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Central Bank Information and Pure Monetary Policy Surprises in Switzerland*

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Abstract

This paper presents a novel high-frequency motive classification strategy – the *Trading Markov Sign Restriction (TMSR)* – to map pure monetary policy and central bank information motives onto monetary surprises. It considers high-frequency dynamics on the interest rate futures and the stock market and examines systematic phases of expectation adjustment behaviour within 30-minute windows around policy announcements. I show that three systematic phases of expectation adjustment intensities can be observed for monetary policy announcements from the Swiss National Bank (SNB). Based on these identified phases, trends in trading directions on the interest rate futures and stock market are then weighted by a measure of expectation adjustment intensity to classify pure monetary policy and central bank information motives per policy announcement. Studying the effects of pure monetary policy and central bank information surprises reveals that both types of surprises affect financial assets; however, for the Swiss case, these effects differ from each other only for the exchange rates and stock market responses.

Keywords: monetary policy, central bank information, high-frequency identification, motive classification
JEL Codes: C36, E43, E52, E58, G14

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1 Introduction

Identifying monetary policy shocks and their effects on financial markets and the economy is a longstanding question for academics and practitioners, especially in central banking (Sims (1980), Bernanke & Blinder (1992), Christiano, Eichenbaum & Evans (2005)). Extensive literature focusing primarily on the US and the Euro Area has used high-frequency movements of interest rate futures data around monetary policy announcements (MPA) in event-study frameworks to identify the unanticipated and thus exogenous component of monetary policy – the so-called monetary surprise.[1] For Switzerland, Koeniger, Lennartz & Ramelet (2022) and Nitschka & Ramelet (2023) calculate the monetary surprises as the daily change of futures' contracts based on the Swiss franc short-term rate.

The advent of this approach can be traced back to the seminal works of Kuttner (2001) and Gürkaynak, Sack & Swanson (2005*b*) and has since evolved to encompass the use of high-frequency data to study the transmission of monetary policy on financial markets and the economy (Mertens & Ravn (2013), Gertler & Karadi (2015), Montiel Olea, Stock & Watson (2021)). In detail, monetary policy announcements directly impact, on the one hand, current short-term rates and influence expectations about future interest rates and, thus, the whole yield curve. On the other hand, long-term rates have a more significant impact on firms' and households' decisions and could be regarded as a potential channel for monetary non-neutrality. These have become important considerations for central banks around the world and have shaped communication via monetary policy statements to back the transmission of monetary policy (Woodford & Walsh (2005), Bernanke (2013)).

However, when examining the central bank's monetary policy announcements, such statements often simultaneously convey information about the monetary policy stance and the central bank's assessment of the economic outlook. For central banks, it is therefore essential to recognise that its communication can influence how monetary policy decisions are perceived by economic agents, potentially translating into very different effects on financial markets and the economy (Romer & Romer (2000)). If, for example, economic agents primarily react to the news about the policy stance itself, a negative interest rate surprise is, as textbooks suggest, expansionary. However, if the central bank in the same announcement reveals a rather pessimistic assessment of the economic outlook, research shows that a negative interest rate surprise might exhibit contractionary effects as the confidence of economic agents weakens. This issue has been reassessed by recent literature focusing on the co-movement between monetary surprises and stock prices around short windows at policy announcements to classify the motives of the reactions of economic agents to policy announcements (Cieslak & Schrimpf (2019), Jarociński & Karadi (2020), Andrade & Ferroni (2021), Lewis (2023)). This literature leverages the fact that standard theory makes unambiguous predictions about the reactions of certain variables in response to unanticipated changes in monetary policy. Standard asset pricing theory, for example, predicts that stock prices decrease in response to monetary policy tightening because dividends are expected to decrease while the discount rate increases. A reaction which is in line with the theory prediction can thereby be interpreted as a *"pure"* monetary policy motive, while a reaction contradicting the theory prediction a central bank information motive (Jarociński & Karadi (2020)). As the monetary surprise

[1] The literature alternatively uses the term *monetary policy shock*. In this paper, I stick to the term monetary surprise to stress that changes in interest rate futures prices around policy announcements are used to extract the exogenous component of monetary policy.

itself indicates which direction of response in economic variables is expected according to theory, these motives are then mapped onto the monetary surprises, allowing for the separation of pure monetary policy and central bank information surprises.[2]

This paper contributes to the existing literature in two dimensions.

