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Inflation, Equity Market Volatility, and Bond Prices: Evidence from G7 Countries

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Abstract: This study examines the impacts of the US inflation rate on the bond prices of G7 countries across different maturities using inflation-induced equity market volatility (EMV) to better account for bond price determinants. The regression model, a GED-GARCH (1,1) procedure, is adopted to deal with the volatility clustering and fat tail features in bond return estimation. The testing results indicate that the inflation rate has a negative effect on bond returns across different maturities, although an exception occurs for longer maturities in Japan. Evidence shows that US inflation has a significant impact on bond returns for the non-US G7 countries. The negative effects from US inflation are more profound than those from the domestic market (expect in Japan). This study introduces the equity market volatility arising from inflation or the Fed's interest rate change; this variable produces market volatility that has a positive effect on bond returns, offsetting part of the original negative effect from a rise in inflation.

Keywords: inflation; bond prices; volatility; Fisher hypothesis; stock price; Fed policy

JEL Classification: G11; G12; G15

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1. Introduction

Financial asset prices in general respond negatively to a rise in the inflation rate (Fama and Schwert 1977; Stulz 1986; Campbell and Ammer 1993; Cenedese and Mallucci 2016). This is essentially due to the fact that heightened inflation tends to push up interest rates as implied by the Fisher relationship (Fisher 1930; Fama and Schwert 1977; Jonsson and Reslow 2015). The Fisher hypothesis states that the expected nominal rate of return is equal to the expected inflation plus the expected real rate of return, where the latter is either constant or independent of expected inflation. (Fisher 1930; Engsted and Tanggaard 2002). Because interest rates are a key factor used to determine discount rates for evaluating future cash flows, a rise in the discount rate will result in a decline in bond prices (Kwan 1996). Further, as rising inflation erodes the real future purchasing power of cash flows, a decline in the real value of financial assets will cause investors to reduce their holdings of bonds in accordance with the wealth effect (Tobin 1982). Notably, inflation and bond returns have been revealed to have a negative relationship, as documented by Fama and Schwert (1977) and Stulz (1986). Cenedese and Mallucci (2016) identified inflation news as the main driver of international bond returns. In light of the divergence from the more than four decades of relatively stable variations in the inflation rate, the current study aims to re-examine the impact of inflation on bond prices in the G7 countries.

The inflation rate in the US has remained relatively stable since the 1980s oil crisis, allowing bonds to act as a buffer in balancing portfolio fluctuations. This relative stability, however, came to an end with the spread of the COVID-19 pandemic and the Russia–Ukraine conflict.

These events led to uncertainty regarding energy prices and the excessive expansionary policies of economic relief packages, pushing up the US inflation rate to 9.1% in June 2022. In response, the Fed has taken a hawkish position in raising interest rates, creating uncertainty among investors and triggering significant selloffs. In addition to its effect on the US domestic financial market, US inflation tends to impact other countries due to the dominant role the US plays in global financial markets (Rapach et al. 2013; Chiang and Tang 2023). Hence, the Fed's hikes in short-term rates could further drive up intermediate and longer-term rates through term structure relationships, which could result in a decline in bond prices across different maturities and different countries.

In a general equilibrium framework, the bond market cannot be independent of the stock market. The Fed's disinflationary policy drives costs of borrowing, constraining liquidity that would discourage an appetite for new investments. Further, uncertainty regarding the possibility of future tightening of monetary policy will create fears that could lead to stock market volatility (Engle and Rangel 2008; Zaremba et al. 2023) and increase the likelihood of a plunge in stock prices. On the other hand, investors who use bonds to hedge against downward movements in the stock market tend to move funds from the stock market to the bond market, bidding up bond prices. This arbitrage activity is known as a flight-to-quality in literature (Connolly et al. 2005; Chiang et al. 2015). Additionally, the joint pricing model of stock and bond derived by Lou et al. (2021) also found that inflation, as viewed by risk adverse investors, can explain the majority of time variations in nominal term yields and spreads of bond returns.

The Fed's 2022–2023 monetary policy stance and the investors' reaction to inflation suggest a process by which heightened inflation-induced rate hikes resulted in equity market volatility (EMV) that eventually spilt over to the bond markets. As a result, both the news of EPU (economic policy uncertainty) and changes in the EMV triggered by the change in the Fed's policy (Benlagha and Hemrit 2022; Baker et al. 2022) are crucial factors in determining the market's behavior. In their recent study, Benlagha and Hemrit (2022) identify the effects of EPU on international sovereign bond yields. However, the market behavior affected by EMV has not been incorporated into a model to explain bond prices.

Moreover, in an interconnected financial market, it is plausible to argue that the EMV triggered by US inflation exhibits a spillover effect to the global market. The literature, in fact, provides enormous empirical evidence pertaining to global financial contagion. For instance, Buncic and Gisler (2016) and Chiang (2023) document the spillover effects of US EMV to G7 equity markets; similarly, Vo and Tran (2020) report on the spillover effects from the US to ASEAN stock markets. In conjunction with evidence of a strong linkage between stock volatility and the bond market (Fleming et al. 1998; Connolly et al. 2005; Chiang et al. 2015), these findings establish an association between EMV and global bond prices.

The above observed market phenomena motivated this study's investigation of the following empirical issues. First, as in the traditional approach, we examine the relationship between the changes in bond prices and inflation, including the measures of both actual and expected inflations. However, we added control variables in the test equation by using dummy variables to mitigate the impact of unusual observations due to crises or pandemic. Second, this study explicitly introduces an inflation-induced equity market volatility term to account for the Fed's policy momentum, which affects bond prices. Third, the study factors in a nonlinear term that reflects the behavior of equity market volatility, which interacts with the expected inflation. Fourth, the data are extended to the most recent available time to cover the post-COVID-19 period. To this end, this study uses a dummy variable to control for unusual observations to alleviate the estimation biases (Peña 2001). Fifth, this study uses data that cover G7 countries across different spectrums of maturities to gain some insight into the broader market performance.

This paper achieves several empirical conclusions. First, evidence indicates that inflation has a negative effect on bond prices. Second, inflation (expectation) also produces an adverse effect on stock prices; however, the flight-to-quality effect in response to downturns in the stock market tends to partially offset losses on bond prices. Third, disinflation policy propelled by the Fed's rate hikes displays spillover effects in global bond markets. Evidence reveals that a rise in US EMV will produce a positive effect on bond prices due to a shift in funds from the stock market to bond markets. Fourth, a nonlinear term reflecting the reaction of stock market volatility to news of inflation will give rise to a positive effect on bond prices.

The remainder of this paper is organized as follows. Section 2 provides a literature review of the relationship between bond prices and inflation. Section 3 lays out an econometric model featuring GED-GARCH (1,1) specification while controlling for unusual observations due to crises or COVID-19. Section 4 describes the data. Section 5 reports the empirical results of testing the relationships between bond prices and inflation for G7 countries. Section 6 specifies a different model to examine the impacts of nonlinear specifications and different measures of inflation to evaluate the validity of the model. Section 7 concludes with the findings of the study.

2. Literature Review

2.1. Fisher Effect and Bond Price Change

The Fisher hypothesis states that the expected nominal rate of return is equal to the expected inflation rate plus the expected real rate of return, where the latter is either constant or independent of expected inflation (Fisher 1930; Engsted and Tanggaard 2002). It posits that the existence of one-for-one adjustments in nominal interest rates to changes in expected inflation. Thus, a rise in the nominal interest rate can be predicted by the expected inflation rate given a stable real interest rate. This hypothesis implies that the nominal market interest rate contains an inflation premium sufficient to compensate lenders for the expected loss of purchasing power due to inflation. Evans and Lewis (1995) examined US data for a sample period from 1974 to 1987 and obtained a result that supports the Fisher hypothesis. Phylaktis and Blake (1993) found evidence for a long-term relationship between nominal interest rates and expected inflation for three high inflation countries, namely, Argentina, Brazil, and Mexico. Using the cointegration test, Peng (1995) showed convincing evidence in favor of the Fisher hypothesis for France, the UK, and the US during the period from 1957–1994 but found much weaker evidence of the Fisher effect for Germany and Japan. The difference in findings for these two groups of countries may be attributable to the different degrees of monetary accommodation by different monetary authorities. Tests of the model created by Mishkin (1992), who conducted a study of the US market between 1952 and 1991, do not find supportive evidence for the Fisher hypothesis for short-term interest rates but find a valid result for the Fisher effect in the long term. Mishkin concludes that the Fisher effect would hold only when interest rates and inflation display a stochastic trend. Testing the validity of the Fisher effect in the long term vs. the short term, Yuhn (1996) used cointegration analysis and obtained strong support for the long-term Fisher effect in the US, Germany, and Japan but only some evidence in the UK and Canada; only the short-term Fisher effect was detected in Germany. A similar study by Fahmy and Kandil (2003) using monthly data from the 1980s and into the early 1990s could not find support for the Fisher effect for short-term interest rates. However, the study revealed that inflation and nominal interest rates exhibit common stochastic trends in the long term. It appears that the ability of nominal interest rates to forecast future inflation increases with the maturity of US government securities. The evidence is consistent with an earlier study by Mishkin (1992). Similarly, Ozcan and Ari (2015) investigated the G7 countries over the period from January 2000 to November 2012 by employing cointegration tests. The evidence indicates that the adjustment in nominal interest rates due to changes in inflation is below unity, suggesting the existence of a partial Fisher effect. Further examination of the long-term and short-term Fisher effect by Lee et al. (1998) using a cointegration technique showed that the Fisher effect does not exist in either a long- or short-term form. However, their methodologies and results differ from the conclusions of Mishkin's (1992) study.[1] In sum, the testing results contend that the Fisher effect appears to be more relevant in the long term and does not gain much support in the short term, although there are some minor variations due to different sample periods, frequencies in the data, methods of measuring inflation, and econometric techniques.

2.2. The Transmission Effects of US Inflation and Equity Market Volatility (EMV)

An upward shift in domestic inflation could be imported from foreign countries due to a central bank's attempts to influence the currency market in order to maintain a stable exchange rate. This spillover can flow from trade channels via economic integration, especially considering that a large share of global exports is comprised of US exports, which could explain the transmission of US inflation (Hall et al. 2023). According to Gopinath (2015) and Boz et al. (2022), about 45 percent of global exports are invoiced in US dollars. A large and sustained rise in US inflation may lead to a rise in the prices of export goods, which are denominated in US dollars. Istiak et al. (2021) examined the inflation spillover among G7 countries and found that US inflation does create inflationary pressure in other countries in both the short and long term. This is the case with the recent 2021 and 2022 surge in inflation in the US, which Hall et al. (2023) find was transmitted to the euro area and the United Kingdom in a powerful and consistent way.

