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Influences of the Fed's Monetary Normalization Policy on Emerging Stock Markets

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ABSTRACT

This paper investigates the impact of the Fed's monetary normalization policy on emerging stock market performances. Our findings demonstrate emerging markets were significantly negatively affected shortly after the U.S. rate hikes, market panic increases, and commodity price decreases. We also find the declines in stock market returns were larger for emerging countries with low financial openness, high country-specific risks and long-term trade deficits than for other countries when the Fed raised rates. In terms of geographical locations, Asian stock markets demonstrated their growth momentum over a long period, while Latin American economies, dependent heavily on commodity trades, underwent stagnation and recession during the QE tapering. On the other hand, our results show that the increase in U.S. real output had negative spillovers to emerging stock market performance, potentially due to more funds from these countries flowing into the U.S. market.

JEL Classification: E52, F42

Keywords: QE tapering, emerging stock markets, financial openness, country-specific risk, trade deficit

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I. INTRODUCTION

The global financial crisis in 2008, triggered by U.S. Subprime Mortgage Crisis, brought about a plummet of stock markets and the collapse of industries. In response of such systematic risks, the Federal Reserve System (the Fed) gradually cut policy rates from 5.25% to a range of 0-0.25% since September 2007, which led the U.S. financial market to a zero lower bound (ZLB) environment. Moreover, the Fed also adopted quantitative easing (QE) policy by releasing funds through purchasing bonds in large quantities to stimulate the market in late 2008. Later, the QE policy was implemented for three times until late 2014. These policies encouraged market participants to invest their money in the stock market. Additionally, the decrease in long-term interest rates reduced funding costs, boosting the productivity of businesses and improving their profitability. Consequently, there was a significant enhancement in the market's willingness to invest, leading the U.S. economy into a virtuous cycle after the crisis. Many studies have found that the stimulating effect of the U.S. QE policy also spilled over to other countries, as evidenced by the improvement in the global economic outlook and the large inflow of funds released by QE into foreign markets, particularly emerging countries with growth potential. However, the Fed began implementing a series of normalization measures, including reducing bond purchases, raising interest rates, and shrinking the balance sheet, in view of the improving job market and stable economic growth. The intention was to reduce the intervention of monetary policy in the market and reserve policy space for the next economic downturn. Although it was generally believed that prolonged abnormal monetary policies might distort the market and create bubbles, the normalization of monetary policy would also cool down the financial market. Emerging economies, especially, were considered to be the most severely affected. In light of these, our study aims to investigate the impact of QE tapering on stock market trends in various countries. We will examine both developed and emerging economies to verify whether emerging countries are affected more severely compared to developed economies. Furthermore, we will classify emerging countries based on their characteristics in order to understand if countries with different features are impacted differently.

Regarding improvements in employment and economic conditions, Ben Bernanke, the Fed's incumbent chairman, stated for the first time on May 22nd, 2013 that the Fed might reduce bond purchases, which led to Taper Tantrum in global financial markets. On June 19th, 2013, Bernanke delivered a public and formal speech on tapering. These declarations marked a new era for the financial market, attracting researchers analyzing their effects. Afterwards, in December, the Federal Open Market Committee (FOMC) declared that the exit mechanism of QE policy would begin to be executed in 2014 by decreasing the total purchasing amount of 85 billion per month to 75 billion, followed by cut-back purchases of 5 billion agency MBS and long-term bonds per month, marking the end of QE3. The detail process of QE tapering policy is presented in Appendix Table A1.

In September 2014, when QE3 came to an end, the FOMC declared its "Policy Normalization Principles and Plans", revealing that the Fed would achieve the goal of normalization by gradually increasing the range of Federal funds rate and reducing holding security amounts. The purpose of these plans was to reserve available margins of stimulus policies for potential recessions, and to avoid the Fed's huge balances, which might cause distortions of financial markets, such as soaring inflation and market bubbles.

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In mid-2015, the market began to expect the Fed would raise interest rates in September, as the U.S. economy had greatly improved in recent years. However, affected by Chinese economy slowdowns and global stock market crashes in August, the Fed decided to suspend its plan of rate hikes in September. Until December, the FOMC finally decided to increase rates after the meeting, which was the first hike since December 2008. In late 2016, as the U.S. economy continued to strengthen and political uncertainties caused by the presidential election were eliminated in November, the Fed started to raise interest rates gradually. Since then, the federal funds rate had been lifted to 2.25-2.5% by the end of 2018. Appendix Table A2 provides a summary of the detailed interest rate hike policy process. Furthermore, Appendix Figure A1 demonstrates that the trend of the federal funds rate and the average U.S. lending rate tends to be consistently aligned overall.

In June 2017, in the context of the U.S. economy development and the increase of federal funds rate, the Fed planned to shrink its balance sheet. Starting in October, the Fed would gradually decrease the reinvestment of securities at maturity to reduce the Fed's balance of assets. In March 2019, however, due to the slowdown of Chinese and European economic growth, weak business investments and inflation in the U.S., the Fed postponed its plan to raise interest rates and to shrink the balance sheet. In September, the Fed further announced the termination of the shrinking process. The detail process schedule of the Fed's shrinkage of its balance sheet is shown in Appendix Table A3.

Figure 1 illustrates the total assets held by the Fed's System Open Market Account (SOMA) since November 25th, 2008. The Fed's implementation of QE policies, including QE1, QE2, and QE3, resulted in the release of 1.75, 0.6, and 1.63 trillion U.S. dollars respectively. These policies led to a significant increase in the Fed's assets, rising from 1.9 trillion in early 2009 to 4.5 trillion in late 2014. The majority of these assets consisted of government debts, accounting for 54.6%, followed by agency mortgage-backed securities (MBS) at 38.7%, and agency debts at 0.9%. Figure 2 shows the U.S. monetary base experienced a sharp increase from 1.5 trillion in early 2009 to 4 trillion in late 2014, with the most significant increase observed during QE3. However, the Fed's balance sheet began to shrink in October 2017, causing a decrease in assets to around 4 trillion by the end of 2018. During this period, government debts remained the largest portion at 55%, followed by agency MBS at 40.2% and agency debts at 0.1%. The U.S. monetary base also decreased to 3.4 trillion. Facing the tightening of monetary policy, market participants were increasingly worried about the potential cooling down of financial markets, especially in emerging countries. In our research, we investigate the impacts of the Fed's monetary normalization policy on emerging stock markets. We analyze monthly data from January 2009 to June 2017, aiming to derive insights from the Fed's previous Monetary Normalization Policy cycle. Our focus is to understand the shocks experienced by the stock markets of various countries, especially in emerging economies, due to interest rate hikes and QE tapering. We intend for these insights to serve as policy references, hoping they will aid in better managing the effects of the Fed's new cycle of rate hikes and tightening policies in the current post-COVID financial landscape. Our study also includes developed countries as the control group to determine if emerging economies were more adversely affected than developed ones when QE policy exited. Specifically, we classify emerging countries by their characteristics to explore whether various types of countries reacted differently. During QE tapering, as global financial markets were also affected by European Sovereign Debt Crisis, U.S.

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Debt Ceiling Crisis, U.S. economic conditions and oil price fluctuations, we incorporate relevant explanatory variables such as VIX index, U.S. industrial production index and commodity price index into our models. Our empirical results indicate that as the U.S. monetary policy normalized, financial conditions gradually tightened and funds were withdrawn from foreign markets. Consequently, stock markets in both developed and emerging countries went through declines. The decline in emerging stock markets was particularly pronounced compared to developed markets during the U.S. rate hikes, especially for emerging countries characterized by lower degrees of financial openness, higher country-specific risk, and long-term trade deficits. When market panics surged, emerging economies in Russia, Turkey, South Africa and Latin America, whose economic and financial systems were fragile, were most severely affected. We also find that the increase in commodity prices boosted the stock market performance of most countries, particularly for the emerging countries that heavily rely on commodity trade. However, the increase in U.S. real output had no incentivizing effects on foreign stock market performance, which might be due to foreign capital flowing into the U.S. market, thus weakening the momentum of emerging stock markets.

