GPIF Working Paper

Impact of macroeconomic news on asset returns and portfolio risk

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EXECUTIVE SUMMARY

- GPIF rebalances its portfolio when the asset allocation of the actual portfolio deviates from the policy asset mix, and manages the portfolio to keep it within the allowable deviation range. In doing so, it carefully assesses domestic and international market trends, and takes care to avoid impacting the market as much as possible.
- In light of the need to ensure that rebalancing does not impact the market, it is beneficial to examine in detail the impact of macroeconomic news, such as the release of economic indicators, on the traditional assets and the policy asset mix. This is also an important issue for financial economics to address, as it characterizes the asset price discovery process.
- In this study, we examine the impact of U.S. macroeconomic news on asset returns and risk. Based on previous studies, we propose a model with more explanatory power. In addition, we extend the analysis from single assets to a portfolio and explicitly examine the mechanism of controlling portfolio risk.

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1. Introduction

According to the annual report, GPIF manages funds that do not need to be withdrawn immediately and aims to “achieve stable returns through ‘long-term investment’ by holding a variety of assets for a long period of time without being overly dependent on temporary market fluctuations (GPIF 2023).” Under such circumstances, GPIF rebalances its portfolio when the asset allocation of the actual portfolio deviates from the policy asset mix, and manages the portfolio to keep it within the allowable deviation range. In doing so, it carefully assesses domestic and international market trends, and takes care to avoid impacting the market as much as possible.

In light of the need to ensure that rebalancing does not impact the market, it is beneficial to examine in detail the impact of macroeconomic news, such as the release of economic indicators (hereinafter referred to as “economic news”), on the traditional assets and the policy asset mix. This is also an important issue for financial economics to address: characterizing the asset price discovery process.

Previous studies analyzing the impact of economic news on asset prices include Andersen et al. (2003), Bollerslev and Vega (2003), Hess et al. (2008), Balduzzi et al. (2009), and Corbet et al. (2020). Andersen et al. (2003) find that surprises in economic news (deviations between released values and prior market expectations) cause jumps in the conditional mean for the exchange rate against the U.S. dollar, meaning that exchange rate dynamics in high frequency data are linked to economic fundamentals. Hess et al. (2008), examining the impact of the releases of 17 different U.S. economic indicators on 2 representative commodity futures indices (CRB and GSCI commodity futures indices), find that high (low) inflation and real economic activity cause a positive (negative) adjustment in commodity futures prices during recessions, while these adjustments are less pronounced during economic expansions. Balduzzi et al. (2009) examine the impact of economic news (28 in all) on prices, trading volume, and bit-ask spreads using intraday trading data for U.S. Treasuries. For prices, they find that 17 economic news stories have a significant impact on at least 3-month short-term U.S. Treasury Bill, 2- or 10-year U.S. Treasury Note, and 30-year U.S. Treasury Bond, 10 of which have a significant impact on all 2-year, 10-year, and 30-year U.S. Treasuries, and the impact occurs within one minute after the economic news is released. Corbet et al. (2020) examine the impact of sentiment indices from the announcement (newspaper articles) related to 4 economic indicators (GDP, unemployment rate, CPI, and durable goods) on bitcoin returns. They find that as positive news regarding unemployment and consumer durables increases, stock returns typically increase, while bitcoin returns decrease. They also report that there is no statistically significant relationship between the release of news about GDP or CPI and bitcoin returns.

All of these previous studies use regression models with the following characteristics in estimating the impact of economic news on asset prices. (1) the assumption of a first-order autoregressive (AR(1)) process for the explained variable, asset returns immediately after the release of economic news (hereafter referred to as "returns"), and (2) the assumption of market surprise in response to economic news (the deviation of the median of the released value and the market's prior forecast divided by the standard deviation of the deviation between the released value and forecast over the period under analysis) as the explanatory variable. This study attempts to refine the approach of previous studies in light of its use in asset management business.

Since it is difficult to analyze returns at the portfolio level using risk models such as Value at Risk (VaR) if the AR(1) process is assumed for a given return as in (1), a new return modeling is necessary. Simple daily returns include return fluctuations that occur even in the absence of economic news. Thus, it is necessary to extract the return fluctuations solely due to the impact of economic news. We utilize the average daily return over the past 6 months as a measure to capture the simple return fluctuations. The return immediately after the economic news is announced minus the daily average return over the past 6 months, is the return fluctuations due solely to the impact of the economic news. Since the degree of impact varies depending on the magnitude of return volatility even if the change in returns is solely due to the impact of economic news, it is desirable to use "standardized returns solely due to the impact of economic news," which are standardized by dividing by the volatility of returns.

