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Inflation Expectations, U.S. Categorical Equity Market Uncertainty and Real Stock Returns – Evidence from Global Markets

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ABSTRACT

This study examines the response of real stock returns to expected inflation and uncertainty as measured by state variable correlated with equity market volatility (EMV). Evidence reveals a significantly negative relationship between real stock returns and expected inflation for each country except some cases in India and Japan. Evidence indicates a negative relationship between real stock returns and uncertainty, which is measured not only by the impact of the Fed's monetary policy uncertainty but also from various state variables that covary with EMV. These elements have not been explicitly incorporated into test equations in previous studies of the inflation-stock return relationship. The model is robust in its ability to test data for both advanced and emerging markets, level or the first difference of explanatory variables, and various categorical EMVs. Evidence shows that the Fed's rate hikes respond to the inflation data, displaying a nonlinear impact on real stock returns.

KEYWORDS

Stock Returns; Expected Inflation; Equity Market Volatility; Monetary Policy; Rate Hikes; Uncertainty Hypothesis

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1. Introduction

The impacts of the COVID-19 pandemic on social economic activities, which include the closure of businesses, a rise in unemployment, interruptions in supply chains, limited daily food supplies and the hardships related to social distancing, were tremendous. To contain the spread of the coronavirus, most countries implemented full or partial lockdown measures by imposing restrictions in international travel and commodity shipping, thus causing significant border barriers in international trade (Chiang and Tang, 2023; Naseer, 2023). Various discretionary government rescue programs, fiscal policy and monetary policy were adopted to meet public needs (Milstein and Wessel, 2024).[1] As a result, enormous funds were provided via quantitative easing, which pushed up excess demand for goods and services, leading to sharply rising prices. In June 2022, escalating inflation in the US peaked at 8.9% annually as measured by the CPI, which far exceeded the target level of around 2% annually.[2] In response, the Fed started to raise interest rates in mid-March 2022, hiking interest rates at 11 meetings leading up to September 2023 and bringing the Fed funds rate to within a range of 5.25%-5.50%. In retrospect, whenever the Fed raised interest rates, investors' fears also rose. With each rate hike, uncertainty about future monetary policy increased, which led to heightened stock market volatility and resulted in a plunge in stock prices. The course of inflation and the Fed's rate hikes, which intensified market volatility and in turn caused a plunge in stock prices, provides an unusual market experience to better describe the negative relationship between inflation and stock returns.

Numerous studies have been proposed in earlier literature to illustrate the negative relationship between inflation and stock returns. Fama's proxy hypothesis (1981) argues that there is a positive relationship between stock returns and real economic activity, but a negative relationship between the real activity and inflation rate. The combination of these two relationships leads to a negative relationship between inflation and stock returns. Geske and Roll (1983) introduce fiscal and monetary policies into the process. They observe that a decline in stock prices reflects a setback in economic activity, which creates pressure on government revenue and potentially triggers budget deficits. Anticipation of government borrowing by monetization can raise expectations for higher inflation. This process leads to a negative relationship between stock returns and inflation expectations. Despite their validity in providing economic rationales in explaining the negative effect attributable to higher inflation expectations, these two approaches ignore a crucial element in explaining stock returns, a risk factor, which is considered as a core in the asset pricing model (Merton, 1980; Bali and Engle, 2010; Chen et al., 2018).

In an effort to explain the variability of stock returns, Sarte (1998) examines the stock return equation by considering a consumption-based asset pricing model to test the existence of an inflation risk premium. The testing result suggests that estimates of an inflation risk premium are trivial. Using an alternative asset pricing model, however, Brandt and Wang (2003) find evidence to support the hypothesis that aggregate risk aversion varies in response to news about inflation. In departing from a consumption-based CAPM, Chiang (2023) uses an asset market-based model that focuses on news of inflation that tends to positively provoke equity market volatility, which produces a negative effect on stock returns. The impact on financial market disruptions caused by the COVID-19 crisis and the Fed's policy reaction can be captured by adding other qualified state variables that positively covary with equity market volatility, in effect generalizing the uncertainty approach, and then examining the uncertainty effects on stock market movements. These state variables include heightened inflation, Fed's rate hikes, changes in monetary policy or fiscal policy, a rise in oil prices, and a widening spread of the infectious diseases, among others.

Testing of 15 international stock markets produces several important empirical results. First, evidence from

[1] IMF entitled "Policy responses to Covid-19" provides a good summary for policy operations to COVID-19.
[2] Four months later, inflation in the euro area peaked at 10.6% as measured by Harmonized index of consumer prices (HICP) in October 2022.

this study, which supports the risk-return tradeoff hypothesis, indicates that there is a positive relationship between stock return and conditional variance. One exception occurs in the Chinese market where investors may possibly perceive the volatility of stock returns as being too high (see nominal and real measures of standard deviation in Table 1) to take the risk. Second, empirical evidence supports the hypothesis that real stock returns are negatively related to expected inflation in a fully specified model. Third, tests on the real stock returns and each categorical EMV are mainly negative and statistically significant. This finding is consistent with the uncertainty hypothesis that posits that negative news regarding state/policy variables in the US is positively correlated with an upward shift in equity market volatility, which tends to produce an adverse effect on US stocks. This effect further spills over to global markets. Evidence indicates that the spillover effect is more profound for the G7 markets compared with the impact on the eight emerging markets. Fourth, evidence shows that the Fed's rate hikes are often in response to the release of news of inflation data, which has a nonlinear effect on real stock returns. This study makes an important contribution to the literature by identifying and rigorously investigating a set of categorical EMV variables that are both economically and statistically significant in explaining stock returns but have been previously ignored in the literature.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 presents an econometric model pertinent to empirical investigation. The model features an asymmetric TARCH for a generalized error distributional approach. Section 4 describes the data. Section 5 reports evidence for the real stock return equations of each market. Section 6 conducts robustness tests using a different model form and nonlinear specification. Section 7 concludes empirical findings and draws a number of practical implications.

2. Literature review

The relationship between stock returns and inflation expectations in earlier studies is based on the Fisher equation (1930), which posits that the expected nominal rate of return is a sum of the expected inflation and the expected real return, assuming that the real rate of return is constant or independence of inflation expectations (Fisher, 1930). The Fisher hypothesis was then tested by examining whether stock returns are in proportionate to the expected inflation. Evidence provided by Boudoukh and Richardson (1983), Crowder and Hoffman (1996) and Solnik and Solnik (1997) supports a notion that stock returns are positively related to expected inflation. Similar findings are documented by Hasan (2008) using UK data, while Toyoshima and Hamori (2011) confirm the Fisher hypothesis by applying data for US, UK and Japan.

Tests of the Fisher equation were also applied to emerging market data. Wong and Wu (2010) report a positive relationship between stock returns and inflation in eight Asian countries. Al-Khazali and Pyun (2004) reach a similar conclusion by applying Pacific Basin data. They further demonstrate that stock returns exhibit a time-varying relationship with inflation shocks, indicating that stocks are a good hedge against inflation in the long-run. Carneiro et al. (2002) test the Fisher equation using data for Argentina, Brazil, and Mexico and find a positive relationship to support the notion that the movement of stock returns is in proportionate to the inflation rate. Further investigation by Tiwari et al. (2022), who use long term annual US data, relies on wavelet techniques. Their study finds evidence of a weak co-movement between stock returns and inflation in the short run but a much stronger co-movement in the long run.

Applying the Fisher equation to the stock market, however, has been rejected in the work of various researchers. Studies by Nelson (1976), Bodie, (1976), Fama and Schwert (1977) document that stock returns are negatively related to inflation in the US market. Investigation of the relationship between stock returns and inflation in 26 countries by Gultekin (1983) does not find evidence to support the Fisher hypothesis. Gultekin further demonstrates that there is a lack of a consistent positive relationship between stock returns and inflation in most countries. Since the short-term interest rate was used as a proxy for inflation expectation, the testing results can be contaminated by an interest effect.

A number of rationales have been suggested to explain the departure from the Fisher hypothesis. First, Modigliani and Cohn (1979) propose a money illusion hypothesis, which suggests that investors fail to adjust equity cash flows upward in the same proportion as the upward shift in the discount rate during times of higher expected inflation. Thus, the undervaluation in stocks causes stock prices to decline. An empirical analysis by Cohen et al. (2005), who use NYSE, AMEX and NASDAQ data, finds evidence to support the money illusion hypothesis. Brown et al. (2016) further test the sensitivity of stock earnings to inflation and find that low asset growth stocks have a greater exposure to the inflation illusion factor than their counterparts and find evidence of displaying underpricing at times of high inflation.

Second, Fama (1981) advocates a "proxy hypothesis" based on the following observations (i) there is a positive relationship between real stock returns and real economic activity; (ii) there is a negative relationship between real economic activity and expected inflation. These two statements therefore lead to the supposition that there is a negative relationship between real stock returns and expected inflation. Balduzzi (1994) examines Fama's proxy hypothesis based on the Vector Autoregressive (VAR) model and finds evidence that inflation is a central factor in the dynamic movement of stock returns and the interest rate accounts for a substantial share of a negative correlation between stock returns and inflation. Gallagher and Taylor (2002) examine the proxy hypothesis and obtain supportive evidence to confirm the Fama (1981) hypothesis. However, in their test proxy hypothesis using data of the US, UK, Germany and Canada, Liu et al. (1993) reach a conclusion that although expected inflation is negatively correlated with anticipated real activity, no significant relationship exists between real stock returns and anticipated real activity. Thus, their evidence does not support the proxy hypothesis. A main criticism of Fama's model is its failure to consider the Phillips curve theory that suggests a positive relationship between real economic activity and inflation (Kryzanowski and Rahman, 2009).

Third, Geske and Roll (1983) provide a reverse causation hypothesis, which states that a decline in stock prices indicates a slowdown in real economic activity, which puts pressure on government revenue and harbingers a potential rise in budget deficits. Rational behavior implies that as anticipation of government future borrowing by monetization rises, the subsequent growth in money supply will raise expected inflation. The Geske and Roll (1983) hypothesis provides an explanation for the negative relationship between stock returns and expected inflation. In a subsequent study using a vector autoregressive moving average model, James et al. (1985) find evidence to support Geske and Roll's reversed causality model. Solnik (1983) examines the data for nine countries and finds evidence to reject the relationship that real returns are independent of inflationary expectations. Solnik's result seems consistent with the Geske and Roll hypothesis that stock price movements signal revisions in inflationary expectations. However, in Solnick's study, the short-term interest rate was used as a proxy for expected inflation, which erroneously misrepresents the inflation expectation effect with the interest rate effect.[3]

Fourth, the risk/uncertainty approach suggests that news of inflation causes market volatility, which precipitates a decline in stock returns. This negative relationship between stock prices and volatility has been documented by Campbell and Hentschel (1992), Bekaert and Wu (2000), and Bae, Kim, and Nelson (2007). Brandt and Wang (2003) employ a consumption-based asset pricing model in which aggregate risk aversion varies in response to news of inflation and aggregate consumption growth. The resulting evidence suggests that aggregate risk aversion varies in response to news about inflation. Saryal (2007) examines the data of Turkey and Canada and finds that the rate of inflation is highly predictive of stock market volatility in Turkey, whereas it has a weaker but still significant impact on the Canadian market. Note that the variance in these models is usually assumed to be exogeneous, which is inconsistent with recent experience in that the stock volatility is often driven by the Fed's

[3] It is not this study's intention to provide an exhaustive review of major studies but rather to report on the key results. Bosupeng (2016) and Madadpour and Asgari (2019) provide a review of articles from earlier literature.

aggressive monetary policy in implementing rate hikes. Chiang (2023) demonstrates that the variability of the equity market volatility (EMV) is positively associated with heightened inflation and finds a significant negative relationship between real stock returns and expected inflation. Batten et al. (2021) show that during the global financial crisis, investors reduced their stock positions, which was mainly attributable to the fact that VIX shocks negatively affected the portfolio returns of stock oil hedges. Sekandary and Bask (2023) examine the Federal Funds Rate (FFR) data for the period 1994–2008 in the US market and uncover a negative relationship between monetary policy surprises and stock returns. Salisu et al. (2022) use a VAR model to examine a group of emerging stock markets and find evidence that oil price shocks have a significant and negative effect on the majority of global stock markets. These test results point to a more generalized market behavior, i.e., any state variables, which significantly affect investors' expectations and threaten future profits, will result in a stock selloff, leading to higher volatility and a drop in stock returns.

The above evidence suggests that volatility can be induced by negative news, which may be in the form of heightened inflation, Fed rate hikes, financial crisis, or oil price shocks, among others. The purpose of this study is to provide a systematic study that addresses different categorical measures of EMV affecting stock returns. In estimating the parametric effect, this study emphasizes the measure of EMV calibrated to state variables associated with inflation, interest rate, oil price, monetary policy, fiscal policy, oil price changes (Baker et al., 2022). These covariances between EMV and state variables feature different forms of uncertainty that lead to different impacts on stock returns. This dynamic process can further spillover to global markets through volatility contagion (Chiang et al., 2007; Chiang, 2020; Wang et al., 2018).