First, I propose a novel motive classification strategy – I call it the *Trading Markov Sign Restriction (TMSR)*. In detail, the *TMSR* can be viewed as a refinement of the commonly used *Poor Man's Sign Restriction (PMSR)* proposed in by Jarociński & Karadi (2020) because it explicitly considers the high-frequency dynamics of trading patterns and the expectation adjustment behaviour of market participants on interest rate futures and stock markets within 30-minute windows around policy announcements to classify motives. I show that simple motive classifications such as the *PMSR*, which disregard such dynamics, are prone to the misclassification of motives.

Trading because the strategy focuses on high-frequency interest rate, price and volume data.

Markov because using a Markov switching model allows for identifying systematic phases of expectation adjustment behaviour within 30 minutes around policy announcements. Specifically, I show that for the monetary policy announcements of the Swiss National Bank (SNB), three systematic expectation adjustment phases can be observed: a *pre-announcement betting phase*, which is the 10-minute pre-announcement window with hardly any rate movement and the lowest volatility in trading volume; a *high-intensity positioning phase* which is the 5-minute post-announcement window, with abrupt rate movement and the highest volatility in trading volume; and a *post-announcement tuning phase*, which is the last 15-minute window, with some rate movement and still considerable but less pronounced volatility in trading volume.

Sign Restriction because for each previously identified systematic phase, the trends in trading directions on the Swiss interest rate futures and stock market are used to classify motives. After weighing these classified motives by a phase-duration-adjusted trading volume measure, the *TM weights*, the overall motive tendency can be inferred from this strategy for each policy announcement; this is the result of the *TMSR*.

Second, I map the classified motives onto monetary surprises and study the effects of pure monetary policy and central bank information surprises on various financial assets for the case of Switzerland.

The results reveal that pure monetary policy and central bank information surprises similarly affect the target rate, interest rate futures contracts and Swiss government bonds, whereas statistical differences in effects are recorded only for the exchange rate and stock market responses in the Swiss case.

For pure monetary policy and central bank information surprises, the target rate and futures contracts show similarly strong and immediate responses at the shorter end, with effects decreasing in size along maturity. The effects on futures contracts reach their peak after 70 working days and persist for up to 100 days. Pure monetary policy and central bank information surprises also have similarly pronounced and sustained impacts

[2]While many authors have adopted the terms pure monetary policy and central bank information surprises from Jarociński & Karadi (2020), Andrade & Ferroni (2021) use the terms Delphic and Odyssean guidance to reflect the context of discussions of forward guidance. For further discussions about reactions of economic variables to unexpected changes in monetary policy, see Campbell, Evans, Fisher, Justiniano, Calomiris & Woodford (2012), Bodenstein, Hebden & Nunes (2012), Del Negro, Giannoni & Patterson (2023), and Andrade, Gaballo, Mengus & Mojon (2019).

on Swiss government bonds, especially at the shorter end. The effects persist for the entire observation horizon for two-year Swiss government bonds, while five-year bonds maintain significant responses for approximately 85 working days. For the exchange rates, only pure monetary policy surprises show significant responses; in response to a +25 bps pure monetary policy surprise, the Swiss franc immediately appreciates by 1% and 0.75% while persisting its effect for 15 working days and even for the entire horizon against the US dollar and euro, respectively. For central bank information surprises, however, only the stock market's reaction exhibits statistical significance with a delay of 58 working days after such announcements.

Related literature — This paper contributes to three key areas of literature: information asymmetry between central banks and private agents, high-frequency shock identification, and the motive classification of the responses of economic variables to changes in monetary policy.

As a critical motivation laying the foundation for the other two strands of research, the empirical literature on information asymmetry between central banks and private agents suggests that central banks may possess more timely, private information about the economy, influencing public expectations (Romer & Romer (2000)). Consequently, the public can infer such private information from central banks when they assess and communicate their monetary policy actions (Barakchian & Crowe (2013)). Theoretical models by Ellingsen & Söderström (2001), Tang (2013), Mertens (2016), and Melosi (2017) further explore the information channel of monetary policy.

This paper further relates to the now extensive literature assessing the impact of high-frequency financial market surprises around key monetary policy announcements on asset prices using interest rate futures to identify the surprise component of monetary policy (Kuttner (2001), Cochrane & Piazzesi (2002), Faust, Rogers, Swanson & Wright (2003), Faust, Swanson & Wright (2004), Bernanke & Kuttner (2005), Gürkaynak, Sack & Swanson (2005*a*), Gürkaynak et al. (2005*b*), Stock & Watson (2012), Gertler & Karadi (2015), Campbell, Fisher, Justiniano & Melosi (2017), Nakamura & Steinsson (2018), Paul (2020)). Most of these studies use vector autoregression (VAR) frameworks to examine effects on a variety of variables at different frequencies. Similar to classic approaches (Bernanke & Blinder (1992), Christiano, Eichenbaum & Evans (1996)), this literature assesses the causal impact of policies by identifying unexpected variations in monetary policy.