In order to obtain the surprise to economic news indicated in (2), the standard deviation regarding the deviation between the released value and the market's prior forecast for the entire period under analysis is required in previous studies. Therefore, it is not possible to obtain that standard deviation from data up to the point of release of the economic news, and it is difficult to use that variable in practice.

An important issue to be considered from the perspective of asset management business, which has not been addressed in previous studies, is the analysis of the impact of economic news on the risk of portfolios. In order to perform this analysis, it is necessary to introduce an appropriate indicator for the risk of portfolios consisting of traditional assets that corresponds to the "standardized return solely due to the impact of economic news" introduced for each price of traditional assets. Possible examples of this appropriate indicator are the scenario Z-score used in Golub et al. (2018) as part of the stress test scenario construction method, and the volatility Z-score and correlation Z-score, which are decompositions of the scenario Z-score. In this study, each of these 3 measures is used as the explained variable in the regression model to measure the impact of economic news on portfolio risk.

This paper is organized as follows. Section 2 examines the impact of economic news on the returns of each traditional asset. Section 3 analyzes the impact of economic news on the risk of a portfolio composed of traditional assets. The final section provides a summary and future issues.

2. Impact of macroeconomic news on the traditional asset returns

2.1 Methods and data

The regression model for weighing the impact of economic news on the returns of each traditional asset uses the Z-score, which is the standardized return on the day the economic indicator is published for each asset, as the explained variable. The standardized value is obtained by subtracting the average of the daily returns over the past 132 business days from the return on the release date, and then dividing it by the standard deviation over the past 132 business days. The explanatory variable, economic news surprise, is the deviation between the released value and the market's prior forecast divided by the standard deviation of the deviation the value and forecast over the period under analysis, in line with previous studies. In addition to this, instead of that standard deviation, we also employ the surprise obtained by dividing the divergence between the maximum and minimum market forecasts just prior to the release of the economic news.

The regression analysis uses equation (1) with the explained and explanatory variables described earlier after controlling for the business cycles.

$$\frac{r_t - \bar{r}}{\sigma_t} = \alpha + \sum_{i=1}^{I} \beta_i^{exp} \cdot D_t^{exp} \cdot S_{i,t} + \sum_{i=1}^{I} \beta_i^{rec} \cdot D_t^{rec} \cdot S_{i,t} + \epsilon_t \qquad (1)$$

Where r_t is the return at the date (t) of the economic indicator release, $\bar{r}$ and σ_t are the mean and standard deviation of the daily return up to 132 business days back from the date of the economic news release, respectively. α is a constant term, $S_{i,t}$ is a surprise of economic news i, D_t^{exp} (D_t^{rec}) is a dummy variable that is 1 during the expansionary (recessionary) period, β_i^{exp} (β_i^{rec}) is a regression coefficient for the surprise of economic news i in the expansionary (recessionary) period, I is the number of types of economic news employed, and ϵ_t is an error term.

In addition to the above analysis, we also perform a regression analysis in which the explained variable

$(r_t - \bar{r})/\sigma_t$ and the explanatory variable $S_{i,t}$ are replaced by the absolute values of $|(r_t - \bar{r})/\sigma_t|$ and $|S_{i,t}|$ respectively. The first purpose behind this is to understand the factors that contribute to the explanatory power of returns due to economic news surprises, separately in terms of the magnitude and direction of the surprises. Second, the absolute value of $|(r_t - \bar{r})/\sigma_t|$ can be taken in the sense of absolute deviation risk, and we are aware that it will be connected to the analysis of the impact of economic news on the risk of a portfolio consisting of four traditional assets, which is discussed in Section 3.

(Remark 1)