In addition to the spillover effect from US inflation on the bond markets, the transmission effect from US stock market volatility cannot be ignored in the analysis of bond prices, since inflation triggers stock market volatility (e.g., Engle et al. 2013; Baker et al. 2022). The ability to predict international stock return-based US stock returns has been identified by Rapach et al. (2013), who show that lagged US returns predict returns in numerous non-US industrialized countries substantially better than the countries' own economic variables. Further, spillover effects of US equity market volatility to G7 equity markets (Buncic and Gisler 2016; Chiang 2020, 2021; Garbi et al. 2023) and ASEAN stock markets (Vo and Tran 2020) has also been identified. Hence, the empirical results provide evidence that the US equity market plays a strong role internationally as a source of information concerning volatility. Additionally, the stock market had been found to have strong volatility linkages between the bond and money markets (Fleming et al. 1998; Connolly et al. 2005; Chiang et al. 2015), implying bond returns are associated with stock market volatility. Hence, the variations in domestic inflation, US inflation, and US equity market volatility cannot be ignored when analyzing bond pricing.

Several points derived from the above literature are worthy of noting. First, the positive relationship between the nominal interest rate and inflation (expectation) implies a negative relationship between bond prices and inflation since bond prices are inversely related to interest rates (Basu and Joshi 2023). Second, a common approach featured in the above analyses is a focus on the one-to-one relationship between the nominal interest rate and inflation (expectation). Evidence indicates that the bond market is often used as an instrument to hedge against a downturn in the stock market, exhibiting a flight-to-safety phenomenon (Connolly et al. 2005). Viewed from this perspective, information concerning the spillover effect from the stock market should be incorporated into a determination of bond prices in a general equilibrium framework. Third, no risk factor is incorporated into the test equation. This is essentially due to the premise that uncertainty is a crucial factor in the long run as it applies to the Fisher model. In a recent study that used a consumption-based asset pricing model, Cieslak and Pflueger (2023) argue that a risk factor, measured by the covariance between future consumption and expected inflation, should be added to the Fisher equation. The authors claim that bonds would be a desirable hedge against inflation when expected inflation rises with high consumption and economic activity. This is what the authors call "good" inflation. However, Chiang (2023), using a market-based model, contends that it is appropriate to use the covariance between inflation and equity market volatility as a measure of risk. This specification is appealing since it captures the Fed's hawkish behavior in the years 2022–2023, which triggered market fears and stock market volatility. Chiang (2023) demonstrates that a rise in US inflation corresponds to an increase in equity market volatility (EMV) (Baker et al. 2022) and tends to result in not only a decline in US stocks but also spillovers to other G7 countries (Chiang 2021).

Connecting this positive relationship between inflation expectation and equity market volatility to the flight-to-bond literature, we establish a positive relationship between EVM and bond prices. This linkage is consistent with evidence presented by Fleming et al. (1998) since negative news can not only directly affect expectations in one market but also impact other markets through hedging demand or information spillover between markets via a contagion effect (King and Wadhwani 1990; Chiang et al. 2007).

Motivated by the established literature and recent developments, this study attempts to shed some light on the Fisher equation by extending Chiang's study (2023), which moves the relationship between EMV and stock returns to the relationship between EMV and bond returns with different maturities in G7 countries. Because of the difficulty in measuring the consumption of goods in a consumption-based model, this study uses a market-based model that highlights the covariance between inflation and equity market volatility (Engle et al. 2013; Baker et al. 2022). This specification helps to identify the role that news of inflation plays as a driving factor in international bond prices (Cenedese and Mallucci 2016). In short, there is a positive correlation between inflation and equity market volatility together with a positive correlation between equity market volatility and bond prices, which forms a positive correlation between inflation-induced equity market volatility and bond prices.

3. Analytical Framework

3.1. The Model

It is convenient to use a regression model to investigate the relationship between inflation and bond returns. Let us assume:

$$r_t^j = C + \beta_1 \Delta p_t^j + \beta_2 D_{Crisis,t} + \beta_3 D_{COVID,t} + \varepsilon_{j,t} \tag{1}$$

$$r_t^j = C + \beta_1 \Delta p_t^{j|US} + \beta_2 \Delta p_t^{US} + \beta_3\, \Delta EMV_{\Delta p,t} + \beta_4 D_{Crisis,t} + \beta_5 D_{COVID,t} + \varepsilon_{j,t} \tag{2}$$

where r_t^j is the returns in bonds for country j; p_t^j is the consumer price index for country j; and Δp_t^j is inflation, which is derived by taking the first difference in CPI in a natural logarithm. Equation (1) is a simple Fisher equation that ignores the product term. Then, in Equation (2), we add a change in inflation-induced equity market volatility, $\Delta EMV_{\Delta p,t_t}$, to highlight the risk factor as noted by Baker et al. (2022) and Chiang (2023).

To capture the volatility clustering phenomenon, we specify a condition variance equation that follows a GARCH (1,1) process (Bollerslev et al. 1992), which is expressed as:[2]

$$\sigma_{j,t}^2 = \omega_0 + \omega_1 \varepsilon_{j,t-1}^2 + \omega_2 \sigma_{j,t-1}^2 \tag{3}$$

where $\sigma_{j,t}^2$ is the conditional variance for assets in country j and $\varepsilon_{j,t-1}^2$ is the lagged error squared for asset j. Following Giacalone et al. (2019) and Li et al. (2005), the GED distribution is utilized in modeling the error term of Equation (1) or (2) (Nelson 1991), which is expressed as:

$$\varepsilon_{j,t} \middle| \Phi_{t-1} \backsim \mathrm{GED}\left(0, \sigma_{j,t-1}^2,\ v\right) \tag{4}$$

The advantage of using GED distribution is its ability to handle fat tails, which are commonly used in the specification of return series.

3.2. Testable Hypotheses

We set up several hypotheses pertinent to our empirical analysis as outlined below.

Bond returns are negatively correlated with inflation. This occurs as inflation has a positive effect on the nominal interest rate as implied in the Fisher equation. Since bond prices are inversely related to interest rates movements, this hypothesis implies a negative relationship between bond returns and inflation (expectation).

Global bond returns are negatively correlated with US inflation. Evidence from advanced markets indicates that inflation rates are positively correlated due to the high integration of global trade markets. A rise in US inflation tends to have a positive effect on the rest of G7 countries if a stable exchange rate system is maintained. This inflation spillover effect also causes a rise in domestic interest rates and hence has a negative effect on bond returns.

Bonds are a hedging asset against equity market volatility. In an attempt to fend off market volatility from either the Fed's rate hikes or jittery market investors, risk averse investors tend to hedge their losses in the equity market by using bonds. The induced shift of funds from the stock market to the bond market with a rise in EMV has a positive impact on bond returns attributable to flight-to-quality activities. The result reveals a positive correlation between $\Delta EMV_{\Delta p,t}$ and r_t^j. This relationship holds true not only in the US market but also spills over to the other G7 bond markets.

4. Data

The data in this study cover bond indices with two-year, five-year, ten-year, and twenty-year maturities and stock market indices for G7 countries from January 2000 through December 2022. In estimations, monthly percentages of the above indices are used by taking a natural logarithm of the monthly price indices multiplied by 100. The data on inflation rates are derived by taking the first difference in the natural logarithm of the monthly CPI indices multiplied by 100. Using the first difference in the logarithm for the related variables not only achieves the unit free property but also removes the trend factor, thereby keeping the variable stationary.[3] The bond indices, stock indices, and CPI indices were downloaded from the database of DataStream International.

This study also utilizes the newspaper-based equity market volatility (EMV) tracker, $EMV_{\Delta p,t}$, that was constructed by Baker et al. (2022); this series moves closely with the CBOE Volatility Index (VIX) (Whaley 2009) and with the realized S&P 500 volatility of returns. To construct their inflation EMV tracker, Baker et al. (2022) use the following terms: E: {economic, economy, financial}; M: {"stock market", equity, equities, and variants}; V: {volatility, volatile, uncertainty, risk, and variants}; and Inflation: {cpi, inflation, consumer prices, and variants}. The calculation of the importance of inflation in equity market volatility during month t is represented by $EMV_{\Delta p,t}$, which is measured by:

$$EMV_{\Delta p,t} = \left(\frac{\#\{E \cap M \cap V \cap Inflation\}_t}{\#\{E \cap M \cap V\}_t} \right) EMV_t \tag{5}$$

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. Likewise, Baker et al. (2022) provide an equivalent version for the EMV calibrated to the change in the interest rate, $EMV_{\Delta i,t}$,which is measured by:

$$EMV_{\Delta i,t} = \left(\frac{\#\{E \cap M \cap V \cap Interest\ rate\}_t}{\#\{E \cap M \cap V\}_t} \right) EMV_t \tag{6}$$

(see Policy News and Equity Market Volatility and Baker et al. (2022) for detail and description).

5. Empirical Results

5.1. Empirical Evidence

Table 1 provides monthly percentage values for inflation, bonds, and stocks. Annual inflation rates range from 0.25% (US) to 0.19% (JP). When these figures are converted to a monthly base, they range from 0.208% (US) to 0.02% (JP). Japanese inflation is much lower than that in the US. With respect to the bond price changes, the ten-year bonds are the highest in this category; the exception is Japan. The bond prices are seen to be smaller than those for CPI changes (inflation rate), indicating a negative value for real bond returns in general. However, the change in stock price indices, which range from 0.55% (CA) to 0.18% (JP), is much higher than the changes in commodity prices and bond prices in the G7 countries, reflecting demand for a premium by investors for their investments in stock markets.

Table 1. Summary of statistics concerning monthly percentages for bonds, stocks, and inflation in G7 countries (January 2000–December 2022).

