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Securities, Sovereign Bond Spread Measures, Indexes, and Economic Measures as Federal Funds Rate Change Predicters

Introduction and Literature Review

The predictive significance of various securities types and indexes concerning FFRC has been a growing interest in financial discourse. Traditionally, economic theory has centered on critical variables such as the inflation rate, GDP per capita (or GDP growth rate), and the unemployment rate as primary determinants influencing FFRC. However, recent inquiries have expanded the scope of analysis to include securities types and indexes, recognizing their potential to provide valuable insights into forthcoming shifts in monetary policy. (Hamilton 2007) laid a foundational framework in this area with his study on "*Daily Changes in Fed Funds Futures Prices*," which investigated the predictive power of long-duration treasuries, previous employment growth, and daily futures prices in estimating FFRC. This research demonstrated the potential of financial market indicators beyond traditional macroeconomic variables in forecasting monetary policy decisions.

Building upon Hamilton's work, this study aims to delve deeper into the predictive significance of securities types and indexes by broadening the scope of analysis to encompass a more comprehensive array of financial instruments and securities indices. It seeks to enhance understanding of the complex relationship between financial markets and macroeconomic variables on FFRC. Expanding perspectives contribute to more diverse forecasts of FFRC and facilitate enhanced portfolio management and fund policy formulation strategies.

Through empirical analysis and refinement of existing methodologies, this research endeavors to offer insights into the dynamics of monetary policy and its broader implications for the economy by incorporating insights from both traditional economic indicators and financial market data, aiming to provide a comprehensive understanding of the factors influencing FFRC and their impact on financial market behavior.

Statement of Theory and Hypothesis

The hypothesis under investigation centers on the relationship between changes in financial asset prices and FFRC. Specifically, the aim is to assess the predictive power of foreign two-year bonds, domestic sovereign bond spreads, and various domestic financial assets on FFRC. Theoretical predictions suggest that certain foreign two-year bonds and domestic financial measures function as leading indicators for FFRC due to their influence on overall economic and market conditions. For instance, bonds from stable foreign economies could reflect international market sentiment and thus predict domestic monetary policy adjustments. Similarly, domestic assets such as the UST 10-2 year spread, VIX, and specific sector ETFs might offer insights into future FFRC by capturing market expectations and volatility. The study hypothesizes that instrumental variable (IV) regression can effectively isolate these relationships and provide a usable model for predicting FFRC over the sample period.

Specification of the Econometric Model

The econometric model employs an IV regression to address endogeneity issues and provide accurate estimates of the impact of financial assets on FFRC. The model includes a set of exogenous variables: foreign two-year bonds from countries like Finland, Sweden, the Netherlands, Australia, Switzerland, France, China, Canada, Japan, Germany, and the UK, and the Mexico three-year bond. The econometric model also incorporates sovereign domestic bond spread measures from Germany, the UK, Japan, and Canada. The endogenous variables encompass domestic financial assets and measures such as HYG, VGSH, VNQ, LQD, SPY, USMV, USTs of various maturities, VIX, UST 10-2 year spread, Core Personal Consumption Expenditures Price Index (PCE,) and the unemployment rate.

Data transformation involvement is encompassed through data observations in the form of percentage changes instead of natural log data transformations or other functions to capture non-linear relationships and stabilize the variance. Each coefficient's expected sign varies based on the economic interpretation of the variables. For instance, an increase in domestic financial measures like VIX may signal market volatility and a potential decrease in FFRC. The IV regression approach aims to eliminate multicollinearity issues observed in the initial OLS model and potential autocorrelation or heteroskedasticity while accounting for the endogeneity problem left in the model after using the robust errors regression. Robust errors regression addresses heteroskedasticity before applying the final IV regression with all variables to improve prediction accuracy and model reliability through robustness.