The regression model in equation (1) differs from the regression model in Hess et al. (2008) in two ways. The first point is the modeling of returns excluding the portion of economic news surprises. If we display the regression model of the previous study with the right-hand side of equation (1) aligned to our model, the left-hand side can be expressed as $r_t - \beta \cdot r_{t-1}$. Thus, they are expressing returns based on the AR(1) model. Therefore, they are weighing the impact of economic news surprises on returns in a way that the return r_t on the day of economic news release depends on the return on the previous day. In this study, considering the connection to the analysis in Section 3 on the impact of economic news on portfolio risk, equation (1) is standardized by dividing the excess of the return r_t on the day of economic news release over the average daily return $\bar{r}$ for the past 132 business days back by the standard deviation for the same period (Z- score) to model the explained variable. In other words, we attempt to explain the risk-adjusted excess return portion by economic news surprises. The second point is the modeling of the economic news surprise $S_{i,t}$. In many previous studies, economic news surprises are modeled by $S_{i,t} = (A_{i,t} - F_{i,t})/STD(A_i - F_i)$, where $A_{i,t}$ is the indicator value actually released at time t, $F_{i,t}$ is the median of the analysts' forecasts, and $STD(A_i - F_i)$ is the standard deviation of the deviation between the released and forecast values over the period under analysis. This modeling has the following characteristics: (1) only medians are used among the information on the forecast values of numerous analysts, and (2) standard deviations are obtained based on the values of $A_{i,t} - F_{i,t}$ over the period under analysis, so standard deviations are not available at each time t. In our approach, economic news surprises are modeled by $S_{i,t} = \left(A_{i,t} - F_{i,t}\right)/\left(F_{i,t}^{max} - F_{i,t}^{min}\right)$, where $F_{i,t}^{max}$ and $F_{i,t}^{min}$ are the maximum and minimum of analyst forecast values, respectively. This modeling assumes that even if $A_{i,t} - F_{i,t}$ is relatively large (small), if there is a large (small) divergence between the maximum and minimum values of analysts' forecasts, the surprise is not so great (small). In other words, it is an attempt to capture the magnitude of the surprise of economic news by contrasting it with the variance of analyst forecasts. This modeling also allows us to construct the surprise variables at each time point t from the data at that time point.

The 4 types of economic news used in this analysis are the month-over-month difference in the number of nonfarm payrolls (NFP), the year-on-year growth rate of the consumer price index (CPI), the month-over-month change in the ISM manufacturing purchasing managers' index (PMI), and the month-over-month change in retail sales (RST) for the United States. The Federal Reserve has a dual mandate of "maximizing employment" and "price stability," and it conducts monetary policy to achieve these objectives. For this reason, NFP and CPI are closely watched by market participants in order to understand U.S. economic trends as well as to forecast monetary policy. PMI is an economic indicator that indicates economic expansion (contraction) when its value is above (below) 50, based on a survey of purchasing and supply managers in the manufacturing industry regarding production, new orders, employment, inventories, and other items. PMI is released on the first business day of each month for the previous month, making it a quick and accurate indicator of U.S. economic trends from a supply-side perspective. RST is an indicator of trends in U.S. goods consumption as well as food service consumption. Since consumer spending accounts for about 70% of U.S. gross domestic product (GDP), RST is an indicator that can provide a view of U.S. economic trends from the perspective of consumer spending, without having to wait for GDP to be released, However, it is an important indicator for the market to reaffirm the direction of the economy as indicated by the NFP and CPI. We examine the impact of these economic indicators of monetary policy operations and economic trends on the returns of each traditional asset.

The asset prices to be analyzed are MSCI ACWI (ACWI), FTSE WGBI (WGBI), TOPIX (including dividends, TPXT), and Nomura BPI (BPI)[1], which GPIF uses as policy benchmarks for its four traditional assets, plus S&P500 (including dividends, SPXT), FTSE US Government Bond Index (hereafter USGBI), and the dollar/yen exchange rate (USD/JPY). In this analysis, we constructed data combining economic indicators for each of the 252 months released from January 3, 2004 to December 17, 2024, and the r_t and $(r_t - \bar{r})/\sigma_t$ for each asset corresponding to the date of release. The number of time points (N) at which economic indicators were released in the data is 968. Note that the total number of months (number of releases) and the number of time points for each economic indicator do not match because in some cases NFP and PMI are released on the same day. Of the periods covered by the data, the period from December 2007 to June 2009 and the period from February to April 2020 are recessionary periods in U.S., while the other periods are expansionary periods[2].

(Remark 2)

U.S. economic indicators are released in the morning of EST. Therefore, for r_t of each asset, the price change rate from the previous day's close to the day's close of the economic indicator release is used for ACWI, WGBI, SPXT, USGBI, and USD/JPY, which are primarily traded in US time. On the other hand, for TPXT and BPI, since the trading hours for the day had already ended by the time the economic indicator is released in U.S.., we use the rate of price change from the close of the day of the release of the economic indicator to the close of the following day. ACWI, WGBI, and USD/JPY are traded in all time zones of Asia, Europe, and U.S. on the same day. Therefore, r_t fluctuates based on information prior to the release of U.S. economic indicators in some parts of the Asian and European time zones. In order to analyze the impact of U.S. economic news in more detail for assets traded across time zones, we may consider dividing the r_t by region and time zone.