The structure of our article is as follows: Section 2 presents the review of related literature and the contribution of our paper. Section 3 introduces data and variables used in our research. Section 4 presents the methodology. Section 5 discusses our empirical results. Finally, section 6 concludes the paper.

Figure 1
Total Assets on the Fed's System Open Market Account

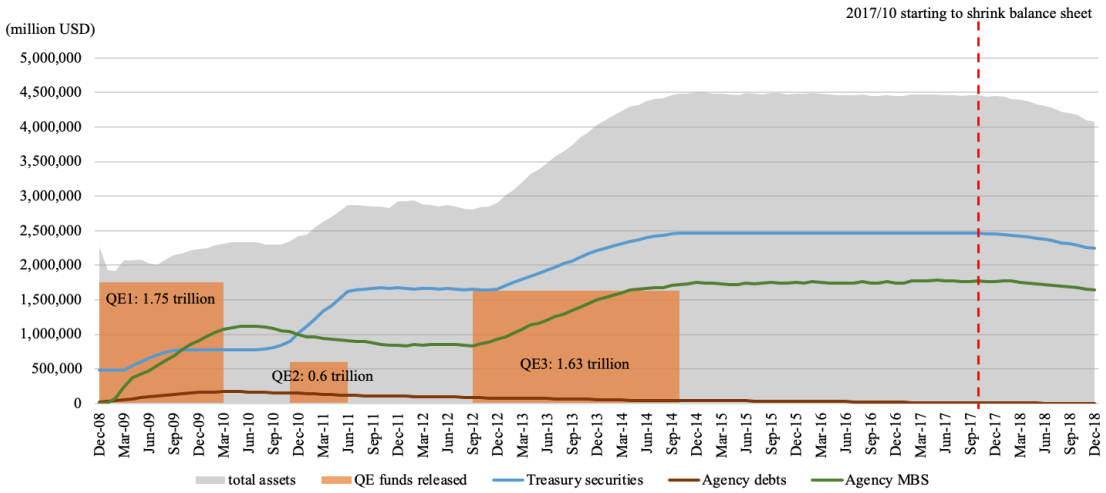

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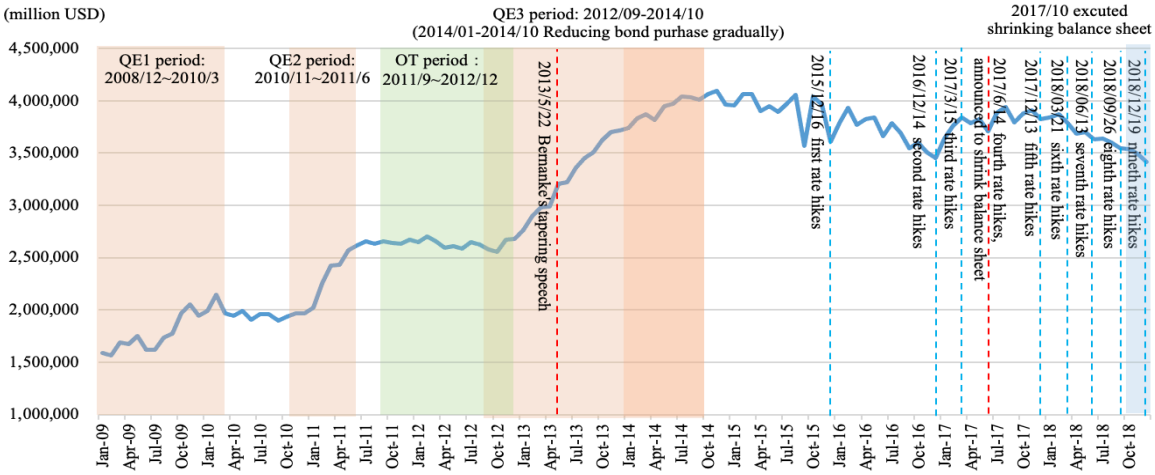
Figure 2
Historical Trends of the U.S. Monetary Base



II. LITERATURE REVIEW AND CONTRIBUTION

A. Literature Review

Since 2008, the U.S. QE policy has greatly changed the market structure and investor behavior, particularly impacting the markets of emerging countries. During the QE period, the hot money inflows were controversial in both academia and among practitioners. They might initially increase real output and stimulate economic growth. However, they could also raise concerns about potential price bubbles in the financial market. For example, Tillmann (2013) believes QE capital had significant positive impacts on emerging countries' economies, but Terhune (2016) finds bubble in bond market after huge capital injections by the Fed.

The QE environment lasted for approximately seven years until Chairman Bernanke announced the tapering policy in 2013. This announcement marked a significant milestone for global financial markets. Terhune (2016) proposes market participants were actually aware that asset prices would finally revise down to their fundamental values in pace of the Fed's tapering based on rational expectation hypothesis. Sahay (2014) addresses the highly correlations between the Fed's monetary policy statements, asset prices and capital flows of emerging markets, as evidenced by Bernanke's announcement about QE tapering in 2013. These statements initially had severe and widespread effects on all emerging economies, but characteristics of each country tended to drive those effects to differentiate in the following periods.

Recent studies bring more perspectives about influences of QE tapering. Antonakakis et al. (2013) conclude an increase of implied volatilities and policy uncertainties lowered stock market returns significantly. Estrada et al. (2015) find stock markets of nearly all emerging economies suffered adverse effects due to QE tapering. Armelius et al. (2020) highlight the importance of central bank policy statements, summarizing a central bank's declarations could cause cross-border contagion and affect foreign countries' policy rates as well as economic conditions. Furthermore, they prove

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that the U.S. Fed is widely perceived to have the most external impact or externalities on the global economy, while the European Central Bank (ECB) is often regarded as the most sensitive to the policies of other central banks.

Following the announcement of the tapering policy, the Federal Reserve additionally declared its intention to implement a gradual rate hike strategy as a means to stabilize the domestic economic conditions. Suryanarayanan (2015) conducts research to infer and quantify the potential impact of interest rate hikes on the return on assets. In a separate study, Iacoviello and Navarro (2019) examine the responses of 50 countries to rate hikes. They find that the contractions experienced by developed countries were strongly correlated with their trade exposure to the United States and exchange rate regimes. In contrast, the reactions of emerging countries were associated with their "vulnerability index," including the factors such as current account balances, foreign exchange reserves, inflation, and foreign debts.

B. Contribution of Our Paper

Similar to Iacoviello and Navarro (2019), we also demonstrate that emerging stock markets experienced more declines during the period of U.S. rate hikes, and countries with fragile economic structures were particularly vulnerable to the impact of these rate hikes. However, we contribute to the current literature by adding the following key points, which provides policy references for emerging countries.

Firstly, Iacoviello and Navarro (2019) conclude that the market openness degree did not significantly impact emerging countries' response to U.S. rate hikes, However, our results indicate that stock markets with higher openness were more resilient to negative shocks from U.S. rate hikes. While a more open market is generally susceptible to external shocks in the global economy, it offers several advantages, including reduced restrictions on cross-border capital flow, lowered transaction and financing costs, and enhanced efficiency of financial activities. Furthermore, a highly open market empowers residents to better cope with income fluctuations and effectively mitigate associated risks. Therefore, based on our findings, we propose that emerging countries can better respond to U.S. normalization policies by gradually and prudently opening their financial markets to the world.

