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Monetary Policy Surprises and Exchange Rate Volatility

ILENIA FIORE

Work project carried out under the supervision of:

Martijn Boons

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Abstract
This research studies the impact of monetary policy surprises on the DXY strength and its volatility, while also comparing cross-market effects on equities and related indices. By employing high-frequency policy shocks and other monetary policy measures, the analysis demonstrates that hawkish surprises result in dollar appreciation and a reduction in DXY volatility. Conversely, equity prices decline, and the VIX rises, reflecting heightened market uncertainty. These findings highlight the heterogeneous transmission mechanisms of monetary policy across asset classes. By integrating forward guidance and immediate rate changes, the study provides insights into the broader financial stability implications of central bank communication.

Keywords
Monetary Policy, FOMC Meetings, Foreign Exchange, Volatility, DXY Index

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1. Introduction

1.1. Background and Context

Exchange rates serve as pivotal indicators within the global financial system, exerting a profound influence on international trade, investment flows, and economic stability. It is of paramount importance for policymakers, investors and businesses alike to have a comprehensive understanding of the factors influencing exchange rate fluctuations. My internship on a trading floor within the foreign exchange market was the catalyst for my interest in this field, providing me with invaluable hands-on experience in analysing market shifts and observing the immediate effects of central bank decisions, particularly those of the Federal Reserve. This experience underscored the significance of distinguishing between the various types of monetary policy surprises, as central bank announcements and forward guidance can result in substantial, occasionally unanticipated, movements in the foreign exchange market. Therefore, this thesis will focus on the volatility of exchange rates in response to communications from central banks, with a particular emphasis on the impact of monetary policy surprises on the volatility of the US dollar. A quantitative analysis of historical data on rate decisions and exchange rate fluctuations enables the application of the analytical skills developed during the internship, while addressing a curiosity about how markets respond to central bank signals. The objective of this research is to enhance the understanding of how disparate categories of monetary policy surprises influence the foreign exchange market, and, more broadly, to gain insight into the ways in which financial markets adapt to central bank communications.

1.2. Research Problems and Objective

Despite a well-established academic literature examining the impact of Federal Open Market Committee (FOMC) surprises on various asset classes, including equities (Acosta 2023, Kuttner 2001, Bomfim 2003), bonds (Zhu 2013) and commodities (Scrimgeour 2015), there remains a notable gap in studies that directly address how these surprises influence foreign exchange (FX) volatility. The dearth of studies examining the influence of central bank communications on FX market (Gürkaynak, et al. 2021, Mueller, Tahbaz-Salehi and Vedolin 2017) represents a significant gap in the existing literature, offering a promising avenue for further research. This project aims to address the aforementioned gap by examining the influence of monetary policy, specifically the setting of current interest rates and the communication of future interest rate intentions, and information provision policy, which encompasses the effects of disclosing information about macroeconomic fundamentals (Acosta 2023), on the FX markets. Previous studies on monetary policy have identified a diverse range of shocks, suggesting that target surprises tend to prompt immediate adjustments in the market, while path surprises are indicative of future policy directions that may result in more gradual adjustments in asset prices (Gürkaynak, Sack and Swanson 2004, Zhu 2013). Therefore, subsequent studies have enhanced the measurement of these surprises, resulting in monetary shocks that are not solely based on unexpected alterations in the Federal Funds rate (Bernanke and Kuttner 2005), but also on changes in the trajectory of future interest rates in response to FOMC statements (Nakamura and Steinsson 2018). Nakamura and Steinsson's (NS) approach synthesizes these two crucial types of surprises into a single shock measure, allowing for a more comprehensive representation of monetary policy's impact. For this reason, their shock measure is particularly informative, as it captures both the immediate and future implications of central bank communications. The primary objective of this research is to evaluate the impact of FOMC monetary policy surprises, with a particular focus on monetary NS policy shock series (Nakamura and Steinsson 2018) on the volatility of the US dollar, and to ascertain the direction of this change, namely its impact on the relative strength of the dollar. Additionally, this research contributes insights into the distinct ways in which monetary policy actions shape the foreign exchange (FX) market, both in the immediate aftermath of announcements and in the days leading up to and following meetings of the FOMC. Furthermore, this analysis contributes to the distinction between FX volatility and other financial assets in response to unexpected monetary policy signals.

1.3. Research Question

This study examines the influence of unanticipated monetary policy changes on exchange rate volatility, with a particular emphasis on several pivotal elements. Firstly, the research examines the impact of unexpected components of policy announcements on exchange rate fluctuations within a defined event window. To quantify these fluctuations, the study utilises a GARCH model, which captures time-varying volatility. Secondly, the study examines the consistency of effects across different types of surprises, comparing the impact of immediate rate changes and forward guidance on FX market volatility. It can be posited that target surprises and shocks to the Federal Funds rate may prompt immediate adjustments in exchange rates, whereas path surprises could exert influence over market expectations over a longer time horizon. This comparison offers a more detailed insight into the way distinct elements of monetary policy announcements impact volatility. Thirdly, the analysis seeks to ascertain whether the US dollar exhibits an appreciation or depreciation in response to policy surprises. This includes an examination of the factors that drive post-announcement changes in the DXY Index, with particular attention paid to two key hypotheses from the existing literature. In closing, the study compares these findings with the observed responses of other asset classes, i.e. US equities. In particular, it assesses whether the US dollar responds in accordance with or in opposition to the patterns identified in prior research on other financial markets.

2. Literature Review

2.1. Theoretical Framework on FX Rates and Monetary Policy

A comprehensive understanding of the dynamics of foreign exchange rates is essential for a thorough analysis of the impact of monetary policy on financial markets. Exchange rates are at the core of global trade, investment decisions and economic stability, and thus represent a key focus in international finance. This section introduces to the concept of exchange rates and their significance, thereby providing a foundation for understanding the object of the analysis. Subsequently, the focus shifts to monetary policy as a pivotal factor influencing exchange rates. By associating exchange rate behaviour with monetary policy actions, this section establishes the foundation for the empirical analysis of how surprises in central bank communication impact exchange rate volatility.

2.1.1. Exchange Rate Determination Models

Exchange rates represent the relative value of one currency against another and play a critical role in global trade, investments, and monetary policy transmission. The determination of exchange rates has been a cornerstone of international economics, attracting extensive research due to its practical importance and theoretical complexity. Despite the existence of several economic models, accurately predicting exchange rate movements remains a challenging task, particularly in the short term, and model such as the random walk is frequently found to generate better guesses (Meese and Rogoff 1981). The literature on exchange rate determination can broadly be categorized into two streams: traditional economic models and modern approaches incorporating advanced predictors and methodologies (Rossi 2013). The Uncovered Interest Rate Parity (UIRP), dating back to Fisher (Fisher 1896), posits that differences in interest rates between two countries should equal the expected change in exchange rates between their currencies. Although the theoretical framework is sound, empirical tests frequently fail to corroborate the predictions of UIRP, particularly at short time horizons (less than two to three years). This is due to deviations driven by risk premia and market imperfections. The Purchasing Power Parity (PPP) theory (Cassel 1918) posits that exchange rates should adjust to equalise the price levels of identical goods across countries. Similarly, PPP is also effective over long periods; yet it is less effective in explaining short-term fluctuations due to trade barriers, capital flows, and speculation. These models establish a correlation between exchange rates and a number of economic variables, including money supply, inflation rates and output levels. The shortcomings of conventional models have prompted researchers to investigate alternative predictors and pioneering methodologies. Some models concentrate on the Taylor Rule fundamentals (Molodtsova and Papell 2009), incorporating central banks' monetary policy responses to inflation and output gaps. These models demonstrate considerable potential for elucidating and anticipating exchange rates in a manner that surpasses the capabilities of the random walk, particularly in the context of currencies from countries with well-defined monetary frameworks (Rossi 2013). Other studies have concentrated on the net foreign assets of a country and have demonstrated that external imbalances can serve as an effective predictor of medium- to long-term exchange rate trends (Gourinchas and Rey 2007). Ultimately, a model based on global commodity prices appears to elucidate exchange rate movements for countries where primary commodities constitute a substantial share of exports (Chen and Rogoff 2003). Empirical insights from disparate studies demonstrate that while traditional models are unable to outperform a random walk, innovative predictors and methodological advancements, such as the success of Taylor-rule fundamentals and net foreign assets in predicting exchange rates over longer periods, show promise. However, even sophisticated models frequently fail to surpass a naive random walk model in the short-term (Rossi 2013). This thesis extends the existing research by investigating the impact of central bank communication on exchange rate, offering a detailed examination of how unexpected shifts in monetary policy, as reflected in frameworks such as the Taylor rule, influence market behaviour in the short-term.

