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**Research Report**

## The Effects of Central Banks' Rate Change Patterns on Financial Market Variables

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# The Effects of Central Banks' Rate Change Patterns on Financial Market Variables

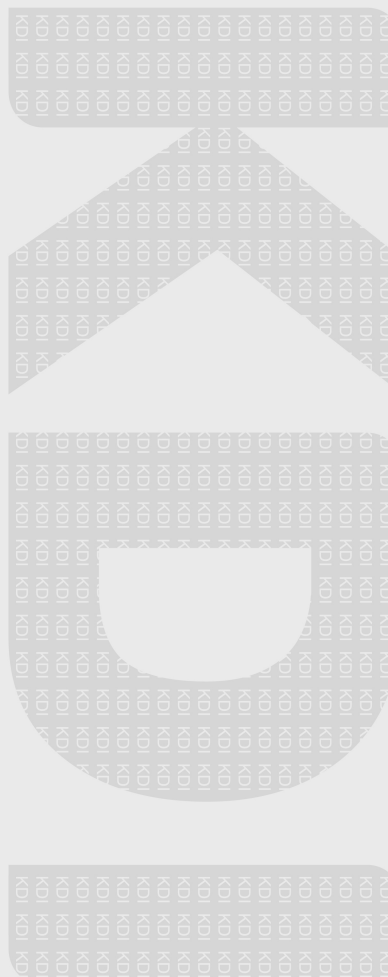
Wook Sohn  
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KOREA DEVELOPMENT INSTITUTE



# The Effects of Central Banks' Rate Change Patterns on Financial Market Variables

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## | Preface |

Central banks take into account the current state and future prospect of the economy in determining the level of target interest rates. In spite of similarities in economic situations across nations, their central banks act differently from one another when it comes to the frequency and range of interest rate changes.

Inspired by such observations, Wook Sohn at the KDI School of Public Policy and Management and Byeongmook Sung at the Bank of Korea examine whether central banks' patterns of changing interest rates are associated with their contributions to variances in the forecast errors in financial markets variables, but no robust results are found. They also conduct panel analyses to show that the frequency and range of changes in policy rates are significantly related to the volatility of long-term interest rates.

A monetary policy is the endogenous response of central banks to developments in the economy and financial markets. I hope this paper can help scholars and policymakers better understand and get involved in researches on the nature of central banks' monetary policy decision-making and financial market responses.

The views expressed herein are those of the authors and should not be attributed to the Korea Development Institute or the Bank of Korea.

Joon-Kyung KIM  
President of KDI

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# Summary

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This study examines whether different patterns of change to the benchmark interest rates of central banks are associated with their contributions to variances in the forecast errors of three financial market variables: the long-term interest rate, the foreign exchange rate, and the stock market index. On average, the central bank's interest rate accounts for approximately 20% of the variance in each variable. We find that the total range of changes is more important than the frequency of changes. The panel regression shows that the range and frequency of policy rate changes is positively associated with the volatility of long-term interest rates but no association with the volatilities of stock prices and exchange rates. These results suggest that small and frequent adjustments of policy rates are desirable for reducing the volatility of interest rates.



# CHAPTER 1

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## Introduction

In many countries, monetary policy is carried out mainly through changes in the benchmark short-term interest rates. Thus, financial market participants watch closely the interest rates that are controlled by the central banks. In determining the levels of short-term interest rates, central banks consider the current state and the future path of economic variables, notably inflation and the gross domestic product (GDP) growth rate. However, in spite of the similarities in economic situations across nations, different central banks show different frequencies and ranges of interest rate changes. For instance, during the period 1999 to 2007, the US central bank changed the federal (Fed) fund rate 39 times, for a total change of 12.5% point, while the European Central Bank (ECB) changed only 23 times, for a 7.5% point change during the same period. Among emerging market countries, Brazil changed 66 times, whereas Russia and Thailand changed only 17 and 23 times, respectively.

This paper aims to explore whether different patterns of changes to interest rates contribute to variances in the forecast errors of three financial market variables: long-term interest rates, foreign exchange rates, and stock prices. Variance decomposition determines how much of the forecast error variance in each variable can be explained by exogenous shocks (i.e., changes in the benchmark interest rate by the central bank) to the variables.

These financial market prices play a critical role in the transmission mechanism of monetary policy. Accordingly, this study is also related to

the effectiveness of the transmission mechanism because it investigates how the central bank's frequency and range of changes to interest rates influence the amount of information that the benchmark interest rates contributes to the three financial variables.

We find that, on average, the information that the pattern of a central bank's changes to rates contributes to each variable is approximately 20% of the total amount of information. We also find that the total range of changes is more important than the frequency of changes.

The panel analysis shows that the range and frequency of policy rate changes have a significant influence on the volatility of long-term interest rates but no effect on the volatility of stock prices or exchange rates. As the range increases and the number of policy rate changes decrease, the volatility of long-term interest rates increases. These results suggest that small and frequent adjustments to policy rates are desirable for reducing the volatility of interest rates. The impulse responses from the vector autocorrelation (VAR) analysis are relevant to conventional macroeconomic theory.

This paper is organized as follows: Chapter 2 reviews the extant literature related to the central bank's pattern of rate changes and analyzes how the frequency and range of changes to interest rates differ by nation. In chapter 3, we conduct a VAR analysis to investigate the contribution of the central bank's interest rate to the variance in financial variables. Chapter 4 explores whether the pattern of changes in the central bank's interest rate are associated with its contribution to the variance in financial variables and thus the effectiveness of the monetary policy transmission mechanism. In chapter 5, using panel data analysis, we examine the relation between policy rate patterns, the number and frequency of policy rate changes, and the volatility of the financial variables. Chapter 6 concludes the paper.

## CHAPTER 2

---

### Pattern of Central Bank Rate Changes

Several empirical studies suggest that gradualism is preferable to sudden changes in monetary policy. Clarida, Gali, and Gertler (2000) state that the inertia of the monetary policy of the Volcker-Greenspan era is greater than that of the pre-Volcker era, and Poole (2003) and Rudebusch (2006) assert that the Federal Reserve's steady response to shocks showed improvement in the inertia results. In other words, Fed's baby step strategy is not its intentional efforts for smoothing but results from its responses to shocks. Orphanides (2003) and Sack (2000) show that gradual adjustment is a desirable response when there is uncertainty in an economy, while Goodfriend (1991) suggests that the expanding volatility of interest rates has harmful effects on the stability of financial markets and institutions. Woodford (1999) asserts that smoothing the interest rate could induce economic agents to form rational expectations of monetary policy and thus reduce inflation bias.

In contrast, other studies claim that aggressive policy action could achieve better outcome than a passive interest rate adjustment could. Caplin and Leahy (1996) show that monetary policy can become inefficient when a conservative reaction by the central bank leads investors to expect additional policy actions and thus delay investments accordingly. Amato and Laubach (2004) argue that a gradual rate adjustment is likely to prevent the economy from quickly converging into long-term equilibrium if consumption and inflation inertia is strong. Sargent (1999) emphasizes that severe uncertainty calls for an active monetary policy, while Herrera and Valdes (2001) point out that active

policy action is more effective in mitigating the differences between domestic and foreign interest rates to restrain the volatility of capital flow.

These studies focus on examining whether gradual or active changes in the interest rate are desirable for the outcome of monetary policy. Unlike these previous studies, we use various measures, to explore the effects of the patterns of changes to interest rates by central banks on the framework of financial market variables on the monetary transmission mechanism.

We use three different measures to analyze the pattern of changes made by central banks' to interest rates: the number of interest rate changes, the total range of the changes, and the duration of a successive raise or cut in interest rates.