3. The Model

This section presents a generalized uncertainty hypothesis in which risk is based on a covariance between state variable and equity market volatility. The model is expressed as follows:

$$R_t = C + \beta_1 \Delta p_t^e + \beta_2 cov(x_t, EMV_t) + \beta_3 Controls + \varepsilon_t \quad (1)$$

where R_t is the stock return, Δp_t^e is the expected inflation, $cov(x_t, EMV_t)$ is the covariance term between state/policy variable x_t, and EMV_t. The conventional approach suggests that $\beta_1 < 0$ (Fama, 1981), while Fisher hypothesis posits that $\beta_1 > 0$ as representing a hedge against inflation; $\beta_2 < 0$ implies that bad news causes stock returns to plunge. The error term follows $\varepsilon_t \big| \Omega_{t-1} \backsim \text{GED}(0, \sigma_{t-1}^2, \nu)$.

The restriction of $\beta_1 < 0$ and $\beta_2 < 0$ in equation (1) suggests that the (real) stock return is negatively related to expected inflations, Δp_t^e, (Fama, 1981; Geske and Roll, 1983) and risk, $cov(x_t, EMV_t)$ (Chiang, 2023). The model in equation (1) should take into account the impacts of extreme observations resulting from the 2008-09 global financial crisis (GFC) and 2019-20 COVID-19 pandemic. These factors are controlled for using indicator variables given by I_{Crisis} and I_{Covid}, respectively (Cheema et al., 2020; Chiang., 2023).[4] The inclusion of these indicator variables helps to alleviate a potential biasedness of parameter estimations as noted by Peña (2001).

The conditional variance is assumed to follow a Threshold-GARCH (TARCH) process (Bollerslev, 2010) given by:

$$\sigma_t^2 = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 I \cdot \varepsilon_{t-1}^2 / \varepsilon_{t-1}^- + \omega_3 \sigma_{t-1}^2 \quad (2)$$

Equation (2) is characteristic of the GJR model (Glosten, Jagannathan and Runkle model (1993)), which is designed to capture the more profound impact that a significant rise in negative news from the lgged shock (ε_{t-1}^-)

[4] The use of indicator variables (I_{Crisis} and $I_{COVID-19}$) to capture the impacts of GFC and COVTD-19 is necessary as noted by Terry et al. (2022), who show that the COVID-19 shock increased the VIX by about 500% from 15 January 2020 to 31 March 2020. This induced shock undoubtedly affected stock returns in equity market.

has on volatility when compared with the effect created by a normal positive effect.[5] Due to the fact that stock prices often exhibit a fat tail, the error term more appropriately follows a generalized error distribution (GED) as noted by Nelson (1991), which is written as (Equation 3):

$$\varepsilon_t \,\big|\, \Phi_{t-1} \backsim GED(0, \sigma_{t-1}^2, \upsilon) \tag{3}$$

The GED is also better able to deal with leptokurtotic issues in analyzing asset return series, and therefore a more popular approach (Li et al., 2005; Chiang, 2019).

4. Data selection and description

The data in this study cover monthly observations for the period from January 1990 through December 2023. The data include aggregate stock and CPI indices for the advanced markets: United States (US), Canada (CA), United Kingdom (UK), France (FR), Germany (GM), Italy (IT) and Japan (JP), popularly designated as the G7 industrial markets. This study also examines the emerging markets (EM8): China (CN), India (IN), Indonesia (ID), South Korea (KO), Malaysia (MA), Brazil (BR), Mexico (MX), and Peru (PR). The decision to select these markets is based on the size of their GDP, different degrees of financial market maturity, different geographic locations and various cultural backgrounds that may reveal different market behavior.[6] The sources of data for stock indices and CPI were downloaded from the *Datastream* and *Economic Data Base* of the Federal Reserve Bank of St. Louis.

The stock returns and inflation rate series are obtained by taking the natural log-difference of each price indices times 100. A summary of these data is reported in Table 1, which shows the monthly inflation rates range from -0.007% (China) to 1.433% (Brazil). In comparison, the highest inflation rate for G7 countries is the US (0.216%) with a standard deviation of 0.327. The monthly stock returns in Table 1 range from 0.045%% (Japan) to 0.720% (Canada); the latter has the highest standard deviations (4.018) of stock returns relatively to the other G7 markets. With respect to real stock returns, their range spans from -0.047 (India) to 0.642 (Canada), and the spread in standard deviations is from 1.774 (Italy) to 4.117 (China). China's stock market has the highest volatility based on the measure of real stock returns. Table 1 also reports the Jarque-Bera statistics (JB) in stock returns, which tests the validity of normality. The JB statistics, which range from 18.42 (Germany) to 575.97 (Peru), indicate a rejection of normality for all the markets under investigation as evidenced by the high significance of the calculated statistics compared with the critical value at the 5% level (=5.991) with 2 degrees of freedom. The rejection of null suggests the use the GED-TARCH type of model is relevant.

Table 1. Summary of monthly inflation rates and stock returns: 1990.M1 –2023.M12.

Inflation		Δp_t^{US}	Δp_t^{CA}	Δp_t^{UK}	Δp_t^{FR}	Δp_t^{GM}	Δp_t^{IT}	Δp_t^{JP}
Mean		0.216	0.078	0.062	0.074	0.093	0.097	0.021
Median		0.210	0.077	0.057	0.057	0.087	0.110	0.000
Maximum		1.215	1.127	0.614	0.852	1.458	1.431	0.898
Minimum		-1.934	-0.453	-0.437	-0.516	-0.296	-0.408	-0.402
Std. Dev.		0.327	0.162	0.132	0.166	0.132	0.189	0.150
Skewness		-0.931	0.614	0.079	0.622	2.876	1.092	1.000
Kurtosis		8.285	7.347	4.276	5.910	30.831	11.001	7.710
JB		518.11	346.87	28.09	170.19	13729	1169.35	445.02
Obs		408	408	408	408	408	408	408
Inflation	Δp_t^{CN}	Δp_t^{ID}	Δp_t^{IN}	Δp_t^{KO}	Δp_t^{MA}	Δp_t^{BR}	Δp_t^{MX}	Δp_t^{PR}
Mean	-0.007	0.273	0.582	0.121	0.090	1.433	0.307	0.771
Median	0.000	0.159	0.576	0.106	0.079	0.225	0.237	0.150
Maximum	0.975	5.182	4.474	1.088	1.689	30.103	3.330	69.784

[5] The variance equations were also estimated by using the asymmetric power GARCH model (APARCH) Ding et al. (1993). However, in this study's empirical experiments, some models reveal negative R-squares due to an over parameterization problem although some information of the long memory can be achieved. For this reason, a TARCH model is maintained.

[6] Data constraints are another factor; for instance, Australia and New Zealand are excluded due to lack of monthly CPI data.

Minimum	-1.133	-0.445	-2.120	-0.324	-1.202	-0.296	-0.442	-0.239
Std. Dev.	0.294	0.537	0.787	0.193	0.181	3.637	0.367	3.981
Skewness	-0.169	4.918	0.277	0.995	0.759	3.464	3.107	13.640
Kurtosis	4.338	35.008	4.952	6.334	24.492	17.106	19.345	225.752
JB	32.39	15651	69.99	256.27	7891.86	4188.51	5198.20	856163
Obs	408	335	408	408	408	407	408	408
Stock return		R_t^{US}	R_t^{CA}	R_t^{UK}	R_t^{FR}	R_t^{GM}	R_t^{IT}	R_t^{JP}
Mean		0.367	0.720	0.303	*0.233*	0.203	0.271	0.045
Median		0.575	1.114	0.516	*0.430*	0.179	0.508	0.190
Maximum		5.439	10.883	7.280	*6.699*	9.207	5.189	7.705
Minimum		-8.164	21.033	-7.997	-10.382	-10.208	-7.173	-9.867
Std. Dev.		1.877	4.018	2.196	*2.312*	2.623	1.765	2.319
Skewness		-0.717	-1.134	-0.508	*-0.821*	-0.024	-0.631	-0.422
Kurtosis		4.517	7.211	3.947	*5.050*	4.040	4.361	4.357
JB		74.07	388.91	32.81	117.26	18.42	58.59	43.40
Obs		408	408	408	408	408	408	408
Stock return	R_t^{CN}	R_t^{ID}	R_t^{IN}	R_t^{KO}	R_t^{MA}	R_t^{BR}	R_t^{MX}	R_t^{PR}
Mean	0.273	0.311	0.538	0.232	0.239	0.472	0.590	0.357
Median	0.191	0.535	0.531	0.167	0.358	0.550	0.608	0.409
Maximum	17.135	11.954	23.361	18.625	12.470	8.922	9.410	11.620
Minimum	-13.413	-16.675	16.566	-14.458	12.845	-15.443	-12.325	-13.438
Std. Dev.	4.125	3.363	3.699	3.369	2.643	3.033	2.641	2.480
Skewness	0.135	-0.808	0.065	0.326	-0.158	-0.944	-0.378	-0.659
Kurtosis	4.657	7.095	8.612	6.364	8.066	6.963	5.260	9.064
JB	42.86	326.15	534.45	199.62	438.06	283.44	96.59	575.97
Obs	365	404	407	408	408	353	408	359
Real Stock return		r_t^{US}	r_t^{CA}	r_t^{UK}	r_t^{FR}	r_t^{GM}	r_t^{IT}	r_t^{JP}
Mean		0.260	0.642	0.240	0.159	0.110	0.175	0.024
Median		0.484	1.023	0.431	0.350	0.072	0.340	0.168
Maximum		5.731	10.837	7.189	6.809	9.086	5.253	7.226
Minimum		-7.723	21.033	-8.022	-1 0.382	-10.250	-7.171	-10.206
Std. Dev.		1.885	4.004	2.201	2.312	2.629	1.774	2.317
Skewness		-0.635	-1.110	-0.503	-0.797	-0.033	-0.618	-0.446
Kurtosis		4.291	7.079	3.929	5.012	3.993	4.257	4.374
JB		56	367	32	112	17	53	46
Obs		408	408	408	408	408	408	408
Real Stock return	r_t^{CN}	r_t^{ID}	r_t^{IN}	r_t^{KO}	r_t^{MA}	r_t^{BR}	r_t^{MX}	r_t^{PR}
Mean	0.291	0.070	-0.047	0.111	0.148	0.226	0.283	0.210
Median	0.302	0.482	0.060	0.048	0.254	0.379	0.349	0.242
Maximum	17.091	11.634	23.361	17.607	12.416	8.562	8.795	11.198
Minimum	-13.163	-18.155	-17.856	-14.458	-12.901	-15.221	-12.741	-13.704
Std. Dev.	4.117	3.371	3.850	3.377	2.641	3.032	2.639	2.494
Skewness	0.116	-1.232	-0.016	0.285	-0.189	-0.910	-0.584	-0.688
Kurtosis	4.656	8.762	8.236	5.947	7.909	6.544	5.739	8.879
JB	43	548	465	153	412	233	151	545
Obs	365	335	407	408	408	353	408	359

Notes: Δp_t^j *is the monthly inflation rate for country j;* R_t^j *is the monthly stock return for country j. Country j refers to the United States (US), Canada (CA), United Kingdom (UK), France (FR), Germany (GM), Italy (IT), and Japan (JP), these are the G7 industrial markets. This study also examines the emerging markets (EM8): China (CN), India (IN), Indonesia (ID), South Korea (KO), Malaysia (MA), Brazil (BR), Mexico (MX), and Peru (PR).* r_t^j *is the monthly real stock return for country j. Country j refers to the United States (US), Canada (CA), United Kingdom (UK), France (FR), Germany (GM), Italy (IT), and Japan (JP), these are the G7 industrial markets. This study also examines the emerging markets (EM8): China (CN), India (IN), Indonesia (ID), South Korea (KO), Malaysia (MA), Brazil (BR), Mexico (MX), and Peru (PR).*

This study employs a newspaper-based Equity Market Volatility (EMV) tracker (Baker et al., 2022) that closely moves with the CBOE Implied Volatility Index (VIX). The measures of EMV are calibrated to a specific-state variable provided by Baker et al. (2022). EMV refers to three-words that are denoted by E: {economic, economy, financial}, M: {"stock market", equity, equities, "Standard and Poors" (and variants)}, V: {volatility, volatile, uncertain, uncertainty, risk, risky}. The category specific EMV trackers are calculated by the share of EMV articles in each category and multiplied by the contemporaneous EMV tracker value. The calculated *x* specific to EMV is given by $emv_{x,t}$, which is:

$$emv_{x,t} = \left(\frac{\#\{E \cap M \cap V \cap x\}_t}{\#\{E \cap M \cap V\}_t}\right) EMV_t \quad (4)$$

where # denotes the count of newspaper articles in the indicated set, and EMV_t is the value of the overall EMV tracker in month t.[7] The specification of equation (4) implies that $emv_{x,t} \equiv cov(x_t, EMV_t)$ as stated in equation (1) will be used in the empirical estimations.