2.1.2. Monetary Policy Tools

Monetary Policy in the United States is the process through which the Federal Reserve (Fed) exerts influence over the availability and cost of money and credit in the economy, with the objective of achieving key targets such as maximum employment, price stability and moderate long-term interest rates (Federal Reserve (1) 2024). The tools available to the Fed to reach these goals are categorised as conventional and non-conventional. Conventional tools of monetary policy include Open Market Operations (OMO), the Discount Window, and Reserve Requirements. OMOs (Federal Reserve (3) 2024) entail the purchase and sale of government securities in the open market, with the objective of regulating the supply of money and influencing short-term interest rates, particularly the Federal Funds rate, which constitutes the rate at which depository institutions lend reserves to one another overnight. The Discount Window enables banks to borrow funds directly from the Fed at the discount rate, thereby providing liquidity when required. Reserve Requirements consists of the percentage of deposits that banks are obliged to hold in reserve, which limits their lending capacity and, as a result, controls the money supply. Furthermore, since 2008, the Interest on Reserve Balances (IORB) has been employed as a means of influencing short-term interest rates, whereby interest is paid to banks on their excess reserves held at the Fed (Federal Reserve (2) 2024). Non-conventional tools, however, were introduced during times of economic crisis when conventional tools were insufficient. These include measures like the Overnight Reverse Repurchase Agreement Facility (ON RRP), the Term Deposit Facility (TDF), and Central Bank Liquidity Swaps, among others (Federal Reserve (2) 2024). The ON RRP is used to manage liquidity in the financial system by allowing the Fed to sell securities to market participants and agree to repurchase them the next day. The TDF, introduced in 2010 to help manage reserve balances held by depository institutions, and Liquidity Swaps, were extensively used during the financial crisis of 2008 and again during the COVID-19 pandemic to provide additional liquidity to markets and support global financial stability. The Standing Overnight Repurchase Agreement Facility (SRF), introduced in 2021 (Federal Reserve (5) 2021), serves as a permanent mechanism to ensure smooth market functioning during periods of stress. This thesis will primarily concentrate on conventional monetary policy tools, namely the adjustment of the Federal Funds rate, which exerts a direct influence on exchange rate dynamics. In addition, it will address a non-conventional tool, forward guidance, which enables the Federal Reserve to communicate its expectations for future monetary policy, thereby shaping market expectations and influencing longer-term interest rates, a crucial factor in determining exchange rate movements.

2.1.3. Monetary Policy Surprises

As the field of monetary policy continues to evolve, so too does the understanding of its impact on financial markets and the broader economy. In this context, the role of monetary policy surprises as a key variable has become increasingly prominent. These surprises are defined as unexpected changes in interest rates or forward guidance that occur in a narrow window around FOMC announcements. That is to say, they represent the unexpected components of monetary policy announcements. In contrast to broader alterations in monetary policy, these surprises are not foreseen by the market, thereby constituting a vital instrument for discerning causal effects in economic research (Bauer and Swanson 2023, Gürkaynak, Sack and Swanson 2005, Kuttner 2001). One of the key benefits of utilising monetary policy surprises is their exogenous nature. As the FOMC decisions are finalised shortly before they are made public, any fluctuations in the prices of assets at the time of the announcement are unlikely to be caused by external factors. This helps to address any potential issues related to endogeneity (Rigobon and Sack 2004), and permits researchers to identify the effect of monetary policy on financial markets. Nevertheless, researchers have challenged the extent to which these surprises can be considered exogenous and indicated that surprises are frequently correlated with publicly accessible macroeconomic data preceding the announcements, thus challenging the assumption that these shocks are entirely independent (Bauer and Swanson 2021). It has subsequently been demonstrated that 10-40% of the variance in these surprises can be explained by existing data

(Bauer and Swanson 2021), which raises questions about the accuracy of models that treat these shocks as exogenous. In order to address these limitations, researchers have refined the concept of monetary policy surprises. Recent studies have expanded the definition of monetary policy announcements to include press conferences, speeches, and testimonies delivered by the Federal Reserve Chair (Bauer and Swanson 2021). By incorporating these supplementary occurrences and "orthogonalising" the impact of monetary policy surprises in relation to macroeconomic variables, the objective is to mitigate endogeneity concerns and enhance the precision of policy impact estimates. This revised approach enhances the relevance of monetary policy surprises as a tool for elucidating the causal effects of monetary policy on exchange rates and other asset prices.

2.2. Empirical Evidence on the Effects of FOMC Announcements on Financial Markets

2.2.1. Evidence from other asset classes

One of the foundational studies on the impact of FOMC announcements on financial markets from this century is Kuttner (2001). This introduced the use of Federal Funds futures to distinguish between anticipated and unanticipated changes in the target rate. The analysis conducted revealed that short-term interest rates exhibit a more pronounced response to unanticipated changes than long-term rates, while anticipated changes exert a negligible influence (Kuttner 2001). This represented a notable advancement over earlier studies that did not distinguish between expected and unexpected policy shifts. Subsequent studies (Bernanke and Kuttner 2005) shifted the focus to stock markets, demonstrating that unanticipated reductions in the federal funds rate result in an increase in stock prices, predominantly through adjustments in the equity premium, as opposed to changes in anticipated dividends or interest rates. A significant breakthrough was the distinction between two dimensions of monetary policy surprises, that is, target surprises (immediate alterations in the policy rate) and path surprises (forward guidance on prospective policy). The results of high-frequency analysis

(Gürkaynak, Sack and Swanson 2004) demonstrated that path surprises exert a considerable influence on long-term interest rates and financial asset prices, even in the absence of a change in the current policy rate, suggesting that forward guidance may be as impactful as actual policy rate changes. This concept was later formalised as the “Fed Information Effect” (Bauer and Swanson 2021), which suggests that monetary policy announcements disclose privileged information regarding the Fed’s assessment of the economic situation. Results within a 30-minute window around announcements demonstrated that such announcements frequently result in an increase in growth expectations and challenged the conventional view that rate hikes have a detrimental effect on economic growth. Bomfim (2003) was among the first to examine the impact of FOMC announcements on volatility, rather than solely returns. The analysis revealed the “calm-before-the-storm” phenomenon (Bomfim 2003), whereby stock market volatility decreases in the hours preceding an FOMC announcement and then spikes afterwards, particularly in response to unexpected announcements. Later, it was additionally identified a pre-announcement drift (Lucca and Moench 2015), that is, a large portion of equity market returns occurs in the 24-hour window before the announcement. A recent development in the analysis of monetary policy surprises is the examination of textual data from news articles surrounding policy announcements (Acosta 2023). This approach identifies four distinct types of shocks: current rate shocks, path surprises, supply shocks, and demand shocks. Building upon previous research (Gürkaynak, Sack and Swanson 2005, Nakamura and Steinsson 2018), this method captures the “information effects” embedded in Federal Reserve communications, thereby extending the analytical scope. The research was subsequently expanded to encompass credit spreads, commodities and multi-asset analysis. Data of monetary policy surprises on corporate bond credit spreads (Zhu 2013) demonstrated that surprises in the target had a significant impact, particularly during economic downturns. Path surprises had a limited impact, indicating that immediate changes in interest rates are a key determinant of firms' borrowing costs. Furthermore, it was demonstrated that commodity prices respond with greater rapidity to policy surprises than is predicted by standard VAR (Vector Autoregressive) models (Scrimgeour 2015). This is evidenced by the sharp declines observed in the prices of metals and agricultural commodities following unexpected increases in interest rates. This reaction emphasises the role of policy-driven changes in the cost of carry, which in turn influences storage and production decisions. The principal development in the academic literature on the effects of FOMC announcements is the broader trend toward recognizing the multi-dimensional nature of monetary policy transmission, i.e. the growing recognition that central bank communication not only affects market rates but also modifies expectations about future economic conditions (Acosta 2023, Nakamura and Steinsson 2018).