Variables	Mean	Median	Max	Min	Std. Dev.	Skew	Kurtosis	JB	ADF	Break	PACF (12)
Δp_t^{US}	2.50[0.208]	2.16[0.18]	9.06	−2.10	1.80	1.17	5.60	141			
$\Delta p_t^{e,US}$	2.50[0.208]	2.22[0.19]	9.39	−2.56	1.91	1.03	5.34	112			
$r_{2y,t}^{US}$	0.04	0.03	1.67	−1.50	0.44	0.37	5.41	73	−14.42	2021.12	0.060
$r_{5y,t}^{US}$	0.08	0.08	4.30	−3.88	1.22	−0.06	3.99	11	−15.54	2020.03	0.100
$r_{10y,t}^{US}$	0.08	0.00	9.16	−7.72	2.15	0.05	4.47	25	−15.75	2003.07	0.017
$r_{20y,t}^{US}$	0.07	0.26	13.00	−14.01	3.81	0.13	4.51	24	−15.07	2008.12	−0.038
$R_{m,t}^{US}$	0.52	1.20	12.52	−18.80	4.47	−0.69	4.31	42	−17.08	2008.10	0.004
Δp_t^{CA}	2.15[0.18]	2.02[0.17]	8.13	−0.95	1.39	1.64	7.37	343			
$\Delta p_t^{e,CA}$	2.14[0.18]	2.02[0.17]	8.11	−0.91	1.36	1.66	7.69	380			
$r_{2y,t}^{CA}$	0.03	0.00	1.83	−1.44	0.41	0.28	5.54	78	−16.39	2001.10	−0.026
$r_{5y,t}^{CA}$	0.09	0.03	3.17	−3.19	0.97	−0.12	3.63	5	−16.66	2021.10	−0.002
$r_{10y,t}^{CA}$	0.11	0.13	5.48	−4.72	1.70	−0.01	3.36	1	−17.06	2021.02	0.013
$r_{20y,t}^{CA}$	0.05	0.13	6.93	−6.61	2.24	0.05	3.46	3	−17.96	2021.11	0.055
$R_{m,t}^{CA}$	0.55	1.06	10.42	−19.14	3.96	−1.18	6.82	231	−15.75	2020.03	−0.080
Δp_t^{BD}	1.77[0.15]	1.52[0.13]	10.39	−0.54	1.59	3.02	14.36	1905			
$\Delta p_t^{e,BD}$	1.75[0.15]	1.53[0.13]	10.33	−0.47	1.52	3.10	15.33	2191			
$r_{2y,t}^{BD}$	−0.02	−0.03	1.67	−1.41	0.34	0.21	5.96	103	−14.39	2008.10	0.009
$r_{5y,t}^{BD}$	0.05	0.08	2.87	−3.87	0.94	−0.22	4.16	18	−16.01	2022.07	0.012
$r_{10y,t}^{BD}$	0.13	0.29	5.81	−6.60	1.73	−0.16	3.99	13	−17.25	2022.01	0.020
$r_{20y,t}^{BD}$	0.04	0.11	8.94	−9.56	2.81	0.04	4.30	19	−17.81	2020.07	0.007
$R_{m,t}^{BD}$	0.28	0.66	15.42	−23.90	5.40	−0.77	4.97	72	−19.25	2002.09	0.058
Δp_t^{FR}	1.56[0.13]	1.52[0.13]	6.20	−0.73	1.14	1.45	7.17	297			
$\Delta p_t^{e,FR}$	1.54[0.13]	1.53[0.13]	6.17	−0.72	1.11	1.40	7.25	298			
$r_{2y,t}^{FR}$	−0.12	−0.18	1.57	−1.63	0.37	0.51	5.54	86	−13.59	2012.05	0.036
$r_{5y,t}^{FR}$	0.02	0.09	2.82	−3.94	0.92	−0.20	4.27	21	−16.46	2022.01	0.038
$r_{10y,t}^{FR}$	0.13	0.36	5.30	−5.98	1.76	−0.26	3.88	12	−17.24	2022.01	0.006
$r_{20y,t}^{FR}$	0.07	0.21	8.83	−9.47	2.76	−0.19	4.48	27	−17.82	2021.11	0.010
$R_{m,t}^{FR}$	0.43	1.09	16.76	−18.41	5.00	−0.58	4.39	38	−16.06	2020.03	0.069
Δp_t^{IT}	1.93[0.16]	1.88[0.16]	11.84	−0.60	1.79	2.46	13.12	1455			
$\Delta p_t^{e,IT}$	1.89[0.16]	1.88[0.16]	11.76	−0.57	1.69	2.27	12.56	1288			
$r_{2y,t}^{IT}$	−0.01	−0.01	3.72	−2.99	0.62	0.35	12.09	955	−16.85	2011.11	0.016
$r_{5y,t}^{IT}$	0.09	0.17	5.93	−6.61	1.41	−0.46	8.08	307	−16.18	2011.11	0.018
$r_{10y,t}^{IT}$	0.10	0.38	7.78	−9.12	2.25	−0.49	5.21	67	−14.91	2018.05	−0.001
$r_{20y,t}^{IT}$	0.06	0.14	8.94	−9.56	2.78	0.03	4.39	22	−14.63	2021.11	−0.033
$R_{m,t}^{IT}$	0.18	0.53	19.58	−23.50	5.63	−0.42	4.58	37	−17.10	2020.03	0.006
Δp_t^{UK}	2.32[0.19]	1.95[0.16]	11.10	−0.10	1.87	2.38	10.50	908			
$\Delta p_t^{e,UK}$	2.29[0.19]	1.95[0.16]	11.07	−0.10	1.80	2.36	10.75	947			

Table 1. *Cont.*

Variables	Mean	Median	Max	Min	Std. Dev.	Skew	Kurtosis	JB	ADF	Break	PACF (12)
$r^{UK}_{2y,t}$	−0.10	−0.12	1.83	−2.40	0.42	0.04	9.03	418	−13.88	2008.10	−0.020
$r^{UK}_{5y,t}$	0.02	0.07	3.82	−7.40	1.05	−1.56	13.77	1447	−17.54	2022.09	0.054
$r^{UK}_{10y,t}$	0.09	0.22	5.57	−10.43	1.92	−0.75	6.70	183	−17.59	2022.09	−0.020
$r^{UK}_{20y,t}$	0.00	0.13	7.47	−12.02	2.71	−0.38	4.89	48	−16.98	2022.09	0.054
$R^{UK}_{m,t}$	0.36	1.03	11.95	−16.52	4.08	−0.79	4.74	64	−17.13	2020.03	0.071
Δp^{JP}_t	0.19[0.02]	0.00	4.00	−2.56	1.11	1.12	4.88	98			
$\Delta p^{e,JP}_t$	0.18[0.02]	0.00	3.80	−2.55	1.08	1.08	4.83	92			
$r^{JP}_{2y,t}$	−0.02	0.00	0.44	−0.74	0.14	−1.25	8.71	447	−16.49	2002.05	0.090
$r^{JP}_{5y,t}$	0.02	0.03	1.49	−1.91	0.38	−0.70	7.50	255	−15.93	2003.08	−0.065
$r^{JP}_{10y,t}$	0.10	0.12	2.59	−4.62	0.86	−0.84	6.72	192	−17.35	2003.08	−0.126
$r^{JP}_{20y,t}$	0.11	0.12	5.79	−7.65	1.63	−0.10	5.38	65	−15.24	2003.08	−0.090
$R^{JP}_{m,t}$	0.16	0.77	11.99	−22.00	4.86	−0.56	4.07	28	−15.27	2008.10	−0.033

Notes: The symbol for country j is defined as follows. Δp^j_t is the inflation rate, $\Delta p^{e,j}_t$ is the expected inflation rate; both are expressed annually. The monthly calculations are in brackets [.]. $r^j_{2y,t}$ is the two-year bond rate, $r^j_{5y,t}$ is the five-year bond rate, $r^j_{10y,t}$ is the ten-year bond rate, $r^j_{20y,t}$ is the twenty-year bond rate, $R^j_{m,t}$ is the stock market index return; the asset returns are expressed monthly. JB refers to Jarque–Bera statistics, OBS refers to observations. ADF is augmented by the Dicky–Fuller unit root test. The critical value at 5% for the unit root test is −4.44, which leads to a rejection of the null, and we conclude the series is stationary. Break refers to the breakup date. PACF (12) is the partial autocorrelation function at lag 12. OBS denotes the number of observations for each country, which is 276. Using US two-year bonds as an example, s.e. = $1/\sqrt{obs}$ = 0.060, $t^{us}_{2y,t}$ of ϕ_{12} = 0.060/0.060 = 1, the null of the $\phi_{12} = 0$, cannot be rejected and indicates the absence of seasonal correlation. The only exception is the Japanese ten-year bonds.

We also checked the time series properties of the data. In conducting the unit root tests, the augmented Dicky–Fuller (ADF) statistics were calculated and indicated to reject the null at the 5% level for all return series. We concluded that the test statistics were stationary. The breakup tests also indicated that the most breakup dates fell within our range of dummy variables for both the global financial crisis and COVID-19. The exceptions are the ten-year bond market in the US and the stock market in Germany. Some cases of two-year bonds in France and Italy may be connected to the European sovereign debt crisis. To check whether monthly data is seasonally adjusted, we reported the partial autocorrelation function at lag 12, PACF (12), for each series by checking the correlogram. In comparing the calculated coefficients of PACF against the corresponding standard error (0.060), the results do not indicate a rejection of the null and indicate the absence of a seasonal factor. However, some minor effects for the ten-year bond in Japanese market are visible.

Equation (1) is estimated using the GED-GARCH procedure; employing GED helps us to deal with the fat tail of asset returns, while the GARCH (1,1) model enables model estimation under the volatility clustering phenomenon. Estimates in Table 2 provide a report of the hypothesis that the domestic inflation rate has a negative effect on ten-year bond returns, which is consistent with the hypothesis that bond returns are negatively correlated with a rise in inflation. The coefficients are significant at the 5% level for all countries under investigation.

Equation (2) is estimated with two modifications. That is, a foreign inflation rate was added in the test equation and the bond maturities were expanded to include two-year, five-year and twenty-year bonds in addition to ten-year bonds. Further, the changes in the inflation-induced equity market volatility, $\Delta EMV_{\Delta p,t}$, are also included. The latter is based on the rationale that investors are assumed to be risk averse and tend to shift their portfolio from the stock market to the bond market as the $\Delta EMV_{\Delta p,t}$ rises. The estimated results are reported in Table 3. Several comments are noteworthy. First, focusing on the

US market, the evidence from the domestic (US) inflation rate displays a negative effect on bond returns across different maturities. Examining the impact of inflation from the global market, $\Delta p_t^{EU|US}$ (EU as a proxy) is obtained by neutralizing the influence from the effects of US inflation (a residual obtained by regressing Δp_t^{EU} on Δp_t^{US}). The estimated coefficients of $\Delta p_t^{EU|US}$ are negative and statistically significant across different bond maturities. Thus, we can unambiguously conclude that inflation, whether it is from domestic or global markets, has a harmful effect on bond returns.

Table 2. Estimates of ten-year bond returns in response to domestic inflation for G7 countries.

Market	C	Δp_t^j	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{10y,t}^{US}$	0.380	−0.134	−0.092	0.181	2.924	0.262	0.199	0.01
	6.34	−8.07	−8.23	0.23	0.41	0.41	1.86	
$r_{10y,t}^{CA}$	0.293	−0.074	1.116	−0.306	2.127	0.134	0.646	0.002
	6.07	−2.48	3.18	−1.27	0.26	0.37	0.52	
$r_{10y,t}^{BD}$	0.574	−0.263	−0.679	0.796	2.001	0.209	0.659	0.06
	8.69	−7.17	−2.46	5.66	0.36	0.43	0.79	
$r_{10y,t}^{FR}$	0.574	−0.279	−1.223	0.507	0.665	0.234	0.864	0.04
	6.53	−5.20	−2.86	1.96	0.45	0.56	3.74	
$r_{10y,t}^{IT}$	0.631	−0.235	−2.641	−0.385	0.864	0.448	0.773	0.06
	9.05	−7.25	−7.60	−8.63	0.70	0.94	3.86	
$r_{10y,t}^{UK}$	0.378	−0.127	−0.220	0.499	4.061	0.956	0.547	0.02
	7.31	−5.83	−19.48	16.98	0.48	0.71	0.78	
$r_{10y,t}^{JP}$	0.106	−0.002	−0.196	0.064	0.179	0.914	0.827	0.002
	10.60	−13.75	−0.61	0.31	0.41	0.79	3.91	

Notes: The estimated equation is given by: $r_{10y,t}^j = C + \beta_1 \Delta p_t^j + \beta_2 D_{Crisis,t} + \beta_3 D_{COVID,t} + \varepsilon_{j,t}$, where $r_{10y,t}^j$ is the return of ten-year bonds in country j. The. Δp_t^j is the inflation rate in country j, j denotes the markets of the United States (US), Canada (CA), Germany (BD), France (FR), Italy (IT), the United Kingdom (UK), and Japan (JP). $D_{GFC,t}$ and $D_{COVID,\,t}$ are the dummy variables, which were set to unity when an event occurred during the global financial crisis or the COVID-19 pandemic and zero otherwise. The numbers in the first row are the estimated coefficients, and the second row contains the z-statistics. The critical values of z-distribution at the 1%, 5%, and 10% significance levels are 2.63, 1.98, and 1.66, respectively. R^2 is the coefficient of determination.