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[1] GPIF uses Nomura BPI (excluding ABS) as its policy benchmark for domestic bonds, but since the index was first calculated at the end of March 2008, Nomura BPI, for which longer-term data can be obtained, is used in the analysis.

[2] Periods of business cycle expansion and recession are based on the NBER (NATIONAL BUREAU of ECONOMIC RESEARCH) dates for US Business Cycle Expansions and Contractions (https://www.nber.org/research/ data/us-business-cycle-expansions-and-contractions).

2.2 Results and discussion

Table 1 shows the results of the regression analysis. The columns show the name of each asset as the explained variable, and the rows show each economic indicator as the explanatory variable. Below the constant term (intercept), the impact of the economic indicator during the expansion period is shown (exp: expansion is shown in the upper right corner of each indicator), and below it, the impact of the indicator during the recession period is shown (rec: recession is shown in the upper right corner of each indicator). If the coefficient estimate of an economic indicator is positive (negative) during both expansion and recession, it indicates that a positive surprise in the released value of the indicator exceeding market expectations will push up (push down) the daily return. The bottom four rows of the table show the statistics related to the regression model. First, the adjusted R^2 ($adjusted\ R^2$), which indicates the explanatory power of the explained variable by the model, and the result of the F-test ($F-value$), which simultaneously tests whether multiple regression coefficients in the regression model are significantly different from 0. The Durbin-Watson statistic (DW) checks for autocorrelation in the error terms in the regression model, and a DW of about 2 confirms that there is no autocorrelation[3]. The last row is the number of samples.

Here we check the statistics of the regression model for each asset. The adjusted R^2 is positive in all cases, indicating that the models have explanatory power, and DW is approximately 2, suggesting that there is no autocorrelation among the error terms. However, the F-test indicates that the coefficients of the regression model for BPI are not significantly different from 0 when multiple regression coefficients are tested simultaneously. The regression coefficients indicate that PMI surprises significantly affect all assets during periods of economic expansion. The sign of the coefficients is positive for ACWI, SPXT, TPXT and USD/JPY, indicating that U.S. economic expansion from the supply side has led to higher stock prices and a stronger dollar. On the other hand, the coefficient is negative for USGBI and BPI, confirming that economic

Table 1 Impact of surprises ($S_{i,t} = (A_{i,t} - F_{i,t})/STD(A_i - F_i)$) of economic indicators from previous studies on returns

	ACWI (in JPY)	SPXT (in USD)	WGBI (in JPY)	USGBI (in USD)	TPXT (in JPY)	BPI (in JPY)	USD/JPY
$Intercept$	0.013	0.032	-0.016	-0.003	0.000	0.033	-0.008
NFP^{exp}	0.110 *	0.085	0.058	-0.131 *	0.067	-0.042	0.119 *
CPI^{exp}	0.051	-0.158 **	0.158 **	-0.164 *	-0.092	0.026	0.310 ***
PMI^{exp}	0.322 ***	0.222 ***	0.161 **	-0.454 ***	0.177 **	-0.194 **	0.373 ***
RST^{exp}	0.086	0.047	0.034	-0.101	-0.060	-0.094	0.097
NFP^{rec}	-0.158	-0.327	0.016	0.182	-3.487 ***	0.941	-0.467
CPI^{rec}	0.233	0.120	0.190	-0.210	0.159	-0.170	0.308 **
PMI^{rec}	-0.042	-0.007	-0.061	-0.032	0.208	-0.059	0.138
RST^{rec}	0.381	0.473	0.346	-0.084	0.787 **	-0.501	0.441
$adjusted\ R^2$	1.96%	1.08%	0.60%	2.77%	1.56%	0.47%	4.12%
F-value	3.41 ***	2.32 **	1.74 *	4.45 ***	2.92 ***	1.57	6.20 ***
DW	2.022	2.038	2.012	1.924	1.838	1.983	2.013
N	968	968	968	968	968	968	968

***p<0.01, **p<0.05, *p<0.10

[3] If autocorrelation occurs between the error terms, the significance test of the regression coefficients may be biased.

expansion leads to lower bond prices (higher interest rates). The coefficient is positive for WGBI. It is plausible that this is because the appreciation of USD/JPY pushed up the return in yen terms. In addition to NFP and CPI during expansion, NFP, CPI, and RST during recession are also shown to have a statistically significant effect on returns. However, the method used by previous studies (e.g., Andersen et al. (2003)) to calculate explanatory variables requires standard deviations regarding deviations between released values and market forecasts for the entire period under analysis, which limits their practical applicability. Therefore, in the following, we conduct a regression analysis using the calculation method for explanatory variables proposed by this study. The estimation results are shown in Table 2.