2.2.2. Prior studies on FX Market

In the context of the existing literature on the subject, it is notable that the impact of monetary policy announcements on exchange rates has been the subject of relatively little research. Indeed, there is a paucity of studies that have focused on changes in exchange rate volatility and excess returns. Prior research has demonstrated that returns from a strategy that shorts the US dollar and longs other currencies are markedly larger on FOMC announcement days in comparison to non-announcement days (Mueller, Tahbaz-Salehi and Vedolin 2017). Additionally, returns are observed to be higher for currencies exhibiting larger interest rate differentials relative to the US and found to be further amplified during periods of monetary easing. It is of particular significance the distinction of pre- and post-announcement effects. The returns observed prior to the announcement were associated with elevated uncertainty, whereas those occurring subsequent to the announcement were attributed to the stance adopted by the Federal Reserve. Furthermore, contrary to traditional expectations, a surprise policy tightening might lead to a depreciation of the domestic currency, rather than an appreciation (Gürkaynak, et al. 2021). This phenomenon is attributed to central bank information effects, whereby policy actions signal unobserved economic conditions to the market. Additionally, research emphasises the role of information asymmetry (Bauer and Swanson 2021) and illustrates how interactions with bond yields and asset prices help to explain these deviations incorporating cross-market covariances (Gürkaynak, et al. 2021).

2.3. Research Gaps and Motivation for Study

In light of the extensive existing literature discussed above, it is evident that there is a notable absence of studies focusing on exchange rate volatility. Most of the earlier work (e.g. Kuttner 2001, Bernanke and Kuttner 2005), has concentrated on equity prices or interest rate changes following monetary policy surprises. In contrast, studies that do explore volatility (Bomfim 2003) have been largely confined to stock markets, with little attention paid to foreign exchange markets. This gap is significant given the unique role that exchange rates play in global financial stability and international trade. Moreover, existing research has frequently concentrated on a singular dimension of monetary policy surprises, frequently utilising a one-factor model centred on target rate alterations. Nevertheless, a more comprehensive approach necessitates a distinction between target surprises and path surprises (forward guidance) in order to fully encompass the broader impact of FOMC communications. Although this two-dimensional framework has been applied to bond and equity markets (Gürkaynak, Sack and Swanson 2004) its application to exchange rate volatility remains limited. Given that exchange rates are driven by both short-term interest rate changes and future expectations, a more nuanced understanding of these two components is essential. To gain a more comprehensive insight, it is necessary to employ measures of the shock that encompass both elements (Nakamura and Steinsson 2018). A further critical research gap pertains to the dearth of cross-asset comparisons of reaction of exchange rates with that of other asset classes, such as equities, which may yield insights into the broader market dynamics surrounding central bank announcements. Considering these shortcomings, this study addresses these issues by focusing on exchange rate volatility and comparing it to level shifts. Furthermore, by comparing the effects of these surprises on foreign exchange rates and other financial markets, this study uncovers potential similarities or divergences in asset class reactions. This comprehensive approach allows for a more nuanced understanding of FOMC-driven market volatility and positions this research as a novel contribution to the broader literature on financial market reactions to central bank communications.

3. Data and Methodology

A comprehensive overview of the data collection process, key sources, methodology and transformations of the variables used in the empirical analysis is presented below.

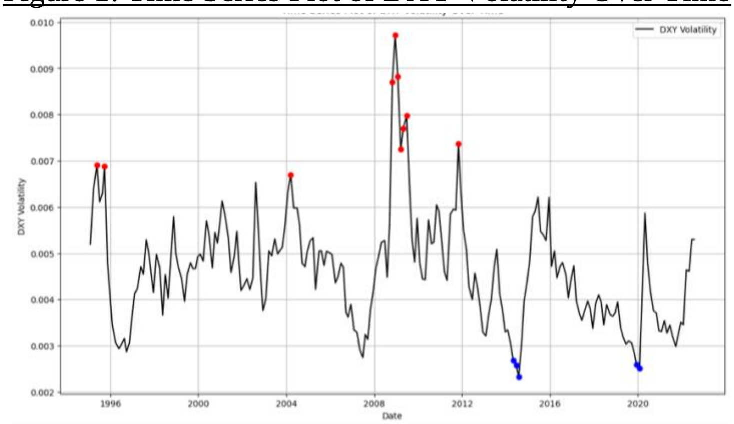
3.1. Data Sources and Variables

This paper uses high-frequency data from 1 January 1995 to 31 July 2022. There are eight scheduled FOMC meetings per year (Federal Reserve (6) 2024). This leaves 220 FOMC scheduled announcement days and 7195 trading days. Days when the FOMC made a surprise announcement after an unscheduled meeting are not included in this dataset.

3.1.1. DXY Index as a Proxy of US Dollar Value

As a proxy for the value of the US dollar, the DXY index was chosen for this study. The US dollar index tracks the strength of the dollar against a basket of major currencies; it was originally developed by the US Federal Reserve in 1973 to provide an external bilateral trade-weighted average value of the US dollar against world currencies (Trading View 2024). The DXY Index rises when the US Dollar gains "strength" (value) against other currencies and it provides a comprehensive reflection of the dollar's performance in the foreign exchange market, given its broad coverage of major global currencies. It employs a basket of six major currencies in descending percentages: the Euro, Japanese Yen, British Pound, Canadian Dollar, Swedish Krona, and Swiss Franc (Trading View 2024). The DXY index, as obtained from Bloomberg, provides a reliable and standardised measure of dollar fluctuations, thus offering a comprehensive perspective for the analysis of FOMC-induced volatility. In this empirical study, the DXY index is employed as the dependent variable with the objective of evaluating the impact of monetary policy surprises on the dollar's value and volatility following FOMC announcements. In contrast to previous research, which frequently examines the spot exchange rates of individual G10 currencies relative to the US dollar (Mueller, Tahbaz-Salehi and Vedolin 2017), this analysis employs the aggregated nature of the DXY index to encapsulate broader market movements. Moreover, the DXY index is used to calculate its GARCH-based volatility, thereby offering insights into changes in the relative value of the US dollar. To illustrate, the 2008 financial crisis was characterised by a pronounced lack of market stability in the wake of the collapse of Lehman Brothers, resulting in pronounced fluctuations in the value of the dollar (Figure 1). Similarly, during the European sovereign debt crisis of 2011–2012, concerns about a potential Greek default and the stability of the Eurozone led to increased dollar volatility as the market responded to heightened risk. A further notable peak is observed during the onset of the 2020 coronavirus pandemic, when global financial disruptions and economic shutdowns created unprecedented uncertainty. In contrast, periods of low volatility, such as those observed during the quantitative easing period after 2013, saw reduced volatility as market expectations stabilised due to clear communication from the Federal Reserve.