Table 3. Estimates of bond returns in response to domestic and US inflation and inflation-induced equity market volatility for G7 countries.

US	C	$\Delta p_t^{EU\,|\,US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{US}$	0.009	−0.044	−0.023	0.001	0.181	0.404	0.005	0.967	0.780	0.10
	5.48	−14.30	−22.57	7.17	6.48	4.36	0.36	1.18	4.67	
$r_{5y,t}^{US}$	0.263	−0.033	−0.093	0.004	−0.262	0.405	0.967	0.221	0.872	0.04
	8.33	−7.73	−7.37	13.88	−3.77	2.96	0.35	0.30	2.61	
$r_{10y,t}^{US}$	0.290	−0.119	−0.153	0.007	0.130	−0.513	8.939	0.262	0.000	0.03
	4.47	−5.57	−7.90	6.44	2.41	−0.87	0.96	0.51	0.00	
$r_{20y,t}^{US}$	0.468	−0.317	−0.195	0.007	0.940	0.074	9.880	0.195	0.631	0.03
	5.26	−2.41	−3.52	5.26	4.42	0.08	0.44	0.54	0.86	
CA	C	$\Delta p_t^{CA\,|\,US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{CA}$	0.106	−0.042	−0.038	0.001	0.060	0.294	0.006	0.345	0.890	0.04
	15.10	−5.04	−17.59	15.76	1.31	2.49	0.35	1.08	8.15	
$r_{5y,t}^{CA}$	0.147	−0.102	−0.055	0.003	0.902	−0.555	0.052	0.102	0.900	0.001
	2.73	−2.78	−2.73	5.35	3.29	−1.53	0.42	0.93	6.64	
$r_{10y,t}^{CA}$	0.261	−0.025	−0.083	0.005	1.204	−0.086	2.133	0.089	0.697	0.01
	7.01	−2.53	−6.79	7.24	4.67	−0.66	0.18	0.25	0.45	
$r_{20y,t}^{CA}$	0.521	−0.106	−0.141	0.002	−0.786	0.181	1.950	0.202	0.673	0.01
	4.00	−1.80	−3.12	1.84	−1.12	0.23	0.47	0.68	1.17	

Table 3. *Cont.*

BD	C	$\Delta p_t^{BD\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{BD}$	0.009	−0.044	−0.023	0.001	0.181	0.404	0.005	0.967	0.780	0.10
	5.48	−14.30	−22.57	7.17	6.48	4.36	0.36	1.18	4.67	
$r_{5y,t}^{BD}$	0.208	−0.207	−0.074	0.002	−0.091	0.835	0.123	0.382	0.804	0.08
	8.29	−7.10	−8.51	2.89	−1.19	2.03	0.43	0.81	3.16	
$r_{10y,t}^{BD}$	0.461	−0.453	−0.143	0.003	−0.999	0.725	1.834	0.277	0.633	0.07
	5.96	−7.38	−4.94	3.23	−3.31	2.16	0.41	0.51	0.83	
$r_{20y,t}^{BD}$	0.657	−0.687	−0.259	0.002	−0.938	0.145	3.589	0.594	0.809	0.07
	9.39	−9.71	−6.99	3.56	−1.07	0.24	0.41	0.52	2.26	
FR	C	$\Delta p_t^{FR\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{FR}$	−0.189	−0.028	−0.016	0.000	0.071	0.740	0.003	0.489	0.724	0.02
	−15.23	−2.31	−3.73	1.34	1.79	3.87	0.83	1.75	5.42	
$r_{5y,t}^{FR}$	0.230	−0.020	−0.078	0.001	−0.423	0.642	0.166	0.515	0.778	0.05
	7.36	−3.28	−5.48	2.80	−11.68	3.71	0.48	0.79	2.87	
$r_{10y,t}^{FR}$	0.656	−0.085	−0.191	0.001	−0.841	0.413	1.647	0.388	0.777	0.04
	8.16	−2.97	−8.07	3.62	−1.57	4.71	0.40	0.50	1.73	
$r_{20y,t}^{FR}$	0.984	−0.350	−0.301	0.003	−1.398	−0.672	1.215	0.426	0.786	0.04
	9.06	−3.29	−8.15	3.21	−1.44	−5.43	0.54	0.90	3.27	
IT	C	$\Delta p_t^{IT\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{IT}$	0.065	−0.003	−0.043	0.000	−0.435	0.471	0.044	0.891	0.621	0.04
	5.91	−5.71	−10.13	4.70	−4.39	2.88	1.07	1.32	3.59	
$r_{5y,t}^{IT}$	0.490	−0.028	−0.148	0.001	−1.299	0.459	0.382	0.576	0.638	0.05
	12.35	−4.28	−8.69	5.33	−4.75	5.83	0.89	1.05	2.46	
$r_{10y,t}^{IT}$	0.656	−0.085	−0.191	0.001	−0.841	0.413	1.647	0.388	0.777	0.04
	8.16	−2.97	−8.07	3.62	−1.57	4.71	0.40	0.50	1.73	
$r_{20y,t}^{IT}$	0.745	−0.203	−0.281	0.002	−0.685	0.393	4.946	0.241	0.828	0.04
	24.43	−5.15	−20.26	5.61	−6.05	1.56	0.39	0.40	2.09	
UK	C	$\Delta p_t^{UK\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{UK}$	0.101	0.046	0.017	0.001	0.026	0.873	0.017	0.675	0.792	0.08
	17.44	15.08	10.28	39.01	0.33	10.75	0.57	1.17	4.58	
$r_{5y,t}^{UK}$	0.220	0.049	0.074	0.001	0.056	0.806	0.224	0.414	0.772	0.03
	7.39	7.39	5.48	2.93	0.39	2.23	0.43	0.97	2.50	
$r_{10y,t}^{UK}$	0.466	0.043	0.158	0.003	0.312	0.171	1.956	0.660	0.741	0.03
	6.89	5.58	6.96	4.06	1.93	0.32	0.43	0.74	1.85	
$r_{20y,t}^{UK}$	0.735	0.067	0.297	0.004	0.160	0.811	1.238	0.591	0.856	0.04
	8.03	2.85	8.39	4.37	0.63	1.27	0.46	0.70	4.72	
JP	C	$\Delta p_t^{JP\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{JP}$	0.015	0.004	0.002	0.000	0.031	0.024	0.001	0.759	0.599	0.06
	5.69	3.22	2.62	2.46	0.95	0.44	1.23	1.72	3.90	
$r_{5y,t}^{JP}$	0.047	0.005	0.008	0.001	0.113	0.153	0.007	0.512	0.729	0.01
	9.13	4.65	5.78	6.71	1.07	0.77	0.90	1.61	5.68	
$r_{10y,t}^{JP}$	0.15	0.02	0.02	0.00	0.09	0.15	0.05	0.24	0.86	0.00
	7.45	1.27	1.98	0.96	0.32	0.59	0.55	1.08	6.75	
$r_{20y,t}^{JP}$	0.006	0.012	0.005	0.000	0.001	0.019	0.001	0.872	0.643	0.03
	3.11	8.44	9.65	2.35	1.11	0.52	0.84	1.53	3.74	

Notes: The first column lists returns for bonds. Δp_t^{US} represents the US inflation and $\Delta p_t^{j|US}$ represents the actual inflation in country j, which is a residual series obtained by regressing inflation in country i on US inflation. For the US, we employ the EU as country i. $\Delta EMV_{\Delta p,t}$ is the US equity market volatility attributable to inflation. $D_{GFC,t}$ and $D_{COVID,\ t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.58, 1.96, and 1.65, respectively. R^2 is the coefficient of determination.

Second, heightened inflation tends to create uncertainty concerning business profits due to an erosion of future income streams. This fear causes investors to sell their holdings, causing stock market volatility, $EMV_{\Delta p,t}$, to rise. In response to the change in market volatility, investors are induced to shift funds to buy bonds (or other quality assets); this flight-to-quality phenomenon (Connolly et al. 2005; Chiang et al. 2015) drives up bond prices. This dynamic behavior is reflected in the positive coefficients of $\Delta EMV_{\Delta p,t}$. The z-statistics also indicate a rejection of the null. This positive effect offsets part of the negative effect arising from heightened inflation.[4]

Third, the effects of domestic inflation on bond returns exhibit comparable results for the non-US G7 markets, with the exception of longer maturities in Japan. A more striking result is the impact of US inflation on foreign bonds; the evidence shows that US inflation is negative and statistically significant. In most countries (expect the JP market), US inflation has more profound effects in terms of the magnitude or level of significance. The precise channel of transmission is less clear. One possible explanation is that US inflation may be exported to the rest of the G7 countries, especially in cases where bilateral exchange rates against USD are maintained in a steady fashion, depending on the preference function of each national monetary authority.

Fourth, the effect of $\Delta EMV_{\Delta p,t}$ on bonds in the US and its spillover to the rest of the G7 countries are striking. The coefficients of $\Delta EMV_{\Delta p,t}$ are positive and highly significant; only $r^{FR}_{2y,t}$ and $r^{JP}_{10y,t}$ lack significance at the conventional level. The findings suggest that as inflation fears rise, investors tend to dispose of their stocks, which causes equity market volatility; the activities that shift funds from stock markets to bond markets produce a positive effect on bonds. This flight-to-quality activity partially offsets the original price losses from heightened inflation. The results confirm our hypothesis that $\Delta EMV_{\Delta p,t}$ and bond returns are positively correlated.

To check the effects of inflation and the $\Delta EMV_{\Delta p,t}$ on stock returns, we estimated the test equation, replacing the stock market return as a dependent variable, $R^{j}_{m,t}$. The estimated results are reported in Table 4. Obviously, the estimated coefficients of inflation display a negative effect on stock returns. The evidence is consistent with the results reported by Chiang (2023). Notably, the effect of the estimated US inflation on each non-US G7 country is more consistent and profound compared to that from domestic inflation, reflecting the dominant role of the US in global equity markets (Rapach et al. 2013).

Table 4. Estimates of stock returns in response to inflation and equity market volatility.