The selection of the *x* variable is based on the established empirical experiments, combined with prior beliefs as to whether the variables are meaningful to describe the recent policy stances, market conditions and investors' behavior. The *x* variable consists of the following categories: {News and outlook, Monetary policy, Fiscal policy, Inflation, Interest rates, Exchange rate, Energy, Petroleum, Infectious disease, and Healthcare policy} as expressed by NEWS, MP, FP, INFL, INTR, EXCH, ENGY, PTRL, DISE, HLTH}. In symbols, the state variables, which covary with the EMV, are denoted as: {$emv_{NEWS,t}$, $emv_{MP,t}$, $emv_{FP,t}$, $emv_{INFL,t}$, $emv_{INTR,t}$, $emv_{EXCR,t}$, $emv_{ENGY,t}$, $emv_{PTRL,t}$ $emv_{DISE,t}$ and $emv_{HLTH,t}$}.[8]

The plot of the time series paths of a group of 10 $emv_{x,t}$ variables is shown in Figure 1, which shows that $emv_{x,t}$ variables exhibit some degree of comovements. The position of $emv_{NEWS,t}$ is generally higher, while the position of $emv_{DISE,t}$ is relatively lower over most of the historical time but spiked during the unprecedent pandemic time, reaching a peak in February 2020. Yet, the values of $emv_{MP,t}$, $emv_{FP,t}$, $emv_{INTR,t}$ and $emv_{PTRL,t}$ lie in the middle. These outcomes become much more apparent in the statistics shown in Table 2. The mean values of $emv_{x,t}$ range from 0.273 ($emv_{ENGY,t}$) to 14.659 ($emv_{NEWS,t}$); the magnitude of fluctuations of these series can be observed in the maximum (58.124) and minimum (0.049) values as shown in $emv_{DISE,t}$ (V_DISE). Apparently, the maximum value of $emv_{DISE,t}$ corresponds to the peak of COVID-2019 in the US. Further information is revealed in the correlation analysis. Evidence in Table 3 indicates that the most values of $emv_{x,t}$ exhibit high correlation with $emv_{NEWS,t}$, which is more generally used to measure the social-macroeconomic news. The correlation coefficients of $emv_{NEWS,t}$ range from 0.72 to 0.88 with $emv_{INFL,t}$, $emv_{PTRL,t}$, $emv_{INTR,t}$, $emv_{FP,t}$, $emv_{INTR,t}$ and $emv_{MP,t}$, indicating the news of uncertainties often spills over to the innovations for interest rates, inflation, monetary and fiscal policy changes, which can interact. This finding implies that when these variables are jointly treated as regressors in a test equation, they may produce a multicollinearity problem.

Table 2. Summary of monthly categorical equity market volatility: 1990.M1 –2023.M11.

	V_NEWS	V_MP	V_FP	V_INF	V_INTR	V_EXCR	V_ENGY	V_PTRL	V_DISE	V_HLTH
Mean	14.659	6.367	7.045	5.771	6.140	0.342	0.273	4.571	2.188	0.818
Median	13.228	5.621	6.270	5.268	5.590	0.211	0.230	3.979	0.574	0.679
Maximum	51.644	23.862	31.157	20.822	19.017	3.899	1.883	19.229	58.124	6.385
Minimum	6.902	1.582	2.364	1.965	1.741	0.000	0.000	0.862	0.049	0.000
Std. Dev.	5.811	3.342	3.103	2.404	2.670	0.516	0.215	2.338	5.635	0.603
Skewness	2.709	2.295	2.591	1.660	1.600	3.970	2.295	2.091	5.074	3.432
Kurtosis	14.308	10.328	15.240	7.931	6.633	21.701	13.565	9.933	36.219	23.959
Jarque-Bera	2666	1268	2995	599	3977	7000	2250	1111	20460	8248
Obs	407	407	407	407	407	407	407	407	407	407

Notes: V refers to equity market volatility (emv). {V_NEWS, V_MP, V_FP, V_INF, V_INTR, V_EXCR, V_PTRL, V_DISE and V_HLTH}, respectively, denotes {$emv_{NEWS,t}$, $emv_{MP,t}$, $emv_{FP,t}$, $emv_{INFL,t}$, $emv_{INTR,t}$, $emv_{EXCR,t}$, $emv_{ENGY,t}$, $emv_{PTRL,t}$ $emv_{DISE,t}$ *and* $emv_{HLTH,t}$}.

[7] Source: Policy News and Stock Market Volatility" by Scott Baker, Nicholas Bloom, Steven J. Davis and Kyle Kost, 2019. (The data are updated from time to time, see www.PolicyUncertainty.co.). Baker (2022) notes that "the petroleum Markets EMV tracker correlates at 0.59 with the CBOE Crude Oil Volatility Index (0.68 in quarterly data) from 2007 to 2018 and at 0.52 with the CBOE Crude Oil Realized Volatility (0.57 in quarterly data) from 1986 to 2018."

[8] Source: Policy News and Stock Market Volatility" by Scott Baker, Nicholas Bloom, Steven J. Davis and Kyle Kost, 2019. (The data are updated from time to time, see www.PolicyUncertainty.co.). Baker (2022) notes that "the petroleum Markets EMV tracker correlates at 0.59 with the CBOE Crude Oil Volatility Index (0.68 in quarterly data) from 2007 to 2018 and at 0.52 with the CBOE Crude Oil Realized Volatility (0.57 in quarterly data) from 1986 to 2018."

Table 3. Correlation analysis for equity market volatilities: 1989M12 - 2023M10.

CORR/t	V_NEWS	V_MP	V_FP	V_INFL	V_INTR	V_FEXR	V_ENGY	V_PETR	V_DISE	V_HETH
V_NEWS	1									

V_MP	0.88	1								
	37.88	-----								
V_FP	0.82	0.67	1							
	29.23	18.32	-----							
V_INFL	0.70	0.72	0.54	1						
	19.74	20.81	12.97	-----						
V_INTR	0.72	0.80	0.56	0.84	1					
	20.67	26.70	13.56	30.78	-----					
V_EXCR	0.23	0.21	0.22	0.28	0.35	1				
	4.69	4.42	4.49	5.96	7.48	-----				
V_ENGY	0.32	0.28	0.35	0.07	0.10	0.01	1			
	6.87	5.82	7.52	1.50	2.10	0.12	-----			
V_PTRL	0.72	0.65	0.48	0.55	0.50	0.22	0.28	1		
	21.00	17.35	10.98	13.19	11.57	4.50	5.79	-----		
V_DISE	0.31	0.25	0.23	0.14	0.11	-0.12	0.06	0.19	1	
	6.50	5.13	4.79	2.85	2.24	-2.36	1.29	3.86	-----	
V_HLTH	0.53	0.43	0.67	0.25	0.25	-0.01	0.28	0.30	0.47	1
	12.54	9.65	17.99	5.24	5.16	-0.29	5.84	6.23	10.67	-----

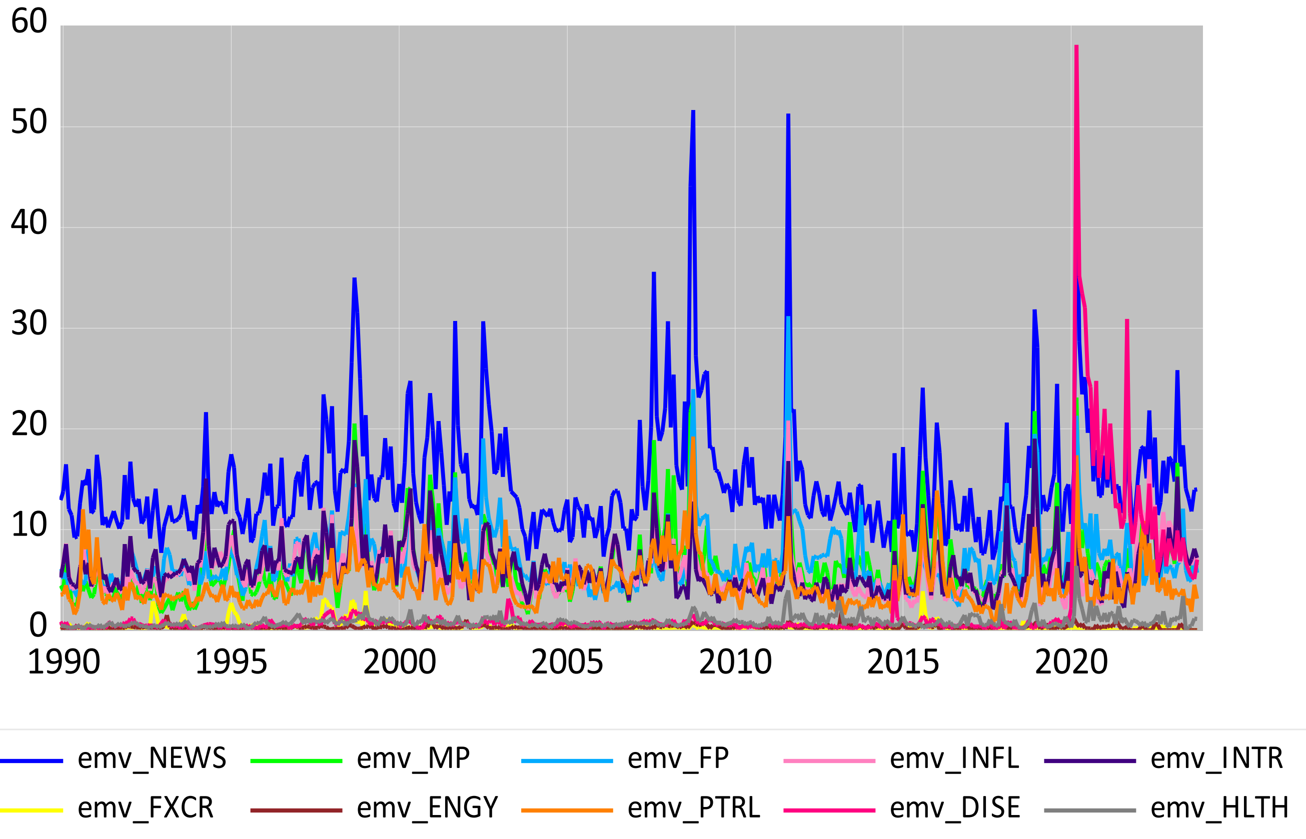

Figure 1. Time series plots of categorical equity market volatility (emv).

5. Empirical Evidence

5.1. Evidence from advanced markets

To conduct an empirical estimation, equation (1) is rewritten as follows:

$$r_t = \mathrm{C} + \beta_1 \ln\sigma_t^2 + \beta_2 \Delta p_t^e + \beta_3 emv_{x,t} + \beta_4 I_{GFC,t} + \beta_5 I_{COVID,t} + \varepsilon_t \quad (5)$$

where r_t is the real stock return, which is measured by subtracting the inflation rate from the nominal stock return. Δp_t^e is the expected inflation measured by the instrumental variable, which is Δp_{t-1}, the lagged inflation rate is also based on the rationale that investors adopt a real options strategy (Pindyck, 1991) by waiting for new information and delaying the exercise of the options (Dixit and Pindyck, 1994). The $emv_{x,t}$ is the categorical equity market volatility calibrated to x_t, the state variable changes or policy innovations. The test equation includes two indicator variables to control for the impacts of the 2008-09 global financial crisis (GFC) and 2019-20 COVID-19 (Cheema et al., 2020; Batten et al., 2023; Chiang., 2023).[9] This approach helps to mitigate the biasedness arising from sharp changes in time series (Peña 2001).

The specification of equation (5) can be viewed as a multiple-factor model: the risk from conditional variance, $\ln\sigma_t^2$; the risk associated with uncertainty of inflation expectation, Δp_t^e; and the risk arising from a change in state variable, x_t, which causes an upward shift in equity market volatility, $emv_{x,t}$.

The results for equation (5), which are estimated by using GED-TARCH-Mean procedure, are reported in Table 4. Panel A contains the estimates of the US market arrived by examining the real stock returns' response to inflation expectations and different categorical $emv_{x,t}$. Several findings are obtained from the estimations.

First, the coefficients of the conditional variance, $\ln\sigma_t^2$, present positive signs and are statistically significant at 1% level for all the estimated equations. These findings are consistent with the risk-return tradeoff hypothesis, which states that higher risk is compensated for greater returns as noted by Ghysels et al. (2005), Lundblad (2007) and Bali and Engle (2010).

Second, the evidence reveals that stock returns are negatively related to expected inflation, and the coefficients are statistically significant. The results are attributable to the fact that higher inflation is expected to erode the value of money, causing consumers to pare down spending. This cutback in spending combined with rising costs of production and uncertain revenue growth can drive an economy into recession and lead to a decline in stock prices. The finding of a negative relationship between real stock returns and expected inflation is consistent with the evidence provided by Fama (1981), Schwert, (1981), Gallagher and Taylor (2002) and Chiang and Chen (2023) but is inconsistent with reports by Boudoukh and Richardson (1983) and Crowder and Hoffman (1996).