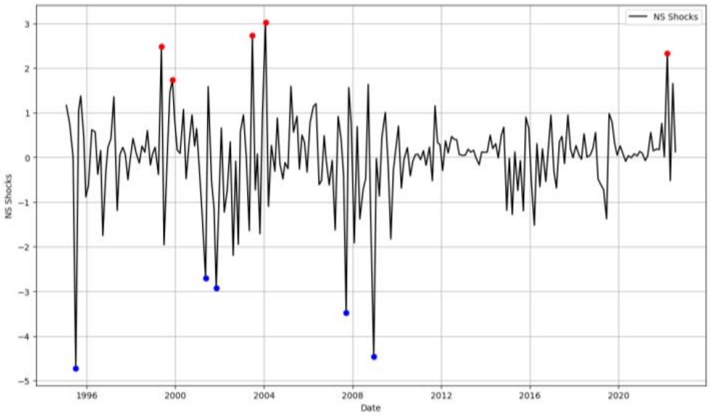
Figure 1: Time Series Plot of DXY Volatility Over Time



3.1.2. Measures of Monetary Policy Surprise

The monetary policy surprise measures employed in this analysis are based on established methodologies from the literature. In line with Acosta (2023), shocks are derived from high-frequency data and have been scaled to have unit standard deviation and a positive correlation with the one-day change in the one-year treasury yield around the FOMC announcement (Acosta 2023). The NS Shocks (Nakamura and Steinsson 2018), are computed from tick-frequency data of federal funds futures from the Chicago Mercantile Exchange and represent a sum of both short-term interest rate changes and future expectations. Peaks of NS shocks indicate significant positive monetary policy surprises (Figure 2), whereby the Fed's actions were more hawkish than anticipated.

Figure 2: Time Series Plot of NS Shocks Over Time



For example, the spikes observed around the early 2000s and after 2008 correspond to pivotal rate decisions during the bursting of the technology stock bubble and the onset of the global financial crisis. Similarly, the shocks observed after 2022 reflect significant surprises stemming from the Fed's aggressive rate hikes to combat high inflation, which represents one of the most hawkish stances in recent decades. This follows a prolonged period of near-zero interest rates and accommodative monetary policy during the pandemic caused by the COVD-19 pandemic. In contrast, substantial negative shocks, indicative of dovish surprises, have occurred when the Fed's actions have been more accommodative than anticipated. Such events include the aggressive monetary easing in response to crises, such as the significant interventions during the 2008 financial crisis. These downward movements are indicative of the Fed's role in stabilising financial markets during periods of economic distress. Furthermore, the study replicates the analysis with Target and Path Surprises (Gürkaynak, Sack and Swanson 2004), and Federal Funds Rate (FFR) Shocks (Acosta 2023), specifically tied to movements in the FFR, which have been previously discussed in the literature review.

3.2. Methodological Framework

3.2.1 Event Study Approach

This study employs an event study approach to investigate the impact of monetary policy surprises, captured through NS shocks, on both the volatility and log levels of the DXY index. The methodology is centred on the examination of the impact of these shocks, occurring on FOMC days, on market behaviour over a six-day time horizon (k = [0,5]), from the announcement day to five days after the event. By aligning high-frequency monetary policy shock data with daily DXY index observations, the event study captures the immediate and cumulative effects of unexpected Federal Reserve policy decisions.

3.2.2 Regression Model Specifications

In order to evaluate the effect of monetary policy shocks on DXY volatility and logarithmic levels, a series of OLS regressions is conducted in a loop across the aforementioned event window (k = [0,5]). The regression framework is derived from previous studies that employed analogous models to examine the influence of monetary policy surprises on equity returns (Nagel and Xu 2024). However, the distinctive feature of this study is the implementation of the regressions in a loop across multiple time horizons, thereby allowing for the analysis of the cumulative impact of shocks over time. The first specification, as illustrated in (1), represents the change in GARCH-based DXY volatility between day $d+k$ and day $d-1$ as a function of NS shocks on day d (announcement day). This approach identifies the extent to which unanticipated monetary policy announcements influence volatility, both on the day of the announcement itself and in subsequent days. Each regression provides a coefficient (α_k), which captures the magnitude of the policy shock effect on that day (k).

$$DXY\ Vol_{d+k} - DXY\ Vol_{d-1} = constant + \alpha_k \cdot policy\ surprise_d + \epsilon_{d+k} \quad (1)$$

The second specification (2) examines the logarithmic changes in DXY levels over the same window. The model incorporates the lagged log level of the DXY Index to account for prior market conditions, thereby enhancing the robustness of the results.

$$ln\, DXY_{d+k} - ln\, DXY_{d-1} = constant + \alpha_k \cdot policy\ surprise_d + \epsilon_{d+k} \quad (2)$$

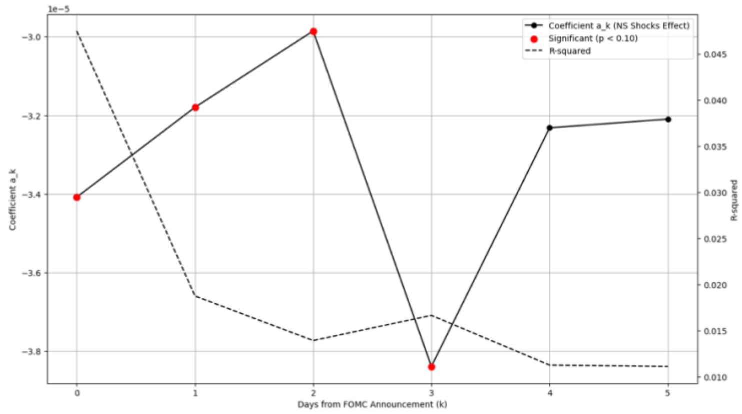
Furthermore, HAC errors are employed to address heteroscedasticity and autocorrelation, ensuring that the standard errors are consistent with the data's time-series structure. The methodology is then extended to analyse the effect of the aforementioned target, path surprises and FFR shocks, as well as stock market returns and volatility. This is done to provide a comparative view of the impact of different monetary policy shocks and across asset classes.

4. Empirical Results

4.1. Initial findings on Exchange Rate Volatility

The first specification (1) examines the impact of NS shocks on DXY volatility over a six-day time horizon (k = [0,5]). The results consistently reveal negative coefficients (α_k) across all time horizons, indicating that NS shocks systematically reduce DXY volatility (Figure 3). These preliminary findings suggest that unanticipated monetary policy decisions characterised by a policy surprise lead to decreased market uncertainty, as reflected in the lower volatility of the dollar index. In detail, the initial impact (k = 0) is represented by a slightly negative coefficient ($\alpha_0 = -0.0034\%$), which, in relative terms, corresponds to 2.8% of the daily standard deviation of GARCH-implied volatility. This immediate effect demonstrates that NS shocks exert a statistically and economically significant dampening influence on volatility shortly after an FOMC announcement. In the subsequent days (k = [1,5]), the coefficients remain negative but gradually diminish in magnitude. The largest effect is observed three days after the announcement date (k = 3), with $\alpha_3 = -0.0038\%$. This result indicates that the impact of policy surprises (NS Shocks) is not limited to the announcement day but rather persists over multiple days. Moreover, these coefficients are the statistically significant at the 10% level (p-value < 0.10) for several horizons (k = [0,3]), as indicated by the red points in the plot (Figure 3).