The estimation results in Table 2 show that the results of the F-test are statistically significant for all assets, thus the model is able to explain the impact of economic news on BPI which is not significant in Table 1. In addition, $adjusted\ R^2$ is also significantly improved, which better captures the impact of economic news on returns, compared to the explanatory variables in the previous studies. In particular, the $adjusted\ R^2$ of USGBI improved from 2.77% in the previous study to 13.75%. Moreover, DW of each asset is about 2, suggesting that there is no autocorrelation among the error terms.

The regression coefficients show that when there is a positive surprise in economic news during the expansionary period, stock prices rise for NFP and bond prices except WGBI decline. For CPI, USD/JPY rises as USGBI declines and interest rates rise (dollar appreciates against yen). NFP and CPI are thought to indicate the outlook for U.S. monetary policy, which reminds investors that interest rates are likely to rise, causing bond prices to fall. While higher interest rates are believed to cause stock prices to fall, positive surprises in NFP and CPI have had an upward effect on stock prices. it is plausible to consider that stock market participants are paying more attention to the strength of the economy as indicated by economic indicators rather than monetary policy tightening. PMI, a supply-side indicator, significantly affects all assets, while the RST, a demand-side indicator, significantly affects USGBI, BPI, and USD/JPY. Therefore, from the supply side

Table 2 Impact of surprises of economic indicators in this study on returns ($S_{i,t} = (A_{i,t} - F_{i,t})/(F_{i,t}^{max} - F_{i,t}^{min})$)

	ACWI (in JPY)		SPXT (in USD)		WGBI (in JPY)		USGBI (in USD)		TPXT (in JPY)		BPI (in JPY)		USD/JPY	
$Intercept$	0.015		0.029		-0.009		-0.006		0.003		0.032		0.002	
NFP^{exp}	1.034	***	0.705	***	0.115		-1.776	***	0.631	***	-0.915	***	1.171	***
CPI^{exp}	0.168		-0.317		0.190		-0.529	**	-0.153		0.065		0.758	***
PMI^{exp}	0.768	***	0.525	***	0.440	***	-1.043	***	0.498	***	-0.391	**	0.897	***
RST^{exp}	0.286		0.039		0.104		-0.666	***	-0.154		-0.339	*	0.557	***
NFP^{rec}	-0.281		-0.365		0.463		0.424		-1.058	*	0.137		0.175	
CPI^{rec}	0.797		0.275		0.810		-0.713		0.457		-0.461		1.310	**
PMI^{rec}	0.232		0.260		0.206		-0.368		0.905	*	-0.277		0.697	
RST^{rec}	0.480		0.420		1.026	*	0.287		1.590	**	-0.797		0.723	
$adjusted\ R^2$	6.66%		2.85%		0.80%		13.75%		2.91%		3.72%		10.38%	
F-value	9.63	***	4.55	***	1.97	**	20.27	***	4.62	***	5.67	***	14.99	***
DW	2.025		2.035		2.016		1.913		1.859		1.981		2.018	
N	968		968		968		968		968		968		968	

***p<0.01, **p<0.05, *p<0.10

to the demand side, the expansion of U.S. economy has the effect of pushing up stock prices, bond yield, and USD/JPY. In WGBI, as in Table 1, positive economic news surprises led to lower bond prices and a weaker yen, with the return boost from a weaker yen being more significant. During recessions, RST has a positive impact on TPXT and CPI has a positive impact on USD/JPY. The reason for the positive impact on TPXT rather than SPXT for U.S. stock index, which is the country covered by the economic indicator, is that Japanese stock market participants are less likely than U.S. stock market participants to factor the forecast of U.S. economic indicator into their stock prices, which may explain the larger shock. With regard to the relationship between CPI and USD/JPY, it is possible to consider that during recessions, foreign exchange market participants take a rise in CPI as a signal of a turn toward economic expansion and incorporate their forecasts into prices at an early stage.

The above estimates indicate that U.S. economic news affects more assets during the expansionary period than the recessionary period. The results also suggest that market participants' attention to economic news differs by asset, as indicated by the market's reaction to NFP. Tables 1 and 2 discuss the analysis for daily returns and confirm that surprises in economic indicators affect returns. In investment practice, it is important to understand the characteristics of risk as well as the returns. Therefore, we examine the impact of economic news on risk by taking the absolute values of the explained and explanatory variables introduced in the analysis of Table 2 and conduct a regression analysis.