Our sample includes 24 nations that utilize benchmark short-term interest rates as the main tool of their countries' monetary policies. The study period is mainly from January 1999 to December 2007, but several exceptions are made because of the lack of data. Because our main interest is patterns of changes to policy rates, we exclude the period after the global financial crisis in 2008, when policy rates were not a main tool of monetary policy because of quantitative easing. For these reasons, our main analysis is restricted to the period before the global financial crisis even though we sometimes compare periods excluding the global financial crisis and other periods including the crisis. Table 1 provides a list of interest rates targeted by the nations' central banks and the data period. The data are obtained from each central bank's website.

As shown in Figure 1, business cycles in selected advanced countries and emerging markets are similar during the study period. The patterns of inflation in major economies are also similar even though the degree of similarity is not as strong as in business cycles. Although business cycles and inflation show strong co-movement among major advanced and emerging countries, we find that there is a strong diversity in the patterns of policy rate changes.

Table 2 shows the three measures that indicate the pattern of monetary policy decisions. The first measure is the number of changes to interest rates determined by a central bank. Although this measure is

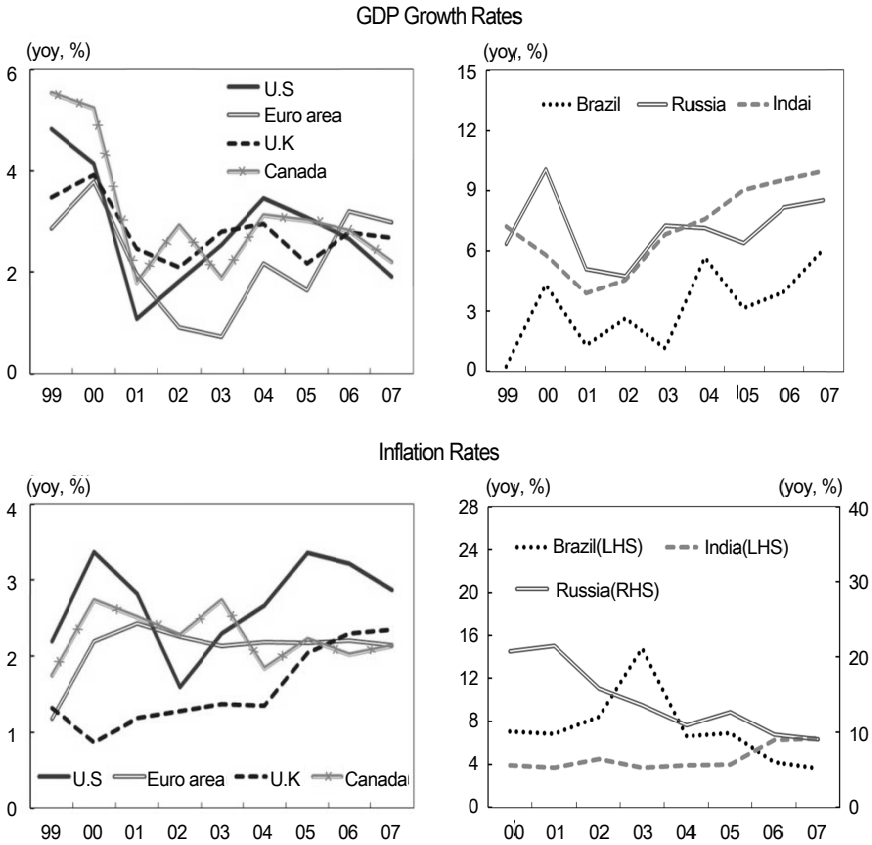


**Table 1 | Data Summary**

<b>Nation</b>	<b>Targeted interest rate</b>	<b>Data period</b>
Australia	Cash rate	Jan 1999 ~ Dec 2007
Brazil	SELIC overnight rate	Mar 1999 ~ Dec 2007
Canada	Overnight funding rate	Jan 1999 ~ Dec 2007
Chile	Discount rate	Jan 1999 ~ Dec 2007
Croatia	Discount rate	Feb 1999 ~ Dec 2007
Czech	2-week repo rate	Mar 1999 ~ Dec 2007
Denmark	Discount rate	Jan 1999 ~ Dec 2007
Eurozone	Minimum bid rate	Jan 1999 ~ Dec 2007
Hong Kong	Discount window base rate	Jun 1999 ~ Dec 2007
Hungary	2-week deposit rate	Jan 1999 ~ Dec 2007
India	Repo rate	Jan 2001 ~ Dec 2007
Korea	Overnight call rate	May 1999 ~ Dec 2007
Norway	Deposit rate	Jan 1999 ~ Dec 2007
Philippines	Reverse repo rate	Jan 1999 ~ Dec 2007
Poland	14-day intervention rate	Mar 1999 ~ Dec 2007
Russia	Refinancing rate	Jan 1999 ~ Dec 2007
S. Africa	Repo rate	Jan 1999 ~ Dec 2007
Slovakia	2-week repo rate	May 2000 ~ Dec 2007
Sweden	Repo rate	Jan 1999 ~ Dec 2007
Switzerland	3-month Swiss Libor	Jan 2001 ~ Dec 2007
Taiwan	Official discount rate	Jan 1999 ~ Dec 2007
Thailand	Repo rate	Jan 2001 ~ Dec 2007
U.K.	Repo rate	Jan 1999 ~ Dec 2007
U.S.	Federal fund rate	Jan 1999 ~ Dec 2007

closely related to the economic situation of each nation, the measure can be seen as indicating how aggressively the central bank executed its policy to achieve its objectives. The average number of changes is 31. Of these, 14 were rate increases and 17 were rate decreases, which suggest an overall expansionary trend during the study period. Brazil, Chile, Hungary, and the Philippines implemented the most frequent rate changes, averaging 53 times during the study period. On the other hand,

Figure 1 Economic Indicators of Major Countries: GDP Growth and Inflation Rates



Croatia, Korea, Russia, and Slovakia implemented the fewest rate changes, only 14 times on average.

Second, the total range of changes was, on average, 16.5% p, of which 5.6% point was an increase and 10.9% point was a decrease. While Brazil, India, Hungary, Poland, and Russia implemented rate changes of 25.0% point or greater, other countries, such as Australia, Croatia, Denmark, the Eurozone, Korea, Sweden, Switzerland, Thailand, and the UK exhibited much smaller ranges of rate changes. In particular, Korea showed the smallest rate change at only 4.75% p, which implies that this country was passive in implementing its monetary policies.