However, policy announcements come systematically with central bank communication about the economic outlook – if communication moves private sector expectations about the macroeconomy and interest rates, it can bias the estimated effects of monetary policy. This paper contributes a simple framework reflecting the expectation adjustment process and patterns in trading volumes on interest rate futures markets using high-frequency data to classify motives and map them onto monetary surprises. As the proposed motive classification strategy builds on sign restriction focusing on the interest rate futures and stock market, this paper directly relates to the work of Cieslak & Schrimpf (2019), Jarociński & Karadi (2020), Andrade & Ferroni (2021), and Lewis (2023) with the difference that the proposed motive classification strategy in this paper does not rely on the use of a VAR framework. A different but somewhat related method is proposed by Miranda-Agrippino & Ricco (2021), where the authors project high-frequency surprises onto observable measures of central bank information to isolate pure monetary policy shocks. Only very recently, Nunes, Ozdagli & Tang (2023) proposed a method using a VAR framework that extends the analysis to interest rate changes on days of

macroeconomic data releases (e.g., non-monetary policy announcement dates) to identify the impact of information shocks while distilling pure policy shocks from interest rate surprises around policy announcements.
Nevertheless, whether a central bank information effect truly exists is still being debated in the literature. Bauer & Swanson (2023*a*), for example, argues that the source of monetary policy surprises might not always be exogenous but may also emerge from incomplete information about the central bank's monetary policy rule. As a result, monetary policy surprises can be correlated with economic variables prior to the policy announcement.[3]

The remainder of this paper proceeds as follows: Section 2 describes the common high-frequency shock identification strategy to obtain monetary surprises. Section 3 presents the idea behind motive classification and introduces the *TMSR*. Section 4 analyses the immediate and persistent effects of pure monetary policy and central bank information surprises on various asset prices. Section 5 concludes.

2 High-frequency shock identification

I focus on 114 monetary policy announcements from 2000 to March 2024. From 2000 to June 2019, the Swiss National Bank (SNB) targeted the CHF 3M LIBOR range. In June 2019, the SNB introduced the SNB policy rate and the SARON as its new operational target. The SNB holds quarterly monetary policy meetings where policy decisions are communicated to the broader public through press releases. In such press releases, the decision on the monetary policy stance and a brief assessment of the economic outlook are provided.[4] However, if monetary policy actions need to be taken outside regular meetings, the SNB can intervene without pre-announcements. Notable examples of such irregular policy decisions mark the irregular policy decisions on 8 October, 6 November and 20 November 2008, where the SNB took actions against the unfolding of the *Great Financial Crisis (GFC)*.[5] The list of irregular policy decisions also include the introduction of the minimum exchange rate at CHF 1.20 per euro on 6 September 2011 (a week before the regular MPA), the introduction of negative interest rates on 18 December 2014 (a week after the regular MPA), and the discontinuation of the minimum exchange rate and simultaneous rate cut to historical lows of -0.75% on 15 January 2015. Both types of monetary policy decisions (regular and irregular) are included in the sample.[6]
I identify monetary surprises using the classical event-study type high-frequency identification framework (Kuttner (2001), Gürkaynak et al. (2005*a*), Gertler & Karadi (2015), Nakamura & Steinsson (2018)). Thereby, the impact of monetary policy news is isolated by measuring changes in interest rate futures prices within a short window (typically 30 minutes) around monetary policy announcements. This is because the market price of such interest rate futures reflects the expectations of market participants about the

[3]In this context, the authors call this the *"response to news"* channel. A precondition for this channel is the systematic underestimation of the strength of central banks' reaction to economic news by the public. Also see Bauer & Swanson (2023*b*).

[4]Press releases are typically released at 09:30 CET and are followed by a press conference, taking place 30 minutes after the release of the announcements. For regular announcements, timetables are released in advance on the official website of the SNB.

[5]In those irregular policy announcements, the SNB eased conditions in the money market by lowering the target range (symmetrically) by 200 basis points in total over all those three announcements (-50, -50 and -100 bps).