Market	C	$\Delta p_t^{j\,\vert\,US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε^2_{t-1}	σ^2_{t-1}	R^2
$R^{US}_{m,t}$	2.111	−0.412	−0.301	−0.018	−5.458	−10.377	1.651	0.444	0.725	0.21
	11.42	−2.66	−4.23	−11.27	−3.44	−12.28	0.69	1.43	3.99	
$R^{CA}_{m,t}$	1.674	−0.386	−0.257	−0.024	0.664	−4.669	3.576	0.598	0.788	0.17
	10.83	−6.47	−4.56	−11.15	1.91	−3.56	0.49	0.84	2.97	
$R^{BD}_{m,t}$	1.851	0.255	−0.364	−0.032	−5.687	−10.786	10.133	0.662	0.726	0.19
	12.60	14.04	−8.37	−15.20	−2.85	−9.63	0.52	0.75	2.04	
$R^{FR}_{m,t}$	1.755	−0.477	−0.261	−0.030	−4.483	−9.862	13.006	0.367	0.739	0.20
	10.66	−4.67	−4.28	−13.42	−15.68	−31.79	0.40	0.49	1.34	
$R^{IT}_{m,t}$	1.759	0.081	−0.380	−0.034	−3.006	−10.538	11.982	0.026	0.574	0.19
	4.36	0.39	−2.87	−6.05	−1.47	−6.81	0.56	0.24	0.78	
$R^{UK}_{m,t}$	1.426	0.186	−0.172	−0.022	−2.186	−8.611	4.046	0.233	0.467	0.21
	4.30	1.23	−1.74	−5.70	−1.13	−5.37	1.76	1.80	1.97	
$R^{JP}_{m,t}$	1.506	0.320	−0.306	−0.029	−3.704	−9.637	13.222	0.223	0.784	0.19
	9.64	4.10	−6.33	−18.58	−3.25	−7.18	0.36	0.31	1.44	

Notes: The dependent variable is stock returns for countries listed in the first column. Δp_t^{US} denotes US inflation and $\Delta p_t^{j|US}$ denotes the actual inflation in country *j*, which is a residual series obtained by regressing inflation in country *j* on US inflation. For the US, we employ the EU as country *j*. $\Delta EMV_{\Delta p,t}$ is the US equity market volatility attributable to inflation. $D_{GFC,t}$ and $D_{COVID,\,t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the *z*-statistics. The critical values of the *z*-distribution at the 1%, 5%, and 10% significance levels are 2.58, 1.96, and 1.65, respectively. R^2 is the coefficient of determination.

With respect to the estimation of $\Delta EMV_{\Delta p,t}$, statistics in Table 4 reveal that all coefficients are negative and statistically significant. This finding contrasts with the outcome of bond coefficients. Thus, opposite signs of coefficients for two assets can be interpreted as the source of decoupling between stock–bond movements, which is attributable to a rise in stock market uncertainty. The evidence is consistent with the findings reported by Connolly et al. (2005) and Chiang et al. (2015). However, $\Delta EMV_{\Delta p,t}$ is not an element included in their test equations.

5.2. The Fed's Rate Hike Policy

During times of high inflation, the central bank attempts to adopt a disinflation policy by raising interest rates. This was recently the case in the US when the Fed raised interest rates eleven times during the period from 17 March 2022 to 26 July 2023, taking the Federal fund's rate to a target range between 5.25% and 5.50%. It was clear that during the course of rate hikes, the Fed's action caused stock market volatility, which prompted investors to shift funds from the stock market to bonds. This series of events raised bond prices. To capture this parametric impact, we employed the measure of changes in equity market volatility calibrated to changes in the interest rate, $\Delta EMV_{\Delta i,t}$, as proposed by Baker et al. (2022). The results of replacing $\Delta EMV_{\Delta p,t}$ with $\Delta EMV_{\Delta i,t}$ are reported in Table 5.

Table 5. Estimates of bond returns in response to domestic and US inflation and equity market volatility calibrated to the change in the interest rates of G7 countries.

US	C	$\Delta p_t^{EU\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{CFC}	D_{COVID}	ω_0	ε^2_{t-1}	σ^2_{t-1}	R^2
$r^{US}_{2y,t}$	0.136	−0.014	−0.047	0.002	0.576	0.019	0.028	1.071	0.807	0.08
	16.36	−6.25	−11.59	12.84	3.13	0.72	0.46	0.88	4.27	
$r^{US}_{5y,t}$	0.135	−0.001	−0.048	0.002	0.784	0.020	0.032	1.188	0.811	0.06
	32.99	−8.54	−23.69	25.56	4.17	0.11	0.43	0.91	4.37	
$r^{US}_{10y,t}$	0.311	−0.133	−0.136	0.002	−0.268	−0.100	8.573	0.276	0.074	0.02
	4.54	−2.43	−5.84	2.47	−0.81	−0.76	0.79	0.52	0.07	
$r^{US}_{20y,t}$	0.487	−0.337	−0.196	−0.002	1.847	−0.849	26.174	0.716	0.001	0.01
	3.66	−3.36	−3.76	−1.11	4.93	−0.63	1.15	0.93	0.01	
CA	C	$\Delta p_t^{CA\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{CFC}	D_{COVID}	ω_0	ε^2_{t-1}	σ^2_{t-1}	R^2
$r^{CA}_{2y,t}$	0.095	−0.019	−0.042	0.001	0.307	0.120	0.027	0.826	0.736	0.04
	9.87	−5.65	−12.52	16.14	1.50	1.56	0.68	1.05	3.40	
$r^{CA}_{5y,t}$	0.137	−0.033	−0.057	0.002	−0.457	0.955	0.069	0.111	0.886	0.00
	2.46	−0.63	−2.75	2.52	−1.20	5.23	0.41	0.84	5.10	
$r^{CA}_{10y,t}$	0.263	0.080	−0.067	0.000	−0.040	1.119	2.050	0.185	0.660	0.01
	4.49	4.28	−3.77	0.17	−0.91	6.24	0.30	0.43	0.64	
$r^{CA}_{20y,t}$	0.430	0.125	−0.132	−0.003	−1.729	0.614	3.166	0.318	0.654	0.02
	7.19	1.41	−5.77	−2.64	−5.74	2.28	0.37	0.53	0.83	
BD	C	$\Delta p_t^{BD\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{CFC}	D_{COVID}	ω_0	ε^2_{t-1}	σ^2_{t-1}	R^2
$r^{BD}_{2y,t}$	0.013	−0.071	−0.023	0.000	0.410	0.171	0.005	0.863	0.800	0.10
	14.62	−25.29	−17.39	17.61	16.44	9.39	0.37	1.09	4.78	
$r^{BD}_{5y,t}$	0.230	−0.165	−0.077	0.001	0.810	−0.057	0.098	0.357	0.813	0.07
	11.30	−6.12	−7.83	2.46	1.91	−0.23	0.45	0.90	3.73	
$r^{BD}_{10y,t}$	0.526	−0.467	−0.141	−0.001	0.785	−1.160	1.753	0.209	0.602	0.06
	5.96	−7.12	−4.41	−2.79	2.07	−5.37	0.42	0.54	0.75	
$r^{BD}_{20y,t}$	0.675	−0.676	−0.264	−0.004	0.499	−0.595	4.484	0.504	0.792	0.07
	14.08	−10.09	−15.75	−27.17	14.51	−0.74	0.40	0.46	1.83	

Table 5. *Cont.*

FR	C	$\Delta p_t^{FR\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{CFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{FR}$	−0.101	0.042	−0.016	0.000	0.597	−0.039	0.025	1.352	0.717	0.08
	−10.57	3.56	−3.59	4.34	3.59	−0.54	0.48	0.99	2.77	
$r_{5y,t}^{FR}$	0.260	−0.113	−0.076	0.000	0.705	−0.558	0.158	0.521	0.777	0.04
	9.35	−4.09	−7.06	2.80	3.23	−2.06	0.46	0.86	2.96	
$r_{10y,t}^{FR}$	0.802	−0.129	−0.181	−0.004	0.526	−0.884	0.313	0.131	0.899	0.04
	8.63	−3.48	−5.95	−3.76	1.37	−1.85	0.55	0.70	6.63	
$r_{20y,t}^{FR}$	1.028	−0.213	−0.291	−0.004	−0.258	−0.921	0.966	0.403	0.812	0.05
	8.47	−4.51	−7.96	−4.13	−7.01	−0.92	0.51	0.94	3.94	
IT	C	$\Delta p_t^{IT\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{IT}$	0.08	0.01	−0.04	0.00	0.42	−0.38	0.04	0.79	0.65	0.04
	6.54	4.47	−8.31	10.64	2.58	−4.59	1.08	1.25	3.83	
$r_{5y,t}^{IT}$	0.409	−0.116	−0.113	−0.002	0.920	−1.325	0.224	0.306	0.660	0.03
	5.91	−2.72	−4.85	−2.69	3.07	−4.10	1.37	1.51	3.83	
$r_{10y,t}^{IT}$	0.923	−0.037	−0.278	−0.003	0.454	−2.180	1.066	0.485	0.778	0.08
	12.09	−2.23	−9.73	−3.10	0.77	−16.12	0.67	0.91	3.66	
$r_{20y,t}^{IT}$	0.774	−0.204	−0.283	−0.004	0.639	−0.387	3.299	0.573	0.818	0.05
	9.29	−6.47	−11.14	−5.00	1.47	−7.63	0.42	0.59	2.61	
UK	C	$\Delta p_t^{UK\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{UK}$	−0.101	−0.046	−0.017	0.001	0.873	−0.026	0.017	0.675	0.792	0.078
	−17.44	−15.08	−10.28	39.01	10.75	−0.33	0.57	1.17	4.58	
$r_{5y,t}^{UK}$	0.217	−0.033	−0.064	0.001	0.791	0.039	0.230	0.371	0.780	0.03
	6.30	−6.86	−4.20	3.51	2.94	2.78	0.42	0.92	2.45	
$r_{10y,t}^{UK}$	0.477	−0.051	−0.156	0.001	0.410	0.656	1.956	0.714	0.729	0.02
	8.29	−8.39	−10.28	10.95	0.74	4.33	0.45	0.77	1.90	
$r_{20y,t}^{UK}$	0.798	−0.051	−0.289	0.002	−0.877	0.116	2.962	0.738	0.772	0.04
	6.37	−1.31	−6.57	5.11	−1.30	4.79	0.49	0.67	2.45	
JP	C	$\Delta p_t^{JP\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{JP}$	0.017	−0.004	−0.003	0.000	0.023	−0.027	0.001	0.929	0.591	−0.06
	7.78	−7.71	−4.86	2.71	1.25	−0.84	1.09	1.62	3.59	
$r_{5y,t}^{JP}$	0.043	0.000	−0.011	0.000	0.171	−0.086	0.012	0.829	0.762	0.01
	13.49	−0.11	−17.92	4.61	0.95	−0.84	0.60	1.11	4.40	
$r_{10y,t}^{JP}$	0.147	0.018	−0.020	0.000	−0.147	−0.081	0.053	0.283	0.855	0.00
	5.52	2.31	−3.78	2.82	−0.63	−0.32	0.52	1.02	6.18	
$r_{20y,t}^{JP}$	0.391	0.060	−0.084	−0.001	−0.499	−1.327	0.552	0.709	0.676	0.02
	8.15	4.32	−6.13	−2.81	−1.59	−8.94	0.73	1.24	2.95	

Notes: The first column lists asset returns from bonds or stock. Δp_t^{US} denotes US inflation and $\Delta p_t^{j|US}$ denotes the actual inflation in country i, which is a residual series obtained by regressing inflation in country on US inflation. For the US, we employ the EU as country j. $\Delta EMV_{\Delta i,t}$ is the US equity market volatility calibrated to changes in the interest rate. $D_{GFC,t}$ and $D_{COVID,\,t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.58, 1.96, and 1.65, respectively. R^2 is the coefficient of determination.

