. Conclusions

This article focuses on the zero interest rate policy era in Japan and employs principal components analysis in addition to regression analyses to examine whether or not this policy was effective for domestic stock prices. The results showed that domestic interest rates, US interest rates, US and Chinese stock prices, and the yen/US dollar exchange rate influence Japanese stock prices; however, the yen/Euro exchange rate does not.

Japan conducted unprecedented and more aggressive monetary policy, quantitative easing and qualitative and quantitative monetary policy. From April 2013, Abenomics was implemented, and the yen deprecated greatly and stock prices rose largely. However, it should be noted that during the zero interest rate policy era, stock prices rose slightly but significantly as expected.

Certainly stock prices are determined by many factors and the factors change always and continuously. It is important to examine whether or not monetary policy was effective during not only the quantitative easing era but also during the era of the zero interest rate policy. Further research is needed for analyses.

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