[6]Of the 114 monetary policy announcements, 97 are regular and 17 are irregular.

level of the contract's underlying reference rate. Therefore, any market price change reveals market participants' expectation adjustment behaviour such that the price changes around MPAs represent the surprise component of monetary policy (Kuttner (2001)). Consequently, positive (negative) values indicate contractionary (expansionary) surprises in the sense that a higher (lower) than expected policy rate was set by the central bank. Therefore, such measures are considered exogenous because these surprises are, by construction, unanticipated and therefore orthogonal to the information set of financial market participants.[7] Retrieving market expectations about the policy rate from interest rate futures contracts has become the standard method to obtain an exogenous measure of the monetary policy shock. This measure is typically referred to as *monetary surprise*.

For the high-frequency interest rate futures data I follow Koeniger et al. (2022) and use tick data for the CHF 3M LIBOR futures and SARON futures contract (both continuous contracts) obtained from *TickDataMarket*.[8] However, unlike these authors, who focused on daily changes, I use the standard approach and consider a time window of 30 minutes, starting 10 minutes before and ending 20 minutes after the monetary policy announcement.

For each MPA date, I calculate the surprise in market expectation as the change of the first and last available one-minute interval *volume weighted average implied rate (VWAIR)* within the 30-minute window,[9]

$$MonetarySurprise_t = \Delta \text{VWAIR}_t^{1min} = \text{VWAIR}_{t,\text{last}}^{1min} - \text{VWAIR}_{t,\text{first}}^{1min}$$

$$\text{VWAIR}_{t,j}^{1min} = \frac{\sum_{i=1}^{N_j} \left(\text{Price}_{i,j}^{1min} \cdot \text{Volume}_{i,j}^{1min} \right)}{\sum_{i=1}^{N_j} \text{Volume}_{i,j}^{1min}} \qquad (1)$$

where t refers the respective MPA date, $j \in \{\text{first}, \text{last}\}$, i marks the respective trades falling in the respective bucket and N_j is the total number of trades within the respective one-minute interval.[10] The bars in Figure 1 correspond to the resulting monetary surprises.

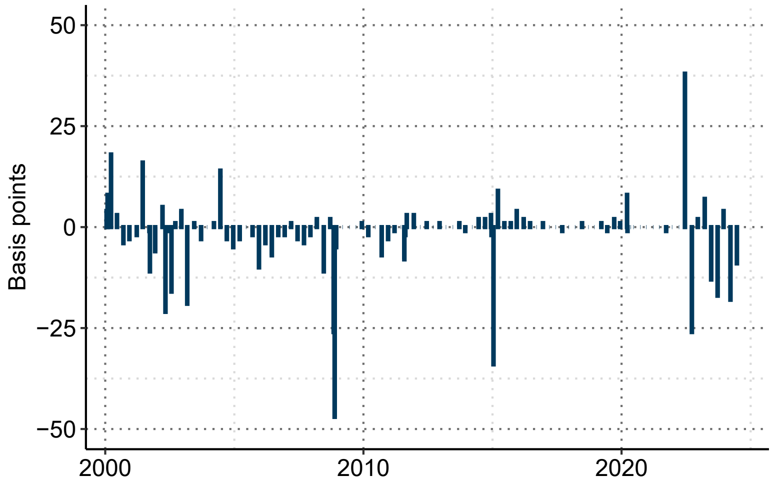
[7] Additionally, one does not need to impose further identifying restrictions to disentangle the exogenous from endogenous components of monetary policy.

[8] The continuous contract rollovers are built with the *volume rule* ensuring that the most actively traded (most liquid) contract is always used. This approach avoids the problem of declining liquidity as a futures contract nears its expiration date, which could lead to distorted price movements and volatility. The CHF LIBOR futures were, and the SARON futures are traded on an electronic and anonymous trading platform provided by the Intercontinental Exchange (ICE). The CHF LIBOR futures were, and the SARON futures are open for trading until two business days prior to their settlement days, the so-called *International Monetary Market (IMM)* dates (Fuhrer, Guggenheim & Jüttner (2018)). The IMM dates refer to the third Wednesday of March, June, September and December.

[9] The CHF LIBOR futures and SARON futures are based on a CHF one million notional, which allows the trading volume to be directly inferred from the number of contracts traded. I, therefore, use these terms interchangeably in this paper.

[10] For robustness, I also perform the calculations for 30-second and 10-second intervals; the results are consistent.

Figure 1: Monetary Surprise Series



Notes: The monetary surprise series is constructed using CHF 3M LIBOR futures and SARON futures high-frequency data obtained from *TickDataMarket*. Positive values indicate higher policy rates than expected (i.e., contractionary shocks); negative values indicate lower policy rates than expected (i.e., expansionary shocks).