Secondly, unlike Iacoviello and Navarro (2019), we identify some distinct regional characteristics in our empirical results by categorizing our sample countries geographically and making comparisons. Specifically, we observe that stock markets in Latin American emerging countries and Russia were particularly more affected by U.S. rate hikes and risk events. In contrast, we find that the stock markets in Asian emerging economies were less negatively impacted by these external shocks. This difference can be attributed to the heavy reliance of Latin American emerging countries and Russia on commodities or energy, which heightened their vulnerability and sensitivity to market fluctuations. Therefore, we recommend that emerging countries, particularly those with unbalanced economic structures and fragile economies, focus on diversifying their economies, strengthening their economic systems, and enhancing financial market mechanisms to safeguard national economic security.

Lastly, we extend the analysis of Iacoviello and Navarro (2019) by examining the impact of additional external shocks, including risk events, U.S. real output, and commodity prices. Contrary to our expectations, we find that an increase in U.S. real

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output levels led to declines in the stock markets of emerging countries. We speculate that this might be attributed to the increased attractiveness of the U.S. market, resulting in the flow of funds from other countries into the U.S. stock market.

III. DATA AND VARIABLES

Our research incorporates data of 17 emerging countries as the target, consisting of 15 countries[1] listed in Chari et al. (2016), as well as Taiwan and China in accordance with MSCI classification. Geographically, we categorize Taiwan, China, South Korea, India, Indonesia, Malaysia, the Philippines, and Thailand as Asian emerging economies, and Mexico, Colombia, Brazil, Peru, Chile, and Argentina as Latin American emerging economies. Additionally, Russia, Turkey, and South Africa are included as key representatives of global emerging countries, labeled as "other regions" in our sample. Furthermore, our sample also considers 5 developed economies as the control group, including Japan, Germany, France, which are listed by Chari et al. (2016), and also Singapore and Hong Kong[2], based on the MSCI index classification. In total, 22 foreign countries are included to explore the impacts of the Fed's normalization policy on stock market performances.

For our analysis, we select and analyze data from the QE tapering period, spanning January 2009 to June 2017, aiming to provide references and policy guidance regarding the impact of the Fed's interest rate hike on the global financial market in the post-COVID era. In addition, we use the monthly stock index data as our dependent variable, which can be accessed via Datastream.

Regarding the target explanatory variables, we choose the U.S. lending rate to reflect the Fed's monetary policy changes. We use U.S. lending rate data published by the IMF, which represents the benchmark interest rate for short-term corporate loans announced by 25 major chartered commercial banks in the United States. To capture additional factors that may account for changes in stock market returns during QE tapering, we follow Alder et al. (2015) by including three other explanatory variables: VIX (CBOE Volatility Index) to capture the market fear gauge when risk events occur, USIPI (U.S. Industrial Production Index) to consider U.S. real output level, and COMMP (Commodity Price Index) to account for the nominal price changes of commodities. The data for the explanatory variables are summarized in Table 1.

Table 1
Description of Explanatory Variables

Variables		Descriptions	Sources
Target Explanatory Variable	USLR, U.S. lending rate	Reflecting U.S. monetary policy	Bloomberg
Other Explanatory Variables	USVIX, CBOE volatility index	Capturing market panics in face of risk events	Datastream
	USIPI, U.S. industrial production index	Capturing U.S. real output levels	Datastream
	COMMP, commodity price index	Capturing effects of commodities' nominal prices fluctuations	IMF WEO database

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IV. METHODOLOGY

A. VAR and Panel VAR

Traditional linear regression models implicitly assume a clear causal relationship between the independent and dependent variables. Specifically, the independent variable is assumed to be unaffected by the dependent variable, while the dependent variable is affected by the independent variable. However, given the complex causal relations among numerous macroeconomic factors, it would be challenging to definitively classify variables as endogenous or exogenous. Therefore, we believe that the Vector Autoregression model proposed by Sims (1980), which treats all variables as endogenous, is better suited for exploring the causal relationship between multivariate sequences in comprehensive economic research. Our research adopts both the Panel Vector Autoregression (Panel VAR) model and Vector Autoregression (VAR) model to measure the effects of QE tapering on various stock markets. The VAR is a multivariate time series model, considering all variables as endogenous and allows for feedbacks between variables within the system. Compared to univariate models, the VAR is more flexible and systematic, making it widely applied in finance and economics. The model considers the linear relationships between the target variable, its lag observations and other variables in the system. A typical VAR(p) model with k variables and p-order autocorrelations can be written as:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + e_t, \mathrm{t} \in \{1,2,\ldots,\mathrm{T}\} \quad (1)$$

where Y_t denotes a ($k\times1$) vector of endogenous variables, A_p are ($k\times k$) coefficient matrices of endogenous variables; C stands for the ($k\times1$) constant vector, and e_t is the error term representing an ($k\times1$) zero mean white noise vector process. Moreover, e_t meets the following conditions: $\mathrm{E}(e_t) = 0$, $\mathrm{E}(e_t e_t') = \Sigma$ and $\mathrm{E}(e_t e_s') = 0$.

Since the VAR model is designed for general time series data, it is not applicable to panel data that includes both time series and cross-sectional data. In order to capture the causal relationship between different variables in panel data, the Panel VAR model developed by Holtz-Eakin et al. (1988) has gained popularity. The Panel VAR model enables the analysis of the dynamic and causal relationships between variables in both the vertical (time series) and horizontal (cross-sectional) dimensions. Like VAR, Panel VAR considers all variables as endogenous and interdependent in the system. However, the model assumes sectoral homogeneity, meaning that the Panel VAR measures the "average" effects across endogenous heterogeneous groups. To account for the existence of heterogeneity among groups, a fixed effect term capturing idiosyncrasies across variables is added. Generally, a Panel VAR model with k variables and p-order autocorrelations could be written as:

$$Y_{i,t} = C + A_1 Y_{i,t-1} + A_2 Y_{i,t-2} + \cdots + A_p Y_{i,t-p} + \gamma_i + e_{i,t}, \quad \mathrm{i} \in \{1,2,\ldots,\mathrm{N}\}, \mathrm{t} \in \{1,2,\ldots,\mathrm{T}\} \quad (2)$$

where γ_i denotes as a ($k\times1$) vector of fixed effect terms, while others are the same as VAR(p).

Similar to VAR, the data of variables should be checked for stationarity before

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incorporating in Panel VAR. To do this, we use the Augmented Dickey-Fuller (ADF) Test to determine if a unit root exists in a time series sample. The more negative the ADF statistic, the stronger the rejection of the hypothesis that a unit root (non-stationarity) exists at some level of confidence. Moreover, we use Moment and Model Selection Criteria (MMSC) proposed by Andrews and Lu (2001) to determine the optimal lag length for endogenous variables. Finally, we select Panel VAR of order 1 (Panel VAR (1)) to measure effects of QE tapering on different countries, and the equation is written as:

$$\begin{pmatrix} USIPI_t \\ USLR_t \\ USVIX_t \\ COMMP_t \\ R_{i,t} \end{pmatrix} = \begin{pmatrix} c_{USIPI} \\ c_{USLR} \\ c_{USVIX} \\ c_{COMMP} \\ c_R \end{pmatrix} + \begin{pmatrix} \alpha_{USIPI,1} & \alpha_{USIPI,2} & \alpha_{USIPI,3} & \alpha_{USIPI,4} & \alpha_{USIPI,5} \\ \alpha_{USLR,1} & \alpha_{USLR,2} & \alpha_{USLR,3} & \alpha_{USLR,4} & \alpha_{USLR,5} \\ \alpha_{USVIX,1} & \alpha_{USVIX,2} & \alpha_{USVIX,3} & \alpha_{USVIX,4} & \alpha_{USVIX,5} \\ \alpha_{COMMP,1} & \alpha_{COMMP,2} & \alpha_{COMMP,3} & \alpha_{COMMP,4} & \alpha_{COMMP,5} \\ \alpha_{R,1} & \alpha_{R,2} & \alpha_{R,3} & \alpha_{R,4} & \alpha_{R,5} \end{pmatrix} \begin{pmatrix} USIPI_{t-1} \\ USLR_{t-1} \\ USVIX_{t-1} \\ COMMP_{t-1} \\ R_{i,t-1} \end{pmatrix} + \begin{pmatrix} \gamma_{USIPI} \\ \gamma_{USLR} \\ \gamma_{USVIX} \\ \gamma_{COMMP} \\ \gamma_R \end{pmatrix} + \begin{pmatrix} \varepsilon_{USIPI} \\ \varepsilon_{USLR} \\ \varepsilon_{USVIX} \\ \varepsilon_{COMMP} \\ \varepsilon_R \end{pmatrix} \quad (3)$$