Figure 3: Cumulative effect of NS Shocks on DXY Volatility over time

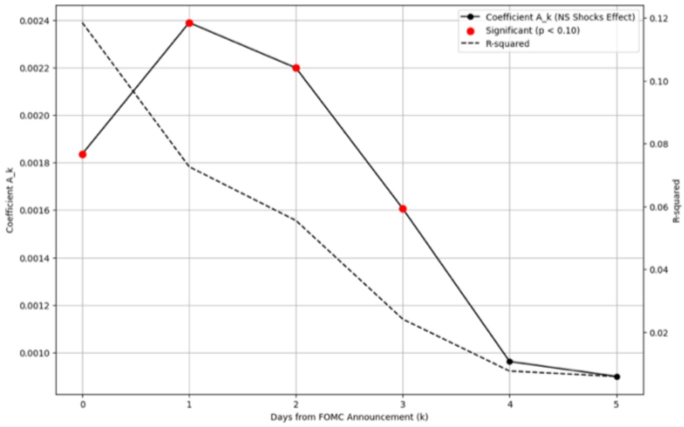


The R-squared values displayed on the secondary axis, indicate that the model explains a modest portion of the variability in DXY volatility. The highest explanatory power is observed two days after the announcement (k = 2) whereby the variable accounts for 4% of the total variability in the dependent variable. However, this magnitude is consistent with those of previous studies whose methodologies this analysis builds upon (Bernanke and Kuttner 2005, Nagel and Xu 2024). The relatively low explanatory power is a consequence of the inclusion of additional unobserved variables in the error term, which precludes the isolation of the effect of the policy surprise variable. Overall, the first specification (1) results reinforce the role of FOMC announcements as uncertainty resolvers (Bauer, Lakdawala and Mueller 2022).

4.2. Results and Economic Implication on Exchange Rate Levels

The negative coefficients yielded by the first regression (1) warrant further investigation into the response of the exchange rate to changes in monetary policy. In particular, it is of interest to examine the impact of these shocks on the dollar level (2), as represented by the DXY Index. This reflects the interplay of two competing mechanisms that have been widely discussed in previous literature (Ozdagli and Velikov 2020). Specifically, the safe haven effect and the investment channel offer contrasting predictions about assets behaviour following monetary policy (e.g., rate decreases). The safe haven hypothesis posits that a rate decrease, often reflecting negative surprises, signals poor global economic conditions, prompting foreign investors to view the US as a relatively safer destination for capital. In this scenario, we would expect that the dollar would appreciate as it becomes a preferred asset. Conversely, the investment channel hypothesis suggests that lower interest rates make US assets less attractive by reducing returns on investment, leading in this analysis to a depreciation of the dollar. Similarly, we would expect that higher interest rates make US dollar denominated assets more attractive thus leading to a dollar appreciation (positive effect on the DXY Index). To test these hypotheses, the empirical examination of the cumulative and dynamic effects of monetary policy surprises on the value of the dollar was implemented (2). The results (Figure 4) demonstrate a consistent positive coefficient (α_k) across the six-day time horizon (k = [0,5]), indicating that NS shocks systematically elevate the DXY index level. The evidence thus indicates that positive surprises are an indicator of a heightened commitment to tightening monetary policy, which in turn serves to reinforce confidence in the US dollar and thereby result in its appreciation. These findings corroborate the hypothesis that unanticipatedly hawkish measures render US assets more attractive, presumably due to elevated anticipated returns or augmented global confidence in the credibility of US monetary policy. In detail, the initial impact on the first day of the event window (k = 0) is characterised by a positive coefficient ($\alpha_0 = 0.00155$), corresponding to an approximate 0.16% increase in the DXY index. This equates to 32.55% of the daily standard deviation of DXY returns. The effect reaches its maximum one day later ($\alpha_1 = 0.00189$) before gradually declining over subsequent days. By the final day of the observation period, the impact remains positive on average, but with a diminished intensity ($\alpha_5 = 0.00132$), indicating that the influence of NS shocks persists but weakens over time.

Figure 4: Cumulative effect of NS Shocks on Log of DXY Level over time

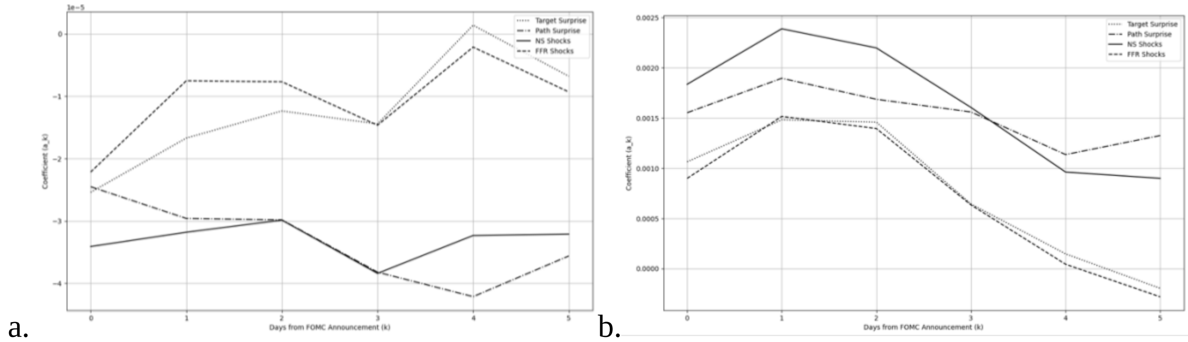


The coefficients are statistically significant at the 10% level for the horizons k = [0, 3], as graphically illustrated by the red points (Figure 4). The R-squared values illustrate that the explanatory power of the model reaches its peak one day after the surprise at 11% (R_1^2 = 0.11) indicating that NS shocks exert the most significant influence on the DXY Level in the immediate aftermath of the FOMC announcement. These results illustrate the dynamic nature of monetary policy surprises, showing that hawkish measures tend to strengthen the dollar over several days. In contrast with previous literature (Gürkaynak, et al. 2021), findings support the idea that such surprises can lead to a dollar appreciation, reinforcing its position as an attractive asset in global markets. This difference may be attributed to the fact that the DXY Index captures the dollar's value relative to a broader basket of currencies, reflecting its overall global standing, whereas the USD/EUR rate, used in previous studies, is a bilateral exchange where specific euro-area dynamics and liquidity factors play a more prominent role. However, when examining the impact on both the DXY level and volatility, the market's response appears more nuanced. The negative effect in GARCH volatility suggests that, despite the positive change, the event did not lead to unexpected or extreme price fluctuations. The small relative impact on the GARCH volatility (2.8% of daily standard deviation) shows that, while the event influences the DXY, its effect on volatility is less pronounced, with markets likely anticipating a return to stability in the short term. Therefore, while the DXY reacts to the event, the implied volatility response suggests that the market does not foresee lasting or extreme fluctuations. This positions the event as a temporary shift rather than a catalyst for sustained market instability. These findings will be further compared to equity market dynamics in Chapter 5 to assess whether similar or divergent effects are observed across asset classes, providing a broader understanding of how monetary policy surprises influence different markets.

4.3. Empirical Effects of Alternative Monetary Policy Shocks

The results for DXY volatility (Figure 5.a) reveal distinct patterns across the different monetary policy shock measures. Target Surprises (Appendix.1.) and FFR shocks (Appendix.2.) exhibit similar behaviour, with a sharp and immediate impact that is significant on the first day at the 10% level but quickly diminishes and becomes insignificant over the following days. This reflects their emphasis on capturing immediate rate changes during FOMC announcements. In contrast, Path Surprises show a more prolonged effect on volatility (Appendix.3.), with significant and consistent impacts over longer horizons (k = [3,5]), in line with their role in capturing forward guidance and expectations about future policy. While all shocks are consistent with NS shocks in reducing volatility, the observed differences highlight how each shock captures distinct aspects of monetary policy. Furthermore, it can be seen how the findings support the idea that NS shocks, as a comprehensive metric encompassing both rate changes and forward guidance, effectively integrate the elements captured by the other shocks. For what concerns the results for logarithmic DXY levels (Figure 5.b), the effects of Target Surprises (Appendix.4.) and FFR Shocks (Appendix.5.) are comparable, with a pronounced initial impact reaching its peak one day after the FOMC meeting, followed by a gradual decline. However, the effects are significant only during the first three days of the event window. In contrast, Path Surprises (Appendix.6.) demonstrate a more sustained and gradual impact, with notable effects persisting over extended periods, aligning with their emphasis on future policy expectations. In comparison to NS shocks, a more comprehensive measure that encompasses both immediate rate alterations and forward guidance, the results exhibit analogous dynamics but demonstrate somewhat greater durability for path surprises. These findings enforce the idea that each measure reflects distinct aspects of the transmission of monetary policy to exchange rate levels.