Table 3 shows the results of the regression analysis in which the explained variables $(r_t - \bar{r})/\sigma_t$ and the explanatory variable $S_{i,t}$ are replaced by the absolute values of $|(r_t - \bar{r})/\sigma_t|$ and $|S_{i,t}|$ respectively in the regression model in equation (1). Compared to the results of the analysis including the sign in Table 2, $adjusted\ R^2$, which represents the explanatory power of the model, is generally reduced to less than half, suggesting that a considerable portion of the explanatory power of the return due to economic news surprises

Table 3 Impact of surprises ($|S_{i,t}| = |(A_{i,t} - F_{i,t})/(F_{i,t}^{max} - F_{i,t}^{min})|$) of the economic indicator in this study on risk

	ACWI (in JPY)		SPXT (in USD)		WGBI (in JPY)		USGBI (in USD)		TPXT (in JPY)		BPI (in JPY)		USD/JPY	
$Intercept$	0.799	***	0.754	***	0.750	***	0.853	***	0.813	***	0.778	***	0.765	***
$\|NFP^{exp}\|$	0.373	***	0.306	***	0.230	**	1.052	***	0.318	**	0.253	**	0.570	***
$\|CPI^{exp}\|$	-0.176		0.135		0.176		0.418	***	0.046		0.274	*	0.146	
$\|PMI^{exp}\|$	0.219	*	0.205		0.038		0.374	***	0.190		0.409	***	0.216	
$\|RST^{exp}\|$	-0.283	**	-0.011		-0.010		0.146		-0.282	*	-0.209		0.075	
$\|NFP^{rec}\|$	0.428		0.236		-0.104		1.169	***	1.343	***	0.494		0.762	**
$\|CPI^{rec}\|$	-0.112		0.612		0.141		0.360		0.357		-0.137		0.085	
$\|PMI^{rec}\|$	0.150		0.069		-0.032		0.246		0.524		-0.007		0.182	
$\|RST^{rec}\|$	0.806	**	0.517		0.452		0.467		0.382		0.262		1.025	**
$adjusted\ R^2$	2.30%		0.42%		-0.13%		7.34%		1.86%		1.17%		2.39%	
F-value	3.85	***	1.51		0.85		10.58	***	3.29	***	2.44	**	3.96	***
DW	1.795		1.756		1.816		2.044		1.694		1.683		1.768	
N	968		968		968		968		968		968		968	

***p<0.01, **p<0.05, *p<0.10

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stems from the direction of the surprise as confirmed. Focusing on the results of the F test, the regression coefficients are significant for all economic indicators in Table 2, but not for SPXT and WGBI in Table 3.

The regression coefficients indicate that NFP significantly magnifies risk for all assets when surprises occur during an economic expansion. The effects of PMI and RST on ACWI, CPI and PMI on USGBI, RST on TPXT, and CPI and PMI on BPI are also confirmed. Note that the coefficients of RST on ACWI and TPXT are negative, which indicates that the volatility of asset prices is reduced when there are surprises in economic news. It is plausible to consider that the reason for this is that RST is published after NFP and CPI in a month, and market expectations for RST are formed based on the results of the two preceding economic indicators. In other words, if there are no surprises in RST (the same economic direction as NFP and CPI), the volatility of asset prices generated by NFP and CPI will continue, while if there are surprises in RST (different economic direction from NFP and CPI), a shift in the economic cycle implied by NFP and CPI will be indicated. This could result in a structure that reduces the volatility of asset prices.

3. The impact of macroeconomic news on portfolio risks

3.1 Methods and data

The economic indicators for the analysis are those presented in Section 2.1. As the explained variable, Section 2.1 employs the Z-score, which is the standardized return of each asset on the date of the economic indicator release. In this section, the analysis is based on a portfolio that hold each of the 4 traditional assets equally. The scenario Z-score from Golub et al. (2018) is used as the Z-score of the portfolio return on the day the economic indicators are released. In addition, the volatility Z-score $V(\boldsymbol{z})$ and correlation Z-score $C(\boldsymbol{r}, \boldsymbol{\Sigma})$ are also employed as explained variables.

The scenario Z-score when the portfolio consists of n assets is given by dividing the Mahalanobis distance (hereinafter referred as "MD") in equation (2) by $\sqrt{n}$ to standardize it, as in equation (3).