where *t* is the time point, *i* stands for a specific country; $USIPI_t$ denotes the changes of the U.S. Industrial Production Index at time *t*; $USLR_t$ is the changes of the U.S. lending rate, representing the U.S. monetary policy's change; $USVIX_t$ stands for the changes of Chicago Board Options Exchange's (CBOE) Volatility Index; $COMMP_t$ denotes the growth rate of the commodity price index; and $R_{i,t}$ represents country *i*'s stock market index returns, calculated as the difference of natural logarithm of stock indexes.

The Panel VAR model implicitly assumes homogeneity in the data structure across different categories. However, in reality, there exists heterogeneity between categories. To account for this heterogeneity, a fixed effect term, γ_i, needs to be included, allowing for the presence of heterogeneity across categories. In our study, the fixed effect term represents unobserved heterogeneity across countries. However, due to the inclusion of lagged variables such as $USVIX_t$, $COMMP_t$, and $R_{i,t}$ with different values depending on the target country, correlation issues arise with the country fixed effect items. Therefore, we refer to Love and Zicchino (2006) and adopt the "Helmert procedure" proposed by Arellano and Bover (1995) to transform these endogenous variables. The transformation formula is as follows:

$$u_{i,t}^H = \sqrt{\frac{T-t}{T-t+1}}\left(u_{i,t} - \frac{1}{T-t}\sum_{n=t+1}^{T} u_{i,n}\right) \quad (4)$$

where $u_{i,t}$ stands for the predetermined variable, and $u_{i,t}^H$ is the variable transformed by Helmert procedure; *t* is the current time point, while *T* is the terminal time point of the sample.

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This transformation preserves the orthogonality between lagged terms and transformed variables, ensuring that deviations resulting from existing correlations do not affect the process of coefficient estimation.

B. Impulse Response Function

When an endogenous variable in a VAR model experiences a shock, we can use the Impulse Response Function to estimate the effects on all other endogenous variables in the system. This function provides information about the dynamics of VAR or Panel VAR. To derive the formula for the Impulse Response Function, we transform VAR (1) model into its moving average form:

$$Y_{i,t} = C + A\,Y_{i,t-1} + e_{i,t} \tag{5}$$

Then, lag operator L is defined such that $L\,Y_{i,t} = Y_{i,t-1}$ and $L^2\,Y_{i,t} = Y_{i,t-2}$:

$$Y_{i,t}(1 - A\,L) = C + e_{i,t} \tag{6}$$

When both sides divided by $(1 - A\,L)$, we derive:

$$Y_{i,t} = \frac{C}{(1-A\,L)} + \frac{e_{i,t}}{(1-A\,L)} \tag{7}$$

Next, when VAR (1) is expressed as its vector moving average form VMA (∞), we derive the result of its impulse response function:

$$Y_{i,t} = \mu + \sum_{j=0}^{\infty} \Psi_j \varepsilon_{t-j} \tag{8}$$

where μ represents a (k×1) vector of k variables' mean; ε_{t-j} a (k×1) vector of error terms at time *t-j*, which can be regarded as unexpected shocks or changes; In addition, by differentiating equation (8), we derive $\frac{\partial Y_{i,t}}{\partial \varepsilon_{t-j}} = \Psi_j$, representing effects of market shocks at time *t-j* on the explanatory variables at time *t*.

However, since the standardized VAR model is a reduced model, $e_{i,t}$ in formulas (1) and (2) does not represent the actual error or shock generated by the original structural economic model in period *t*. Therefore, additional assumptions on the error term are required to identify the shock generated in period *t* of the original structural economic model. In the seminal research by Sims (1980), it is recommended to use Cholesky decomposition to make assumptions about the relative endogenous and exogenous variables. This involves ranking all variables in a VAR system from the most exogenous to the most endogenous. The impact generated by the *k*-th variable in the original structural model can be inferred through this method, thus measuring the impulse response of each variable. In our study, the Cholesky ordering result for equation (3) is:

$$\{USIPI, USLR, USVIX, COMMP, R\}$$

The Cholesky ordering assumes $R_{i,t}$ is the most endogenous variable, meaning

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that $R_{i,t}$ will respond to the impulse of other variables in the same period. The earlier variables in the ordering have less significant effects on R in the same period. Overall, this assumes that R, COMMP and USVIX will respond to changes in USIPI and USLR in the current period, but USIPI and USLR would only respond in the lagged periods after R, COMMP and USVIX have been impacted. Additionally, we apply Monte Carlo simulations to estimate the Impulse Response Function by simulating 500 scenarios randomly and derive confidence intervals at the 95% significance level.

C. Sample Classification

Homogeneity is assumed in Panel VAR, for which the model only estimates the "average" effects of shocks across countries. However, in reality, countries with various features tend to react differently to shocks. Thus, we divide the sample countries into different groups to examine how characteristics would affect their reactions to shocks. Table 2 reports the features we use to classify the countries and classification results[3].

a. Level of Development. This is one of the most common standards to measure a country's progress, based on a country's development indicators including GDP, industrialization degree and incomes per capita. Panel A of Table 2 shows that our sample includes the 17 emerging and 5 developed countries (excluding the U.S.).
b. Geographic Location. This characteristic provides an initial basis to identify features associated with a country's region. Panel B of Table 2 presents the classification results. In our research, we categorize only the 17 emerging countries by geographical location. The 5 developed countries are included as a control group and are not further classified.
c. Financial Openness and Integration. This feature is measured by a country's capital account openness, reflecting its connection to the global economy, as concluded by Quinn et al. (2011). Ahmed et al. (2017) utilize the domestic equity market capitalization to GDP ratio in their model as an indicator of an emerging country's financial development and degree of openness. In our research, we employ this metric to evaluate the level of market openness in various countries. We categorize the 5 nations among all the 17 emerging countries, whose ratio remain above the median during the QE period from January 2009 to April 2013, as "high-degree." Conversely, the 5 countries with ratios below the median are classified as "low-degree." Our classification results are displayed in Panel C of Table 2.
d. Country-specific Risk. Miyakoshi et al. (2017) argue that the interest rate spread between the U.S. and the specific country is crucial to the transmission of monetary policies. A country with a higher spread implies greater risks for investment. In our study, among all the emerging countries, the 6 nations that maintain their spread above the median during the QE period are categorized as "high-risk", while the 7 countries with their spread below the median are categorized as "low-risk." Panel D of Table 2 shows the results.
e. Economic Prospect. Sachs (1982) stresses that an economy's current account balance is influenced by both the current economic environment and future economic trends. For emerging countries, the current account balance is a key indicator as it involves aspects such as foreign exchange reserves, debt levels,

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inflows of investment, and export capacity. A sustained current account surplus is often seen as a positive signal of economic stability and growth, while a continuous deficit may indicate potential economic issues. Therefore, we measure a country's economic prospect by its current account balance. In this research, among all emerging countries, the 6 nations maintaining a current account surplus throughout the QE period are categorized as "excellent", while the 7 countries with a persistent current account deficit are classified as "poor". Panel E of Table 2 displays the classification results.