Figure 5: Summary of Surprises effects on DXY Volatility (a) and Level (b)

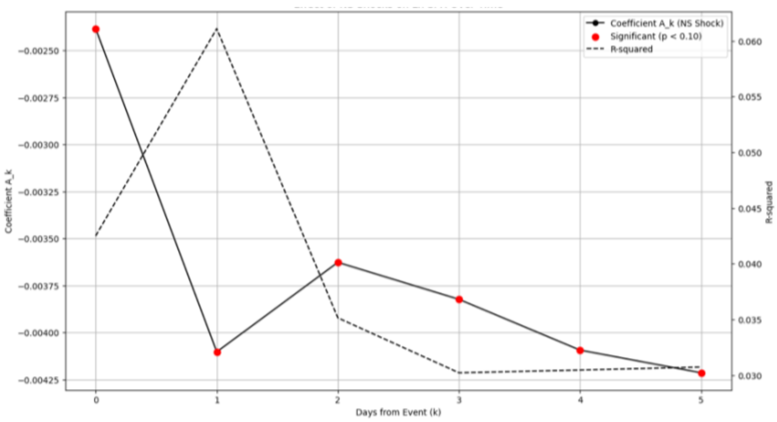


5. Cross-market Comparison

Understanding the cross-market effects of monetary policy shocks is crucial, as it provides insights into how different asset classes respond and interact. Previous research (Lucca 2014), highlights the importance of examining these effects to better understand the broader transmission of monetary policy and the interdependence between markets. To evaluate the equity market response, two key variables sourced from Bloomberg are analysed: the SPX and the VIX. The SPX, or S&P 500 Index, is a widely used benchmark for the US equity market, reflecting the market capitalization-weighted performance of 500 of the largest publicly traded companies in the United States, covering approximately 80% of available market capitalization (S&P Global 2024). The VIX, or CBOE Volatility Index, measures the market’s expectations of near-term volatility based on S&P 500 real-time option prices. Often referred to as the “fear gauge” the VIX is a key indicator of market uncertainty, reflecting investors’ consensus view of future (30-day) expected stock market volatility (CBOE 2024). The results in this analysis performed using again policy (NS) shocks (Nakamura and Steinsson 2018) as regressors confirm that monetary policy surprises lead to a decrease in the SPX and an increase in the

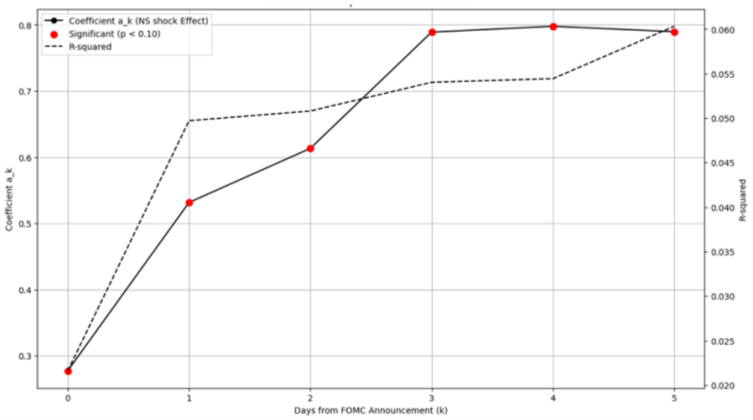
VIX, consistent with prior literature. Specifically, for the SPX (Figure 6), the coefficients indicate approximate -0.24% decrease in response to a unit increase in the policy surprise on the announcement day, equivalent to 20.4% of the daily SPX return volatility. This effect is significant and cumulates over the event window. As already indicated in the literature (Nagel and Xu 2024, Bernanke and Kuttner 2005), equity markets tend to respond negatively to monetary policy tightening due to expectations of reduced liquidity and economic growth and increased costs of borrowing.

Figure 6: Cumulative effect of NS Shocks on Log of SPX over time



These results highlight the dual role of monetary policy surprises in shaping currency and stock market dynamics. While positive policy shocks lead to an appreciation of the DXY, they simultaneously reduce SPX returns, reflecting the different transmission mechanisms in the currency and stock markets. As noted previously, the DXY results are consistent with the investment hypothesis, as higher US interest rates make USD-denominated assets more attractive to foreign investors, triggering capital inflows and strengthening the dollar. At the same time, the negative impact on the SPX is consistent with the idea that higher interest rates increase the cost of capital and reduce equity valuations, highlighting the influence of the discount rate and supporting the aforementioned role of monetary policy as a driver of investment. The divergence in responses highlights the fact that the focus for the SPX is on changes in expected future cash flows and the cost of capital, while the focus for the DXY is on the relative attractiveness of USD-denominated assets to foreign investors. Higher expected rates of return in the US markets, driven by rising interest rates, could increase the demand for the USD while reducing the demand for US equities. Although the safe-haven narrative could explain some of the DXY's appreciation, it is less relevant here as the SPX would have generally risen or held steady alongside the DXY in case of safe-haven demand. Therefore, the rise in the USD seems to be driven more by expectations of higher yields on USD-denominated debt than by a flight-to-safety argument. Conversely, the VIX increases progressively, with an increase of 0.27 in the VIX (Figure 7), on the event day (k = 0), corresponding to 3.95% of the VIX's daily volatility, consistent with the theory that monetary policy surprises increase uncertainty (Bomfim 2003), as reflected in volatility indices. Moreover, these effects are consistent across the different monetary policy shocks for both SPX and VIX (Appendix.7-12.), with only Path Surprises exhibiting slight deviations on the SPX, in view of its previously discussed role in capturing forward guidance and future expectations.

Figure 7: Cumulative effect of NS Shocks on VIX over time



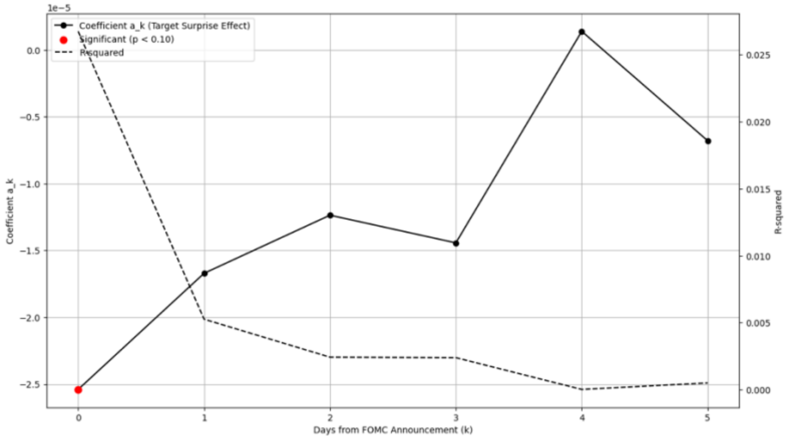
The results from the stock market appear to be opposite to those observed in the currency markets once again. The increase in the VIX indicates an elevated level of implied uncertainty, whereas the decrease in DXY volatility, as measured by the GARCH (1,1) model, suggests a reduction in past realised volatility. It is essential to highlight that direct comparisons between these two measures are not entirely valid, i.e., while the VIX serves as a barometer of the market's expectations regarding future volatility and heightened uncertainty, the DXY volatility metric gauges the extent to which past realised volatility has influenced the immediate market reaction to the policy surprise.