Third, we consider the continuity of the changes to interest rates

Table 2 | Monetary Policy Decision Pattern

	Frequency			Total range			Period (years)			Consecutive change			
	+	-	Total	+	-	Total	Tight	Loose	Switch	++	+-	-+	--
Australia	15	6	21	4	2	6	6.2	0.8	1.8	13	1	2	5
Brazil	19	47	66	16	49.75	65.75	1.3	5	2.1	16	3	3	44
Canada	19	18	37	5	5.75	10.75	4.3	2.2	2.5	16	3	3	15
Chile	21	22	43	8	9.8	17.8	2.4	3.2	3.2	17	3	4	19
Croatia	1	2	3	2	3.4	5.4	0	2.5	1.7	0	1	1	1
Czech	10	24	34	2.5	8.5	11	2.2	4	2.6	7	2	3	22
Denmark	15	9	24	4	3.5	7.5	2.4	2.4	3.6	13	1	2	8
Eurozone	15	8	23	4.25	3.25	7.5	2.4	2.3	3.6	13	1	2	7
Hong Kong	23	16	39	6	6.5	12.5	2.8	2.7	3.4	21	2	2	14
Hungary	12	37	49	9.5	19	28.5	0.9	3	4.7	7	5	5	32
India	15	15	30	13.8	15.05	28.85	1.4	3.6	1.7	11	3	4	12
Korea	10	8	18	2.5	2.25	4.75	2.4	2.1	3.6	7	2	3	6
Norway	19	16	35	5.5	8.25	13.75	2.8	1.9	4.5	16	3	3	13
Philippines	8	45	53	7	15.125	22.125	1	3.9	4.1	6	2	2	43
Poland	11	28	39	8.25	18.75	27	1.7	3.3	3.9	8	2	3	26
Russia	0	17	17	0	50	50	0	8.8	0	0	0	0	17
S. Africa	15	12	27	8.28	9.28	17.56	2.8	2.2	2.9	12	2	3	10
Slovakia	5	14	19	2.25	6.5	8.75	0.6	3.2	3	3	2	2	12
Sweden	16	11	27	4.35	3.75	8.1	3.5	2.8	2.4	13	2	3	9
Switzerland	13	7	20	4.25	3.25	7.5	3.6	1.9	2.1	11	1	2	6
Taiwan	17	17	34	2.255	3.63	5.885	3.2	2.6	3.1	14	2	3	15
Thailand	14	9	23	4.75	3	7.75	1.8	2	3.3	12	2	2	7
U.K.	14	15	29	3.5	4.25	7.75	2.1	2.9	3.9	11	3	3	12
U.S.	23	16	39	6	6.5	12.5	2.8	2.7	3.4	21	2	2	14
Average	14	17	31	5.6	10.9	16.5	2.3	3	3	11.2	2.1	2.6	15.4

controlled by the central banks, which indicates how consistent the rate changes have been. Thus, we define a tightening period as a period of consecutive increase in interest rates, an easing period as a period of continual decrease in interest rates, and a neutral period as the period of switching between increases and decreases in interest rates. During the

period under analysis, the average tightening period was 2.3 years, the average easing period was 3.0 years, and the average neutral period was 3.0 years. Each period accounted for 28%, 36%, and 36% of the period of analysis, respectively.

Australia, Canada, Sweden, and Switzerland had the longest tightening period, while Brazil, the Czech Republic, the Philippines, and Russia had the longest loosening period. We thus can infer that in these nations, interest rate changes were implemented in a relatively long cycle. In contrast, Hungary and Norway had short tightening and loosening periods, implying that policy stances frequently shifted in these countries.

The three measures of patterns of changes in interest rates showed a large difference among countries. Brazil, Chile, Hungary, the Philippines and Russia were far above the average, both in the frequency and the total range of interest rate changes. In contrast, Croatia, Korea, Slovakia, and Switzerland exhibited a narrow range of interest rate changes and a low level of frequency. Developed countries, such as Canada, the Eurozone, the UK, and the US showed moderate and continuous changes in interest rates within a long cycle.

# CHAPTER 3

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## Central Banks' Interest Rates and Financial Market Variables

The monetary transmission mechanism is the process through which monetary policy decisions are transmitted into financial markets and ultimately into changes in real GDP and inflation. Various views are held regarding the emphasis that policies place on financial market prices, such as long-term bond yields, exchange rates and stock prices, and on financial market quantities, such as money supply, bank credit, and the supply of government bonds.

Based on this mechanism of transmission through prices, we examine the effect of short-term interest rates on long-term interest rates, stock prices, and foreign exchange rates.<sup>1</sup> To this end, we construct a Vector Autoregressive (VAR) model as follows:

$$X_t = A(L) X_{t-1}, \quad X_t = [r, k, y, p], \quad (1)$$

where  $r$  is the central bank's policy rate;  $k$  is the long-term interest rate, percentage change of the stock price index and the percentage change of the foreign exchange rate;<sup>2</sup>  $y$  is percentage change of economic activity

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**1** Taylor (1995) also presents the financial market prices framework of the transmission mechanism. He argues that measurement problems have forced econometric modelers away from the quantity of credit and foreign exchange and toward the prices of these items.

**2** Foreign exchange rate represents the value of each country's currency to U.S. dollar. In case of the United States, dollar index, or the value of the US dollar to the basket of major 6 foreign currencies, is used instead.

measures, such as industrial production or retail sales, and  $p$  is the Consumer Price Index (CPI) inflation rate. We use the Akaike information criterion (AIC) to choose an optimal lag for each nation.

Variable ordering in the VAR model is related to model identification. If the policy variable is arranged ahead of the financial and economic variables, then the policy's effect on the economy is prompt, and policy responses to changes in economic conditions are gradual. Sims (1980, 1992) arranged variables related to monetary policy ahead of real economic variables, such as business conditions and inflation, while Bernanke and Blinder (1992), Bernanke and Mihov (1998) identified monetary policy responses to shock by arranging macroeconomic variables ahead of monetary policy indicators. In this study, we use a model based on the assumption that monetary policy response cannot be prompt and that it takes a considerable period for monetary authority to analyze economic conditions and make appropriate decisions.

We then conduct a variance decomposition to measure the degree to which the central banks' short-term interest rates are attributable to variances in the forecast errors of the three major financial variables. The degree of decomposition of variances in forecast errors indicates the amount of information that each variable contributes to the other variables in the VAR model.

We use the ten-year government bond yield as the long-term interest rate. Where the ten-year government bond yield is not available, we consider a lending rate in Brazil, Chile, Croatia, Russia, and Slovakia and a five- or three-year government bond yield in the Czech Republic, Korea, Poland, and Denmark as a long-term rate. Although the quarterly GDP is widely used as an indicator of the overall status of an economy, we use the monthly industrial production index as an alternative indicator of economic activity because of its data frequency.<sup>3</sup> For Australia, Hong Kong, Russia, and Switzerland, we use the retail sales index as the alternative indicator because the industrial production index is not released monthly in these economies. The consumer price index

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**3** Considering our short sample period, monthly data are preferable to quarterly data to secure a sufficient degree of freedom for a VAR analysis.

(CPI) is used as an indicator to measure inflation for all countries. All data were obtained from Bloomberg and the International Financial Statistics of the International Monetary Fund (IMF).

Table 3 shows the results of the variance decomposition analysis. The contributions of the central banks' interest rates to the variances in the long-term interest rate, the foreign exchange rate, and the stock price average approximately 20% for each of these variables.

First, the effect that changes in a central bank's interest rates have on the long-term interest rate is 21.9 to 23.1% on average, although the effect varies depending on the countries considered. Using a six-month lag, the results show that while Hungary, the Philippines, Slovakia, and Thailand present more than 40%, Canada, Croatia, Eurozone, Norway, Switzerland, Taiwan, and the UK record less than 10%.

Second, the influences of change in the central bank's rates on the foreign exchange rate are 19.4 to 20.6% on average. While changes in the central banks' interest rates show a large effect in countries, such as Australia, the Philippines, Slovakia, Sweden, and Switzerland, the effect was negligible in Brazil, Denmark, Eurozone, Norway, Russia, and Thailand.

Third, as in the other two cases, the influence of changes in the central bank's interest rates on stock prices is slightly below 20% on average. The effect appears to be particularly large in the Czech Republic, India, the Philippines, and South Africa, while the Eurozone and Hungary record the lowest influence.

The comparison of two sample periods, 1999 to 2007 and 1999 to 2011, shows that the effect of policy rate changes is less influential if the sample period includes the global financial crisis. Table 4 reports that the effect that changes in a central bank's interest rates have on the long-term interest rate is 16.5% on average. The changes in the central bank's rates are much less influential in the cases of the foreign exchange rate and the stock market index, ranging from 3% and 9% depending on the lag used. These results seem to be mainly driven from the near-zero interest rate policy and quantitative easing, such as purchasing assets and providing long-term liquidity, implemented by central banks in advanced economies after the global financial crisis.