Third, all the coefficients of $emv_{x,t}$, denoted as EMV_t are calibrated to x_t, where x_t refers to various categories of policy and state macroeconomic variables. It is remarkable that all the variables are negative and highly significant, indicating changes in news of uncertainty in relationship to {future economic outlook, inflation perspective, interest rates, monetary policy, fiscal policy, exchange rate, …and health policy} will create fear about the unknown and more uncertain future, which translates into stock market volatility, selling pressure, and eventually, a plunge in stock returns. Particularly, $emv_{NEWS,t}$ reflects risk associated with a broad scope of negative news, while $emv_{MP,t}$, $emv_{FP,t}$, $emv_{INFL,t}$, $emv_{INTR,t}$ and $emv_{EXCR,t}$ could be generally grouped as risk associated with financial policy. It is plausible that as news of heightened inflation is released, market participants are likely to think that the Fed will raise interest rates, which alters expectations about the timing and size of future hikes. Higher interest rates in the form of contractionary monetary policy led to a higher cost for the government to borrow funds from the public to finance its spending. These policies were in fact frequently, interchangeably implemented during the pandemic period. The high correlation of these policy variables, which tend to have interacting effects on volatility, are likely to cause further damage to the stock market. The remaining measures of volatility variables associated with $\{emv_{ENGY,t}, emv_{PTRL,t}\ emv_{DISE,t}$ and $emv_{HLTH,t}\}$ can be viewed as news that adversely affects real sectors or human capital. A negative impact of these EMV will raise costs of production, discourage business growth and create fears that the economy is likely to dip into a recession. These concerns tend to elevate volatility and lead to a decline in stock prices.

[9] The use of indicator (dummy) variables ($D_{GFC,t}$ and $D_{Covid,t}$) to capture the impacts of GFC and COVTD-19 is necessary as Terry et al. (2022) show in their findings that the COVID-19 shock increased the VIX by about 500% from 15 January 2020 to 31 March 2020.

Table 4. Estimates of inflation expectation and changes in monetary policy induced equity market volatility to affect G7 stock returns.

C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel A. US real stock return											
-0.236	1.360	-1.355	-0.093	-3.946	-3.170	1.510	0.231	0.130	0.553	0.13	NEWS
-2.22	13.01	-6.57	-22.47	-14.18	-21.11	4.65	2.93	1.70	8.79		
-0.127	1.101	-1.711	-0.162	-3.925	-1.078	1.444	0.287	0.224	0.537	0.17	MP
-2.27	16.05	-7.59	-29.81	-10.28	-1.95	5.51	3.29	3.33	11.28		
-0.411	1.392	-1.900	-0.138	-4.352	-4.268	1.666	0.123	0.024	0.567	0.10	FP
-2.02	11.30	-7.05	-11.00	-13.45	-9.90	2.97	2.90	1.34	4.80		
0.228	0.977	-0.661	-0.206	-4.202	-0.875	1.598	0.202	0.153	0.575	0.16	INFL
4.71	10.98	-4.57	-11.67	-25.00	-3.12	9.39	5.93	3.11	10.58		
0.306	0.977	-1.145	-0.193	-4.541	-3.290	1.599	0.161	0.270	0.543	0.15	INTR
2.91	13.00	-7.59	-13.27	-13.29	-6.48	4.07	2.29	2.63	7.70		
-0.673	0.880	-1.651	-0.277	-5.193	-3.535	1.687	0.182	0.172	0.546	0.10	EXCR
-1.70	4.90	-6.85	-4.11	-56.81	-6.98	3.18	2.68	1.78	8.80		
-0.810	1.105	-1.574	-0.855	-4.539	-3.239	1.648	0.188	0.054	0.556	0.10	ENGY
-2.38	8.67	-8.68	-4.71	-14.39	-6.63	3.86	6.45	4.64	7.81		
0.175	1.062	-1.697	-0.225	-3.294	-3.493	1.432	0.245	0.144	0.546	0.13	PTRL
5.42	12.01	-8.95	-16.02	-9.89	-9.02	6.71	2.95	4.17	10.25		
-0.912	1.060	-2.189	-0.012	-5.012	-3.310	1.729	0.138	0.033	0.565	0.09	DISE
-1.74	3.82	-14.75	-2.53	-21.35	-7.06	3.65	2.52	8.43	9.58		
-0.818	1.165	-1.560	-0.202	-5.374	-4.219	1.821	0.123	0.018	0.578	0.05	HLTH
-2.48	6.57	-5.58	-3.38	-15.22	-54.00	2.48	2.61	2.08	4.15		
C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel B. CA real stock return											
-22.500	6.712	-1.205	-0.187	-5.806	-1.533	15.370	0.303	0.123	0.640	0.15	NEWS
-5.19	6.25	-3.21	-10.52	-14.22	-17.75	7.23	4.19	2.60	11.89		
0.266	0.804	-0.726	-0.166	-2.813	-4.560	1.384	0.223	0.200	0.534	0.12	MP
2.79	11.29	-6.22	-19.77	-17.23	-8.09	5.04	3.89	3.15	10.69		
-21.837	6.550	-0.500	-0.326	-5.532	-2.227	22.889	0.221	0.044	0.468	0.11	FP
-5.75	8.15	-1.25	-9.27	-4.38	-1.38	3.44	3.36	1.31	3.78		
-10.805	5.150	-1.981	-0.538	-7.149	-3.026	7.002	0.104	0.003	0.564	0.13	INFL
-3.62	4.35	-4.79	-15.78	-8.15	-2.37	4.54	2.51	0.81	7.74		
0.758	1.007	-1.766	-0.372	-9.008	-2.979	0.694	0.160	0.062	0.827	0.14	INTR
0.70	2.31	-1.89	-7.62	-7.02	-2.99	1.97	2.02	0.85	13.20		
-10.873	4.250	-3.084	-1.471	-8.465	-2.817	8.077	0.083	0.022	0.556	0.09	EXCR
-4.08	4.88	-6.30	-12.88	-9.01	-11.72	4.04	5.09	2.28	4.73		
-13.656	5.333	-5.797	-3.570	-9.180	-3.467	8.067	0.098	0.002	0.564	0.03	ENGY
-8.85	11.54	-16.50	-10.76	-8.16	-5.53	5.51	10.17	3.76	9.19		
-21.684	6.839	-0.695	-0.472	-5.197	-6.298	18.660	0.272	0.062	0.454	0.14	PTRL
-15.57	20.20	-2.94	-20.19	-4.07	-6.69	14.47	16.90	2.05	9.36		
-12.315	4.584	-1.842	-0.059	-8.881	-2.879	7.959	0.100	0.009	0.559	0.06	DISE
-3.87	5.00	-3.78	-2.83	-15.23	-2.65	5.01	4.18	0.33	9.97		
-12.077	4.714	-0.253	-0.659	-6.465	-2.038	7.474	0.067	0.018	0.564	0.08	HLTH
-1.25	1.46	-0.43	-3.30	-5.46	-1.67	2.26	1.33	0.50	3.26		
Panel C. FR real stock return											
0.301	0.879	-1.303	-0.115	-2.174	-2.042	2.417	0.183	0.143	0.575	0.12	NEWS
1.91	7.82	-4.03	-11.44	-5.19	-4.35	5.15	2.15	1.84	5.70		
0.823	0.477	-0.460	-0.195	-3.222	-1.830	2.294	0.033	0.632	0.558	0.12	MP
1.94	2.23	-4.62	-12.91	-8.07	-5.25	6.59	0.48	1.72	6.01		
-0.070	0.766	-2.301	-0.133	-4.371	-2.437	2.615	0.145	0.236	0.585	0.07	FP
-1.02	9.24	-8.30	-7.25	-10.60	-4.44	2.29	1.79	1.50	3.58		
0.355	0.765	0.786	-0.241	-3.807	-1.385	2.317	0.320	0.193	0.571	0.09	INFL
2.70	8.79	2.70	-11.74	-9.43	-2.73	2.99	3.11	1.21	6.41		
0.765	0.541	-0.036	-0.215	-4.287	-2.292	2.489	0.243	0.419	0.584	0.10	INTR
1.67	3.11	-3.05	-16.12	-9.31	-4.54	2.31	2.57	2.14	6.17		
-0.160	0.441	-0.946	-0.535	-4.788	-2.877	2.274	0.341	0.238	0.560	0.06	EXCR
-1.42	11.09	-2.94	-6.04	-11.24	-4.57	2.32	2.62	3.99	4.65		
-0.039	0.396	-1.928	-0.581	-4.733	-2.692	2.852	0.128	0.337	0.584	0.05	ENGY
-0.66	9.35	-6.76	-2.84	-14.14	-4.85	1.71	0.76	1.04	2.95		
0.360	0.676	-1.018	-0.268	-2.285	-2.316	2.268	0.235	0.418	0.551	0.12	PTRL
2.58	8.98	-3.57	-13.85	-17.23	-3.86	2.49	2.05	2.02	4.54		
-0.155	0.353	-0.851	-0.001	-4.912	-2.831	3.049	0.242	0.426	0.601	0.04	DISE
-1.80	18.48	-6.83	-1.70	-58.02	-4.54	2.84	1.01	1.42	11.01		
-0.099	0.371	-0.156	-0.069	-4.943	-3.006	2.988	0.341	0.351	0.616	0.03	HLTH
-0.69	7.79	-8.01	-2.14	-20.70	-6.57	2.16	1.62	1.50	5.27		
C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel D. GM real stock return											
-0.177	1.156	-1.251	-0.116	-2.395	-3.677	2.684	0.099	0.070	0.561	0.10	NEWS
-1.23	8.96	-4.51	-10.81	-4.00	-7.04	4.55	1.81	1.09	4.77		
0.232	0.700	-0.760	-0.199	-3.533	-4.088	2.463	0.162	0.318	0.552	0.10	MP
3.15	9.34	-3.00	-12.46	-6.60	-17.72	3.17	2.37	2.30	4.82		
-0.506	1.084	-1.667	-0.155	-4.263	-3.527	2.914	0.053	0.024	0.578	0.07	FP
-2.89	8.94	-10.09	-10.06	-8.91	-4.88	1.86	1.90	0.41	2.68		