V. EMPIRICAL ANALYSIS

A. Monetary Policy Shocks

We first explore global stock market returns' responses to U.S. monetary policy shock. Based on the sample classifications in Section 4, we build models for countries with different characteristics and derive their impulse response functions to U.S. monetary policy. The following impulse response graphs refer to the short-term and long-term responses of stock market returns to a standard deviation (0.28) increase of U.S. Lending Rate (USLR in the figures).

Table 2
Sample Classifications by Different Criteria

Group	Countries
Panel A: Classification of all countries by level of development	
Developed	Japan, Germany, France, Singapore, Hong Kong.
Emerging	Taiwan, China, South Korea, India, Indonesia, Malaysia, the Philippines, Thailand, Mexico, Colombia, Brazil, Peru, Chile, Argentina, Russia, Turkey, South Africa.
Panel B: Classification of emerging countries by geographic locations	
Asian	Taiwan, China, South Korea, India, Indonesia, Malaysia, the Philippines, Thailand.
Latin American	Mexico, Colombia, Brazil, Peru, Argentina, Chile.
Other	Russia, Turkey, South Africa.
Panel C: Results of high and low degree of financial openness for emerging countries	
High-degree	Taiwan, South Korea, Malaysia, Chile, South Africa.
Low-degree	China, Indonesia, Argentina, Mexico, Turkey.
Panel D: Results of high and low risk levels for emerging countries	
High-risk	China, Indonesia, Argentina, Brazil, Russia, South Africa.
Low-risk	Taiwan, South Korea, Thailand, Malaysia, the Philippines, Chile, Peru.
Panel E: Results of excellent and poor economic prospect for emerging countries	
Excellent prospect	Taiwan, China, South Korea, Malaysia, the Philippines, Russia.
Poor prospect	India, Colombia, Mexico, Brazil, Peru, Turkey, South Africa.

Note: In Panel A, we categorize all 22 countries in our sample based on their level of development, dividing them into 17 emerging countries and 5 developed countries. The developed countries serve as the control group for the research. In Panel B, we further divide the 17 emerging countries based on their geographic locations. Panel C classifies these emerging countries based on the ratio of their stock market capitalization to GDP during the QE period (from January 2009 to April 2013). Here, 5 countries consistently above the median are categorized as "high-degree", while those 5 below the median are categorized as "low-degree". In Panel D, 6 emerging countries, whose spreads remained above the median during the QE period, are grouped as "high-risk", while the 7 countries below the median are grouped as "low-risk". Finally, Panel E uses the current account balance to measure the economic prospect of each country. During the QE period, 6 emerging countries with a continuous current account surplus are categorized as "excellent prospect", while the 7 countries with a continuous deficit are categorized as "poor prospect".

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1. Level of Development

Developed countries possess more stable economic systems and lower market risks, while emerging economies develop rapidly and become attractive to investors after financial crisis. Since these two groups are extremely different in terms of economies, policies and funds, their respective stock market returns to the U.S. QE tapering should also be diverse. As Table 3 shows, emerging markets had more significant and larger negative responses to the rise of U.S. interest rates than developed countries, especially in Latin American countries. Moreover, the negative responses were most severe in the current period for all countries and gradually decreased thereafter.

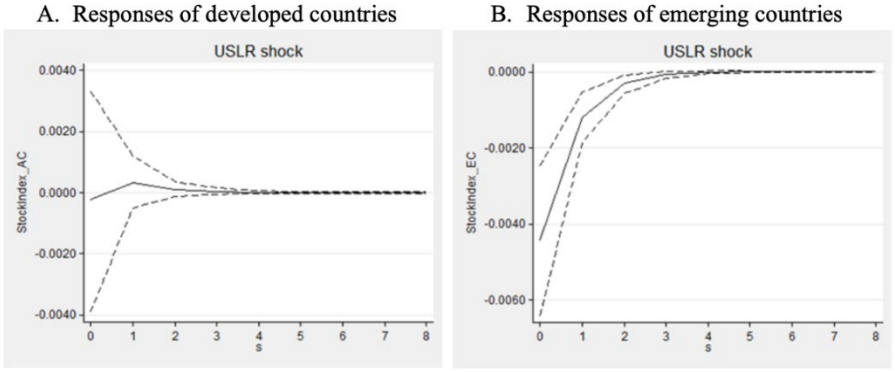
Figure 3 shows that only emerging markets experienced a significant decline in response to U.S. rate hikes. This implies that when the Fed raised interest rates, the previously released hot money from QE returned. This led to a tightening of the global financial environment, resulting in U.S. and other countries' investors reducing their holdings of equity positions in emerging countries.

Table 3
Stock Returns Responses to U.S. Monetary Policy of Different Development Levels Countries

Groups	Response Period		
	t = 0	t = 1	t = 2
Developed Countries	-0.0002	0.0003	0.0001
Emerging Countries	-0.0044*	-0.0012*	-0.0003*
Asian	-0.0026*	-0.0006	-0.0001
Latin American	-0.0064*	-0.0021*	-0.0007*
Other	-0.0053	-0.0012	-0.0002

Note: * represents significant statistically at 5% level.

Figure 3
Impulse Responses of Stock Returns to the U.S. Monetary Policy



Graph A and B show the responses of developed and emerging countries respectively

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2. Financial Openness and Integration

In general, the degree of a country's financial openness to the world positively correlates to its sensitivity to market events. A country with a higher degree would be more vulnerable to risk events, but might also have access to liquidity, thereby reducing risks associated with such shocks. Table 4 proves that countries with both high and low degree of financial openness experienced significant stock market drops during U.S. rate hikes, but the low-degree countries had larger declines. Moreover, the effects were only significant during the current period.

Figure 4 show that economies with lower financial openness were more affected. Market openness can be regarded as an indicator of liquidity risk. Countries with lower financial openness may indeed encounter more liquidity restrictions in their financial markets. As a result, when external risk events arise, liquidity risk and transaction costs tend to escalate, making it challenging for investors to quickly liquidate their assets. This situation intensifies investor panic, amplifying the effects further. Furthermore, increased liquidity risks contribute to higher market risks in a tight market environment, particularly for countries with lower openness. Consequently, compared to countries with higher financial openness, stock markets with lower financial openness are more susceptible to sharp declines. Therefore, while the U.S. raised rates, emerging stock markets with a low degree of openness fell more deeply.

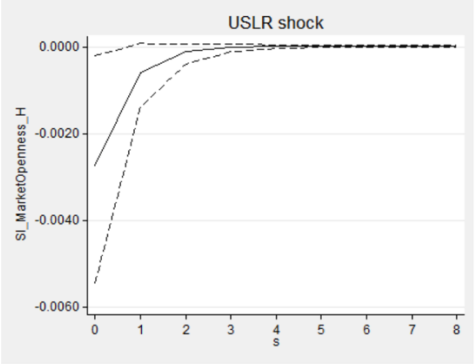
Table 4
Stock Returns Responses to U.S. Monetary Policy of Different Financial Openness Degree Countries

Groups	Response Period		
	t=0	t=1	t=2
High-degree	-0.0027*	-0.0006	-0.0001
Low-degree	-0.0054*	-0.0012	-0.0002

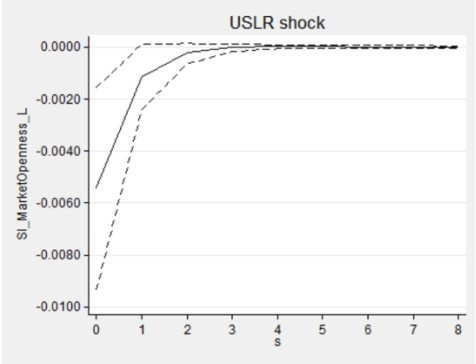
Note: Only emerging countries are classified here; * represents significant statistically at 5% level.