**Table 3** | Variance Decomposition (1999~2007): A Percentage of Policy Rate Changes Attributable to Variances in the Forecast Errors of Financial Variables

	Long-term interest rate			Foreign exchange rate			Stock price index		
	6m	12m	24m	6m	12m	24m	6m	12m	24m
Australia	10.5	9.3	21.5	31.1	25.2	21.5	16.8	22.1	26.6
Brazil	24.4	16.9	12.7	2.3	1.7	1.7	10.9	9.6	11.5
Canada	4.4	6.9	4.0	22.4	7.8	4.2	8.4	3.3	5.0
Chile	11.7	13.8	7.8	20.9	19.2	13.8	23.5	14.9	8.5
Croatia	9.5	12.2	3.9	12.1	7.9	17.4	5.2	10.6	3.1
Czech	32.4	29.8	37.1	28.1	32.4	28.6	36.3	44.6	47.5
Denmark	19.0	12.3	12.0	9.0	5.9	11.4	10.3	8.8	13.3
Eurozone	0.9	0.4	0.5	3.3	4.7	10.4	0.7	2.1	14.7
Hong Kong	30.6	40.9	51.3	11.0	19.6	35.2	16.9	18.8	27.1
Hungary	61.6	66.5	67.1	11.8	16.7	25.6	0.3	1.2	1.6
India	39.1	19.8	18.2	18.1	21.3	13.7	52.8	36.1	36.2
Korea	24.6	17.6	14.4	15.2	15.5	18.0	27.7	14.7	15.0
Norway	2.8	3.0	9.6	4.9	13.5	12.1	24.7	40.2	32.3
Philippine	45.6	44.1	41.4	58.7	55.9	45.0	49.8	47.9	42.0
Poland	21.4	18.9	14.4	10.6	11.8	14.4	18.8	15.4	20.4
Russia	21.2	18.8	18.1	5.1	4.0	9.6	19.7	17.8	17.6
S. Africa	27.4	33.7	41.9	23.7	28.1	29.1	30.4	35.6	22.8
Slovakia	66.7	70.0	44.8	48.7	39.1	22.6	11.9	13.7	17.8
Sweden	15.5	8.7	12.2	58.7	45.8	39.4	13.5	32.8	28.5
Switzerland	8.4	12.6	22.5	51.5	38.1	32.2	7.6	12.7	16.2
Taiwan	6.8	8.8	15.9	20.6	18.4	18.8	6.4	6.0	10.7
Thailand	46.9	16.9	14.8	0.7	5.6	9.9	4.7	7.8	6.0
U.K.	7.3	10.0	15.2	10.0	8.9	11.1	12.6	12.7	12.2
U.S.	16.2	32.4	26.9	15.1	19.4	26.1	7.1	10.9	26.9
Average	23.1	21.9	22.0	20.6	19.4	19.7	17.4	18.4	19.3



Table 4 | Variance Decomposition (1999~2011): A Percentage of Policy Rate Changes Attributable to Variances in the Forecast Errors of Financial Variables

	Long-term interest rate			Foreign exchange rate			Stock price index		
	6m	12m	24m	6m	12m	24m	6m	12m	24m
Australia	4.8	4.2	4.4	2.7	4.8	8.9	1.2	2.7	5.5
Brazil	46.7	45.3	44.7	4.3	5.6	5.7	10.3	12.8	17.3
Canada	2.7	2.2	2.7	8.8	7.5	7.4	1.6	1.3	1.6
Chile	28.5	24.5	19.4	5.3	19.2	17.1	0.6	6.5	13.8
Croatia	0.8	0.6	0.7	0.8	1.8	4.0	4.7	8.7	12.4
Czech	17.1	21.2	22.7	5.3	5.0	6.0	0.1	1.0	1.8
Denmark	2.5	2.3	1.6	3.6	3.2	3.0	1.0	4.7	7.9
Eurozone	0.8	0.7	0.7	10.9	11.9	10.8	0.4	5.2	15.5
Hong Kong	9.1	21.3	26.9	7.0	10.4	12.7	5.6	11.9	12.7
Hungary	25.7	25.6	25.2	9.4	10.0	12.8	1.3	3.6	5.3
India	17.5	23.0	29.6	2.5	1.4	1.1	0.6	5.3	8.3
Korea	2.7	1.6	3.2	1.3	4.0	11.3	0.6	2.6	4.0
Norway	10.4	16.1	20.5	10.1	7.3	8.1	0.4	8.5	17.2
Philippines	27.0	31.1	32.9	13.4	14.0	13.6	1.5	1.4	1.4
Poland	2.1	7.4	8.3	2.7	2.8	2.3	0.6	0.4	0.4
Russia	20.7	17.2	14.9	4.6	4.0	7.2	8.7	11.1	9.2
S. Africa	4.0	4.5	7.6	0.0	0.0	1.7	2.0	8.6	9.7
Slovakia	84.2	74.2	63.3	0.9	0.9	2.3	9.6	9.4	8.1
Sweden	4.0	3.5	4.5	7.2	6.8	15.8	0.9	6.9	20.2
Switzerland	2.7	4.8	8.2	5.9	5.4	8.3	0.5	4.3	11.6
Taiwan	9.7	14.0	19.6	11.7	11.6	15.1	6.2	6.4	11.0
Thailand	7.5	6.3	6.0	11.6	14.2	15.5	0.7	1.6	3.4
U.K.	11.3	11.3	10.2	5.1	3.7	5.1	0.6	2.0	4.7
U.S.	22.4	44.5	49.0	20.7	21.9	37.4	22.0	29.4	33.3
Average	15.2	17.0	17.8	6.5	7.4	9.7	3.4	6.5	9.9

## CHAPTER 4

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### Association of the Pattern of a Central Bank's Rate Changes and Its Contribution to Forecast Error Variance of Financial Market Variables

In this section, we explore whether the pattern of change in a central bank's interest rates affects the effectiveness of the transmission mechanism of monetary policy.

Figure 2 shows the univariate regression results of percentages of policy rate changes attributable to variances in the forecast errors of financial variables in a six-month lag against the pattern of monetary policy decisions. It appears that the width and frequency of a central bank's changes to rates increase its contribution to information explaining the movement of long-term bond yields in the transmission mechanism of monetary policy. However, more frequent and greater changes in policy rates show a negative impact on the contribution of the policy rate to variances in stock prices and foreign exchange rates, although the relationships do not appear to be significant.

We construct a regression model with the dependent variable of the variance decomposition results to explain the effect of the central bank's changes to interest rates on the volatility of long-term interest rates, foreign exchange rates, and stock prices. Our major explanatory variables are the three different measures of the patterns of change in interest rates: the number of interest rate changes, the total range of changes, and the proportion of consecutive rate hikes and cuts. The regression model is as follows:

Figure 2 | Univariate Regression of a Percentage of Policy Rate Changes Attributable to Variances in the Forecast Errors of Financial Variables (the Long-term Interest Rate, the Foreign Exchange Rate, and the Stock Market Index) in a Six-month Lag Against the Pattern of Monetary Policy Decisions ( $X$  Is the Total Range of Policy Rate Changes, and  $Y$  Is the Total Number of Changes)