0.213	0.834	-0.561	-0.276	-3.618	-4.452	2.594	0.164	0.121	0.551	0.11	INFL
7.36	9.73	-2.23	-12.48	-12.10	-5.41	2.85	2.30	2.57	4.28		
0.205	0.676	-0.995	-0.211	-4.353	-1.387	2.106	0.215	0.626	0.514	0.10	INTR
0.97	7.02	-4.81	-12.18	-16.42	-4.11	3.01	1.98	2.64	5.82		
-0.490	0.543	-0.926	-0.682	-4.887	-3.891	2.800	0.180	0.229	0.561	0.05	EXCR
-2.93	7.20	-3.63	-6.18	-11.29	-6.21	2.51	1.15	1.35	4.18		
-0.431	0.583	-1.223	-0.639	-4.316	-2.163	2.951	-0.059	0.458	0.544	0.04	ENGY
-0.68	1.93	-6.10	-2.85	-11.76	-8.58	2.73	-1.53	1.56	4.22		
-0.040	0.934	-1.227	-0.303	-3.115	-3.591	2.680	0.136	0.083	0.566	0.11	PTRL
-1.65	13.71	-6.72	-15.13	-6.75	-6.22	4.66	1.64	0.90	5.56		
-0.562	0.534	-1.008	-0.002	-4.656	-3.851	3.168	0.141	0.328	0.595	0.02	DISE
-3.25	11.34	-8.42	-1.65	-17.83	-53.84	3.51	1.51	2.48	8.36		
-0.439	0.545	-0.875	-0.139	-4.671	-2.151	3.170	0.146	0.290	0.597	0.02	HLTH
-0.92	3.06	-3.65	-1.90	-15.40	-2.38	2.16	1.16	1.35	5.01		
Panel E. IT real stock return											
-0.765	1.126	-2.976	-0.124	-2.741	-1.329	3.612	0.121	0.472	0.578	0.10	NEWS
-1.23	5.72	-9.19	-11.48	-4.27	-1.80	2.56	3.03	3.40	6.32		
0.358	0.509	-1.869	-0.218	-2.535	-1.340	3.168	0.186	0.755	0.552	0.12	MP
2.52	7.05	-4.21	-10.95	-4.26	-1.73	1.81	1.58	1.85	3.97		
-1.407	1.093	-2.630	-0.159	-4.636	-1.680	3.835	0.109	0.358	0.581	0.07	FP
-1.50	3.27	-6.84	-7.27	-8.27	-2.18	2.09	1.94	3.00	4.41		
-0.429	1.103	-5.392	-0.238	-4.665	-0.754	3.993	0.150	0.051	0.600	0.02	INFL
-1.29	8.77	-9.90	-8.60	-36.73	-0.77	1.69	1.82	1.51	3.20		
-0.362	0.812	-2.259	-0.197	-5.349	-1.559	3.496	0.236	0.190	0.569	0.09	INTR
-1.13	7.56	-4.93	-8.34	-8.83	-2.26	2.02	2.05	2.82	3.94		
-2.266	1.116	-1.756	-0.883	-5.255	-1.565	3.993	0.164	0.164	0.574	0.04	EXCR
-1.63	2.12	-3.71	-6.22	-13.21	-2.31	2.69	1.53	2.62	5.47		
-1.402	0.899	-2.387	-1.325	-5.127	-1.426	3.939	0.186	0.361	0.570	0.05	ENGY
-1.47	2.72	-5.33	-8.72	-11.47	-2.17	2.40	1.80	1.78	6.07		
-0.818	0.998	-2.995	-0.349	-1.967	-1.660	3.750	0.136	0.414	0.580	0.11	PTRL
-2.18	9.22	-6.29	-17.91	-3.94	-20.30	2.58	3.81	1.90	4.94		
-1.417	0.865	-0.967	-0.003	-6.307	-3.025	4.139	0.168	0.105	0.597	0.01	DISE
-1.60	2.85	-4.44	-1.73	-13.34	-5.19	2.39	9.92	1.34	5.61		
-1.254	0.727	-1.635	-0.457	-5.194	-1.729	3.456	0.165	0.426	0.593	0.06	HLTH
-1.42	2.20	-4.29	-5.63	-18.81	-6.54	2.61	1.87	1.49	7.13		
C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel F. UK real stock return											
0.091	1.244	-0.660	-0.100	-3.667	-0.628	1.471	0.134	0.027	0.558	0.14	NEWS
1.49	9.10	-7.66	-19.80	-19.37	-2.12	3.56	2.94	1.72	6.18		
0.266	0.804	-0.726	-0.166	-2.813	-4.560	1.384	0.223	0.200	0.534	0.12	MP
2.79	11.29	-6.22	-19.77	-17.23	-8.09	5.04	3.89	3.15	10.69		
-0.255	1.178	-0.652	-0.125	-3.809	-0.941	1.598	0.131	0.033	0.567	0.08	FP
-1.56	11.05	-3.74	-10.47	-10.43	-2.42	4.83	2.32	0.60	7.24		
0.127	1.164	-0.745	-0.207	-4.287	-6.276	1.533	0.110	0.011	0.570	0.06	INFL
1.95	10.87	-9.13	-21.82	-75.49	-19.15	4.72	3.14	0.32	9.41		
0.272	0.813	-0.605	-0.184	-4.146	-0.475	1.415	0.232	0.209	0.541	0.13	INTR
1.28	7.25	-3.45	-13.20	-12.43	-2.92	3.44	2.43	2.59	7.18		
-0.572	0.804	-0.603	-0.688	-4.034	-1.305	1.568	0.221	0.178	0.554	0.04	EXCR
-2.40	7.50	-4.04	-9.61	-10.03	-2.21	2.88	2.23	1.65	6.50		
-0.555	0.912	-0.952	-0.871	-3.903	-1.250	1.678	0.164	0.107	0.570	0.04	ENGY
-1.95	7.16	-5.55	-4.58	-20.67	-15.04	3.12	1.57	2.18	6.22		
0.113	0.702	-1.156	-0.195	-2.806	-0.317	1.561	0.256	0.219	0.561	0.13	PTRL
1.05	10.06	-6.49	-16.64	-19.33	-3.76	3.27	1.76	1.41	6.50		
-0.459	0.714	-0.277	-0.016	-4.028	-1.107	1.769	0.174	0.190	0.484	0.04	DISE
-2.12	7.19	-3.22	-2.38	-16.45	-3.25	3.32	1.56	1.07	4.89		
-0.391	0.704	-0.621	-0.127	-4.008	-0.865	1.632	0.113	0.259	0.549	0.03	HLTH
-5.04	10.69	-6.87	-2.43	-18.88	-3.08	3.06	1.53	1.63	5.45		
Panel G. JP real stock return											
1.043	0.396	-0.085	-0.108	-2.498	-0.475	3.519	0.149	0.086	0.617	0.08	NEWS
1.07	1.00	-0.78	-21.96	-4.20	-1.12	1.14	2.45	2.46	2.54		
0.991	0.155	-0.279	-0.191	-3.339	-0.101	3.044	0.204	0.107	0.619	0.11	MP
4.67	2.15	-1.49	-14.15	-42.41	-0.22	0.76	0.47	0.35	1.40		
0.201	0.416	-0.442	-0.106	-3.573	-2.075	3.431	0.158	0.133	0.613	0.03	FP
0.79	4.02	-1.68	-7.15	-6.37	-11.29	1.37	1.07	1.66	2.66		
1.044	0.370	0.220	-0.265	-3.636	-2.121	3.056	0.150	0.065	0.599	0.10	INFL
1.72	1.38	1.28	-17.25	-6.57	-18.73	4.37	1.14	0.33	5.18		
0.869	0.340	0.690	-0.244	-2.152	-1.105	3.268	0.200	0.207	0.568	0.10	INTR
2.14	1.94	3.23	-17.71	-2.89	-1.48	5.19	0.90	0.99	5.14		
-0.359	0.471	-0.402	-1.092	-3.462	-3.780	3.193	0.162	0.142	0.599	0.04	EXCR
-0.61	1.98	-1.64	-18.77	-10.22	-7.08	1.42	1.09	1.15	2.93		
-0.495	0.456	0.060	-0.335	-3.398	-3.578	3.285	0.100	0.060	0.593	0.01	ENGY
-3.96	6.96	0.46	-2.21	-7.86	-6.43	3.62	0.62	0.47	6.02		
0.584	0.575	-0.435	-0.297	-2.365	-0.013	3.055	0.157	0.081	0.603	0.08	PTRL
1.21	3.11	-2.24	-20.45	-9.38	-0.43	1.68	2.25	1.58	3.87		
1.676	-0.795	0.593	0.021	-3.131	-3.813	0.242	-0.034	0.100	0.942	0.04	DISE
2.03	-1.82	1.18	1.35	-4.34	-6.34	1.90	-1.13	1.53	41.79		
-0.757	0.438	-0.219	0.125	-3.195	-3.427	3.698	-0.031	0.195	0.608	0.02	HLTH
-0.53	0.73	-0.76	2.12	-5.35	-4.74	1.08	-0.69	0.74	1.81		

Note: Dependent variable is real stock return for country j. The independent variables are a constant term, expected inflation and a covariance between state variable x and equity market volatility, Indicator variables for 2008-09 global finance crises and 2019-20 COVID-19 the conditional variance using TARCH(1,1)-M. x :{NEWS, MP, FP, INFL, INTR, EXCH, ENGY, PTRL, DISE, HLTH} denotes {News and Outlook, Monetary Policy, Fiscal Policy, Inflation, Interest rate, Exchange rate, Energy, Petroleum, Disease infection, and Health, respectively}. The numbers in the first row are the estimated coefficients, the row below contains the z-statistics. The critical values of z-distribution at the 1%, 5%, and 10% levels of significance are 2.58, 1.96, and 1.65, respectively. $\bar{R}^2$ is the adjusted R-squared, respectively. $\bar{R}^2$ is the adjusted R-squared. See panel A.

Evidence of financial contagion (Bekaert et al., 2005; Chiang et al., 2007; Forbes, 2012) suggests that volatility in the US tends to spillover to global markets although the impacts vary from market/country to market/country due to different financial integration and market openness (Georgiadis, 2016; Chen et al., 2018). Estimates from Panels B-G in Table 4, which report the results of the other G7 markets based on inflation expectations and different categorical equity market volatilities, shed additional light on the behavior of real stock returns. The evidence shows that non-US markets in G-7 produce very comparable results as those in the US market. The exceptions are the Japanese market in the equations using $emv_{DISE,t}$, $emv_{HLTH,t}$, $emv_{DISE,t}$ and $emv_{HLTH,t}$. This outcome should not be surprising as the Japanese economy has suffered from a "lost decade" that has extended to the Shinzo Abe's administration, which adopted a series of expansionary monetary and fiscal policies to resolve Japan's pessimistic economic condition of low inflation and interest rates.[10] The finding for the Japanese market, however, is partly consistent with the results of Hiraki (1985), who tests Japanese data and reaches the conclusion that inflation does not appear to be a significant determinant of real stock returns. With respect to the other five markets, including CA, FR, GM, IT and UK, the performances of financial uncertainty measure($emv_{MP,t}$,$emv_{FP,t}$, $emv_{INFL,t}$, $emv_{INTR,t}$, $emv_{EXCR,t}$) are very much in line with that in the US market. Yet, the significance level is lower for nonfinancial measure ($emv_{DISE,t}$ and $emv_{HLTH,t}$), since parametric effects of organizing and structuring the DISE and HLTH are mainly subjected to each country's institutional arrangements.

5.2. Evidence from emerging markets

As anticipated, news of US $emv_{x,t}$ can also spillover to emerging markets through the contagion effect (Chiang et al., 2007; Wang et al., 2018; Chiang, 2020). The results, which draw on data from eight different emerging (EM8) markets, are reported in Table 5. In general, the findings are consistent with those reported in the US market. First, the coefficients of conditional variance are positive, confirming the risk-return trade off hypothesis. However, the performance in China and in some cases India fails to show a positive relationship, suggesting that investors in these markets exhibit different attitudes toward risk. In both China and in some cases India, the negative relationship between stock return and volatility could be attributable to a volatility feedback effect, which is linked to a condition of persistent volatility that raises expected future volatility and, hence, the required return on stocks. This dynamic has a negative effect on the current stock prices (Bekaert and Wu, 2000; Bae et al., 2002).

Second, the coefficients of the expected inflation in most markets exhibit negative signs. The findings are consistent with the hypotheses proposed by Fama (1981) and Geske and Roll (1983). One exception is the India market where the coefficients of inflation expectations are positive and statistically significant. This result is essentially due to the fact that the expected inflation dominates the nominal stock return, which produces a negative real return in the Indian market (see Table 1). However, when the nominal return is used as a dependent variable to estimate the equation, the estimated coefficient of the inflation expectation turns negative.[11] This finding

[10] Japan experienced a period of economic stagnation and price deflation from 1991 through 2001, which is known as "Japan's Lost Decade." A survey of historical price movements in the Japanese stock market can be found in Hamao (2018).

[11] Using $emv_{News,,t}$ as a regressor, the estimated results for using nominal return in India is as follows.

	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{News,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$
2.922	0.554	-0.225	-0.263	-3.629	4.175	9.858	0.505	-0.214	0.740	0.05
3.12	2.72	-2.11	-15.13	-2.72	-4.13	1.29	1.81	-0.89	6.30	

contrasts with results in previous studies (Kumari, 2011; Bhandari and Bandi, 2017) that find no significant relationship between stock returns and inflation in the Indian market.

Table 5. Estimates of inflation expectation and U.S. policy changes induced equity market volatility to affect emerging stock returns.