The estimated results for the coefficients of inflation variables, $\Delta p_t^{j|US}$, neutralized for the effect from US inflation, are mainly negative and statistically significant.[5] However, there are some cases, namely Canada and Japan, which fail to follow the expected sign and are insignificant at the conventional level. Again, the US inflation, Δp_t^{US}, appears to have more consistent and profound negative impacts on bond returns.

The performance of $\Delta EMV_{\Delta i,t}$ is comparable to that of $\Delta EMV_{\Delta p,t}$ in short-term maturities. Specifically, the coefficients are positive and statistically significant for bond maturities with a relatively short term, such as two-year and five-year bonds. However, for ten-year and twenty-year bonds, the majority of coefficients show the opposite sign (except in the UK). The findings suggest that the disinflationary rate hike policy by the Fed that spilled over to global markets had a positive effect on two-year and five-year bonds, which moderated losses from heightened inflation. The testing results also suggest that the substituting activity between stocks and bonds mainly occurs for shorter bond maturities as investors perceive that the Fed's rate hikes policy might pause or reverse in subsequent rate hike cycles.

Additional estimates of stock returns using the same set of independent variables reported in Table 6 are comparable to those in Table 4. Evidence suggests that the coefficients of $\Delta p_t^{j|US}$ and Δp_t^{US} are negative and statistically significant. The exceptions are BD, IT, UK, and JP in terms of domestic inflation coefficients. However, the coefficients of $\Delta EMV_{\Delta i,t}$ on stock returns show negative signs, indicating a downside effect associated with a rise in $\Delta EMV_{\Delta i,t}$.

Table 6. Estimates of stock return responses to inflation and equity market volatility induced by interest rate changes (2000.M1–2022.M12).

Market	C	$\Delta p_t^{j\mid US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$R_{m,t}^{US}$	2.108	−0.360	−0.349	−0.021	−9.903	−4.916	1.901	0.373	0.750	0.25
	12.96	−8.73	−6.96	−10.18	−10.31	−3.48	0.62	1.19	3.53	
$R_{m,t}^{CA}$	1.674	−0.386	−0.257	−0.024	−4.669	0.664	3.576	0.598	0.788	0.17
	10.83	−6.47	−4.56	−11.15	−3.56	1.91	0.49	0.84	2.97	
$R_{m,t}^{BD}$	1.902	0.057	−0.202	−0.027	−9.787	−7.091	9.103	0.703	0.711	0.18
	18.76	5.97	−8.05	−20.27	−11.12	−4.47	0.57	0.73	2.01	
$R_{m,t}^{FR}$	1.805	−0.387	−0.298	−0.035	−8.986	−3.972	8.014	0.662	0.738	0.24
	11.08	−5.86	−7.06	−21.70	−9.05	−2.69	0.47	0.68	1.95	
$R_{m,t}^{IT}$	1.948	0.149	−0.370	−0.037	−10.121	−4.533	1.248	0.049	0.898	0.22
	4.32	0.65	−2.62	−6.44	−5.67	−2.42	1.11	1.05	11.84	
$R_{m,t}^{UK}$	1.475	0.177	−0.174	−0.027	−8.637	−2.558	1.797	0.158	0.702	0.26
	4.52	1.19	−1.82	−6.90	−5.65	−1.69	1.09	1.70	3.80	
$R_{m,t}^{JP}$	1.517	0.306	−0.328	−0.026	−8.848	−1.021	15.687	0.293	0.733	0.18
	11.00	7.36	−5.67	−18.45	−9.49	−0.86	0.34	0.37	1.07	

Notes: The dependent variable is stock returns for country j, listed in first column. Δp_t^{US} denotes US inflation and $\Delta p_t^{j|US}$ denotes the actual inflation in country j, which is a residual series obtained by regressing the inflation in country j on US inflation. For the US, we employ the EU as the foreign country. $\Delta EMV_{\Delta i,t}$ is the US equity market volatility attributable to interest rate changes. $D_{GFC,t}$ and $D_{COVID,\,t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.63, 1.98, and 1.66, respectively. R^2 is the coefficient of determination.

6. Alternative Model Specifications

6.1. Nonlinear Specification

The likely interaction between stock volatility and inflation news is specified in the product term captured by $\Delta p_t^j \cdot \Delta EMV_{\Delta p,t}$. Incorporating this term into the regression model yields:

$$r_t^j = C + \beta_1 \Delta p_t^j + \beta_2\, \Delta p_t^j \cdot \Delta EMV_{\Delta p,t} + \beta_3 D_{Crisis,t} + \beta_4 D_{COVID,t} + \varepsilon_{j,t} \tag{7}$$

The estimated results of Equation (7) are reported in Table 7, which indicates that the coefficients of the product terms are significantly positive except for a few cases which are insignificant for twenty-year maturity bonds. The test results are consistent with the estimations using $\Delta EMV_{\Delta p,t}$, which is treated as an independent argument as reported in the previous tables. It appears that the significance of the product term is consistent with the response of investors to news about inflation and the volatility dynamics in the U.S. market, which triggers a flight-to-quality. This is shown in the positive coefficients of $\Delta p_t^j \cdot \Delta EMV_{\Delta p,t}$, which are statistically significant except in some minor cases for twenty-year bonds.

Table 7. Bond returns in response to domestic inflation and its interaction with US changes in inflation-induced EMV.

US	C	Δp_t^{US}	$\Delta p_t^{US}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{US}$	0.117	−0.051	0.0004	−0.057	0.590	0.005	0.527	0.841	0.06
	13.19	−8.97	12.66	−0.32	2.95	0.40	1.28	7.33	
$r_{5y,t}^{US}$	0.285	−0.100	0.001	−0.236	0.429	0.399	0.287	0.852	0.03
	10.06	−9.23	27.33	−5.53	3.76	0.44	0.59	3.44	
$r_{10y,t}^{US}$	0.390	−0.151	0.002	−0.111	−0.693	13.150	0.399	−0.048	0.02
	9.00	−9.43	5.60	−2.65	−7.20	0.98	0.49	−0.05	
$r_{20y,t}^{US}$	0.598	−0.194	0.001	−0.936	0.934	41.786	1.699	−0.050	0.001
	7.22	−5.81	13.81	−5.15	0.85	1.33	0.91	−0.14	
CA	C	Δp_t^{CA}	$\Delta p_t^{CA}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{CA}$	0.082	−0.052	0.001	0.078	0.336	0.004	0.205	0.885	0.02
	9.21	−15.68	12.20	0.63	5.47	0.50	1.36	9.89	
$r_{5y,t}^{CA}$	0.198	−0.063	0.001	0.908	−0.576	0.145	0.230	0.885	0.01
	6.87	−6.54	6.35	6.44	−1.67	0.29	0.62	3.61	
$r_{10y,t}^{CA}$	0.261	−0.080	0.001	1.168	−0.307	2.871	0.162	0.593	0.01
	3.97	−3.36	4.95	3.32	−0.79	0.26	0.34	0.41	
$r_{20y,t}^{CA}$	0.539	−0.166	−0.002	0.084	−0.99	1.317	0.158	0.681	0.01
	2.76	−2.03	−2.71	0.14	−1.29	0.60	0.88	1.59	
BD	C	Δp_t^{BD}	$\Delta p_t^{BD}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{BD}$	−0.024	−0.013	0.0001	0.030	0.585	0.001	0.290	0.743	0.08
	−1.36	−2.21	0.77	0.28	2.21	1.13	3.28	11.70	
$r_{5y,t}^{BD}$	0.306	−0.129	0.001	0.259	0.687	0.125	0.360	0.814	0.07
	9.26	−7.95	8.38	1.28	1.75	0.46	0.82	3.51	
$r_{10y,t}^{BD}$	0.577	−0.269	0.001	−0.642	0.762	1.910	0.223	0.648	0.06
	10.36	−8.00	7.07	−1.28	1.76	0.36	0.44	0.77	
$r_{20y,t}^{BD}$	0.850	−0.435	−0.001	0.026	0.427	0.307	0.105	0.866	0.07
	3.84	−5.30	−0.47	0.02	0.55	1.07	1.54	10.29	
FR	C	Δp_t^{FR}	$\Delta p_t^{FR}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{FR}$	−0.110	−0.023	0.0002	−0.041	0.664	0.018	1.338	0.701	0.09
	−18.20	−4.19	7.60	−2.94	3.76	0.46	1.05	2.66	
$r_{5y,t}^{FR}$	0.214	−0.118	0.001	−0.602	0.733	0.171	0.553	0.765	0.04
	8.22	−5.62	5.05	−2.04	2.04	0.48	0.84	2.80	
$r_{10y,t}^{FR}$	0.571	−0.279	0.001	−1.293	0.282	0.698	0.243	0.858	0.04
	6.33	−5.14	6.52	−2.39	0.67	0.43	0.56	3.48	
$r_{20y,t}^{FR}$	0.969	−0.445	0.001	−1.739	−0.612	1.319	0.459	0.771	0.04
	7.99	−5.92	6.27	−1.78	−1.92	0.58	0.93	3.16	
IT	C	Δp_t^{IT}	$\Delta p_t^{IT}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{IT}$	0.032	−0.025	0.0002	−0.228	0.561	0.062	1.078	0.631	0.03
	6.35	−5.41	9.02	−5.34	4.49	0.97	1.23	3.27	
$r_{5y,t}^{IT}$	0.329	−0.118	0.001	−1.298	−0.178	0.552	0.809	0.704	0.04
	10.10	−6.79	3.68	−26.89	−1.12	0.66	0.84	2.50	
$r_{10y,t}^{IT}$	0.618	−0.233	0.000	−2.627	−1.862	0.906	0.408	0.775	0.05
	14.58	−12.73	2.39	−8.56	−8.30	0.70	0.94	3.79	
$r_{20y,t}^{IT}$	0.693	−0.254	0.001	−1.273	−0.196	0.566	0.166	0.832	0.03
	3.70	−3.03	0.21	−1.16	−0.24	0.68	1.14	5.26	

Table 7. *Cont.*

UK	C	Δp_t^{UK}	$\Delta p_t^{UK}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{UK}$	−0.060	−0.028	0.0003	0.056	0.756	0.028	0.802	0.756	0.08
	−5.51	−6.31	7.85	1.11	6.20	0.60	1.08	3.45	
$r_{5y,t}^{UK}$	0.168	−0.073	0.001	−0.032	0.902	0.641	0.600	0.650	0.03
	6.77	−7.04	21.95	−1.26	3.53	0.44	0.83	1.15	
$r_{10y,t}^{UK}$	0.388	−0.130	0.001	−0.255	0.090	2.454	0.652	0.650	0.02
	8.94	−9.83	3.31	−0.97	0.15	0.49	0.76	1.27	
$r_{20y,t}^{UK}$	0.552	−0.230	0.000	0.788	−1.144	1.801	0.535	0.828	0.02
	4.81	−4.57	9.11	1.78	−1.46	0.45	0.69	3.52	
JP	C	Δp_t^{JP}	$\Delta p_t^{JP}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
$r_{2y,t}^{JP}$	0.010	−0.002	0.000	−0.075	−0.044	0.001	0.712	0.605	−0.07
	6.32	−2.57	1.42	−2.44	−0.76	1.27	1.79	4.22	
$r_{5y,t}^{JP}$	0.019	−0.008	0.001	−0.135	0.190	0.022	1.600	0.732	0.00
	4.04	−5.69	5.64	−6.18	0.98	0.50	1.02	3.54	
$r_{10y,t}^{JP}$	0.107	−0.007	0.001	−0.194	0.062	0.168	0.902	0.843	0.00
	10.97	−5.16	3.27	−0.61	11.28	0.38	0.78	4.37	
$r_{20y,t}^{JP}$	0.140	−0.051	0.001	−1.689	0.283	1.007	0.768	0.694	0.00
	5.98	−2.11	5.95	−8.18	7.82	0.62	0.94	2.35	

Notes: The first column lists the variables for bond returns with different maturities. The Δp_t^j denotes the inflation rate in country j and $\Delta EMV_{\Delta p,t}$ denotes the US equity market volatility attributable to inflation. $D_{GFC,t}$ and $D_{COVID,\,t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.58, 1.96, and 1.65, respectively. R^2 is the coefficient of determination.