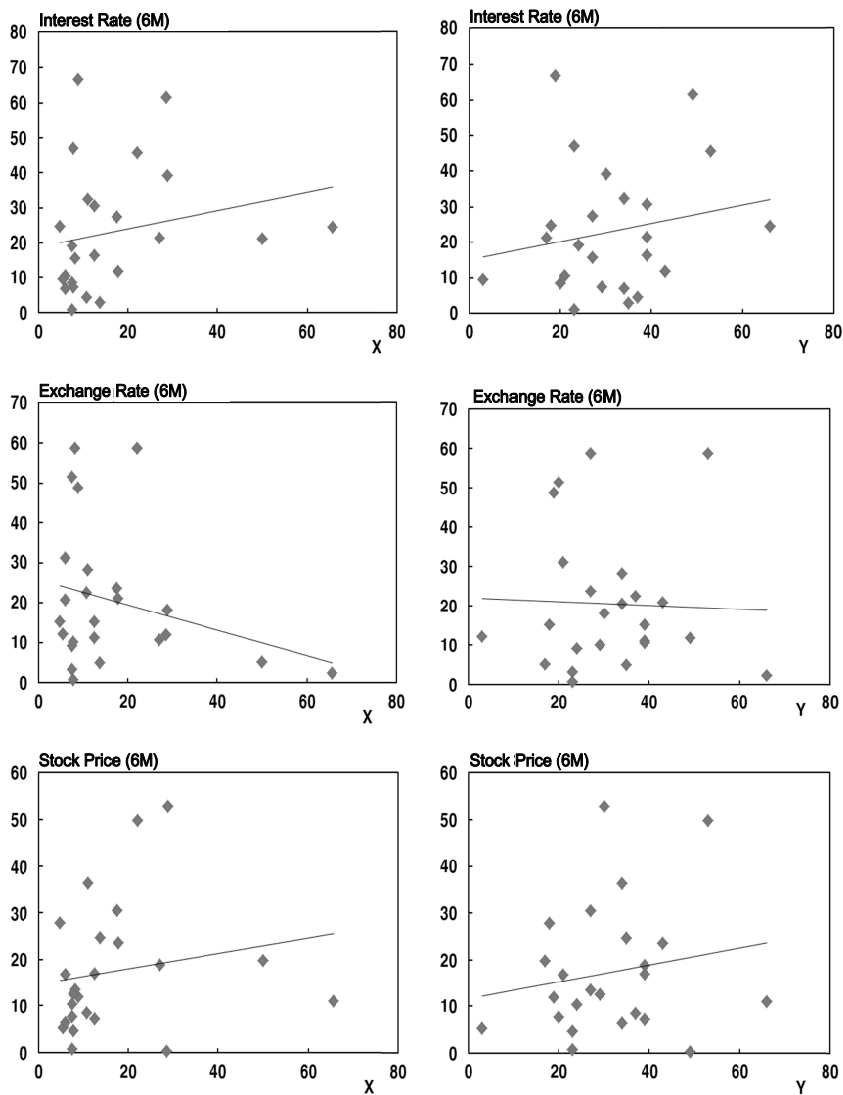


Table 5 | Regression of the Percentage of Policy Rate Changes Attributable to the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern (1999~2007)

	Long-term interest rate			Foreign exchange rate			Stock price index		
	6m	12m	24m	6m	12m	24m	6m	12m	24m
<i>C</i>	15.08 (0.57)	10.00 (0.40)	-3.35 (-0.14)	2.78 (0.11)	-0.12 (-0.01)	8.83 (0.55)	5.82 (0.26)	5.49 (0.25)	-11.14 (-0.60)
<i>X</i>	-0.27 (-0.73)	-0.55 (-1.54)	-0.52 (-1.51)	-0.80** (-2.16)	-0.73** (-2.50)	-0.56** (-2.44)	-0.08 (-0.26)	-0.22 (-0.70)	-0.27 (-1.01)
<i>Y</i>	0.24 (0.69)	0.44 (1.32)	0.44 (1.33)	0.19 (0.54)	0.29 (1.07)	0.24 (1.12)	0.12 (0.41)	0.11 (0.39)	0.09 (0.35)
$\frac{Y_{uu}}{Y}$	-24.76 (-0.69)	-29.02 (-0.85)	-1.52 (-0.05)	7.38 (0.21)	6.40 (0.23)	1.37 (0.06)	-1.05 (-0.03)	3.69 (0.12)	30.22 (1.18)
$\frac{Y_{dd}}{Y}$	29.89 (0.73)	-29.02 (-0.85)	45.17 (1.20)	48.29 (1.21)	43.37 (1.37)	25.99 (1.05)	20.47 (0.60)	24.92 (0.73)	45.82 (1.59)

Notes: *C* is constant; *X* is the total range of policy rate changes; *Y* is the total number of changes;  $Y_{uu}$  is the frequency of consecutive rate hike;  $Y_{dd}$  is the frequency of consecutive rate cut. t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

$$Z = \beta_0 + \beta_1 X + \beta_2 Y + \beta_3 Y_{uu}/Y + \beta_4 Y_{dd}/Y + \varepsilon \quad (2)$$

where *Z* is the effect of the central bank's changes to interest rates on the variance of long-term interest rates, foreign exchange rates, and stock prices; *X* is the total range of policy rate changes; *Y* is the total number of changes;  $Y_{uu}$  is the frequency of consecutive rate hikes;  $Y_{dd}$  is the frequency of consecutive rate cuts; and  $\varepsilon$  is the error term.

The results of these regressions are provided in Table 5. In most cases, the pattern of changes in the central bank's interest rates does not affect statistically significantly its contribution to the variance in financial variables. However, we find that the total range of changes in policy rates appears to be more important than the number of changes in association with variance in the financial variables. In particular, we find that the coefficients of the total range of changes in the foreign exchange rate are from -0.56 to -0.80, which is statistically significant at the 5% level.

Another analysis based on the sample period including the global

**Table 6 | Regression of the Percentage of Policy Rate Changes Attributable to the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern (1999~2011)**

	Long-term interest rate			Foreign exchange rate			Stock price index		
	6m	12m	24m	6m	12m	24m	6m	12m	24m
<i>C</i>	-7.47 (-0.34)	-10.38 (-0.49)	-9.83 (-0.49)	-0.77 (-0.13)	1.06 (0.16)	2.56 (0.27)	-0.26 (-0.04)	3.68 (0.45)	9.86 (1.02)
<i>X</i>	0.17 (0.56)	0.06 (0.21)	0.03 (0.12)	-0.16* (-2.02)	-0.17* (-1.87)	-0.18 (-1.33)	0.10 (1.05)	0.15 (1.30)	0.13 (0.99)
<i>Y</i>	0.00 (-0.01)	0.13 (0.37)	0.19 (0.60)	0.18* (2.02)	0.27** (2.64)	0.22 (1.45)	-0.08 (-0.77)	-0.10 (-0.79)	-0.05 (-0.33)
$\frac{Y_{UU}}{Y}$	-12.34 (-0.35)	-7.15 (-0.21)	-3.64 (-0.11)	3.06 (0.33)	2.07 (0.20)	8.46 (0.56)	3.78 (0.35)	8.64 (0.66)	12.10 (0.79)
$\frac{Y_{dd}}{Y}$	49.26 (1.39)	48.5 (1.42)	41.7 (1.29)	3.84 (0.41)	-4.81 (-0.47)	-2.84 (-0.19)	7.80 (0.72)	1.88 (0.14)	-10.76 (-0.69)

*Notes:* *C* is constant; *X* is the total range of policy rate changes; *Y* is the total number of changes;  $Y_{uu}$  is the frequency of consecutive rate hike;  $Y_{dd}$  is the frequency of consecutive rate cut. t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

financial crisis shows that most variables are insignificant, which is similar to the results of the analysis that did not include the global financial crisis. As shown in Table 6, the coefficients of the total range of changes in the foreign exchange rate are smaller than those in the case of pre-crisis sample. This result suggests that the unconventional monetary policy measures, such as quantitative easing, make market participants less sensitive to the range of changes in policy rates.