C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\vert\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel A. CN real stock return											
1.168	0.115	-0.158	-0.087	-4.211	1.347	9.475	1.186	0.063	0.618	0.02	NEWS
4.92	1.83	-1.02	-10.97	-5.14	13.63	1.05	1.04	0.05	2.88		
1.255	-0.013	-0.536	-0.192	-5.617	0.941	2.562	0.512	0.074	0.690	0.01	MP
19.15	-1.02	-4.15	-15.61	-4.90	3.31	1.20	1.30	0.19	4.34		
1.507	-0.048	-0.100	-0.153	-3.659	0.271	6.210	0.882	0.524	0.752	0.02	FP
4.00	-0.55	-2.12	-8.41	-2.18	0.41	0.86	1.03	1.02	6.50		
1.653	-0.124	-0.082	-0.186	-4.415	0.155	1.448	0.228	0.015	0.676	0.03	INFL
2.02	-0.35	-0.12	-2.79	-2.99	0.09	2.20	2.22	0.13	6.88		
0.906	0.096	-0.409	-0.177	-5.396	0.430	3.534	1.180	0.901	0.611	0.02	INTR
3.26	1.37	-1.71	-10.50	-5.85	0.95	0.90	1.15	1.40	3.45		
-0.317	0.343	-0.490	-1.875	-4.662	0.345	1.848	0.608	0.233	0.741	0.04	EXCR
-1.34	5.11	-2.32	-13.34	-2.73	0.68	0.97	1.67	1.09	8.57		
1.504	-0.250	-0.001	-1.760	-4.029	0.067	14.052	0.544	0.384	0.702	0.01	ENGY
1.50	-1.10	-2.00	-10.38	-4.13	0.07	0.80	0.68	0.30	2.32		
2.243	-0.092	-0.035	-0.345	-3.242	1.186	14.643	1.116	1.494	0.634	0.05	PTRL
23.18	-5.64	-0.37	-23.35	-2.74	10.65	0.77	0.72	0.56	2.09		
1.072	-0.179	-0.471	-0.029	-5.698	0.908	6.905	0.553	0.424	0.719	0.01	DISE
2.49	-1.61	-5.15	-2.05	-4.12	1.07	1.18	1.78	0.48	7.00		
1.173	-0.178	-0.341	-0.203	-4.317	0.624	13.550	0.577	0.424	0.666	0.01	HLTH
1.46	-0.91	-2.55	-1.95	-46.28	0.77	0.92	0.77	1.15	2.88		
C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\vert\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x
Panel B. ID real stock return											
-1.975	1.740	-0.467	-0.160	-2.760	2.361	3.569	0.487	-0.113	0.564	0.11	NEWS
-4.02	12.48	-3.36	-17.96	-11.27	7.59	4.03	4.03	-1.34	9.67		
-2.276	1.825	-1.266	-0.274	-2.913	1.005	3.905	0.421	-0.088	0.579	0.16	MP
-1.61	3.61	-8.09	-14.86	-6.08	5.27	3.28	2.81	-3.19	8.79		
-1.953	1.506	-0.495	-0.185	-3.723	0.364	3.409	0.435	-0.060	0.551	0.07	FP
-1.90	4.54	-3.01	-9.30	-3.39	1.65	3.31	3.94	-3.26	11.09		
-3.297	1.968	-0.621	-0.128	-3.247	-0.104	2.919	0.519	-0.317	0.575	0.04	INFL
-7.59	17.34	-3.08	-6.37	-6.57	-0.25	4.69	3.65	-2.83	9.54		
-2.435	2.126	-1.123	-0.359	-3.494	0.028	4.307	0.167	-0.005	0.570	0.16	INTR
-3.20	10.73	-6.72	-14.70	-6.46	0.11	5.63	3.58	-0.11	12.44		
-4.184	2.165	-1.653	-1.447	-3.458	-0.650	5.583	0.118	0.004	0.562	0.07	EXCR
-1.56	2.35	-7.98	-7.97	-6.02	-3.00	3.44	2.35	4.45	6.20		
-2.290	1.358	-1.676	-1.038	-2.968	-0.288	5.399	0.168	0.059	0.568	0.05	ENGY
-1.35	2.34	-7.42	-2.83	-8.65	-0.43	2.35	1.79	1.11	4.78		
-1.950	1.504	-1.571	-0.333	-3.697	3.425	3.428	0.603	0.131	0.529	0.08	PTRL
-2.52	6.12	-8.30	-12.38	-4.77	6.28	3.17	3.05	3.70	8.87		
-2.285	1.258	-1.192	-0.040	-3.532	1.008	3.699	0.367	0.183	0.504	0.02	DISE
-2.73	4.29	-6.13	-3.32	-4.89	1.26	3.00	2.91	1.46	6.27		
-2.128	1.380	-1.202	-0.395	-3.189	0.406	3.013	0.456	-0.131	0.566	0.03	HLTH
-10.32	14.04	-6.51	-3.83	-4.82	3.23	7.92	3.28	-1.06	10.27		
Panel C. IN real stock return											
1.043	2.764	0.486	-0.432	-0.266	-3.917	-4.033	8.030	0.455	-0.133	0.770	NEWS
1.07	2.56	2.07	-2.90	-15.33	-5.94	-2.50	1.09	1.79	-1.76	7.01	
0.991	4.636	0.033	-0.380	-0.579	-5.518	-2.823	7.525	0.416	-0.201	0.808	MP
4.67	21.03	6.10	-9.03	-20.59	-3.86	-1.53	1.00	1.99	-0.54	11.08	
0.201	1.940	0.476	-0.626	-0.401	-11.042	-4.775	9.349	0.555	-0.180	0.696	FP
0.79	1.43	1.54	-3.51	-15.74	-34.98	-2.73	1.95	2.21	-0.91	9.15	
1.044	2.870	0.619	-0.368	-0.707	-7.481	-1.337	30.735	0.528	-0.236	0.594	INFL
1.72	1.11	1.16	-2.54	-29.06	-3.94	-0.74	1.48	1.55	-1.24	3.10	
0.869	2.292	0.699	-0.560	-0.644	-7.443	-3.991	37.265	0.367	-0.047	0.566	INTR
2.14	3.16	4.29	-4.27	-13.30	-5.91	-9.69	1.18	1.24	-0.66	1.88	
-0.359	-1.292	0.783	-0.645	-2.129	-14.603	-6.133	15.754	0.722	-0.482	0.672	EXCR
-0.61	-0.73	2.03	-4.16	-7.75	-4.61	-4.19	1.61	1.72	-1.49	5.93	
-0.491	-1.583	0.713	-0.549	-0.278	-15.044	-5.902	45.781	0.200	0.619	0.601	ENGY
-0.88	-0.95	2.23	-4.15	-2.47	-4.72	-4.05	1.64	1.90	1.54	4.12	
0.514	0.416	2.644	-0.522	-0.705	-4.423	-2.815	29.717	0.343	0.003	0.604	PTRL
1.94	2.11	2.48	-3.24	-12.42	-2.90	-4.02	1.24	1.49	0.23	2.63	
1.676	-1.465	0.780	-1.309	0.025	-14.081	-5.856	1.974	0.220	-0.119	0.851	DISE
2.03	-0.88	1.82	-4.48	0.57	-4.41	-2.86	1.18	2.07	-1.09	13.43	
-0.757	-0.798	0.584	-0.667	-0.023	-14.919	-5.523	3.666	0.566	-0.276	0.778	HLTH
-0.53	-2.64	7.23	-7.19	-0.38	-4.38	-8.43	1.16	1.98	-1.06	9.14	
C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\vert\varepsilon^-_{t-1}$	σ^2_{t-1}	$\bar{R}^2$	x

The evidence of this equation indicates a negative relationship between nominal stock return and expected inflation.

Panel D. KO real stock return											
-0.289	0.421	-1.954	-0.053	-1.684	-3.223	3.835	0.480	0.293	0.600	0.01	NEWS
-2.04	13.22	-9.65	-12.12	-1.63	-5.14	2.15	1.64	0.85	4.95		
0.311	0.269	-2.043	-0.127	-1.891	-2.914	0.762	0.230	0.302	0.823	0.02	MP
0.91	2.04	-7.18	-9.78	-12.27	-3.95	1.15	1.22	1.21	17.51		
-0.525	0.465	-2.520	-0.077	-2.248	-2.406	4.506	0.577	0.389	0.583	0.02	FP
-2.68	10.24	-10.94	-4.01	-2.27	-2.62	2.90	4.58	1.21	6.18		
0.551	0.411	-2.054	-0.242	-2.169	-3.958	4.603	0.495	0.322	0.555	0.03	INFL
4.91	5.31	-7.96	-9.42	-2.17	-13.47	2.11	2.15	2.13	4.48		
-0.024	0.479	-1.822	-0.163	-2.607	-2.734	2.155	0.385	0.325	0.643	0.03	INTR
-0.37	6.58	-5.23	-6.85	-8.23	-6.26	1.66	1.43	0.98	4.47		
-1.165	0.700	-1.470	-0.578	-2.839	-3.022	6.788	0.150	0.052	0.585	0.01	EXCR
-3.86	9.37	-5.60	-4.56	-3.08	-2.72	1.95	1.09	0.34	3.46		
-0.506	0.365	-2.129	-0.605	-4.620	-1.920	5.699	0.361	0.278	0.530	0.02	ENGY
-1.04	2.45	-12.35	-2.49	-21.19	-2.11	1.61	1.63	1.02	3.30		
0.192	0.369	-2.642	-0.183	-1.670	-2.291	5.242	0.457	0.443	0.541	0.02	PTRL
0.78	4.25	-8.96	-5.67	-1.73	-2.69	1.56	1.94	2.51	2.91		
-0.745	0.426	-2.223	0.031	-4.758	-2.869	0.888	0.075	0.295	0.831	0.02	DISE
-1.56	2.29	-6.69	3.20	-6.18	-2.75	1.56	1.45	1.56	23.64		
-0.729	0.407	-1.841	0.000	-4.831	0.134	4.909	0.399	0.535	0.522	0.01	HLTH
-1.11	1.84	-5.36	-0.01	-23.22	0.55	1.56	1.17	0.97	2.63		
Panel E. MA real stock return											
1.046	0.188	-0.513	-0.071	-1.375	-1.625	0.155	0.537	0.007	0.773	0.01	NEWS
8.36	3.42	-2.33	-18.87	-2.13	-6.22	0.65	2.26	0.09	12.93		
0.905	0.105	-0.637	-0.118	-1.586	-1.575	0.177	0.304	0.114	0.804	0.02	MP
8.13	2.27	-3.09	-10.74	-2.25	-4.02	1.09	1.44	1.43	10.22		
0.607	0.139	-0.906	-0.102	-2.340	-1.646	0.630	0.469	0.372	0.691	0.01	FP
4.71	2.29	-7.92	-13.06	-10.36	-7.44	1.34	1.55	1.48	7.70		
0.617	0.368	-0.764	-0.118	-2.772	-0.481	0.094	0.180	0.058	0.794	0.02	INFL
3.39	3.14	-1.84	-4.41	-4.58	-1.10	1.35	2.81	0.79	15.83		
0.695	0.207	-0.664	-0.151	-2.895	-1.596	0.381	0.635	0.500	0.723	0.02	INTR
6.55	6.06	-4.17	-11.74	-12.41	-4.09	1.73	1.85	1.07	10.87		
-0.207	0.322	-1.024	-0.722	-3.260	-1.994	2.557	0.796	-0.026	0.489	0.01	EXCR
-1.30	5.73	-15.15	-26.86	-4.55	-4.49	1.89	3.59	-1.35	3.36		
0.439	0.027	-0.899	-0.929	-2.983	-0.720	0.230	0.623	0.556	0.788	0.00	ENGY
5.55	0.80	-7.02	-9.25	-3.41	-8.09	1.97	1.03	0.62	7.39		
0.962	0.097	-0.423	-0.222	-1.224	-1.285	0.407	0.504	0.359	0.727	0.03	PTRL
7.74	1.37	-2.00	-10.34	-1.79	-2.76	1.08	1.66	0.73	8.14		
0.219	0.029	-0.546	-0.019	-3.962	-1.700	2.683	0.574	0.669	0.844	0.01	DISE
5.12	2.29	-4.35	-6.41	-7.48	-4.19	0.84	0.72	0.66	7.85		
0.304	0.050	-0.955	-0.158	-3.149	-1.840	0.292	0.364	0.200	0.737	0.01	HLTH
3.00	0.86	-6.90	-2.13	-3.99	-3.62	1.16	1.37	0.79	7.25		
C	$\ln\sigma_{j,t}^2$	$\Delta p_{j,t}^e$	$emv_{x,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε_{t-1}^2	$\varepsilon_{t-1}^2 \mid \varepsilon_{t-1}^-$	σ_{t-1}^2	$\bar{R}^2$	x
Panel F. BR real stock return											
-2.690	1.967	-1.210	-0.135	0.152	0.530	4.897	0.153	0.001	0.568	0.06	NEWS
-1.07	2.15	-3.68	-9.51	0.20	0.77	2.68	1.44	0.38	5.00		
-2.933	2.063	-0.937	-0.270	-0.283	1.030	4.639	0.124	0.013	0.560	0.07	MP
-0.78	1.43	-2.78	-10.73	-0.72	1.01	2.34	1.07	0.77	4.16		
-2.396	1.593	-1.670	-0.168	-1.530	0.222	4.748	0.122	0.223	0.557	0.02	FP
-1.25	2.26	-4.90	-5.80	-1.56	0.54	2.55	1.27	1.33	4.58		
-5.351	3.053	-2.091	-0.306	-1.755	-0.824	4.714	0.133	-0.005	0.561	0.06	INFL
-1.80	2.93	-5.50	-9.03	-2.43	-0.81	2.98	3.40	-0.47	6.20		
-4.675	2.435	-0.901	-0.146	-4.761	1.642	4.948	0.058	-0.032	0.577	0.03	INTR
-1.03	1.40	-2.77	-5.89	-5.86	2.12	1.33	1.42	-0.71	2.04		
-4.997	2.426	-0.594	-2.206	-4.788	-2.875	4.499	0.080	-0.017	0.565	0.06	EXCR
-7.66	13.31	-2.24	-16.68	-19.66	-3.32	5.64	2.82	-0.77	6.94		
-3.341	1.549	-0.490	-0.438	-4.534	-0.201	4.930	0.072	0.066	0.568	0.01	ENGY
-1.39	1.77	-1.41	-2.24	-4.80	-0.17	2.54	0.84	0.81	3.65		
-1.130	1.163	-2.375	-0.340	-0.124	1.603	4.515	0.258	0.169	0.603	0.03	PTRL
-2.07	8.81	-8.60	-14.68	-0.16	3.61	2.84	2.21	1.21	6.27		
-3.740	1.722	-0.511	-0.043	-4.030	0.210	4.869	0.117	0.032	0.549	0.02	DISE
-2.03	2.63	-1.26	-2.49	-4.70	0.57	2.10	1.35	0.34	3.22		
-2.811	1.396	-1.333	-0.538	-4.805	-0.180	5.003	0.134	0.106	0.584	0.01	HLTH
-1.85	2.86	-5.22	-6.56	-6.21	-0.15	2.17	3.54	2.41	4.60		
Panel G. MX real stock return											
-0.806	1.273	-0.334	-0.100	-4.485	-3.006	3.577	0.164	0.030	0.565	0.04	NEWS
-0.66	2.56	-2.68	-10.66	-9.36	-5.77	2.65	1.77	0.32	5.68		
-0.915	1.030	-0.758	-0.106	-4.250	-2.369	2.388	0.448	0.125	0.521	0.04	MP
-2.25	8.16	-5.83	-7.61	-9.59	-5.04	2.83	5.69	0.81	6.83		
-1.179	1.094	-0.682	-0.065	-4.117	-2.417	2.058	0.612	-0.256	0.521	0.04	FP
-1.62	3.68	-3.33	-3.67	-7.40	-8.21	2.62	2.74	-1.49	6.10		
0.817	0.470	-0.409	-0.173	-3.899	-1.290	0.036	0.107	-0.028	0.908	0.08	INFL
3.78	3.27	-2.04	-5.14	-5.62	-2.56	0.84	1.71	-0.45	25.55		
-1.390	1.586	-0.443	-0.270	-4.396	-1.832	3.440	0.169	-0.001	0.557	0.08	INTR
-3.41	11.80	-5.16	-11.91	-10.53	-2.87	3.25	4.77	-0.05	5.37		
-3.247	1.787	-0.619	-0.317	-4.059	-2.398	3.326	0.178	-0.021	0.547	0.06	EXCR
-4.44	6.60	-5.28	-4.57	-10.12	-4.64	5.79	4.38	-0.49	7.42		
-2.069	1.268	-0.661	-0.633	-3.102	-2.590	3.672	0.228	0.031	0.561	0.02	ENGY