OLS Regression model:

$$Y_1 FFRC_t = \beta_0 + \beta_1 \text{Core PCE}_t - \beta_2 \text{Unemployment Rate}_t + \beta_3 HYG_t + \beta_4 VGSH_t + \beta_5 VNQ_t + \beta_6 LQD_t + \beta_7 SPY_t + \beta_8 USMV_t + \beta_9 \text{UST 30 yr.}_t + \beta_{10} \text{UST 10 yr.}_t + \beta_{11} \text{UST 5 yr.}_t + \beta_{12} \text{UST 2 yr.}_t + \beta_{13} \text{UST 3m.}_t - \beta_{14} VIX_t - \beta_{15} \text{UST 10-2 yr. Spread}_t + \beta_{16} \text{UST 10 yr.-Germany 10 yr. Spread}_t + \beta_{17} \text{UST 10 yr.-UK 10 yr. Spread}_t + \beta_{18} \text{UST 10 yr.-Japan 10 yr. Spread}_t + \beta_{19} \text{UST 10 yr.-Canada 10 yr. Spread}_t + \beta_{20} \text{Findland 2 yr.}_t - \beta_{21} \text{Sweden 2 yr.}_t - \beta_{22} \text{Netherlands 2 yr.}_t - \beta_{23} \text{Australia 2 yr.}_t - \beta_{24} \text{Mexico 3 yr.}_t - \beta_{25} \text{Switzerland 2 yr.}_t - \beta_{26} \text{France 2 yr.}_t + \beta_{27} \text{China 2 yr.}_t - \beta_{28} \text{Canada 2 yr.}_t - \beta_{29} \text{Japan 2 yr.}_t - \beta_{30} \text{Germany 2 yr.}_t + \beta_{31} \text{UK 2 yr.}_t + \varepsilon_t$$

- $FFRC_t$: Federal Funds Rate Change at time $_t$
- Core PCE_t: Core Personal Consumption Expenditures at time $_t$
- $\text{Unemployment Rate}_t$: Unemployment Rate at time $_t$
- HYG_t: High Yield Corporate Bond Index at time $_t$
- $VGSH_t$: Vanguard Short-Term Treasury ETF at time $_t$
- VNQ_t: Vanguard Total Stock Market ETF at time $_t$
- LQD_t: Liquidity at time $_t$
- SPY_t: SPDR S&P 500 ETF Trust at time $_t$
- $USMV_t$: iShares Edge MSCI Min Vol USA ETF at time $_t$
- UST 30 yr._t: U.S. Treasury 30-year Bond Yield at time $_t$
- UST 10 yr._t: U.S. Treasury 10-year Bond Yield at time $_t$
- UST 5 yr._t: U.S. Treasury 5-year Bond Yield at time $_t$
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- UST 10-2 yr. $Spread_t$: U.S. Treasury 10-year minus 2-year Yield Spread at time $_t$
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Robust Errors Regression model:

$$Y_1FFRC_t = \beta_0 + \beta_1\text{Core PCE}_t - \beta_2\text{Unemployment Rate}_t + \beta_3HYG_t + \beta_4VGSH_t + \beta_5VNQ_t + \beta_6LQD_t + \beta_7SPY_t + \beta_8USMV_t + \beta_9\text{UST 30 yr.}_t + \beta_{10}\text{UST 10 yr.}_t + \beta_{11}\text{UST 5 yr.}_t + \beta_{12}\text{UST 2 yr.}_t + \beta_{13}\text{UST 3m.}_t - \beta_{14}VIX_t - \beta_{15}\text{UST 10-2 yr. Spread}_t + \beta_{16}\text{UST 10 yr.-Germany 10 yr. Spread}_t + \beta_{17}\text{UST 10 yr.-UK 10 yr. Spread}_t + \beta_{18}\text{UST 10 yr.-Japan 10 yr. Spread}_t + \beta_{19}\text{UST 10 yr.-Canada 10 yr. Spread}_t + \beta_{20}\text{Findland 2 yr.}_t - \beta_{21}\text{Sweden 2 yr.}_t - \beta_{22}\text{Netherlands 2 yr.}_t - \beta_{23}\text{Australia 2 yr.}_t - \beta_{24}\text{Mexico 3 yr.}_t - \beta_{25}\text{Switzerland 2 yr.}_t - \beta_{26}\text{France 2 yr.}_t + \beta_{27}\text{China 2 yr.}_t - \beta_{28}\text{Canada 2 yr.}_t - \beta_{29}\text{Japan 2 yr.}_t - \beta_{30}\text{Germany 2 yr.}_t + \beta_{31}\text{UK 2 yr.}_t + \varepsilon_t$$

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- ε_t: Error term at time $_t$