Now, we test whether institutional characteristics are associated with the financial market responses to the monetary policy pattern. This additional analysis is required because the differing factors of each country determine the effectiveness of the country's monetary policy, such as the monetary policy framework, the foreign exchange policy, and the financial depth. Table 7 shows the various institutional aspects of each country. We include these explanatory variables to determine whether the results in the previous section are robust and whether the variables affect the volatility of the financial variables. First, we add a dummy variable indicating that a country utilizes an inflation-targeting

Table 7 | Monetary Policy Framework, Foreign Exchange Regime and Financial Depth

	Monetary policy regime	Exchange rate regime	Financial depth
Australia	Inflation targeting	Floating rate	1.24
Brazil	Inflation targeting	Floating rate	1.07
Canada	Inflation targeting	Floating rate	0.77
Chile	Inflation targeting	Floating rate	1.77
Croatia	Others	Managed floating rate	0.85
Czech	Inflation targeting	Managed floating rate	0.55
Denmark	Exchange rate targeting	pegged	0.48
Eurozone	Others	Floating rate	1.57
Hong Kong	Exchange rate targeting	Currency board	1.39
Hungary	Inflation targeting	Pegged	0.59
India	Others	Managed floating rate	0.57
Korea	Inflation targeting	Floating rate	0.85
Norway	Inflation targeting	Floating rate	0.79
Philippines	Inflation targeting	Floating rate	0.53
Poland	Inflation targeting	Floating rate	0.39
Russia	Others	Managed floating rate	0.26
S. Africa	Inflation targeting	Floating rate	0.51
Slovakia	Inflation targeting	Pegged	1.72
Sweden	Inflation targeting	Floating rate	1.06
Switzerland	Inflation targeting	Floating rate	1.75
Taiwan	Money targeting	Floating rate	1.29
Thailand	Inflation targeting	Managed floating rate	1.5
U.K.	Inflation targeting	Floating rate	2.17
U.S.	Others	Floating rate	1.56

Notes: "Others" means multiple or no explicit targeting regime. Financial depth is defined as total credit/GDP.

monetary policy. We also add another dummy variable indicating that a country employs a floating exchange rate system. Finally, we use the ratio of domestic credit to the GDP as a proxy variable indicating each country's degree of financial market development. The regression model is as follows:

$$Z = \beta_0 + \beta_1 X + \beta_2 Y + \beta_3 Y_{uu} / Y + \beta_4 Y_{dd} / Y + MR + FR + FD + \varepsilon, \quad (3)$$

**Table 8** | Regression of the Percentage of Policy Rate Changes Attributable to the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern, and Institutional Aspects, Such as the Monetary Policy Framework, the Foreign Exchange Regime and Financial Depth

	Long-term interest rate			Foreign exchange rate			Stock price index		
	6m	12m	24m	6m	12m	24m	6m	12m	24m
<i>C</i>	40.19 (1.62)	35.80 (1.68)	22.72 (0.97)	-4.48 (-0.15)	-2.87 (-0.12)	13.66 (0.71)	5.85 (0.25)	4.66 (0.20)	-10.71 (-0.52)
<i>X</i>	0.03 (0.08)	-0.24 (-0.84)	-0.29 (-0.92)	-0.68 (-1.71)	-0.67* (-2.06)	-0.55* (-2.11)	-0.25 (-0.77)	-0.35 (-1.13)	-0.42 (-1.50)
<i>Y</i>	0.00 (0.00)	0.24 (0.86)	0.27 (0.90)	0.02 (0.04)	0.19 (0.61)	0.23 (0.92)	0.19 (0.63)	0.13 (0.45)	0.18 (0.67)
$\frac{Y_{UU}}{Y}$	-22.36 (-0.72)	-30.43 (-1.15)	0.22 (0.01)	10.31 (0.28)	9.49 (0.32)	3.21 (0.13)	7.02 (0.24)	12.93 (0.46)	35.15 (1.38)
$\frac{Y_{dd}}{Y}$	14.73 (0.42)	23.86 (0.80)	31.18 (0.95)	47.88 (1.16)	42.26 (1.27)	23.59 (0.87)	20.77 (0.63)	24.53 (0.77)	46.75 (1.63)
<i>MR</i>	10.5 (1.50)	6.02 (1.00)	5.75 (0.87)	11.52 (1.39)	7.63 (1.14)	0.94 (0.17)	1.41 (0.21)	4.84 (0.76)	-1.77 (-0.31)
<i>FR</i>	-26.79** (-3.16)	-29.36** (-4.05)	-24.87** (-3.12)	1.55 (0.15)	0.88 (0.11)	-2.35 (-0.36)	10.43 (1.31)	10.18 (1.31)	8.07 (1.16)
<i>FD</i>	-0.86 (-0.13)	2.97 (0.52)	-1.89 (-0.30)	0.86 (0.11)	-1.30 (-0.20)	-2.68 (-0.52)	-11.54* (-1.84)	-11.82* (-1.95)	-8.17 (-1.49)

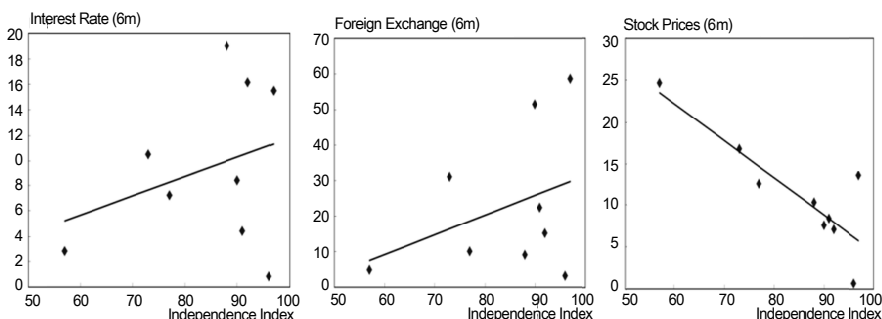
*Notes:* *C* is constant; *X* is the total range of policy rate changes; *Y* is the total number of changes;  $Y_{uu}$  is the frequency of consecutive rate hike;  $Y_{dd}$  is the frequency of consecutive rate cut. *MR* is equal to 1 if a country has an inflation-targeting monetary scheme and zero otherwise; *FR* is equal to 1 if a country has a floating exchange rate scheme and zero otherwise; *FD* is financial depth measured by total credit divided by GDP. t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

where *MR* is equal to 1 if a country has an inflation-targeting monetary scheme and zero otherwise; *FR* is equal to 1 if a country has a floating exchange rate scheme and zero otherwise; *FD* is financial depth measured by total credit divided by GDP; all other variables are the same as in the regression equation (2).

Table 8 summarizes the estimation results. After controlling for the different institutional aspects of each country, we find that the results are not significantly different from the results discussed in the previous section. We find that the floating exchange rate scheme reduces the

|| Figure 3 || Univariate Regression of a Percentage of Policy Rate Changes Attributable to Variances in the Forecast Errors of Financial Variables (the Long-term Interest Rate, the Foreign Exchange Rate, and the Stock Market Index) in a Six-month Lag Against the Central Bank Independence Index



contribution of central bank's target interest rate to the forecast error variance of the market interest rate (coefficients are  $-24.87 \sim -29.36$  depending on the lag used).

We also consider incorporating a central bank independence index into our analysis. However, the indices produced by Alesina and Summers (1993), Fry *et al.* (2000) and Carlstrom and Fuerst (2009) do not match the countries in our sample. Therefore, we use a univariate regression analysis of only 9 countries (Australia, Canada, Denmark, ECB, Norway, Sweden, Switzerland, the UK, and the US). As Figure 3 illustrates, central bank independence shows an overall positive effect on the effectiveness of the transmission mechanism through long term interest rate and foreign exchange rate. However, there is no such effect on the channel of the stock price index. These results imply that financial markets pay more attention to an independent central bank and reflect information about the central bank's benchmark interest rate in their pricing in the bond and foreign exchange markets.