The obtained monetary surprise series resembles other series provided in the literature.[11] While for 25% of announcement days, market participants' expectations matched the policy decision by the SNB (a monetary surprise of zero), they were surprised in 75% of all MPAs in the sample.[12]

The obtained series, therefore, shows that market participants have been strongly surprised on numerous occasions such that market expectations have been adjusted, highlighting the fact that the series provides relevant exogenous variation.

3 Classifying motives: pure monetary policy versus central bank information surprises

In this section, I apply the idea of classifying monetary surprises based on the comovement of the interest rate futures and stock market to pure monetary policy (*theory prediction*) and central bank information (*"wrong-signed"*) motives, as suggested in Jarociński & Karadi (2020), to the Swiss case. I show that the author's simple and now commonly used motive classification strategy called *Poor Man's Sign Restriction (PMSR)* may be prone to misclassification.[13] To overcome this issue and to propose a

[11] I thank the authors in Nitschka & Ramelet (2023) for providing me with their surprise series. The surprise series presented in this paper shows a correlation coefficient of +0.95 to the series provided by these authors, who used Bloomberg data on daily changes of futures contracts (quarter ahead) rather than changes within a 30-minute window around MPAs to calculate the surprises. Differences in surprise size compared to the series presented in this paper indicate that movements in rates sustained (decayed) outside the 30-minute window lead to more (less) pronounced surprise sizes.

[12] Noteworthy examples of instances where market participants have been strongly surprised are the irregular announcements of 6 November 2008 (-26 bps), 20 November 2008 (-47 bps), 15 January 2015 (-34 bps), and the regular announcements of 16 June 2022 (+38 bps) and 22 September 2022 (-26 bps).

[13] The authors propose this method as an alternative to their VAR framework as it produces similar impulse responses.

refined alternative, I introduce a novel high-frequency strategy to classify motives, the *Trading Markov Sign Restriction (TMSR)*. This strategy considers dynamics in trading and expectation adjustments behaviour of market participants within a 30-minute time window around policy announcements.

A few preliminary remarks regarding *"wrong-signed"* stock market responses on monetary policy announcement days. Foremost, this phenomenon is observable for many advanced economies, and by now, the literature focusing on the US and the Euro Area has evolved, with evidence of a considerable share of such responses (Jarociński & Karadi (2020), Andrade & Ferroni (2021)). Furthermore, two explanations of such stock market responses on announcement days are presented in such studies. First, as a well-studied fact, stock markets are volatile; one could, therefore, argue that the observed stock market responses are due to random noise. Second, one could attribute them to some surprise that occurs systematically at the time of the monetary policy announcements of central banks, but that is different from standard monetary policy surprises. The latter motivates the exercise to classify motives and map them onto monetary surprises.

Two assumptions must be made to classify pure monetary policy and central bank information motives with the *PMSR* and *TMSR*. First, over the window of interest on announcement days, the monetary surprise is affected by no other shocks than the two motive shocks (negative and positive co-movement shocks). For narrow time windows (e.g., 30 minutes), this assumption is justified for interest rate futures and arguably also for stock markets. However, while for daily windows, SNB announcements might indeed be the only significant domestic economic event, foreign economic events might contaminate the motive classification – arguably to a lesser extent domestically focused interest rate futures markets, but rather stock markets, which have a considerably broader and international market base.[14] Second, by the sign restrictions, two motives are separated by orthogonality so that a negative (positive) co-movement shock is associated with an increase in interest rates and a decrease (increase) in stock prices. The asset pricing theory motivates the negative co-movement shock: a monetary tightening generates a contraction, reducing the expected value of future dividends. Furthermore, the higher interest rate raises the discount rate for discounting dividends. This results in stock prices, as the present discounted value of future dividends, to decrease. Therefore, one may argue that shocks causing adverse movements are consistent with news being revealed about and interpreted, to a first order approximation, as *"pure"* monetary policy surprises.[15] On the other hand, positive co-movements must reflect something in the central bank's announcement that is not news about monetary policy, such that such shocks can be defined, to a first order approximation, as central bank information surprises. For the remainder of this paper, I adopt the terms used to describe the negative and positive co-movement shocks from Jarociński & Karadi (2020).