Figure 4
Impulse Responses of Stock Returns to the U.S. Monetary Policy

A. Responses of high degree of financial openness countries



B. Responses of low degree of financial openness countries



Graph A and B show the responses of high and low degree of financial openness countries respectively

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3. Country-specific Risk

Country-specific risk is measured through the spread, computed by the policy rate difference between a country and the United States. As we mentioned above, riskier countries tend to provide higher interest rates to attract foreign funds. Also, changes in the spread would lead to fluctuations in asset values. As Table 5 shows, both high-risk and low-risk countries had significant stock market declines during U.S. rate hikes in the current period and one month later, but high-risk countries experienced larger declines.

Figure 5 show that as the U.S. lending rate grew by a standard deviation, high-spread markets would suffer more significantly than low-spread markets. This result demonstrates that when the U.S. launches a tightening monetary policy, investors tend to cut back positions in high-risk emerging markets.

Table 5

Stock Returns Responses to U.S. Monetary Policy of Different Country-specific Risk Levels

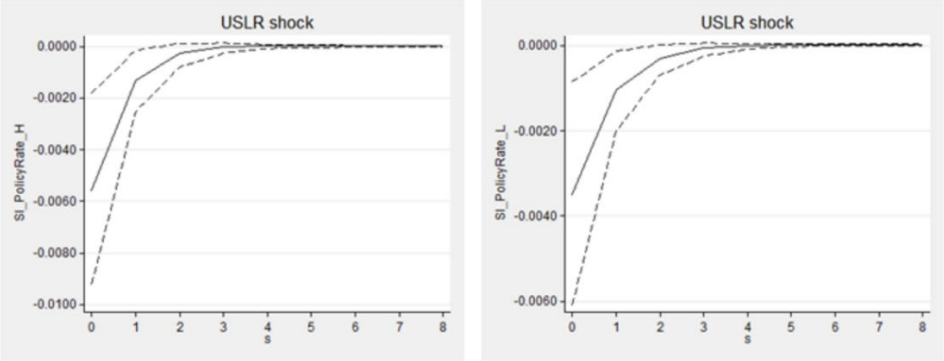
Groups	Response Period		
	t = 0	t = 1	t = 2
High-risk	-0.0056*	-0.0013*	-0.0003
Low-risk	-0.0035*	-0.0011*	-0.0003

Note: Only emerging countries are classified here; * represents significant statistically at 5% level.

Figure 5

Impulse Responses of Stock Returns to the U.S. Monetary Policy

A. Responses of high spread countries B. Responses of low spread countries



Graph A and B show the responses of high and low spread countries respectively.

4. Economic Prospect

Investors' willingness to invest positively correlates with a country's economic prospects, which is usually determined by its past economic performance. We use the current account balance as the measure for a country's economic prospect. A country with a long-term surplus of current account balance means not only promising economic prospects but also being a net creditor (negative capital account) to other countries, while a long-term deficit of current account balance implies weak productivity and a net debtor (positive capital account) to others. Table 6 shows that when the U.S. raised rates, countries with poor prospects experienced declines significantly in their stock market

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return in the current period, as well as one and two months ahead, with the largest slumps in the current period. The U.S. rate hikes also had adverse impacts on excellent-prospect stock markets, but not significant.

Figure 6 reflects stock market returns of deficit countries dropped nearly 3 times as much as those of surplus countries, proving that a net debtor country is unattractive to investors.

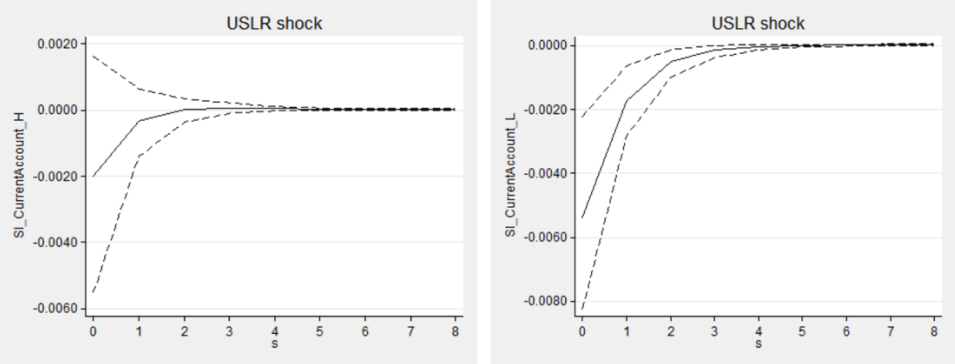
Table 6
Stock Returns Responses to U.S. Monetary Policy of Different Economic Prospect Countries

Groups	Response Period		
	t = 0	t = 1	t = 2
Excellent Prospect	-0.0020	-0.0003	0.0000
Poor Prospect	-0.0054*	-0.0017*	-0.0005*

Note: Only emerging countries are classified here; * represents significant statistically at 5% level.

Figure 6
Impulse Responses of Stock Returns to the U.S. Monetary Policy

A. Responses of trade surplus countries B. Responses of trade deficit countries



Graph A and B show the responses of excellent and poor economic prospect countries respectively.

B. Other Shocks

In addition to presenting the impulse response to USLR, we also construct impulse response functions of the VIX index, the U.S. industrial production index and the commodity price index on stock market returns.

1. Risk Event Shocks

Risk events directly impact investors' behavior. Most unexpected events, such as European Sovereign Debt crisis, 311 Earthquake in Japan, U.S. Debt Ceiling Crisis and the Brexit referendum, would cause the VIX to rise sharply. Table 7 shows the stock market responses in current and lagged periods to a one-standard deviation (7.53) increase of VIX.

Figure 7 shows that both developed and emerging stock markets went through immediate and significant downturns, and the response lasted for 2 or 3 months after

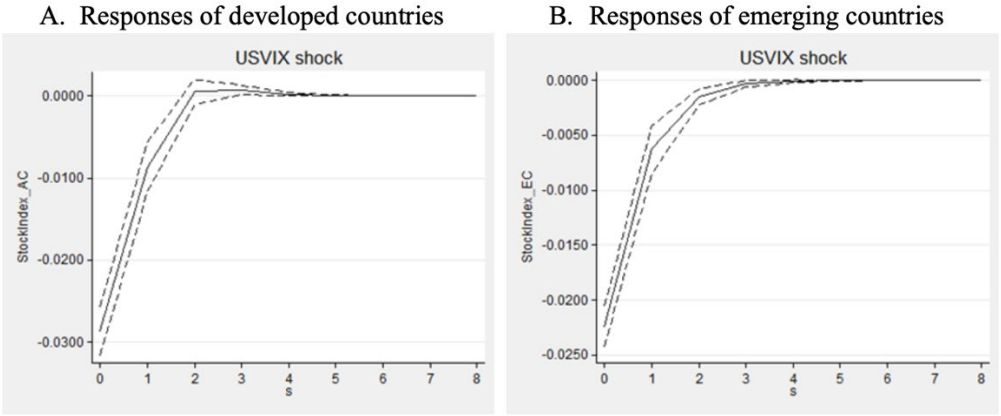
shocks occurred. From Table 7, we observe that developed stock markets experienced even greater declines than emerging markets. However, the significant adverse effects persisted for two months in emerging countries, whereas it typically only lasted for one month in developed countries. Besides, among emerging countries, "other" group had the deepest drops, while the Asian group fell the least. This indicates Russia, Turkey and South Africa had fragile economic systems and financial markets compared to most Asian emerging countries, and therefore suffered more on the occurrence of risk events.