With respect to the coefficients of the domestic inflation variable, the study yields comparable qualitative results. That is, coefficients for Δp_t^j are negative and highly significant across different countries and various maturities. The test concludes that inflation most definitely has harmful effects on bonds; however, the stock market volatility from the US market does produce a positive effect that partially offsets losses from the initial inflationary effect, although the magnitudes are rather small.

6.2. Result by Using Expected Inflation

In the examination of the relationship between asset returns and inflation, Fama and Schwert (1977), Geske and Roll (1983), and Amihud (1996) propose the use of expected inflation as the explanatory variable. This study extends the investigation by using an adaptive expectation process (Geske and Roll 1983; Chiang 2023) and by incorporating a seasonal factor. This process is consistent with the behavior of the error learning process.[6] Specifically, we write:

$$\Delta p_t^e = \Delta p_{t-1} + \alpha\left(\Delta p_{t-1} - \Delta p_{t-1}^e\right) + \gamma \cdot \Delta p_{t-12} \quad (8)$$

where Δp_t and Δp_t^e are the actual and expected inflation, respectively, and $(\Delta p_{t-1} - \Delta p_{t-1}^e)$ is the error from the previous forecast of inflation; α and γ are fixed parameters, with the restrictions of $1 \geq \alpha \geq 0$ and $1 \geq \gamma \geq 0$, respectively; and Δp_{t-12} is a monthly seasonal factor. Estimates of expected inflation are reported in Table 8.

The estimated results when Δp_t^e is incorporated into the test equation show that the coefficients of Δp_t^e are negative and statistically significant. These results, which are reported in Table 9, contain a few instances where the coefficients for longer term bonds in Canada, Italy, and Japan fail to meet the conventional significance level. For the product term, $\Delta p_t^{e,j} \cdot \Delta EMV_{\Delta p,t}$, we obtained comparable results to those in Table 7, i.e., the estimated coefficients are positive and statistically significant. Finally, we conducted diagnostic checking on the residuals from each estimated equation. The Q (24) statistics, which test the absence of autocorrelations on the residuals as a group up to 24 lags, indicate that none of the test results are statistically significant, confirming the absence of autocorrelation. However, two-year bond returns in the US, France, and Japan are an exception. However, after including appropriate AR terms, the residuals from the reformulating models contain no more serial correlations. In sum, the findings suggest that the test relations are robust whether the actual inflation or expected inflation is used in the test equation.

Table 8. Estimates of expected inflation based on an adaptive process.

Expected Inflation	α	γ	RMSE
$\Delta p_t^{e,US}$	0.96	0.10	0.475
$\Delta p_t^{e,CA}$	0.93	0.31	0.465
$\Delta p_t^{e,EU}$	0.99	0.10	0.313
$\Delta p_t^{e,BD}$	0.90	0.15	0.389
$\Delta p_t^{e,FR}$	0.95	0.10	0.281
$\Delta p_t^{e,IT}$	0.94	-	0.327
$\Delta p_t^{e,UK}$	0.97	-	0.354
$\Delta p_t^{e,JP}$	0.98	0.15	0.335

Notes: The expected inflation is assumed to follow an adaptive process, which is projected by using an exponential smoothing process plus a seasonal factor. It is expressed by $\Delta p_t^e = \Delta p_{t-1} + \alpha(\Delta p_{t-1} - \Delta p_{t-1}^e) + \gamma \cdot \Delta p_{t-12}$, where Δp_t and Δp_t^e are the actual and expected inflation, respectively. "-" indicates no seasonal factor. The US and CA tend to present lag 13 as a seasonal factor. RMSE is a measure of root mean squared errors.

Table 9. Bond returns responding to domestic inflation expectations and their interaction with U.S. changes in EMV.

US	C	$\Delta p_t^{e,US}$	$\Delta p_t^{e,US}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	Q(24)	R^2
$r_{2y,t}^{US}$	0.109	−0.038	0.000	0.008	0.565	0.010	0.627	0.793	33.52	0.054
	30.86	−19.63	21.20	4.75	2.91	0.56	1.28	5.80		
$r_{5y,t}^{US}$	0.186	−0.052	0.001	0.016	0.108	0.443	0.262	0.845	24.99	0.022
	4.83	−3.81	6.71	3.13	0.35	0.44	0.53	3.02		
$r_{10y,t}^{US}$	0.195	−0.065	0.001	0.066	−0.835	3.439	0.136	0.746	18.97	0.006
	2.74	−3.00	4.66	0.16	−1.82	0.33	0.32	1.03		
$r_{20y,t}^{US}$	0.588	−0.195	0.001	−0.909	−0.552	10.570	0.232	0.770	15.33	0.004
	10.87	−19.09	2.83	−0.78	−0.55	0.34	0.41	1.32		
CA	C	$\Delta p_t^{e,CA}$	$\Delta p_t^{e,CA}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	Q(24)	R^2
$r_{2y,t}^{CA}$	0.072	−0.029	0.000	0.089	0.312	0.029	0.599	0.644	15.02	0.025
	7.15	−4.56	5.23	0.62	1.49	1.06	1.44	3.19		
$r_{5y,t}^{CA}$	0.146	−0.065	0.001	0.927	−0.586	0.543	0.344	0.748	17.56	0.007
	7.06	−5.59	19.49	6.32	−2.01	0.43	0.48	1.46		
$r_{10y,t}^{CA}$	0.075	−0.021	0.001	1.234	−0.324	1.957	0.224	0.813	11.40	0.000
	1.80	−1.33	6.17	5.07	−0.93	0.21	0.34	1.10		
$r_{20y,t}^{CA}$	0.253	−0.051	−0.001	0.544	0.055	2.614	0.535	0.875	13.25	0.009
	4.66	−3.69	−7.39	0.66	1.69	0.26	0.44	2.71		
BD	C	$\Delta p_t^{e,BD}$	$\Delta p_t^{e,BD}\Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	Q(24)	R^2
$r_{2y,t}^{BD}$	0.002	−0.030	0.000	0.141	0.509	0.003	0.614	0.775	20.10	0.085
	0.28	−25.04	6.20	2.55	6.36	0.47	1.40	5.60		
$r_{5y,t}^{BD}$	0.242	−0.121	0.001	0.413	0.729	0.125	0.401	0.813	16.12	0.052
	8.58	−7.21	3.26	6.93	1.61	0.44	0.80	3.39		
$r_{10y,t}^{BD}$	0.510	−0.234	0.001	−1.142	0.848	0.356	0.118	0.914	17.79	0.041
	7.29	−5.73	10.51	−4.82	2.84	0.39	0.50	5.39		
$r_{20y,t}^{BD}$	0.726	−0.418	−0.001	−0.033	0.547	0.604	0.243	0.882	13.11	0.047
	6.16	−6.19	−1.24	−0.39	2.37	0.57	0.81	6.54		

Table 9. *Cont.*

FR	C	$\Delta p_t^{e,FR}$	$\Delta p_t^{e,FR} \Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	$Q(24)$	R^2
$r_{2y,t}^{FR}$	−0.085	−0.003	0.001	−0.013	0.403	0.011	1.049	0.747	20.92	0.183
	−10.05	−0.64	19.27	−0.52	3.91	0.49	1.10	3.51		
$r_{5y,t}^{FR}$	0.474	−0.227	0.000	−1.966	0.287	2.111	0.221	0.811	17.20	0.020
	6.59	−4.48	3.47	−3.39	1.25	0.37	0.34	1.75		
$r_{10y,t}^{FR}$	0.474	−0.227	0.000	−1.966	0.287	2.111	0.221	0.811	9.07	0.020
	6.59	−4.48	3.47	−3.39	1.25	0.37	0.34	1.75		
$r_{20y,t}^{FR}$	0.777	−0.367	0.001	−1.801	−0.593	1.199	0.444	0.788	9.51	0.023
	5.61	−4.21	3.15	−1.66	−1.43	0.55	0.93	3.46		
IT	C	$\Delta p_t^{e,IT}$	$\Delta p_t^{e,IT} \Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	$Q(24)$	R^2
$r_{2y,t}^{IT}$	0.018	−0.015	0.001	−0.478	0.391	0.058	1.149	0.627	20.98	0.031
	7.10	−4.76	9.04	−4.59	2.96	0.95	1.23	3.32		
$r_{5y,t}^{IT}$	0.321	−0.114	0.001	−1.352	−0.180	0.668	1.025	0.645	22.62	0.038
	8.58	−5.85	4.18	−7.64	−1.51	0.68	0.84	1.99		
$r_{10y,t}^{IT}$	0.601	−0.243	0.001	−2.581	−2.182	1.597	0.665	0.732	25.74	0.037
	20.31	−11.67	44.73	−8.25	−4.59	0.65	0.86	2.83		
$r_{20y,t}^{IT}$	0.570	−0.130	0.000	−1.784	0.032	0.519	0.188	0.830	12.73	0.011
	2.98	−1.49	−0.09	−1.57	0.05	0.65	1.18	5.47		
UK	C	$\Delta p_t^{e,UK}$	$\Delta p_t^{e,UK} \Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	$Q(24)$	R^2
$r_{2y,t}^{UK}$	−0.060	−0.034	0.000	0.070	0.885	0.031	0.902	0.721	24.85	0.075
	−7.30	−10.53	6.90	0.95	5.07	0.64	1.13	3.12		
$r_{5y,t}^{UK}$	0.165	−0.073	0.001	0.120	0.892	0.679	0.546	0.652	10.95	0.031
	8.07	−10.28	6.56	0.72	3.40	0.43	0.78	1.09		
$r_{10y,t}^{UK}$	0.408	−0.131	0.001	−0.367	−0.069	2.178	0.627	0.676	15.45	0.014
	8.02	−5.49	9.94	−18.14	−0.15	0.48	0.77	1.43		
$r_{20y,t}^{UK}$	0.612	−0.195	0.000	0.845	−0.391	2.013	0.433	0.836	13.72	0.018
	8.13	−8.70	3.40	1.88	−0.50	0.48	0.64	3.49		
JP	C	$\Delta p_t^{e,JP}$	$\Delta p_t^{e,JP} \Delta EMV_{\Delta p,t}$	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	$Q(24)$	R^2
$r_{2y,t}^{JP}$	−0.003	−0.001	0.0001	0.261	0.171	0.001	0.774	0.628	18.17	0.157
	−2.23	−2.31	3.17	16.60	15.99	0.99	1.62	3.75		
$r_{5y,t}^{JP}$	0.020	−0.008	0.001	−0.139	0.189	0.014	0.983	0.735	16.98	0.008
	4.19	−7.42	5.90	−1.35	1.22	0.60	1.17	4.17		
$r_{10y,t}^{JP}$	0.109	−0.007	0.001	−0.386	−0.031	0.031	0.135	0.825	18.99	0.003
	2.65	−0.19	0.71	−1.71	−0.06	1.46	2.82	13.18		
$r_{20y,t}^{JP}$	0.071	−0.028	0.000	−1.646	0.196	1.086	0.913	0.660	21.77	0.002
	3.95	−1.99	2.19	−10.16	1.40	0.64	0.97	2.11		