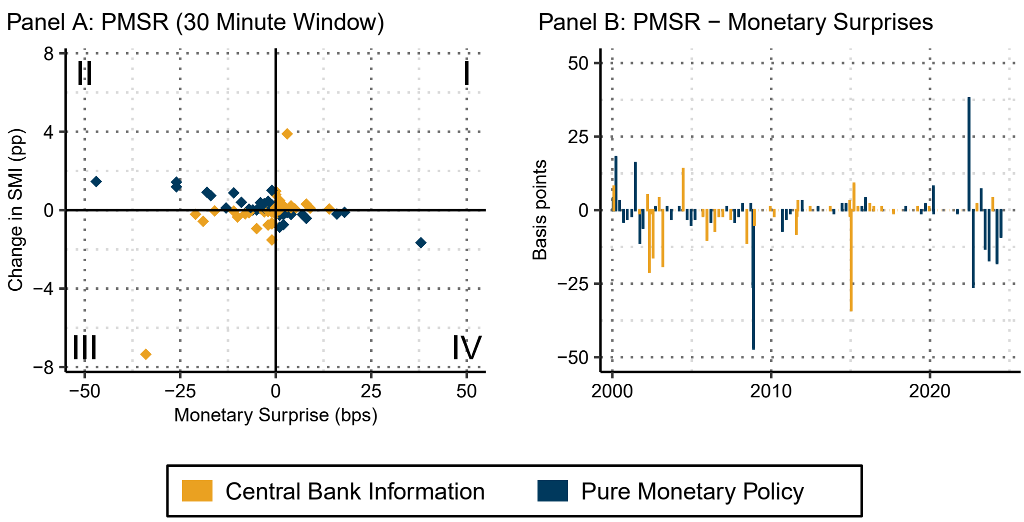
[14]While stock markets have diverse investor types (domestic, foreign, retail, institutional), interest rate futures markets usually have a strong professional and institutional focus (institutional investors, hedgers, speculators) (Bessembinder & Seguin (1992)). In general, interest rate futures are used to hedge interest rate risk or to speculate on future interest rates (Veyrassat (2004)). This makes them highly sensitive to monetary policy.

[15]The authors in Jarociński & Karadi (2020) use the term *"Pure"* in pure monetary policy to describe the fact that the co-movement matches the theory predicted sign.

3.1 Poor Man's Sign Restriction (PMSR)

The idea is simple – a surprise tightening in monetary policy increases interest rates and decreases stock prices. In contrast, a surprise about the central bank's positive assessment of the economy does not decrease but increases stock prices. Therefore, according to the *PMSR*, one can compare the sign of the monetary surprise and the sign of change in the stock market on days of policy announcements.[16] If the resulting signs do not match (*theory prediction*), a pure monetary policy motive is classified and assigned to the surprise; if the signs match (*"wrong-signed"*), a central bank information motive is classified and assigned to the surprise. This is typically illustrated in a scatterplot as shown in Panel A of Figure 2, where the MPAs with classified pure monetary policy motives are the ones falling into quadrants *II* and *IV* and the MPAs with classified central bank information motives are the ones falling into quadrants *I* and *III*. Panel B in Figure 2 then shows the resulting mapping of classified motives onto monetary surprises.

Figure 2: PMSR Motive Classification



Notes: Each diamond in Panel A represents an SNB monetary policy announcement. High-frequency data for the Swiss Market Index (SMI) and to construct the monetary surprise series based on the CHF 3M LIBOR and SARON futures data obtained from *TickDataMarket*. As for the monetary surprise series, changes in the SMI are analogously calculated based on one-minute interval *volume weighted average prices (VWAP)*.

A few observations regarding the *PMSR* motive classification of Swiss monetary surprises.

First, 55% of all non-zero monetary surprises are classified as exhibiting pure monetary policy motives and 45% are classified as exhibiting central bank information motives. This is slightly more as found for the Euro Area but less compared to the US (Jarociński &

[16] In the literature on sign restriction motive classification, common practise is to calculate the change using a 30-minute window (Jarociński & Karadi (2020), Amberg, Jansson, Klein & Picco (2022)). For Switzerland, (Grisse (2020)) used daily data on the CHF 3M LIBOR futures, where only shocks with a negative co-movement to the stock market, i.e., the pure monetary policy surprises, were used in the analysis.

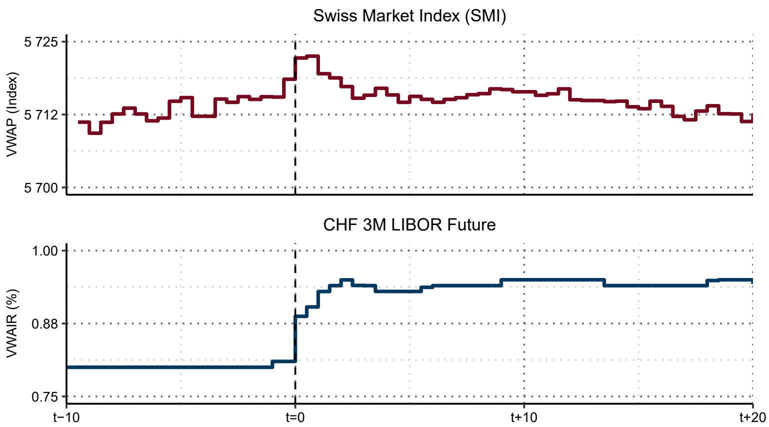
Karadi (2020)).[17]

Second, the largest and smaller monetary surprises ($\geq$ |20 bps| and $\leq$ |10 bps|, respectively) are predominantly classified to exhibit pure monetary policy motives, whereas the large monetary surprises ($>$ |10 bps| and $<$ |20 bps|) are rather equally distributed in terms of motives.