6. Conclusion

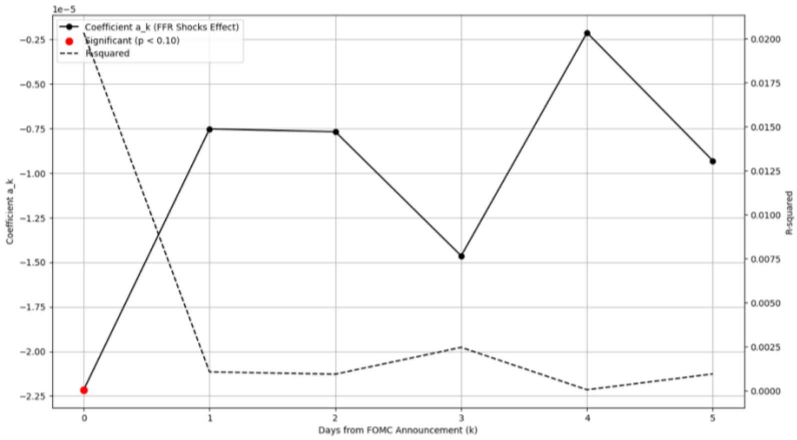
This thesis examines the impact of monetary policy surprises on the DXY Index and its volatility, as well as on equities and volatility indices. It offers new insights into the transmission of central bank communications across asset classes. The findings demonstrate a consistent pattern whereby hawkish surprises result in an appreciation of the US dollar, as evidenced by a sustained positive impact on the DXY Index. Conversely, DXY volatility declines, indicating that returns are not as extreme as previously thought. However, the impact on equities is found to diverge. A decline in stock prices is accompanied by an increase in implied volatility (VIX), which reflects heightened market uncertainty and an elevated risk premium. This discrepancy in responses underscores the disparate characteristics of realised and implied volatility. The former, as represented by GARCH volatility, reflects actual price movements, whereas the latter, as exemplified by VIX, encapsulates forward-looking uncertainty. Furthermore, the evidence lends support to the investment driver hypothesis, as the appreciation of the dollar reflects the appeal of higher-yielding dollar-denominated assets, while US equities are negatively affected by higher discount rates, suggesting a potential reallocation of capital towards alternative US-based investments. These findings highlight the broader implications of monetary policy surprises, offering valuable insights for policymakers and market participants. In essence, they underscore the need for further research into how central bank signals shape global asset allocation and risk perception, particularly in understanding the sources behind the divergent reactions of different asset classes.

7. Appendix

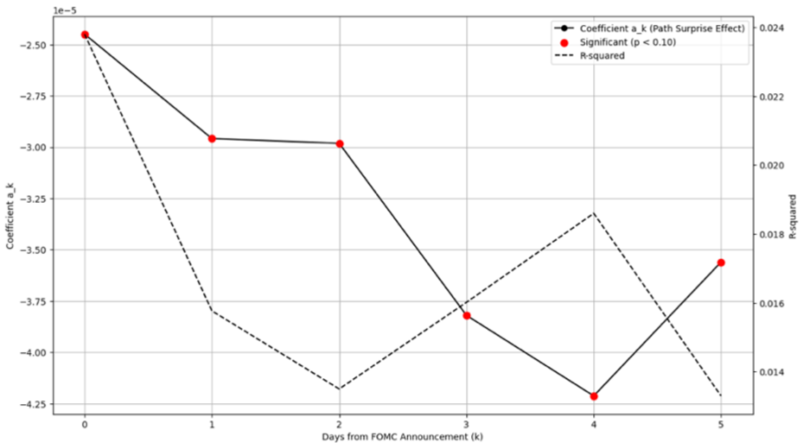
A.1. Cumulative effect of Target Surprises on DXY Volatility over time



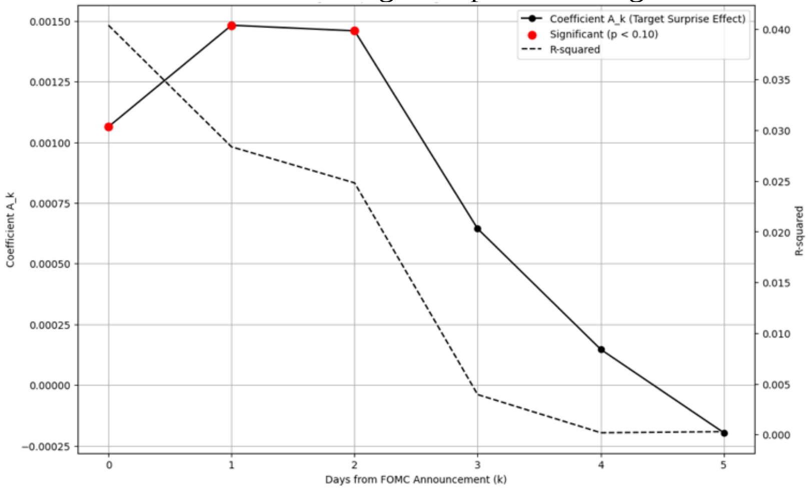
A.2. Cumulative effect of Normalized FFR Shocks on DXY Volatility over time



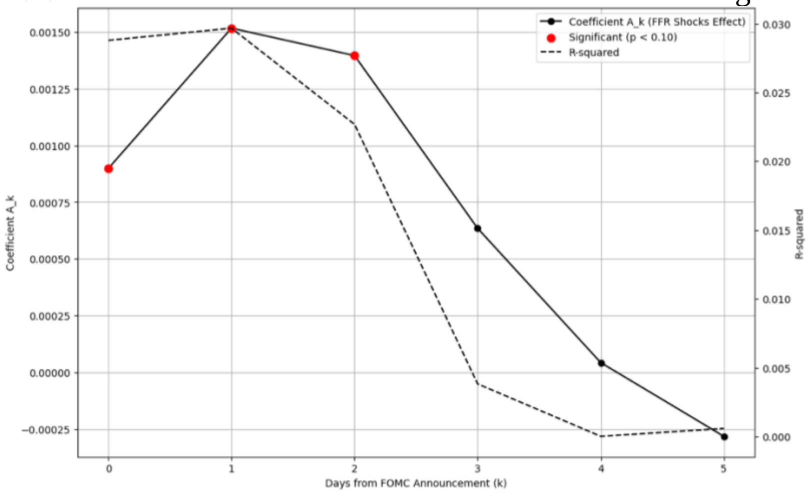
A.3. Cumulative effect of Path Surprises on DXY Volatility over time



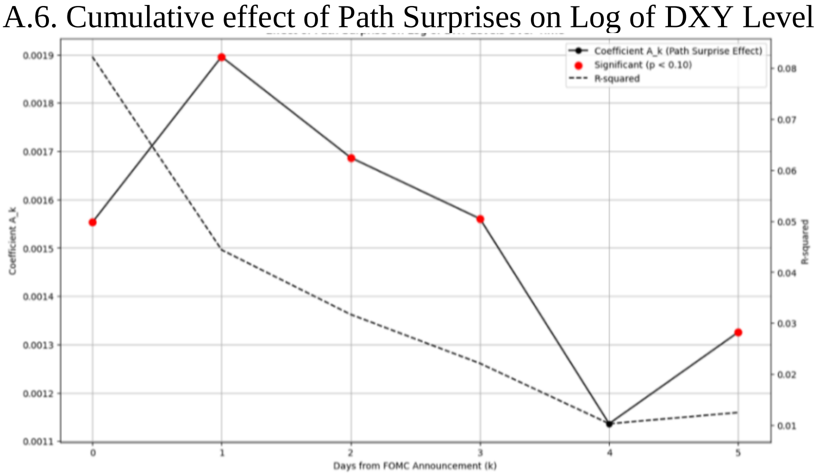
A.4. Cumulative effect of Target Surprises on Log of DXY Level over time