Table 7
Stock Returns Responses to Risk Events

	Response Period		
	t = 0	t = 1	t = 2
Developed Countries	-0.0287*	-0.0087*	-0.0006
Emerging Countries	-0.0224*	-0.0063*	-0.0015*
Asian	-0.0193*	-0.0066*	-0.0014*
Latin American	-0.0223*	-0.0061*	-0.0018*
Other	-0.0305*	-0.0053	-0.0008

Note: * represents significant statistically at 5% level.

Figure 7
Impulse Responses of Stock Returns to Risk Events



Graph A and B show the responses of developed and emerging countries respectively.

2. U.S. Real Output Shocks

As the world's largest economy, the U.S. real output level has systematic effects on global market. In our model, we include the U.S. industrial production index (USIPI in the figures) to observe stock market reactions to a rise in U.S. real output. Table 8 shows the stock market responses in current and lagged periods to a one-standard deviation (5.10) increase of USIPI.

By referring to Table 8 and Figure 8, we observe that both developed and emerging stock markets experienced declines, with the magnitude of the decline generally similar. Moreover, Figure 8 indicates that the decline in developed countries primarily occurred one month after the shock, while the declines in emerging countries were most noticeable

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at the time of the shock. Based on this evidence, we can infer that the increase in U.S. real output has made the U.S. stock market more appealing to international funds, resulting in a relative decrease in funds allocated to foreign stock markets. Consequently, the outflow of funds drove both emerging and developed countries to experience a drop in their stock markets.

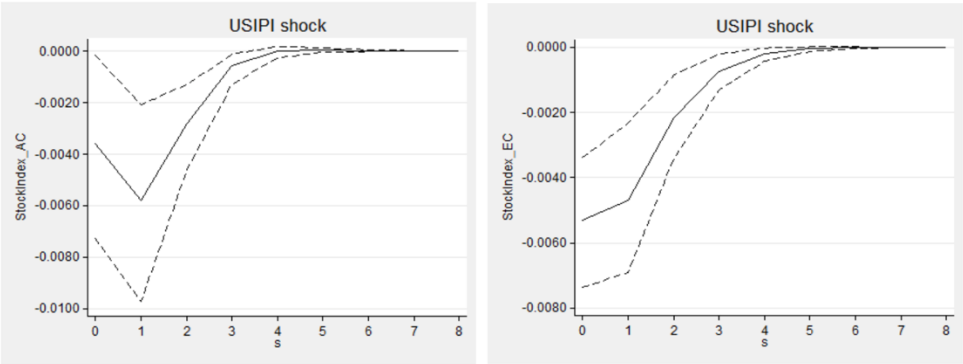
Table 8
Stock Returns Responses to U.S. Industrial Production Index

Groups	Response Period		
	t = 0	t = 1	t = 2
Developed Countries	-0.0036*	-0.0058*	-0.0028*
Emerging Countries	-0.0053*	-0.0047*	-0.0022*
Asian	-0.0042*	-0.0040*	-0.0022*
Latin American	-0.0055*	-0.0053*	-0.0025
Other	-0.0080*	-0.0052	-0.0015

Note: * represents significant statistically at 5% level.

Figure 8
Impulse Responses of Stock Returns to U.S. Real Output Levels

A. Responses of developed countries B. Responses of emerging countries



Graph A and B show the responses of developed and emerging countries respectively.

3. Commodity Price Shocks

We incorporate the commodity price index (COMMP in the figures) into our model for the reason that most emerging economies rely largely on commodity trade. Thus, changes in prices might bring fluctuations to their balance of payments. On the other hand, the commodity index implies global consumption power, which is positively correlated to global economic strength. Table 9 sorts out the stock market responses in the current and lagged periods to a one-standard deviation (36.48) increase of COMMP.

Both Table 9 and Figure 9 prove that as global commodity prices surged, stock markets in both emerging and developed countries rose, although the increases in developed countries were relatively smaller. Table 9 also confirms that among emerging markets, Russia, Turkey, South Africa and Latin American countries had the greatest increases. Such results demonstrate the positive correlations between commodity prices and the global economy, and we further prove that most emerging markets particularly

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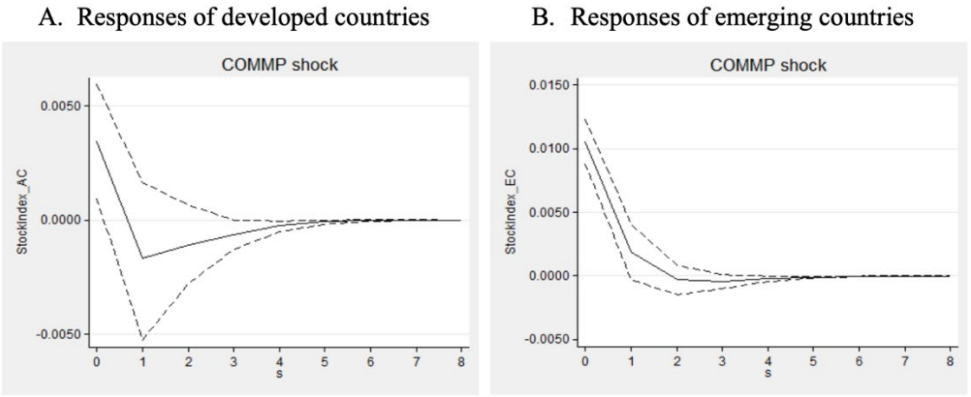
benefited from rising prices with lucrative trade gains.

Table 9
Stock Returns Responses to Commodity Price Index

	Response Period		
	t = 0	t = 1	t = 2
Developed Countries	0.0035*	-0.0017	-0.0011
Emerging Countries	0.0105*	0.0019	-0.0003
Asian	0.0051*	0.0012	-0.0002
Latin American	0.0123*	0.0032	0.0001
Other	0.0184*	0.0010	-0.0013

Note: * represents significant statistically at 5% level.

Figure 9
Impulse Responses of Stock Returns to Global Commodity Price



Graph A and B show the responses of developed and emerging countries respectively.

VI. CONCLUSION AND FUTURE WORK

Our research utilizes the Panel VAR model and Impulse Response Function to analyze the reactions of emerging stock markets to various shocks, with a particular emphasis on the impacts of U.S. monetary policy changes. As the U.S. entered the phase of monetary policy normalization, the capital environment gradually tightened. This led to the rapid return of funds released through the QE policy, prompting investors from the U.S. and other countries to reduce their investments in foreign stock markets. Consequently, both developed and emerging stock markets were expected to experience negative impacts, resulting in a downward reaction. Our findings further confirm that U.S. rate hikes led to significant drops in emerging stock returns, while the returns of developed countries remained relatively stable and less affected. Furthermore, we classify emerging economies based on their characteristics and observe that countries with low financial openness, high country-specific risks, and long-term trade deficits experienced more pronounced declines in their stock returns during U.S. rate hikes compared to other countries.

In addition to monetary policy, our research also considers the effects of three related factors, which serve as explanatory variables in our model. Firstly, we find that

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the increase in the VIX index, representing the market panics, resulted in a systematic decline in all markets within our sample. In particular, Russia, Turkey, South Africa and emerging countries in Latin America, whose economic systems and financial markets were vulnerable, were the most severely affected. Furthermore, by incorporating the U.S. industrial production index and commodity price index, we demonstrate that an increase in U.S. real output had negative impacts on both emerging and foreign developed stock markets, potentially due to the flow of funds from these countries into the U.S. within a short period. However, we also find that there were incentive effects on stock markets in response to a growing commodity price index, particularly for emerging countries heavily reliant on commodity trades.

Besides, our results indicate that nearly all stock markets experienced a downturn during the QE tapering period. Among them, the most severe conditions were observed in Latin American emerging economies, which relied heavily on commodity exports, and in Russia, which was dominated by energy exports. These regions faced additional plunges in commodity and fuel prices during the QE tapering, exacerbating the impact on their stock markets.