Notes: The first column lists returns from bonds. $\Delta p_t^{e,j}$ denotes the expected inflation rate in country j based on an adaptive process (the exponential smoothing method). $\Delta EMV_{\Delta p,t}$ denotes the US equity market volatility attributable to inflation. $D_{GFC,t}$ and $D_{COVID,\, t}$ are the dummy variables, which are set to unity when an event occurs and zero otherwise. The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.63, 1.98, and 1.66, respectively. The $\chi^2(24)$at the 5% level is 36.4 (Pankatz 1983). The equation for the US two-year bond rate was estimated by adding AR3 (0.060 and t = 7.96); the equation for the FR two-year bond rate was estimated by adding AR1 (0.210 with t = 14.02) and AR3 (0.290 with t = 23.66); and the estimated equation for the JP two-year bond rate was arrived at by adding AR1 (0.261 with t = 16.6) and AR12 (0.171 with t = 15.99) (see Appendix A). R^2 is the coefficient of determination.

6.3. Discussion

Before drawing conclusions from this research, it should be pointed out that a review of the estimated results reveals some weaknesses due to the low explanatory power of the model as reflected in the low R-squares, especially in the case of the two-year bond market in Japan, which shows negative values. The performance, however, is much better in the US market. To address the issue in the Japanese market, the model was re-specified by re-assessing the serial correlations. The return series in Japan typically exhibit lagged 1 and lagged 12. The re-estimated results, which are reported in Appendix A, are summarized as follows. First, the coefficients for expected inflation in Japan are negative and statistically significant. These results are consistent with our expectation of the model's performance. Second, the coefficients of product terms $\Delta p_t^{JP} \Delta EMV_{\Delta p,t}$ and $\Delta p_t^{JP} \Delta EMV_{\Delta p,t}$ are positive and significant. Third, the slopes of the lagged terms are significant. The R-squares are now impressively higher than 12%. Considering that tests of the relation between asset returns and inflation commonly yield low R-squares, our test results are comparable to those reported in the literature (see Gultekin 1983) for the US and European countries.[7] Until recently, the focus of the existing literature has been mainly on the US stock and bond markets; it has paid little attention to other maturities except ten-year bond markets and ignored other markets, especially Japan and other emerging markets. This shortcoming leads our attention to future research, which we have just started to explore in this study and plan to pursue in future research. The difficulty of studying other countries, however, is a hurdle that needs to be overcome in finding compatible data to fit the model.

7. Conclusions and Summary

This study reinvestigates the relationship between inflation (expectation) and bond prices using updated data covering monthly observations for G7 countries for the period from January 2000 to December 2022. The evidence collected by this study indicates that the domestic inflation rate has a negative effect on bond returns across different maturities, except for longer maturities in Japan. Evidence shows that US inflation has a significant impact on bond returns for the non-US G7 countries. The negative effects from US inflation appear to be more profound than those emerging from the domestic market (except the Japanese market).

This study modifies the traditional Fisher equation by introducing a risk variable, equity market volatility ($\Delta EMV_{\Delta p,t}$), which arises from inflation and prompts investor fears and, consequently, cross-asset reallocations. The effect is consistent with the flight-to-quality phenomenon. The positive effect of $\Delta EMV_{\Delta p,t}$ on bond returns appears to offset some of the losses arising from the original negative effects of a rise in inflation. By replacing the $\Delta EMV_{\Delta p,t}$ with $\Delta EMV_{\Delta i,t}$, we find a significant impact of change in equity market volatility calibrated to the Fed's change in interest rates that produces comparable results in bond returns, although the evidence is weaker while using $\Delta EMV_{\Delta i,t}$. Thus, the model is robust whether volatility is measured by $\Delta EMV_{\Delta p,t}$ or $\Delta EMV_{\Delta i,t}$.

One notable result derived from this study is that there is a significant negative correlation between $\Delta EMV_{\Delta p,t}$ ($\Delta EMV_{\Delta i,t}$) and stock returns and a positive correlation between $\Delta EMV_{\Delta p,t}$ ($\Delta EMV_{\Delta i,t}$) and bond returns Taking these two empirical results together implies that stock and bond returns are negatively correlated, since these two classes of asset returns respond to the $\Delta EMV_{\Delta p,t}$ in opposite directions. This conclusion partially explains the stock–bond return decoupling observed in the literature (Gulko 2002; Connolly et al. 2005; Chiang et al. 2015).

The positive effect also presents in a nonlinear fashion, as shown in the product term of $\Delta p_t^{e,j} \cdot \Delta EMV_{\Delta p,t}$. This result reflects the fear that volatility precipitated by news about inflation tends to enhance a flight to quality and produces a positive effect on bond prices, helping to mitigate a decline in bond prices. The positive effect of $\Delta EMV_{\Delta p,t}$ ($\Delta EMV_{\Delta i,t}$) certainly has its policy implication since the significance of this variable provides a new element to help investors balance their portfolios in an inflationary era. Further, from an academic point of view, the significance of this variable highlights that the economic impact of inflation spills over into stock volatility and into bond returns.

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Appendix A

This appendix reports the estimates obtained by adding autocorrelation terms to two-year bonds in the Japanese market and is addressed in models in Tables 3, 5, 7 and 9.

The addition of autocorrelation terms was used to re-estimate the response of two-year bonds in the Japanese market to inflation and a change in equity market volatility. It appears that the negative R-squares were caused because of a lack of attention to autocorrelations. The results are reported as follows.

Table A1. The estimates obtained by adding autocorrelation terms to two-year bonds in the Japanese market.

Equation/JP market	C	$\Delta p_t^{JP\|US}$	Δp_t^{US}	$\Delta EMV_{\Delta p,t}$	$AR(1)$	AR(12)	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
Table 3 $r_{2y,t}^{JP}$	0.007	−0.002	−0.002	0.000	0.189	0.119	−0.012	−0.069	0.001	0.807	0.641	0.12
	3.31	−3.79	−3.73	6.69	10.21	7.32	−0.70	−1.11	0.95	1.55	3.71	
Equation	C	$\Delta p_t^{JP\|US}$	Δp_t^{US}	$\Delta EMV_{\Delta i,t}$	$AR(1)$	AR(7)	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
Table 5 $r_{2y,t}^{JP}$	0.012	−0.003	−0.002	0.000	0.203	0.160	−0.023	−0.061	0.001	0.784	0.604	0.13
	4.20	−3.40	−2.74	−2.17	10.45	7.95	−2.33	−0.84	1.18	1.46	3.43	
Equation	C	Δp_t^{JP}	$\Delta p_t^{JP} \Delta EMV_{\Delta p,t}$		$AR(1)$	AR(12)	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
Table 7 $r_{2y,t}^{JP}$	0.005	−0.001	0.0001		−0.123	−0.077	0.138	0.197	0.001	0.730	0.648	0.13
	4.44	−2.47	7.07		−1.91	−3.41	15.77	14.94	1.01	1.70	4.44	
Equation	C	$\Delta p_t^{e,JP}$	$\Delta p_t^{e,JP} \Delta EMV_{\Delta p,t}$		$AR(1)$	AR(12)	D_{GFC}	D_{COVID}	ω_0	ε_{t-1}^2	σ_{t-1}^2	R^2
Table 9 $r_{2y,t}^{JP}$	−0.003	−0.001	0.0001		0.261	0.171	−0.045	−0.008	0.001	0.774	0.628	0.16
	−2.23	−2.31	3.17		16.60	15.99	−1.72	−1.32	0.99	1.62	3.75	

Notes: The numbers in the first row are the estimated coefficients and the second row contains the z-statistics. The critical values of the z-distribution at the 1%, 5%, and 10% significance levels are 2.58, 1.96, and 1.65, respectively. R^2 is the coefficient of determination.

Notes

1. It is not our intention to provide an exhaustive list of the research concerning the relationship between nominal interest rates and expected inflation. Bosupeng (2016) and Madadpour and Asgari (2019) provide review articles of the earlier literature.
2. Alternative specifications of the conditional variance can be found in Bollerslev (2010), who provides different models of ARCH-type processes.
3. Since t is a rather popular statement and relevant in the empirical context, we do not conduct the unit-root test to save space.
4. This study does not contain the wealth (asset) effect resulting from the decline in asset values. The recent case of Silicon Valley Bank at least partially reflects that the Fed's rate hikes can cause a bank's asset values to decline, which may lead to bank failure. Unfortunately, this effect is not included in the test equation due to a lack of information regarding the value of national total wealth.
5. Istiak et al. (2021) and Hall et al. (2023) find evidence that US inflation spilt over to other G7 countries, suggesting that neutralizing the US effect is an appropriate procedure.
6. This model can be viewed as an IMA or an ARIMA (0,1,1) process in terms of Box–Jenkins methodology.
7. Gultekin (1983) tests the stock returns and inflation using IMF data, which is comparable to the data used in this study and arrives at R-squares for JP and the US of 0.0026 and 0.003, respectively. Those results compare with tests of the equation of stock returns in relation to expected inflation based on the ARIMA process, which yields R-squares for JP and the US of 0.008 and 0.032, respectively. In Table 4 (and Table 6), the R-squares of stock return-inflation for JP and the US are 0.19 (0.18) and 0.21 (0.25), respectively. Those results are much stronger than that those provided by Gultekin (1983) due to the inclusion of the EMV term. With respect to testing of returns for two-year bonds in the US, the R-squares are 0.20, 0.08, 0.06, and 0.054, as shown in Table 3, Table 5, Table 7, and Table 9, respectively.

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