Instrumental Variable Regression Model:

$$Y_1FFRC_t = \beta_0 + \beta_1 Y_{2t}\text{Core PCE}_t - \beta_2\text{Unemployment Rate}_t + \beta_3 HYG_t + \beta_4 VGSH_t + \beta_5 VNQ_t + \beta_6 LQD_t + \beta_7 SPY_t + \beta_8 USMV_t + \beta_9\text{UST 30 yr.}_t + \beta_{10}\text{UST 10 yr.}_t + \beta_{11}\text{UST 5 yr.}_t + \beta_{12}\text{UST 2 yr.}_t + \beta_{13}\text{UST 3m.}_t - \beta_{14} VIX_t + \beta_{15}\text{UST 10-2 yr. Spread}_t + \varepsilon_{1t}$$

$$Y_{2t}\text{Core PCE}_t = \alpha_0 + \alpha_{16}\text{UST 10 yr.-Germany 10 yr. Spread}_t + \alpha_{17}\text{UST 10 yr.-UK 10 yr. Spread}_t + \alpha_{18}\text{UST 10 yr.-Japan 10 yr. Spread}_t + \alpha_{19}\text{UST 10 yr.-Canada 10 yr. Spread}_t - \alpha_{20}\text{Findland 2 yr.}_t - \alpha_{21}\text{Sweden 2 yr.}_t - \alpha_{22}\text{Netherlands 2 yr.}_t - \alpha_{23}\text{Australia 2 yr.}_t - \alpha_{24}\text{ Mexico 3 yr.}_t - \alpha_{25}\text{Switzerland 2 yr.}_t - \alpha_{26}\text{France 2 yr.}_t + \alpha_{27}\text{China 2 yr.}_t - \alpha_{28}\text{Canada 2 yr.}_t - \alpha_{29}\text{Japan 2 yr.}_t - \alpha_{30}\text{Germany 2 yr.}_t + \alpha_{31}\text{UK 2 yr.}_t + \varepsilon_{2t}$$

Endogenous Variables:

- $FFRC_t$: Federal Funds Rate Change at time $_t$
- Core PCE_t: Core Personal Consumption Expenditures at time $_t$
- Unemployment $Rate_t$: Unemployment Rate at time $_t$
- HYG_t: High Yield Corporate Bond Index at time $_t$
- $VGSH_t$: Vanguard Short-Term Treasury ETF at time $_t$
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- UST 10 yr.-Germany 10 yr. $Spread_t$: U.S. Treasury 10-year minus Germany 10-year Yield Spread at time $_t$
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- ε_t: Error term at time $_t$

Obtained Data

An ideal data set for analyzing the predictive power of financial assets on FFRC consists of a comprehensive collection of monthly observations covering a wide range of relevant financial instruments and economic indicators from a consistent and reliable time frame, such as November 1st, 2011, to January 1st, 2024. Such a data set includes foreign two-year bond data from Finland, Sweden, the Netherlands, Australia, Mexico, Switzerland, France, China, Canada, Japan, Germany, and the UK. It would also encompass sovereign domestic bond spread measures from Germany, the UK, Japan, and Canada.

For endogenous variables, the data set would contain information on domestic financial assets and measures, including high-yield corporate bonds (HYG), short-term government bonds (VGSH), real estate investment trusts (VNQ), investment-grade corporate bonds (LQD), the S&P 500 index (SPY), and minimum volatility ETFs (USMV). Additionally, it would feature data on US Treasury securities of various maturities, the VIX index, UST 10-2 year spread, Core PCE, and the unemployment rate.

Available data from reputable institutions such as the Federal Reserve for the Federal Funds Rate measures; the Bureau of Economic Analysis (BEA) for economic measures like Core PCE; the US Bureau of Labor Statistics (BLS) for unemployment rates; and the Chicago Board Options Exchange (CBOE) for the VIX index, The New York Stock Exchange (NYSE) and other financial data providers, for financial market data, including information on various US Treasury

bond securities and equity indices enable the collection of a data set used for in-depth analysis for IV regression to model the relationship between financial assets and FFRC effectively.