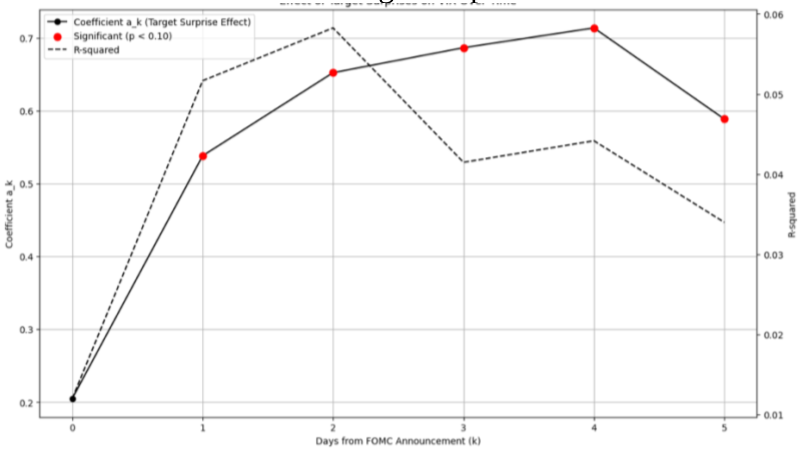
A.5. Cumulative effect of Normalized FFR Shocks on Log of DXY Level over time



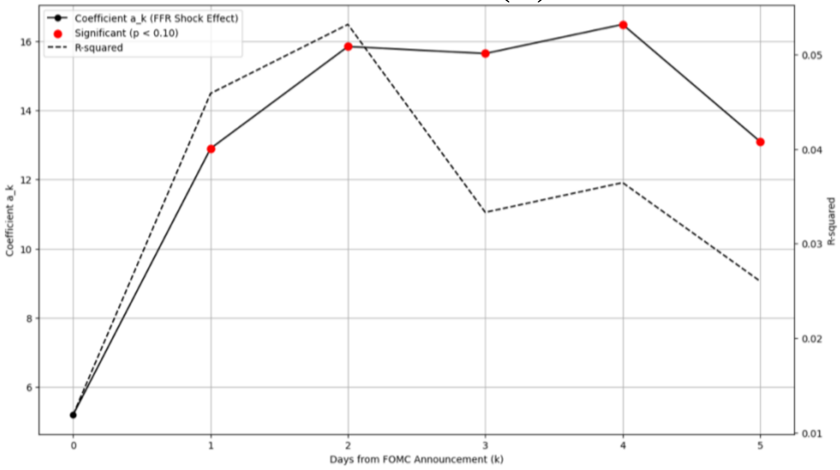
A.6. Cumulative effect of Path Surprises on Log of DXY Level over time



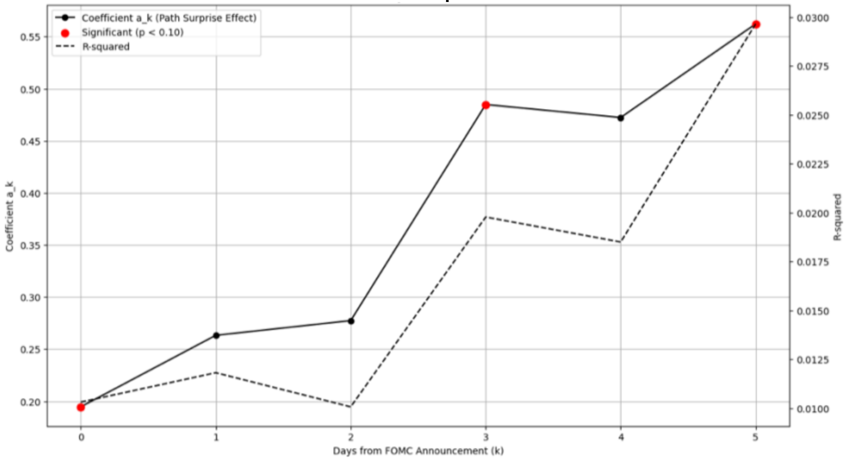
A.7. Cumulative effect of Target Surprises on VIX over time



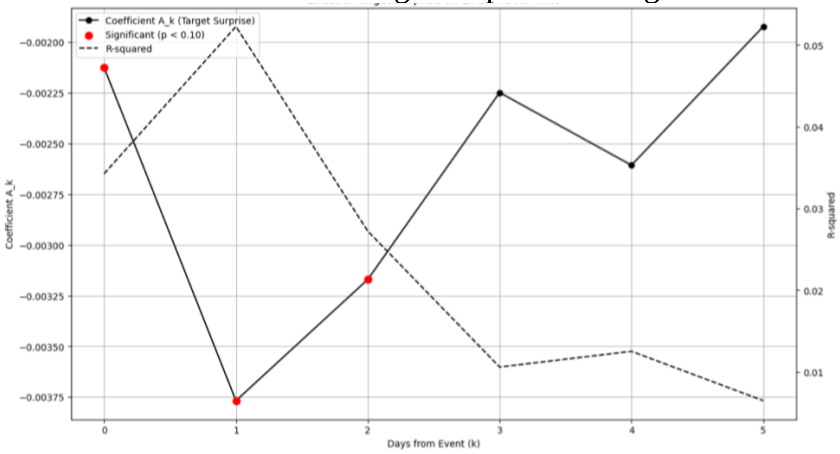
A.8. Cumulative effect of FFR Shocks (%) on VIX over time



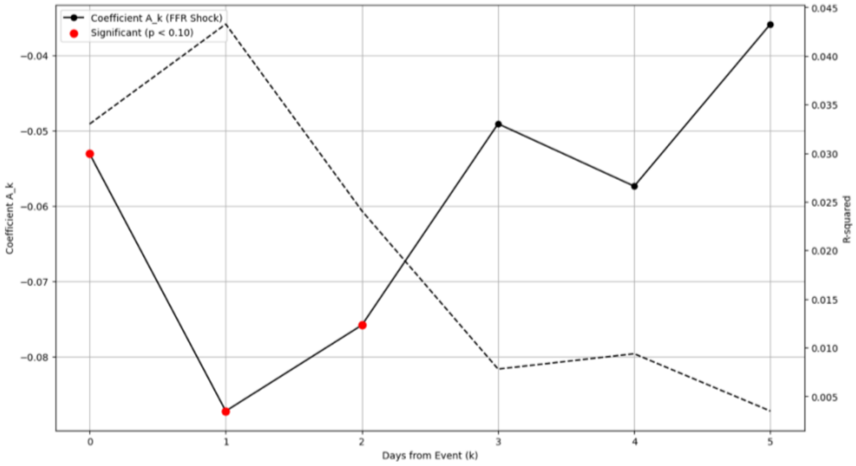
A.9. Cumulative effect of Path Surprises on VIX over time



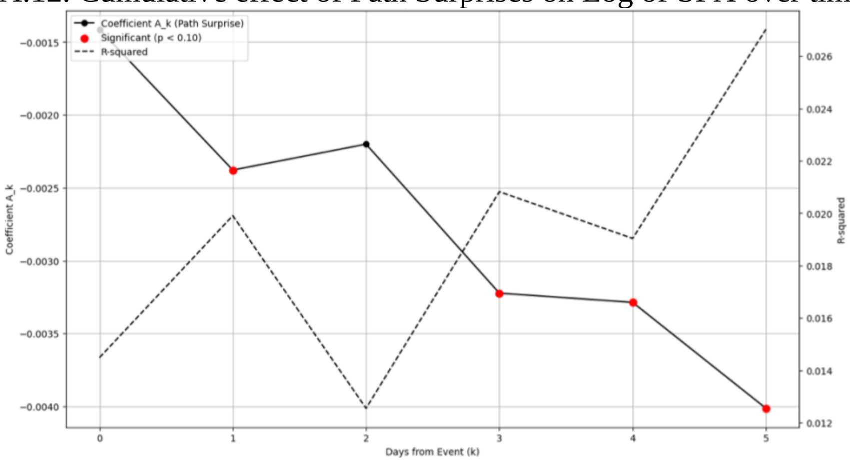
A.10. Cumulative effect of Target Surprises on Log of SPX over time



A.11. Cumulative effect of FFR Shocks (%) on Log of SPX over time



A.12. Cumulative effect of Path Surprises on Log of SPX over time



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