Third, there are some announcements with considerable movement simultaneously in stock prices and monetary surprises; however, there are many occasions with less variation, as suggested by the simple 30-minute window change terminology.

At this point, the question arises as to whether simple metrics, such as the change of a 30-minute window, are appropriate for classifying motives. Consider, for example, the regular policy announcement on 17 June 2004.[18] In that announcement, the SNB tightened its monetary policy, which surprised markets, as reflected by the +14 bps monetary surprise. The press release contained the following passage: *"Since the economic recovery has strengthened and the threat of deflation has disappeared, monetary policy will be slightly tightened."* (Swiss National Bank (2004)). Such passages reflect the primary motivation behind the motive classification literature as the SNB communicates not only its monetary policy stance but also its assessment of the economy – either of which may induce different reactions in the stock market. When considering the simple 30-minute window change of the SMI, it suggests that the reaction was +0.03%, thus indicating by the matching positive signs that the central bank information motive predominated. However, inspecting the high-frequency data visualised in Figure 3 reveals a different course in trading dynamics.

Figure 3: Trading Dynamics – 17 June 2004 Policy Announcement



Notes: The Y-axis shows the 30-second VWAIR and 30-second VWAP. The X-axis shows a 30-minute window, where *t=0* marks the release of the announcement and where 10-minute steps are marked from 10 minutes before (*t-10*) to 20 minutes after (*t+20*) the policy announcement.

[17] For the Euro Area, the sample spans from 1999 to 2016 and contains 280 ECB policy announcements, of which 50% are classified as exhibiting pure monetary policy motives. The US sample spans from 1990 to 2016, with 240 FOMC announcements, of which two-thirds are classified as exhibiting pure monetary policy motives. The Swiss result is interesting because, based on the *PMSR*, the policy announcements of the SNB seem to inherently contain information that influences stock market sentiment somewhat similar to that of the ECB's policy announcements.

[18] This example is to illustrate that markets have already, for a long time, reacted to central bank communication. Similar examples can be found throughout the sample; however, with a +14 bps monetary surprise, this example represents an example of a large monetary surprise.

The figure suggests that the policy announcement itself slightly increased stock prices (+0.06% instantaneously); however, directly after the announcement, trading dynamics took effect, causing the stock prices to move into the opposite direction, which was the most pronounced for approximately the first five minutes after the announcement (-0.13%). The trading dynamics remained in the same direction (decreasing) for the rest of the window (another -0.04%). Therefore, the sign of the simple 30-minute window was only positive because the SMI was increased (+0.13%) in the 10 minutes before the policy announcement. This trend was reversed by the policy announcement itself. The dynamics for the CHF 3M LIBOR future contracts were the opposite, i.e., the announcement increased the rates. However, the trading direction remained positively sloped throughout the rest of the 30-minute window. Therefore, the dynamics suggest a pure monetary policy motive, as trading moved in the opposite direction with the release of the policy announcement. This points to the fact that the *PMSR* might indeed be considered a poor motive classification strategy – including the 10-minute window before the policy announcement can distort the perception of trading dynamics and eventually lead to the misclassification of motives.