Table 1

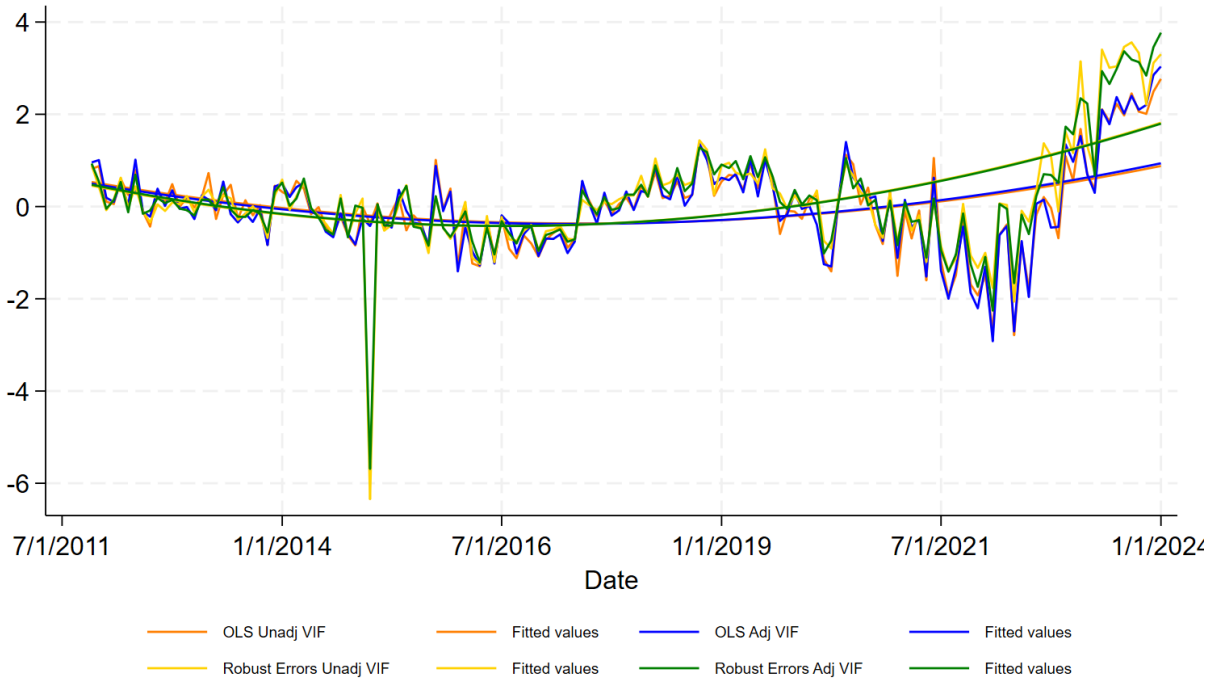
Variable	Obs	Mean	Std.dev.	Min	Max
Date(months)	147	12/1/2017	43.15	11/1/2011	1/1/2024
FF_Rate	147	1.09381	1.537561	0.04	5.33
Core_PCE	147	0.0217483	0.012153	0.009	0.054
Unemploy_Rt	147	0.0544218	0.0198221	0.034	0.147
Three_M_UST	147	0.2180762	1.031091	-1.8	8.875
Two_YR_UST	147	0.0394136	0.1984351	-0.7278	0.7959
Five_YR_UST	147	0.0235442	0.1665346	-0.6074	0.7145
Ten_YR_UST	147	0.0115014	0.1170611	-0.4259	0.3251
Thirty_YR_~T	147	0.0054701	0.0800603	-0.2211	0.2345
US_~S_Two_Yr	147	0.1212014	1.969684	-4.9562	22.25
SPY	147	0.0099782	0.0415082	-0.13	0.127
USMV	147	0.0082456	0.0335318	-0.1185	0.0937
VGSH	147	-0.0002816	0.0037204	-0.0145	0.0147
HYG	147	-0.0007272	0.0216105	-0.1043	0.0622
VNQ	147	0.0037361	0.0495419	-0.2002	0.1208
LQD	147	-0.0000272	0.0224117	-0.069	0.0718
VIX	147	0.0255252	0.269237	-0.459	1.3457
US_JPY_Ten_Yr	147	0.0137728	0.1177908	-0.5879	0.3352
US_CAD_Ten_Yr	147	-0.3246429	4.386935	-47	14.7
US_GR_Ten_Yr	147	0.0831935	0.9592363	-2.7176	10.84615
US_UK_Ten_Yr	147	-0.092283	3.035504	-15	29.1
JPY_Two_Year	147	0.0409483	1.044887	-5.5	6
CAD_Two_Year	147	0.0270143	0.1939892	-0.6323	1.0854
GR_Two_Year	147	0.2148435	2.146509	-4.6857	19.6667
UK_Two_Year	147	0.0687646	0.879028	-4.9091	7.6111
CNY_Two_Year	147	-0.0001415	0.0786536	-0.3301	0.3887
FRA_Two_Year	147	-0.009602	3.676585	-38	19.0667
CHF_Two_Year	147	-0.1970646	3.816254	-31.25	28.6364
AUD_Two_Year	147	0.2242408	1.965388	-0.625	20
DUT_Two_Year	147	0.2612612	2.058653	-5	20
SEK_Two_Year	147	-0.0737878	2.212921	-23.6	11.9524
FIN_Two_Year	147	0.0324673	1.367448	-11.8	6.8824
MXN_Three_Year	147	0.0064748	0.0555307	-0.1543	0.1639