-4.77	10.35	-5.53	-5.64	-5.36	-4.67	2.92	2.52	0.79	5.14		
-0.660	1.117	-0.628	-0.232	-4.388	-2.971	3.970	0.100	-0.026	0.591	0.03	PTRL
-3.81	12.84	-3.95	-15.51	-9.59	-6.27	2.62	2.13	-0.39	3.74		
-2.544	1.420	-0.850	-0.018	-4.126	-2.097	3.585	0.157	-0.003	0.564	0.03	DISE
-1.83	2.63	-10.32	-6.13	-12.26	-4.27	2.63	4.63	-5.12	5.40		
-1.664	1.148	-0.455	-0.406	-4.162	-2.371	3.472	0.224	0.019	0.543	0.03	HLTH
-2.13	3.70	-2.52	-4.84	-39.23	-4.99	2.57	1.56	0.59	3.85		

C	$\ln\sigma_{j,t}^2$	$\Delta p_{j,t}^e$	$emv_{x,,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε_{t-1}^2	$\varepsilon_{t-1}^2 \mid \varepsilon_{t-1}^-$	σ_{t-1}^2	$\bar{R}^2$	x
Panel H. PR real stock return											
-5.179	3.697	-3.458	-0.159	-1.477	-0.521	3.481	0.109	-0.005	0.548	0.06	NEWS
-2.75	4.96	-12.01	-17.69	-1.89	-2.47	4.36	4.80	-1.16	8.84		
-5.117	3.425	-1.781	-0.270	-0.614	0.148	3.648	0.087	-0.021	0.536	0.11	MP
-14.50	18.72	-6.68	-14.82	-1.34	1.78	3.21	2.65	-1.71	4.83		
0.547	0.543	-1.922	-0.121	-2.297	-0.828	0.587	0.115	0.046	0.752	0.07	FP
0.92	1.54	-3.11	-3.36	-1.80	-1.04	2.08	1.68	0.55	8.26		
-9.503	3.973	-0.784	-0.306	-0.696	-0.454	7.632	0.162	-0.034	0.524	0.08	INFL
-20.27	16.49	-4.33	-17.09	-1.94	-4.85	4.36	2.95	-0.70	6.00		
-8.974	4.829	-2.200	-0.241	-0.926	-0.077	4.227	0.053	-0.004	0.516	0.07	INTR
-6.98	7.85	-7.34	-15.07	-1.81	-0.26	4.03	3.14	-1.82	6.44		
-3.199	1.959	-2.242	-1.339	-0.880	-0.950	3.197	0.055	-0.012	0.552	0.06	EXCR
-14.81	13.07	-9.99	-10.54	-1.30	-2.94	3.89	6.65	-1.84	4.37		
-6.646	3.663	-3.443	-0.980	-1.492	-0.618	3.307	0.057	-0.017	0.558	0.02	ENGY
-2.58	3.18	-13.65	-5.14	-2.06	-1.09	4.24	4.17	-1.46	5.44		
-3.992	3.084	-3.157	-0.377	-0.242	0.626	2.865	0.096	-0.006	0.564	0.09	PTRL
-2.30	4.50	-11.58	-18.21	-1.43	11.52	3.58	10.60	-0.27	7.42		
-8.686	3.869	-2.795	0.005	-1.387	-1.342	3.828	0.055	0.005	0.637	0.00	DISE
-3.73	3.82	-23.63	0.59	-3.08	-4.16	22.33	2.44	0.23	10.00		
-0.818	1.165	-1.560	-0.202	-5.374	-4.219	1.821	0.123	0.018	0.578	0.05	HLTH
-2.48	6.57	-5.58	-3.38	-15.22	-54.00	2.48	2.61	2.08	4.15		

Note: Dependent variable is real stock return. The independent variables are a constant term, expected inflation and a covariance between state variable x and equity market volatility, dummy variables for 2008-09 global finance crises and 2019-20 COVID-19 plus the conditional variance using TARCH(1,1)-M. x :{NEWS, MP, FP, INFL, INTR, EXCH, ENGY, PTRL, DISE, HLTH} denotes {News and Outlook, Monetary Policy, Fiscal Policy, Inflation, Interest rate, Exchange rate, Energy, Petroleum, Disease infection, and Health, respectively}. The numbers in the first row are the estimated coefficients, the row below contains the z-statistics. The critical values of z-distribution at the 1%, 5%, and 10% levels of significance are 2.58, 1.96, and 1.65, respectively. $\bar{R}^2$ *is the adjusted R-squared, respectively.* $\bar{R}^2$ *is the adjusted R-squared. See panel A.*

Third, a striking result that emerges from the estimates is the coefficients of $emv_{x,t}$, which all display significantly negative signs; the only exceptions are those equations using variables of $emv_{DISE,t}$ and $emv_{HLTH,t}$ in S. Korea and Peru. The exceptional effect of the estimated results may stem from a lack of an effective coordinated response on the part of different governments to manage the pandemic as well as the adoption of different measures and delayed timing that weakened a response to deal with the pandemic. In any case, evidence points to the effect that damaging news released from the US categorical equity market volatility spilled over to different emerging markets. These findings are consistent with Chiang's study (2023), which finds that the negative impacts of equity market volatility (EMV) associated with heightened inflation rate and rate hikes spilled over to real stock returns in major global economies. However, this study extends the analysis to other categorical EMV and yields evidence of the significantly adverse effects to global markets.

Before concluding this section, it should be mentioned that the indicator variable for the global financial crise, $I_{GFC,t}$, shows consistent performance as represented by statistically significant negative signs. These results are consistent with the findings in the literature (Cheema et al., 2020; Terry et al., 2020; Chiang, 2022; Chiang and Tang, 2023). Comparable results hold true for $I_{COVID,t}$ in the G7 markets. Again, the exception is the Japanese market, where some coefficients are insignificant. Note that the performance of $I_{COVID,t}$ in emerging markets is a bit diverse, depending on the degree to which the government implemented controls or regulation to deal with the pandemic (see IMF report, 2021). The coefficients in China for the 2020-21 COVID-19 period exhibit positive signs, which may be attributable to the adoption of a more restrictive policy via a centralized or home quarantine approach and a mandate of mask wearing in public places. In fact, many other countries installed quarantine and social/physical distancing measures to prevent the further spread of the virus. The coefficients of the $I_{COVID,t}$ in India, Indonesia, S. Korea, Malaysia, Mexico and Peru mainly present negative signs, which in some cases are statistically insignificant. Yet, Indonesia and Brazil have mixed signs and some of the coefficients are statistically significant. The discrepancy of coefficients among different countries may be related to different healthcare infrastructure and the heterogeneity among the countries in terms of health, social and economic factors as well as the government's capacity to deal with the pandemic (Stojko ski. et al., 2022). Whatever the reason, the inclusion of indicator variables in the test equation helps to control some extreme observations and alleviate the estimated biases (Peña, 2001).

6. Robustness Tests

6.1. Effect of US change in equity market volatility calibrated to monetary policy

The previous section suggests that a rise in equity market risk calibrated to the state variables caused a stock selloff and prices to plummet. However, it may be argued that the previous equation does not capture the behavior of a rational trader, who upon seeing a drop in stock prices as a buying opportunity and a chance to make profit as prices in future rebound, tends to place a new order. To capture this contrarian behavior, it is reasonable to replace the risk variable by using a differenced form, $\Delta emv_{MP,t}$. This variable reflects the change of forward-looking equity market volatility as news is reported in the headline and changes in monetary policy are observed (Terry et al., 2020; Baker et al., 2022). Incorporating this notion into the model yields a test equation (6) as:

$$r_t = C + \beta_1 log\hat{\sigma}_t^2 + \beta_2 \Delta p_t^e + \beta_3 \Delta emv_{MP,t} + \beta_4 I_{Crisis} + \beta_5 I_{COVID-19} + \varepsilon_t \quad (6)$$

where $\Delta emv_{MP,t}$ is a change in $emv_{x,t}$ calibrated to a change in monetary policy.

Table 6. Estimates of inflation expectation and monetary policy induced equity market volatility change to affect global stock returns.

	C	$\ln\sigma_{j,t}^2$	$\Delta p_{j,t}^e$	$\Delta emv_{MP,t}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε_{t-1}^2	$\varepsilon_{t-1}^2 \mid \varepsilon_{t-1}^-$	σ_{t-1}^2	$\bar{R}^2$
G7 markets											
US	-0.356	0.723	-1.356	-0.010	-5.615	-3.475	1.757	0.191	0.094	0.584	0.12
	-2.03	12.18	-8.13	-14.56	-15.12	-7.09	3.03	4.07	1.23	7.11	
CA	-14.934	5.645	-2.983	-0.039	-10.853	-2.849	7.367	0.073	-0.008	0.573	0.11
	-2.55	2.87	-18.20	-39.61	-17.78	-3.42	8.61	3.37	-6.31	13.92	
FR	0.302	0.012	-0.734	-0.017	-4.250	-2.173	1.835	0.123	0.700	0.587	0.16
	6.81	3.22	-3.49	-17.06	-15.40	-3.37	1.10	0.47	0.93	2.25	
GM	-0.025	0.204	-1.034	-0.014	-4.152	-3.270	2.459	0.013	0.525	0.560	0.12
	-0.63	5.74	-4.93	-14.61	-8.95	-5.15	2.51	0.29	1.42	3.37	
IT	-0.042	0.161	-1.707	-0.018	-3.995	-1.382	0.117	0.039	0.032	0.937	0.14
	-0.07	0.50	-2.39	-7.73	-6.01	-1.64	0.55	0.85	0.60	15.96	
UK	-0.962	1.169	-1.060	-0.010	-3.891	-5.030	1.531	0.121	0.041	0.574	0.08
	-1.20	2.38	-5.64	-10.77	-10.96	-7.16	2.64	1.42	1.67	4.90	
JP	-0.244	0.275	-0.036	-0.015	-3.989	-1.671	4.085	0.214	-0.063	0.670	0.09
	-0.62	1.99	-4.82	-22.69	-12.90	-2.32	0.58	0.93	-1.87	1.36	
E8 Markets											
CN	0.628	-0.169	-0.161	-0.014	-4.410	1.115	3.207	0.623	0.340	0.643	0.03
	2.28	-1.98	-1.77	-11.91	-3.43	2.03	1.26	1.35	0.71	5.17	
ID	-3.256	1.631	-2.024	-0.014	-3.150	-1.223	5.611	0.232	0.037	0.572	0.07
	-1.82	2.93	-11.61	-12.07	-6.49	-1.45	3.13	3.46	4.43	7.83	
IN	-0.478	0.356	-0.526	-0.024	-7.116	-4.644	5.603	0.396	-0.139	0.825	0.05
	-0.39	1.35	-3.70	-7.97	-10.17	-6.61	0.91	1.41	-0.47	8.63	
KO	0.428	-0.052	-1.780	-0.016	-4.680	-3.223	0.099	0.098	0.123	0.926	0.06
	6.69	-2.81	-8.66	-15.98	-6.06	-4.14	0.99	0.90	0.69	28.56	
MA	0.103	0.065	-0.145	-0.011	-0.511	-1.731	1.520	0.874	0.741	0.759	0.02
	5.35	6.99	-3.16	-22.47	-1.00	-3.44	1.55	1.63	1.53	15.83	
BR	-3.297	1.611	-1.588	-0.013	-2.988	1.377	5.297	0.266	-0.049	0.548	0.08
	-4.86	8.00	-7.08	-8.70	-6.08	1.74	13.26	4.47	-2.16	7.99	
MX	-2.318	1.299	-0.678	-0.004	-4.009	-2.274	3.206	0.281	-0.032	0.546	0.05
	-1.84	2.62	-4.58	-4.06	-8.38	-4.65	2.82	2.56	-0.32	7.00	
PR	-7.192	3.684	-3.837	-0.010	-1.138	-1.182	3.500	0.088	-0.014	0.543	0.03
	-4.04	4.37	-17.73	-12.02	-3.20	-2.08	4.23	3.16	-3.76	8.36	

Note: Dependent variable is real stock return. The independent variables are a constant term, expected inflation and change in covariance between monetary policy and change in natural log equity market volatility, $\Delta emv_{MP,t}$*, indicator variables for 2008-09 global finance crises and 2019-20 COVID-19 plus the conditional variance using TARCH(1,1)-M. The numbers in the first row are the estimated coefficients, the row below contains the z-statistics. The critical values of z-distribution at the 1%, 5%, and 10% levels of significance are 2.58, 1.96, and 1.65, respectively.* $\bar{R}^2$ *is the adjusted R-squared, respectively.* $\bar{R}^2$ *is the adjusted R-squared.*

Table 6 reports the estimates of real stock returns' response to expected inflation and $\Delta emv_{MP,t}$ based on the GED-TARCH(1,1)-M process. To conserve space and recognize the significance of monetary policy as a major tool to curb inflation, we focus on the variable of monetary policy that causes a change in $emv_{MP,t}$, which affects stock returns. The results are reported in Table 6.