## CHAPTER 5

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### Association of the Pattern of a Central Bank's Rate Changes and the Movement of the Financial Market Variables

The results of the cross-sectional analysis of 24 countries show that the pattern of policy rate changes has more influence on exchange rates than on long-term interest rates or stock prices. This may be due to the higher volatility of the exchange rate than that of interest rates and stock prices. Furthermore, the co-movement characteristics of exchange rates are not as strong as interest rates or stock prices are among different countries. The cross-sectional analysis of different countries is good method for investigating the effect of different patterns of changes in policy rates on the monetary policy transmission mechanism.

Table 9 shows the results of pooled regression without controlling for the characteristics of each country. We obtain variables in policy rate patterns, such as the range and frequency of changes, during each year. The range of target interest rate changes has significant effects on exchange rates and stock prices, while the frequency of the changes significantly affects long-term interest rates, after controlling for business conditions and inflation.

However, because each country has its own characteristics, the data from different countries are not homogenous. Therefore, the pooled regression may be inappropriate to analyze the effects of the pattern of changes to policy rates.

Therefore, we now conduct a panel analysis considering random or

**Table 9 | Pooled Regression of the Movement of Each Financial Variable Against the Monetary Policy Decision Pattern and Major Economic Indicators**

	Long-term interest rate		foreign exchange rate		Stock price index	
<i>C</i>	3.95	(0.95)	-1.63	(-0.86)	7.74	(2.30)
$\Delta IP$	0.15	(0.37)	-0.57**	(-3.06)	2.55**	(7.68)
$\pi$	0.31	(1.26)	1.15**	(10.24)	-0.38*	(-1.90)
<i>X</i>	1.14	(1.64)	0.78**	(2.47)	1.64**	(2.91)
<i>Y</i>	2.06**	(2.25)	-0.48	(-1.15)	-1.00	(-1.36)

*Notes:* A decrease (increase) in foreign exchange rate indicates the appreciation (depreciation) of the currency; *C* is constant;  $\Delta IP$  is the rate of change of economic activity measure, such as industrial production and retail sales;  $\pi$  is Consumer Price Index (CPI) inflation rate; *X* is the total range of policy rate changes; *Y* is the total number of changes; t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

fixed effect. The panel analysis is desirable method because variables related to policy rate patterns are included in the model, and we can use data from different countries. In this section, we estimate a regression equation by using panel data, and we investigate the effect that policy rate patterns have on the level and volatility of the financial variable. We also estimate impulse responses from the VAR analysis, and we determine whether the effect of the pattern of policy rates on financial variables is relevant to economic theory.

We estimate a regression model by using panel data to examine the effects of the pattern of policy rates on the volatility of long-term interest rates, exchange rates, and stock prices. We use changes in interest rates and the year-to-year changes in foreign exchange rates and stock prices. The regression model is as follows:

$$SD(R) = \beta_0 + \beta_1 \Delta IP + \beta_2 \pi + \beta_3 X + \beta_4 Y \quad (4)$$

where  $SD(R)$  is the standard deviation of the interest rate, foreign exchange rate, and stock price;  $\Delta IP$  is the rate of change of economic activity, such as industrial production and retail sales;  $\pi$  is the CPI inflation rate; *X* is the total range of policy rate changes; *Y* is the total number of changes

We estimate the effects of random and fixed regression considering the unique characteristics of each country. Using the results of the

Table 10 | Hausman Test

Hausman Test	Long-term interest rate		Foreign exchange rate		Stock price index	
$\chi^2$ statistics (p-value)	3.25	(0.52)	5.59	(0.23)	36.36	(0.00)

Table 11 | Random or Fixed Effect Regressions of the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern

	Standard deviation of long-term interest rate		Standard deviation of foreign exchange rate		Standard deviation of stock price index	
<i>C</i>	0.63	(1.97)	3.43	(1.63)	564.09	(4.35)
$\Delta IP$	-0.01	(-0.52)	0.12	(1.12)	15.92	(1.14)
$\pi$	0.03**	(3.80)	0.03	(0.48)	0.02	(0.00)
<i>X</i>	0.28**	(14.67)	0.09	(0.64)	-31.85*	(-1.71)
<i>Y</i>	-0.09**	(-3.37)	-0.08	(-0.41)	12.81	(0.49)

Notes: Random effect models are used in estimating the equations of the long-term interest rate and foreign exchange rate while fixed effect models are used in that of the stock price index; *C* is constant;  $\Delta IP$  is the rate of change of economic activity measure, such as industrial production and retail sales;  $\pi$  is Consumer Price Index (CPI) inflation rate; *X* is the total range of policy rate changes; *Y* is the total number of changes; t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

Hausman test shown in Table 10, we estimate the equation (4) using either random or fixed effect regression. Random effect models are used in estimating the equations of the long-term interest rate and foreign exchange rate while fixed effect models are used in that of the stock price index.

Table 11 shows the results of estimation. We find that the policy rate pattern has a significant relation to the volatility of interest rates, but no significant effect on the volatility of stock prices and exchange rates. As the range increases and the number of policy rate changes decreases, the volatility of long-term interest rates increases. The large range and small number of policy rate changes indicates wide changes in the central bank's policy rates. The volatility of long-term interest rates increase when changes to the central bank's policy are aggressive. In other words, gradual adjustment (i.e., the baby-step strategy; small and frequent

**Table 12** Random or Fixed Effect Regressions of the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern Including Consecutive Policy Rate Changes

	Standard deviations of long term interest rate		Standard deviations of foreign exchange rate		Standard deviations of stock price index	
<i>C</i>	0.64	(1.88)	3.02	(1.46)	557.91	(4.08)
$\Delta IP$	-0.01	(-0.38)	0.22*	(1.93)	26.55*	(1.78)
$\pi$	0.03**	(3.76)	0.06	(0.95)	3.44	(0.45)
<i>X</i>	0.28**	(14.27)	0.03	(0.23)	-39.25**	(-2.11)
<i>Y</i>	-0.12	(-1.45)	0.07	(0.13)	-50.03	(-0.65)
$Y_{uu}$	0.02	(0.24)	-0.51	(-0.85)	22.39	(0.29)
$Y_{dd}$	0.03	(0.40)	0.07	(0.12)	93.51	(1.22)

*Notes:* Random effect models are used in estimating the equations of the long-term interest rate and foreign exchange rate while fixed effect models are used in that of the stock price index; *C* is constant;  $\Delta IP$  is the rate of change of economic activity measure, such as industrial production and retail sales;  $\pi$  is Consumer Price Index (CPI) inflation rate; *X* is the total range of policy rate changes; *Y* is the total number of changes;  $Y_{uu}$  is the frequency of consecutive rate hike;  $Y_{dd}$  is the frequency of consecutive rate cut. t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

changes) is more desirable than aggressive adjustment to policy rates to minimize the volatility of interest rates. The results of the regression analysis, including variables of the persistence of policy rates and consecutive changes in policy rates are shown in Table 12.