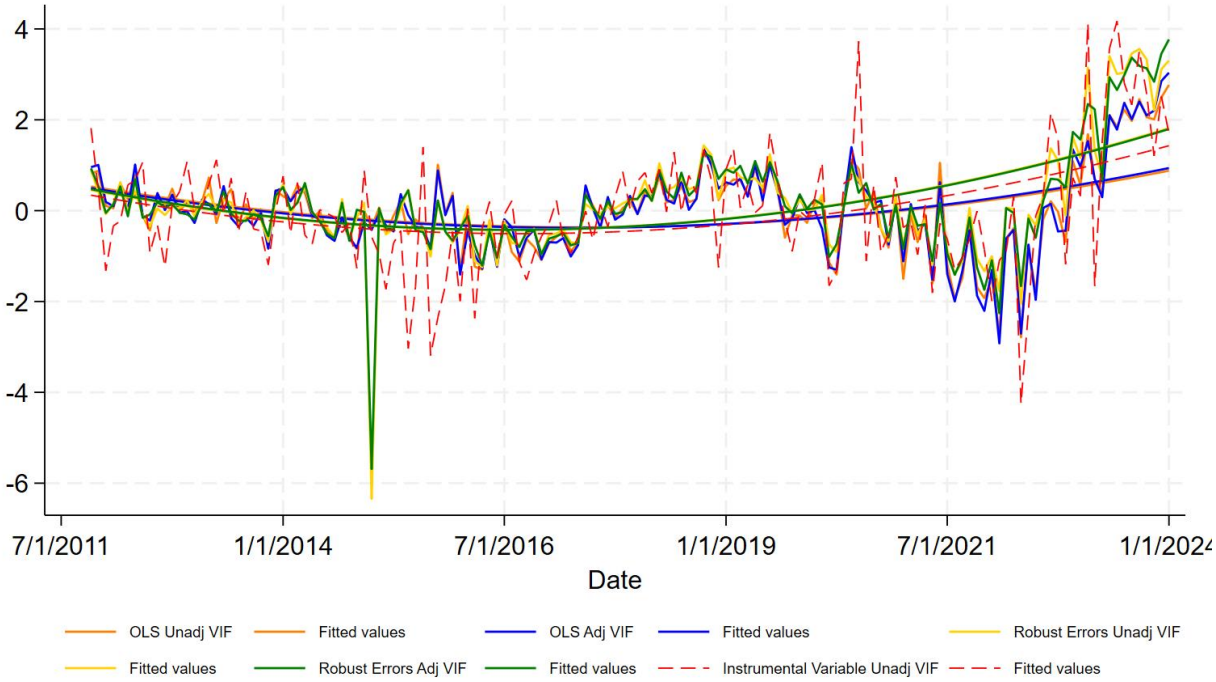
Estimation of the Econometric Model and Diagnostic Tests

Estimating the econometric model begins with Stata's ordinary least squares (OLS) regression. Initial tests for potential problems, such as multicollinearity, involve using the variance inflation factor (VIF) test ('vif'). High VIF values indicate multicollinearity, prompting the removal of unnecessary variables from the model. Next, robust errors regression is applied, using the Breusch-Pagan / Cook-Weisberg test ('hettest') to check for heteroskedasticity. If the test reveals heteroskedasticity, switching to IV regression corrects for it by using the instrumental variables to account for endogeneity issues.