Statistical estimates in Table 6 produce highly comparable results to those in Tables 4 and 5. Let us focus on two key variables, Δp_t^e and $\Delta emv_{MP,t}$. First, estimated coefficients of Δp_t^e show negative signs and are statistically significant. The negative coefficients suggest that real stock returns unfavorably respond to a rise in expected inflation. The evidence is consistent with the results of Fama (1981), Geske and Roll (1983) , James et al. (1985), Kaul (1990), Gallagher and Taylor (2002) and Zhang (2021).

The most remarkable result is the coefficients of $\Delta emv_{MP,t}$ in Table 6, which are indisputably negative and statistically significant at the 1% level for all markets under investigation. This outcome is consistent with the market behavior that sees the Fed's restrictive monetary policy via interest rate hikes and the rise in borrowing costs as a harbinger of increased volatility. This perception prompts fears among investors regarding the future course of rate increases in the US. Likewise, this elevated equity market volatility in the US in turn spills over to global markets through the contagion effect (Chiang et al., 2007), causing stock returns to plunge globally. The evidence is consistent with the uncertainty hypothesis proposed by Chiang (2023). It can be shown that the negative coefficient of $\Delta emv_{MP,t}$ implicitly supports the risk premium hypothesis. For instance, the estimated coefficient in the case of the US is -0.010$\Delta emv_{MP,t}$ = - 0.010$emv_{MP,t}$ + 0.010$emv_{MP,t-1}$. The first term of -0.010$emv_{MP,t}$ with a negative sign is consistent with the one presented in Table 4, while the second term of + 0.010 $emv_{MP,t-1}$ with a positive sign implies that a rational trader who bought stocks when stock prices were low and volatility was high is now rewarded by a higher stock return in current period. Note that the risk premium under this perspective differs from the one that is derived from the conditional volatility $\ln\sigma_{j,t}^2$ as expressed in a TARCH(1,1) process, which is based on a past time series pattern. However, the information of $emv_{MP,t}$ is obtained from the news released in newspapers and compiled by journalists. Thus, the estimation of the current model combines information using risk derived from a time series prediction made by econometricians and based on qualitative news used by journalists to explain real stock returns.

6.2. Effect of US monetary policy interacting to recent release of inflation

Recent experience suggests that Fed's conduct of monetary policy tends to be a reaction to news regarding recently released inflation data reported by the Labor Department. This behavior can be captured using an interacting term specified by $\Delta emv_{MP,t} \cdot \Delta p_{us,t-1}$ that gives rise to the following equation:

$$r_t = \mathrm{C} + \beta_1 \ln\hat{\sigma}_t^2 + \beta_2 \Delta p_t^e + \beta_3 (\Delta emv_{MP,t} \cdot \Delta p_{us,t-1}) + \beta_4 I_{Crisis} + \beta_5 I_{COVID-19} + \varepsilon_t \tag{7}$$

where $r_t = (R_t - \Delta p_t)$ is the real stock return. Estimates of equation (7), which are reported in Table 7, are summarized as follows. First, coefficients of $\ln\hat{\sigma}_t^2$ are positive and significant, supporting the risk-return tradeoff hypothesis. The only exceptions are the performance of China, which has a negative sign, and Peru whose result is statistically insignificant. The results can be caused by spurious correlation. Second, the coefficients of inflation expectations display negative signs and are statistically significant, suggesting that heightened inflation tends to erode households' real income and raise input costs of production, both economic forces tend to cause a deterioration in business profits that precipitate a decline in stock prices. Third, the evidence from the nonlinear terms,$\Delta emv_{MP,t} \cdot \Delta p_{us,t-1}$, is negative and highly significant. The negative sign is consistent with the phenomenon that a news release that reports on high inflation propels the Fed to raise interest rates, which triggers investors' fears and causes a rise in equity market volatility; the increase in volatility drives down stock returns, which further spreads to global markets via spillover effects.

Table 7. Estimates of inflation expectation and monetary policy induced equity market volatility change interacting with inflation news.

	C	$\ln\sigma^2_{j,t}$	$\Delta p^e_{j,t}$	$\Delta emv_{MP,t} \cdot \Delta p_{us,t-1}$	$I_{GFC,t}$	$I_{COVID,t}$	ω	ε^2_{t-1}	$\varepsilon^2_{t-1}\|\varepsilon^-_{t-}$	σ^2_{t-1}	$\bar{R}^2$
G7 markets											
US	-0.893	1.060	-1.551	-0.007	-5.124	-3.326	1.645	0.129	0.033	0.557	0.11
	-1.83	4.27	-12.23	-3.11	-29.32	-10.87	3.01	9.06	3.42	5.69	
CA	-11.780	4.440	-2.899	-0.064	-5.431	-2.371	8.020	0.075	0.025	0.570	0.03
	-3.80	5.03	-13.25	-10.20	-5.26	-1.83	4.06	4.02	6.08	6.84	
FR	-0.099	0.347	-0.295	-0.039	-5.980	-2.237	2.525	0.226	0.629	0.560	0.04
	-1.77	8.64	-2.32	-13.76	-12.17	-4.25	2.24	1.38	1.33	3.69	
GM	-0.527	0.498	-1.684	-0.013	-4.483	-3.421	2.663	0.124	0.382	0.538	0.05
	-1.23	2.61	-6.92	-3.98	-10.60	-4.97	2.06	1.45	1.62	3.71	
IT	-1.825	0.962	-2.015	-0.040	-6.048	-1.976	4.144	0.144	0.115	0.593	0.05
	-1.28	1.83	-4.09	-5.52	-26.90	-13.91	1.65	1.10	1.12	3.43	
UK	-0.626	0.842	-0.786	-0.022	-4.247	-1.149	1.682	0.117	0.014	0.573	0.05
	-1.23	2.93	-4.70	-5.09	-9.83	-2.28	2.33	4.88	1.14	4.18	
JP	-0.525	0.418	-0.188	-0.027	-3.398	-3.451	3.480	0.115	0.215	0.612	0.01
	-0.93	1.91	-4.97	-4.00	-15.36	-6.18	1.32	0.86	0.92	3.06	
E8 markets											
CN	1.013	-0.156	-0.284	-0.001	-4.453	0.318	3.701	0.575	0.335	0.732	0.01
	3.50	-1.93	-2.20	-1.68	-3.07	0.37	0.97	2.62	1.10	8.95	
ID	-2.971	1.507	-1.974	-0.069	-3.315	0.379	5.850	0.218	-0.032	0.566	0.05
	-1.25	1.83	-20.55	-11.24	-9.22	1.03	2.93	1.88	-4.68	7.66	
IN	-1.775	0.706	-0.571	-0.008	-14.778	-5.412	30.750	0.429	-0.038	0.582	0.03
	-5.74	8.28	-5.70	-3.25	-4.63	-3.05	2.18	2.67	-0.53	5.12	
KO	-0.983	0.547	-1.858	-0.050	-2.983	-2.464	5.679	0.344	0.197	0.569	0.01
	-1.60	3.12	-6.28	-4.77	-2.72	-2.34	3.01	1.46	0.88	5.79	
MA	0.083	0.105	-0.819	-0.034	-3.643	-1.484	0.846	0.443	0.342	0.714	0.01
	0.78	2.20	-7.49	-9.28	-27.00	-30.39	1.12	1.23	1.21	5.98	
BR	-3.129	1.451	-1.164	-0.035	-3.240	0.751	4.640	0.655	-0.288	0.501	0.05
	-2.28	3.00	-6.15	-4.95	-7.10	1.82	3.11	2.34	-1.56	5.96	
MX	-2.719	1.482	-0.589	-0.008	-4.049	-2.670	3.578	0.152	-0.011	0.558	0.04
	-13.35	17.23	-7.91	-13.11	-10.64	-4.63	6.06	3.48	-2.58	8.19	
PR	0.098	0.270	-1.503	-0.025	-3.011	-1.358	0.546	0.119	0.072	0.750	0.02
	0.23	0.90	-2.35	-2.12	-2.43	-2.07	2.22	1.86	0.91	8.97	

Notes: Dependent variable is real stock return. The independent variables are a constant term, expected inflation, $\Delta p^e_{j,t}$ and a product term, $\Delta emv_{MP,t} \cdot \Delta p_{us,t-1}$, which is change in the natural log on $emv_{mp,t}$ times lagged inflation rate in US, $\Delta p_{us,t-1}$. indicator variables for 2008-09 global finance crises and 2019-20 COVID-19 plus the conditional variance using TARCH(1,1)-M. The numbers in the first row are the estimated coefficients, the row below contains the z-statistics. The critical values of z-distribution at the 1%, 5%, and 10% levels of significance are 2.58, 1.96, and 1.65, respectively. $\bar{R}^2$ is the adjusted R-squared, respectively. $\bar{R}^2$ is the adjusted R-squared.

7. Conclusions and Summary

This study utilizes a GED-TARCH-M model to examine the effects of inflation expectations and various categorical equity market volatilities on real stock returns. Testing of monthly data for 15 markets shows that the real stock returns are negatively correlated to expected inflation for most markets. The exceptions occur in India where the coefficients are positive for real stock returns and in some cases in Japan where low real stock returns or spurious correlation are present. The negative relationship between real stock returns and inflation expectation is consistent with the findings documented by Fama (1981), McCarthy et al. (1990) and Chiang and Chen (2023). Evidence indicates that the negative impact on real stock returns even ripples through the channel of US equity market volatility that produces a spillover effect to global markets. Thus, both the direct domestic effect and the US volatility spillover effect provide evidence to substantiate the uncertainty hypothesis that postulates a negative relationship between real stock returns and inflation.

This study introduces categorical equity market volatility, which reflects the covariance between state variables and equity market volatility that can be viewed as an incremental variable for measuring risk. It posits that negative news of state variables such as heightened inflation, hikes in interest rates, shortages in energy supply, rising petroleum prices, lack of medical provisions, widening spread of the coronavirus, etc. will trigger a rise in equity market volatility that leads to a decline in stock returns. Based on the different measures of categorical EMV ($emv_{x,t}$), this study finds evidence that real stock returns are negatively related to the categorical $emv_{x,t}$, which supports a broader version of the uncertainty hypothesis (Chiang, 2023). The model specifications are robust using different measures of $emv_{x,t}$, regardless of their level or change form. Valid evidence also finds that the Fed's monetary policy is often a reaction to the release of recent inflation data and demonstrates a nonlinear movement. Evidence from this study indicates that US categorical EMV has a stronger spillover effect on the G7 markets (except Japan) than that on the emerging markets.

The evidence for categorical EMV effects on real stock returns has empirical implications for asset management in that it provides information, which allows managers to focus not only on the conditional equity market volatility per se but also news of state variables changes affecting volatility and stock returns. More specifically, the news emerging from the US could produce a significant effect on stock market volatility and spillover to global markets. Therefore, changes in volatility induced by US state variables or policy changes should be priced into domestic stocks.

This study also has significant policy implications. Most notable are the variations of $emv_{MP,t}$ that are mainly associated with the fear of managing frequent rate hikes announced by the Fed. The current monetary policy has attempted to make modification for past monetary policy stands that drove the neutral rate of interest to a very low level (Rachel and Smith, 2017; Summers, 2018; Clarida, 2022).[12] The difficulty with the Zero-bound was associated with an extraordinary expansion of monetary policy that led to high inflation rate. This study suggests that smoothing monetary growth by targeting a neutral rate of interest (r^*) is essential to maintaining financial market stability. At the same time, it would be helpful to implement a monetary policy around r^* as a way to achieve an optimal monetary policy in the longer time horizon.[13]

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[12] The neutral rate of interest (also the natural rate or r^*) is the short-term interest rate that would prevail when the economy is at full employment and stable inflation. Fed Chair Powell has long been skeptical of over-relying on the neutral rate to conduct monetary policy. The Fed Chair prefers to adopt a risk management approach by "balancing the risk of tightening monetary policy too much against the risk of tightening too little." (https://www.youtube.com/watch?v=Y-1SowXR8zY). This risk management approach could be discretionary.

[13] Bernanke (2017) comments on alternative monetary targets. For instance, to raise the target to, say, 3 or 4 percent, instead of stick to 2 percent, this will allow the Fed to retain current focus on hitting a targets value of inflation. Alternatively, central bank can keep the *level* of prices on a steady growth path, rising by (say) 2 percent per year, this is the price-level targeting. See https://www.brookings.edu/articles/temporary-price-level-targeting-an-alternative-framework-for-monetary-policy

Conflict of interest

The author claims that the manuscript is completely original. The author also declares no conflict of interest.

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