Lastly, based on the empirical research results, we recommend that emerging countries should adopt gradual and steady approaches to promoting open conditions and expanding the level of financial market openness. What's more, they should focus on reducing dependence on commodity trading and instead prioritize the development of more diversified industries. This can be achieved by establishing a comprehensive economic system and fostering a mature financial market. By pursuing these strategies, emerging economies can simultaneously promote market openness and enhance their overall economic resilience against external risks.

Future research could investigate the COVID-19 outbreak alongside the simultaneous array of interventions by governments and central banks worldwide, which included interest rate, the reinstatement of quantitative easing policies, and fiscal stimulus measures. Following the outbreak, stock market prices initially underwent a sharp decline, then rapidly rebounded, even reaching new highs, influenced by governmental and monetary stimuli. This period also saw considerable shifts in investor behavior. We posit that the stock market dynamics during COVID-19 were the result of complex interplay among various factors, precipitating structural changes within the markets. As we move beyond the pandemic, nations are progressively transitioning into a new cycle of monetary contraction. Consequently, we advocate for future research to undertake a detailed and precise examination of COVID-19's outbreak, the ensuing alterations in the Fed's monetary stance, and the broader implications for stock markets around the globe, with a particular focus on emerging economies.

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ENDNOTES

[1]Chari et al. (2016) analyze data from 15 emerging countries, including Malaysia, Indonesia, the Philippines, Thailand, South Korea, India, Mexico, Colombia, Brazil, Peru, Chile, Argentina, Russia, Turkey, and South Africa.

[2]In 2021, Hong Kong's per capita nominal GDP reached US$49,800.54, surpassing the International Monetary Fund's threshold of US$20,000. Therefore, we recognize Hong Kong as a developed country.

[3]Considering that the primary research focus of our paper is on emerging countries, our grouping includes developed countries solely in the first category, while the subsequent groups are specifically classified for emerging countries.

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APPENDIX A. THE FED'S NORMALIZATION POLICY

Table A1
The Fed's QE Tapering Policy

Date	Illustrations
May 22nd, 2013	Chairman Bernanke testified in Congress for the first time that the Fed would reduce the bond purchase scales.
June 19th, 2013	Chairman Bernanke delivered the speech of QE tapering and expected to end QE policy in mid-2014.
December 18th, 2013	The Fed would purchase 35 billion agency MBS and 40 billion long-term bonds per month from January 2014.
January 29th, 2014	The Fed would purchase 30 billion agency MBS and 35 billion long-term bonds per month from February 2014.
March 19th, 2014	The Fed would purchase 25 billion agency MBS and 30 billion long-term bonds per month from April 2014.
April 30th, 2014	The Fed would purchase 20 billion agency MBS and 25 billion long-term bonds per month from May 2014.
June 18th, 2014	The Fed would purchase 15 billion agency MBS and 20 billion long-term bonds per month from July 2014.
July 30th, 2014	The Fed would purchase 10 billion agency MBS and 15 billion long-term bonds per month from August 2014.
September 17th, 2014	The Fed would purchase 5 billion agency MBS and 10 billion long-term bonds per month from October 2014.

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Table A2
Federal Funds Rate Normalization Policy

Date	Range of Federal Funds Rate	Illustrations
December 16th, 2008	0-0.25%	In mid-2007, the Subprime Mortgage Crisis broke out in U.S., the Fed began to cut interest rates in September, expecting to release liquidity and encourage private investment. The federal funds rate was gradually reduced from 5.25% to 0-0.25% range.
December 16th, 2015	0.25-0.5%	The Fed originally expected to raise interest rates in September 2015. Owing to concerns about the Chinese economy slowdowns and global stock market crashes in August, however, the Fed suspended its rate hike plan in September. The first rate hike was finally launched in December.
December 14th, 2016	0.5-0.75%	The first half of 2016 witnessed slowdowns of U.S. domestic employment growth, weak corporate fixed investments, plummet of global oil prices, the Brexit referendum in June and the U.S. presidential election in November. The Fed therefore postponed its decision of rate hike at the end of 2016.
March 15th, 2017	0.75-1%	The 3rd rate hikes
June 14th, 2017	1-1.25%	The 4th rate hikes
December 13th, 2017	1.25-1.5%	The 5th rate hikes
March 21st, 2018	1.5-1.75%	The 6th rate hikes
June 13th, 2018	1.75-2%	The 7th rate hikes
September 26th, 2018	2-2.25%	The 8th rate hikes
December 19th, 2018	2.25-2.5%	The 9th rate hikes

Table A3
The Fed's Balance Sheet Shrinking Plans

Shrinking Schedule	Not-for-Investment Cap
October 2017 to December 2017	Public Debts: 6 billion; MBS: 4 billion
January 2018 to March 2018	Public Debts: 12 billion; MBS: 8 billion
April 2018 to June 2018	Public Debts: 18 billion; MBS: 12 billion
July 2018 to September 2018	Public Debts: 24 billion; MBS: 16 billion
October 2018 to April 2019	Public Debts: 30 billion; MBS: 20 billion
May 2019 to September 2019	Public Debts: 15 billion; MBS: 20 billion

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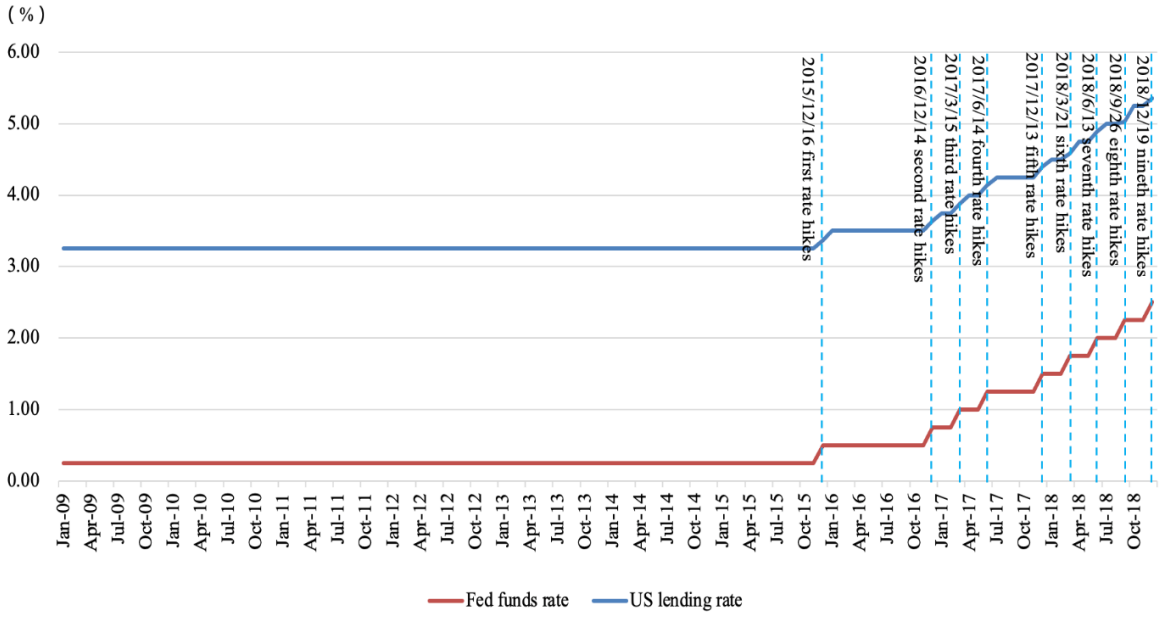
Figure A3
Trends of Federal Funds Rate and U.S. Lending Rate Over the Years



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