The model is re-estimated using IV regression, reintroducing previously removed variables from the VIF test after the OLS estimation. After adjusting for endogeneity through the IV regression method, additional tests for significance, such as the Wald test, also known as an F-test ('test'), will be conducted to assess whether the model's variables remain statistically meaningful. The Wald test tests the joint significance of the specified coefficients associated with the IV regression model. This test evaluates whether the specified variables' coefficients are equal to zero.

In other words, the test assesses whether the specified variables collectively have a significant effect on the dependent variable in the IV regression model. If the test results in a significant p-value (typically less than 0.05), it suggests that the variables jointly contribute to the model and are not equal to zero. Conversely, a non-significant p-value indicates that the variables do not have a significant joint effect on the dependent variable. This multi-step approach ensures an accurate model that accounts for the impact of asset prices on the FFRC while handling multicollinearity, heteroskedasticity, and endogeneity.





Hypotheses Test

In the IV regression model, the Wald test tested the hypotheses to assess the joint significance of the endogenous group of coefficients. This test evaluates whether the coefficients of the specified variables are simultaneously equal to zero, providing insight into the collective impact of the variables on the dependent variable. Typically, the significance level for evaluating the outcome ranges from 0.1 (10%) to 0.01 (1%), and asterisks groups indicate the different significance levels. One asterisk labels significance at the 10% level; two asterisks denote significance at the 5% level, and three mark significance at the 1% level. Suppose the p-value from the Wald test is below the specified significance range levels. In that case, reject the null hypothesis, suggesting that the selected group of variables has a statistically significant effect on the FFRC. This analysis helps validate the model's predictions and enhances understanding of the predictive power of the included financial assets and measures.

The regression results show no significant evidence to reject the null when using IV regression on the selected variables over the observed period. No significant evidence leaves an opportunity for further research where one seeks to increase the variables and extend the observation period. Suppose a researcher uses all available financial data, indexes, and economic indicators through a data provider such as Bloomberg to apply IV regression to variables that show the most significance in FFRC predictions. With increased data and observations, the possibility remains for accurate predictions for FFRCs using publicly available data and IV regression analysis.

Table 2 IV Regression Results

FF_Rate	Coefficient	P>|t|
Core_PCE	38.49	0.64
	(81.70)	
Unemploy_Rt	(35.72)	0.30
	(34.33)	
Three_M_UST	0.31	0.68
	(0.75)	
Two_YR_UST	(0.31)	0.95
	(4.78)	
Five_YR_UST	(4.83)	0.63
	(10.00)	
Ten_YR_UST	11.46	0.80
	(45.91)	
Thirty_YR_UST	7.16	0.89
	(51.46)	
US_Ten_Minus_US_Two_Yr	(0.11)	0.68
	0.28	
SPY	(4.56)	0.96
	(80.95)	
USMV	0.43	1.00
	(111.81)	
VGSH	201.69	0.58
	(365.92)	
HYG	(46.56)	0.51
	(70.04)	
VNQ	(5.01)	0.88
	(33.56)	
LQD	65.43	0.26
	(57.24)	
VIX	(1.93)	0.76
	(6.21)	

Std. err. in parenthesis

Legend: * p<.05; ** p<.01; *** p<.001

Forecasting or Prediction

Using the estimated IV regression model to make forecasts or predictions involves applying advanced economic analysis techniques to the model's data output. One approach is to use Probit or Logit models to estimate speculative federal funds rate changes (FFRC) based on constructed forward variable data observations. This method allows for assessing the likelihood of specific outcomes based on the model's predictive variables. Additionally, moving averages, such as simple or exponential moving averages, can provide smoothed projections of future data observations.

Another method is utilizing average annual growth expectations or geometric averages to project the growth of variables for forward observations, giving insight into potential trends in asset prices and their effects on the FFRC. Trend analysis techniques, such as the average true range (ATR), can also help understand and forecast market volatility and potential fluctuations in the FFRC. By combining these various techniques, the IV regression model offers a comprehensive framework for making informed forecasts and predictions about the impact of financial assets on the FFRC and the FFRC trend direction, such as a positive or negative trend.

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