[MD]

$$MD(\boldsymbol{r}, \boldsymbol{\Sigma}) = \sqrt{(\boldsymbol{r} - \bar{\boldsymbol{r}})^T \boldsymbol{\Sigma}^{-1} (\boldsymbol{r} - \bar{\boldsymbol{r}})} \tag{2}$$

Where $\boldsymbol{r} = (r_1, r_2, \cdots, r_k)$ is the value of the return vector on the economic news release date, $\bar{\boldsymbol{r}} = (\bar{r}_1, \bar{r}_2, \cdots, \bar{r}_k)$ and $\boldsymbol{\Sigma}$ are the expected value vector and variance-covariance matrix of daily returns for the past 132 business days, respectively. From the form of equation (2), it can be read that MD is a multivariate version of the Z-score in a univariate random variable.

[Scenario Z-score]

$$Z(\boldsymbol{r}, \boldsymbol{\Sigma}) = MD(\boldsymbol{r}, \boldsymbol{\Sigma}) / \sqrt{n} \tag{3}$$

The implication of the scenario Z-score is that the value $\boldsymbol{r} = (r_1, r_2, \cdots, r_k)$ of the return vector on the date of the economic news release deviates from the past expected value $\bar{\boldsymbol{r}} = (\bar{r}_1, \bar{r}_2, \cdots, \bar{r}_k)$ by a factor of $\boldsymbol{\Sigma}$. A higher scenario Z-score means that an excess return is generated on the day of the economic news release with a lower probability of occurrence.

We define volatility Z-score $V(\boldsymbol{z})$ as the scenario Z-score calculated by relying on Kinlaw and Turkington (2014) with the correlation coefficient between asset returns set to zero, as in equation (4).

The reason for adopting this as the explained variable is to decompose portfolio fluctuations into volatility and correlation among assets, and to examine whether there is a mechanism to suppress overall portfolio fluctuations by reducing the correlation among assets even if volatility increases due to economic news.

[volatility Z-score]

$$V(\boldsymbol{z}) = \sqrt{\frac{\boldsymbol{z}^T\boldsymbol{z}}{n}} \tag{4}$$

The correlation Z-score $C(\boldsymbol{r},\boldsymbol{\Sigma})$, which indicates the correlation between assets, is defined as in equation (5) by normalizing the scenario Z-score $Z(\boldsymbol{r},\boldsymbol{\Sigma})$ by the volatility Z-score $V(\boldsymbol{z})$.

[correlation Z-score]

$$C(\boldsymbol{r},\boldsymbol{\Sigma}) = \frac{Z(\boldsymbol{r},\boldsymbol{\Sigma})}{V(\boldsymbol{z})} \tag{5}$$

The correlation Z-score $C(\boldsymbol{r},\boldsymbol{\Sigma})$ can be expressed explicitly as in equation (6) using the correlation matrix $\boldsymbol{\Lambda}$ between asset returns and a Z-score vector $\boldsymbol{z}/\sqrt{\boldsymbol{z}^T\boldsymbol{z}}$ normalized to size 1.

$$C(\boldsymbol{r},\boldsymbol{\Sigma}) = \sqrt{\frac{\boldsymbol{z}^T}{\sqrt{\boldsymbol{z}^T\boldsymbol{z}}}\boldsymbol{\Lambda}^{-1}\frac{\boldsymbol{z}}{\sqrt{\boldsymbol{z}^T\boldsymbol{z}}}} \tag{6}$$

Equation (6) shows that the correlation Z-score $C(\boldsymbol{r},\boldsymbol{\Sigma})$ depends on the relative magnitude (and sign) rather than the absolute magnitude of the individual Z-scores and is scale invariant with respect to the return vector at the date of economic news release.

3.2 Results and discussion

Table 4 shows the results of the regression analysis with $Z(\boldsymbol{r},\boldsymbol{\Sigma})$, $V(\boldsymbol{z})$, and $C(\boldsymbol{r},\boldsymbol{\Sigma})$ as the explained variables and the same explanatory variables as in Table 3. In both models, $adjusted\ R^2$ is small, and the F-test indicates that the coefficients are not significantly different from 0. Therefore, the regression model for $Z(\boldsymbol{r},\boldsymbol{\Sigma})$, the variation of the overall portfolio, does not indicate that the surprise of the economic indicator affects the portfolio in terms of the F-test. It confirms that the portfolio with equal holdings of the 4 traditional assets is robust to the release of U.S. economic indicator.