We also add the variables of institutional factors that were used in the above section to check the robustness of equation. The regression model is as follows:

$$SD(R) = \beta_0 + \beta_1 \Delta IP + \beta_2 \pi + \beta_3 X + \beta_4 Y + MR + FR + FD + GPC + Gini + Adv \quad (5)$$

where *R* is the interest rate, the rate of change in the foreign exchange rate, and the stock price; *SD(R)* is the standard deviation of the interest rate, foreign exchange rate, and stock price;  $\Delta IP$  is the rate of change in economic activity measure, such as industrial production and retail sales;  $\pi$  is the CPI inflation rate; *X* is the total range of changes in policy rate; *Y* is the total number of changes; *GPC* is GDP per capita;

**Table 13** Random or Fixed Effect Regressions of the Volatility of Each Financial Variable Against the Monetary Policy Decision Pattern, Institutional Aspects Such as the Monetary Policy Framework, the Foreign Exchange Regime, Financial Depth, GDP Per Capita, GINI Coefficient and Whether the Country is Classified as the Developed Countries

	Standard deviation of long-term interest rate		Standard deviation of foreign exchange rate		Standard deviation of stock price index	
<i>C</i>	-1.52	(-0.88)	1.54	(0.12)	-98.57	(-0.26)
$\Delta IP$	-0.01	(-0.54)	0.18	(1.61)	6.73	(0.47)
$\pi$	0.03**	(3.70)	0.03	(0.51)	-0.45	(-0.06)
<i>X</i>	0.28**	(14.31)	0.05	(0.38)	-26.77	(-1.45)
<i>Y</i>	-0.09**	(-3.39)	-0.08	(-0.39)	8.82	(0.34)
<i>MR</i>	0.31	(0.44)	5.08	(1.00)	..	..
<i>FR</i>	0.12	(0.13)	-2.06	(-0.32)	..	..
<i>FD</i>	-0.17	(-0.48)	2.53	(0.99)	-210.71	(-0.61)
<i>GPC</i>	0.00	(-0.13)	0.00*	(-2.40)	0.04**	(2.27)
<i>Gini</i>	0.06	(1.57)	0.08	(0.30)	..	..
<i>Adv</i>	-0.06	(-0.07)	2.86	(0.49)	..	..

*Notes:* Random effect models are used in estimating the equations of the long-term interest rate and foreign exchange rate while fixed effect models are used in that of the stock price index; *C* is constant;  $\Delta IP$  is the rate of change of economic activity measure, such as industrial production and retail sales;  $\pi$  is Consumer Price Index (CPI) inflation rate; *X* is the total range of policy rate changes; *Y* is the total number of changes; *GPC* is GDP per capita; *Gini* is the Gini coefficient; *Adv* is whether the country is classified as the developed countries. t-values are in parentheses.

\* significant at a 10% level, \*\* significant at a 5% level

*Gini* is the Gini coefficient; *Adv* indicates whether the country is classified as advanced countries.<sup>4</sup>

The results of the regression are summarized in Table 13. We find that neither the range nor the frequency showed significant effects on the volatility of exchange rates and stock prices, whereas the range shows significant effects on the volatility of long-term interest rates.

<sup>4</sup> We include Gini coefficients as an explanatory variable in in the regression equations (5). The more equal an economy is, the more people can participate in the financial markets. Thus, financial markets may respond more to shocks or events.

These results are similar to those of equation (4). The results support that the estimation of equation (4) is a good indicator for the effects of the patterns of changes in policy rates on the movement and volatility of financial variables, which are important factors in the policy transmission mechanism, considering the unique factors of each country.<sup>5</sup>

We also confirmed that the results of the panel regression were relevant to macroeconomic theory by using panel data to estimate the impulse response from the VAR model. The VAR model is as follows:

$$X_t = A(L)X_{t-1}, X_t = [r, k, y, p] \quad (6)$$

where  $r$  is the range and frequency of changes in central bank's policy rate;  $k$  is the long-term interest rate, percentage change of the stock price index and the percentage change of the foreign exchange rate;  $y$  is percentage change of economic activity measures, such as industrial production or retail sales, and  $p$  is the Consumer Price Index (CPI) inflation rate.

Table 14 presents the results of the impulse response to the long-term interest rate, the foreign exchange rate, and the stock price to the range and frequency of changes in policy rates. Interest rates and currency value increased and stock prices decreased in response to the increase in the range and frequency of policy rate hikes. Interest rates decreased in response to the range and frequency of policy rate cuts. Currency value decreased but stock prices increased in response to the frequency of policy rate cuts, whereas currency value increased and stock prices decreased in response to the shock caused by the range of interest rate cuts. The responses to the tightening shock were relevant to macroeconomic theory. The frequency of tightening shock was more relevant than the range of policy change shock was.

While the responses of financial variables to pattern changes generally coincided with economic theory, the responses of stock prices

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**5** We confirmed the robustness of the regression by replacing variables of business conditions, such as industrial production and retail sales, with the GDP. The results of estimating equations (4)–(5) using GDP are remain similar to the results using industrial production or retail sales.

**Table 14** | Impulse Response of Each Financial Market Variable to the Range and Frequency of Policy Rate Changes

Total	Long-term interest rate		Foreign exchange rate		Stock price index	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
Range of increase	0.42	0.37	-0.74	-0.63	-2.00	0.03
Range of decrease	-0.52	-0.52	-0.10	-0.08	-0.24	0.09
Frequency of increase	0.16	0.21	-0.32	-0.18	-1.69	-0.74
Frequency of decrease	-0.34	-0.37	0.14	0.08	0.52	0.05

*Notes:* Impulse response to the 1 unit shock of the range and frequency of policy rate changes

and exchange rate to expansionary shock were not relevant to economic theory. These results suggest that tightening shock is more consistent than expansionary shock is.<sup>6</sup>

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**6** We checked the robustness by replacing industrial production and retail sales with GDP. The impulse responses from the model including the GDP are similar to the previous results.

# CHAPTER 6

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## Conclusion

Although business cycles and inflation show strong co-movement among major advanced and emerging countries, our results show strong diversity in the patterns of changes to policy rates. This study analyzes data from 24 nations to determine whether different patterns of changes in the benchmark interest rates of central banks are associated with their contributions to variances in the forecast errors in the long-term interest rate, the foreign exchange rate, and the stock market index. We do not find robust results showing an association of these patterns with the financial market aspect of the transmission mechanism of monetary policy. However, the results indicate that the total range of changes is more important than the frequency of changes in information affecting the financial variables.

In the cross sectional analysis, the sample is small, and it is difficult to control for the unique characteristics of each country. Considering the limitations of the above analysis, we use a panel analysis. We annualize monthly data to obtain variables of policy rate patterns, such as the range and frequency of changes. The results of the panel analysis show that the range and frequency of changes in policy rates are significantly related to the volatility of long-term interest rates, while there is no significant relation to stock prices and exchange rates. The results indicate that the baby-step strategy (small and frequent changes) is more effective than aggressive changes are in minimizing the volatility of long-term interest rates.

The analysis of impulse responses using VAR model find that the



range and frequency of changes in policy rates are generally relevant to conventional economic concepts. This result indicates that the variables in the patterns of changes in policy rates are rational. The empirical results show that the pattern of changes in policy rates, such as range and frequency, has influential effects on important financial variables in the monetary policy transmission mechanism. Therefore, an economic theory that includes the behavior of central banks and the patterns of changes in policy rates warrants further development.

Monetary policy is the endogenous response of the central bank to developments in the economy. In a certain sense, good policy would involve no exogenous shocks. So how am I to interpret the VAR results? Are these really shocks, or (more likely) are these movements of the central bank in response to some variables that are not in the VAR? But then, is monetary policy leading to the forecast variance, or is the underlying missing variable leading to the forecast error? Questions like these make it more difficult to understand why "the number of changes" or "the range of changes" should affect the variance decomposition at all. To address these questions successfully, an empirical model should incorporate policy reaction function, persistence of the economic shocks and policy rate change, financial and economic structure, and any other underlying factors. To resolve the endogeneity problem, an instrumental variable approach is desirable using variables that affect central bank's rate change pattern, but does not affect unexpected shocks to financial market variables. This further investigation remains for the future research.

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