The regression coefficient, $Z(\boldsymbol{r},\boldsymbol{\Sigma})$, shows that only PMI during the expansionary period is significant at the 10% level. Decomposing the impact of economic news on the portfolio into $V(\boldsymbol{z})$, the volatility, and $C(\boldsymbol{r},\boldsymbol{\Sigma})$, the correlation between assets, we find that in $V(\boldsymbol{z})$, NFP pushes up volatility regardless of whether the economy is in an expansion or recession. On the other hand, $C(\boldsymbol{r},\boldsymbol{\Sigma})$ has a negative impact on correlations across assets, indicating a mechanism whereby shocks from economic news surprises cancel each other out in the overall portfolio. The coefficients of PMI and CPI surprises are also positive for $V(\boldsymbol{z})$ and negative for

Table 4 Impact of surprises of economic indicators ($|S_{i,t}| = |(A_{i,t} - F_{i,t})/(F_{i,t}^{max} - F_{i,t}^{min})|$) on portfolio risk

	$Z(r,\Sigma)$		$V(z)$		$C(r,\Sigma)$	
Intercept	0.920	***	0.889	***	1.012	
$\|NFP^{exp}\|$	0.083		0.244	***	-0.164	*
$\|CPI^{exp}\|$	-0.007		0.102		-0.192	*
$\|PMI^{exp}\|$	0.284	*	0.239	**	-0.003	
$\|RST^{exp}\|$	-0.240		-0.202	*	-0.081	
$\|NFP^{rec}\|$	0.071		0.647	**	-0.488	*
$\|CPI^{rec}\|$	0.224		0.158		0.043	
$\|PMI^{rec}\|$	0.065		-0.003		0.116	
$\|RST^{rec}\|$	0.452		0.477		-0.053	
adjusted R^2	0.11%		1.68%		0.17%	
F-value	0.74		1.14		0.64	
DW	1.923		1.645		2.061	
N	968		968		968	

***p<0.01, **p<0.05, *p<0.10

$\boldsymbol{C(r,\Sigma)}$ in an expansion, although one of the coefficients is not significant, suggesting that while volatility increases, the correlation between assets decreases, a mechanism that suppresses overall portfolio volatility.

Note that GPIF (2023) states that "detailed rebalancing will be implemented" for stable portfolio management, and in investment practice, statistical significance is not necessarily a criterion for decision making. Even if a change in the portfolio is not considered statistically significant, it may result in a change in portfolio weighting of a size that cannot be ignored in practice.

4. Summary and future issues

This study examines the impact of U.S. economic news on asset returns and risk. In Section 2, we proposed a regression model to weigh the impact of the release of economic news on the return and risk of each traditional asset based on previous studies. The results of the return analysis confirm that the model proposed by this study improves the explanatory power of the impact of economic news compared to the model based on previous studies (Tables 1 and 2). Furthermore, the results of the regression analysis that examines risk suggest that a considerable portion of the explanatory power of economic news surprises depends on the direction of the surprise (Table 3). In Section 3, we extended the single-asset Z-score used as the explained variable in the model in Section 2 to a multi-asset Z-score, since the analysis is based on a portfolio with equal holdings of each of the 4 traditional assets. The analysis confirms that although economic news surprises increase the volatility of the portfolio, correlations among the assets offset the effect, so that the portfolio with 4 assets held equally is robust to fluctuations in U.S. economic indicators (Table 4).

The contributions of this study are as follows. First, we proposed a model (explained and explanatory variables) that provides more explanatory power than previous studies regarding the impact of economic news on asset returns and risk. In addition, we extended the analysis from single assets to a portfolio and explicitly showed the mechanism that suppresses portfolio risk. By doing so, we tackled an important theme in financial economics, "characterizing the asset price discovery process," and quantitatively clarified the impact of multiple U.S. economic indicators on asset prices. Another major contribution of this study is the presentation of a quantitative analysis framework for the relationship between economic fundamentals and asset prices that can be used in practice. There are three main issues to be addressed in the future.

The first issue is how to deal with the time lag that occurs between the release of forecasts of economic indicators by economists and analysts and the actual release of the relevant indicators. During this time lag, some information about the economic indicator is expected to be factored into asset prices. Although it is difficult, we believe that the explanatory power of the model can be enhanced if the portion of information incorporated into asset prices can be measured.

The second issue is to consider using this model as a forecasting model for returns on the date of the economic news release, once the explanatory power of the model is enhanced. Specifically, for example, for the surprise indicator $S_{i,t} = (A_{i,t} - F_{i,t})/(F_{i,t}^{max} - F_{i,t}^{min})$, the released value of the economic indicator $A_{i,t}$ could be replaced by the forecast of the economist or analyst who has been the most accurate predictor of the released value.

The third issue is to use this model for more detailed financial market analysis. The results of the empirical analysis in this study show that surprises in NFP have a significant impact on the returns of BPI and USGBI on the indicators release date. For example, it is envisioned to examine in more detail how the impact of NFP surprises on the returns of U.S. Treasuries and Japanese government bonds varies with the remaining maturity of the bonds.

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