3.2 Trading Markov Sign Restriction (TMSR)

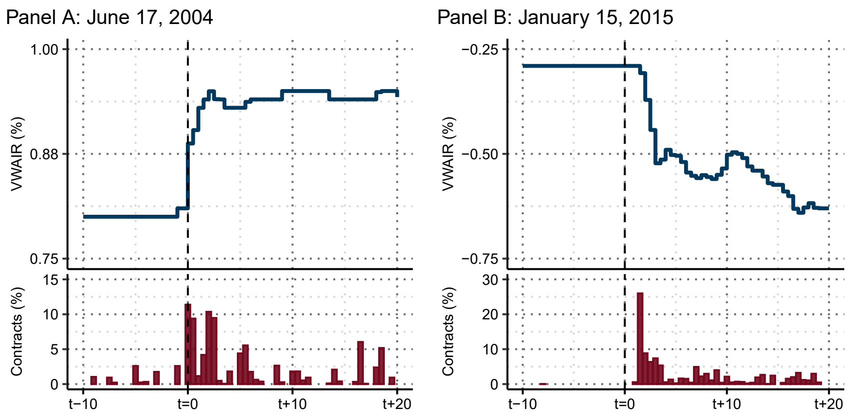
As the example of the regular policy announcement on 17 June 2004 illustrates, considering high-frequency dynamics when using the 30-minute window event study framework might reveal valuable information to classify motives on policy announcement days. I propose a simple high-frequency motive classification strategy that resolves the issue of the 10-minute pre-announcement window and explicitly considers the high-frequency dynamics in trading volumes and the direction, as well as the expectation adjustment intensities and patterns during the 30-minute window around policy meetings to classify motives – I call it the *Trading Markov Sign Restriction (TMSR)* strategy.

The *Trading* part is straightforward – for this strategy to explore high-frequency dynamics, one needs to have high-frequency trading data (e.g., ticks or seconds) on the variables of interest, which are the volume, price, and rate of interest rate futures and stock market indices. Considering the volume in addition to the price and rate not only allows for the calculation of the volume-weighted average prices or rates reflecting market sentiment but also allows for the analysis of an additional layer of trading dynamics, which is the intensity of expectation adjustment. For the latter, interest rate futures markets are a rich source of information, providing a direct real-time measure of expectation adjustment in response to policy announcements. The strong monetary policy focus and highly professional and institutional market participant movements in implied rates and volume on interest rate futures markets thereby represent ideal variables to study this matter (Cochrane & Piazzesi (2002)).[19] Figure 4 illustrates a common pattern of how the

[19] Alternatively, one could use stock market variables to study market participants' expectation adjustments. However, due to the diverse professionalism and investment motives among participants, this measure might arguably be noisier. In Appendix A.1, Panel A of Figure A.1 shows that the average volume of the CHF 3M LIBOR and SARON futures market significantly declined after the financial crisis. However, Panel B shows that extraordinarily high trading activity can occur on days with significant economic news releases, such as policy announcements (see the pink bars). Furthermore, on policy announcement days, Figure A.2 shows that, on average, a quarter of the total trading activity is conducted within the 30-minute window around the policy announcements. This highlights the fact that interest rate futures markets are sensitive to monetary policy announcements and present an ideal measure of expectation adjustment policy on policy announcement days (Kuttner (2001), Gürkaynak et al. (2005*a*),

expectation adjustment process is reflected in movements of implied rates and volumes traded at regular (Panel A) and irregular (Panel B) policy announcements.

Figure 4: Implied Rates and Volumes at Policy Announcements



Notes: For implied rate movement (blue), the 30-second VWAIR is shown, whereas the share of the total number of contracts (volume) traded within the 30-second bucket relative to the overall volume traded within the 30-minute window (red) is shown. The CHF 3M LIBOR futures and SARON futures are based on a CHF one million notional, high-frequency data obtained from *TickDataMarket*. The X-axis shows the 30-minute window, where *t=0* marks the release of the announcement and where 10-minute steps are marked from 10 minutes before (*t-10*) to 20 minutes after (*t+20*) the policy announcement. Panel A shows an example of a regular policy announcement, whereas Panel B shows an example of an irregular policy announcement.

There are a few noteworthy observations about the trading dynamics in interest rate futures markets on policy announcement dates, as shown in Figure 4.

First, policy announcements induce changes in implied rates (blue lines) and volume traded (red bars). With the policy announcement, new information is released, causing market participants to reposition and adjust their expectations, which eventually translates into changes in trading activity. This process prevails for the time period after the announcement, although the magnitude is reduced compared to the first few minutes after the announcement.

Second, the intensity of the expectation adjustment process, as represented by the share of total volume traded within the 30-minute window, is the highest in the first few minutes after the policy announcement. This significant increase in volume traded (red bars) coincides with the sharp rate adjustment (blue lines).[20] For the regular policy announcement on 17 June 2004, for example, around 50% of the 30-minute window volume was traded within the first five minutes after the announcement, while less than 10% and approximately 40% were traded in the 10 minutes before and 15 minutes after the announcement, respectively. For the irregular announcement on 15 January 2015, 60% of the 30-minute window volume was traded within the first five minutes after the announcement, while the remaining 40% was traded in the 15 minutes after the announcement.

Bernanke & Kuttner (2005), Andersen, Bollerslev, Diebold & Vega (2007)).

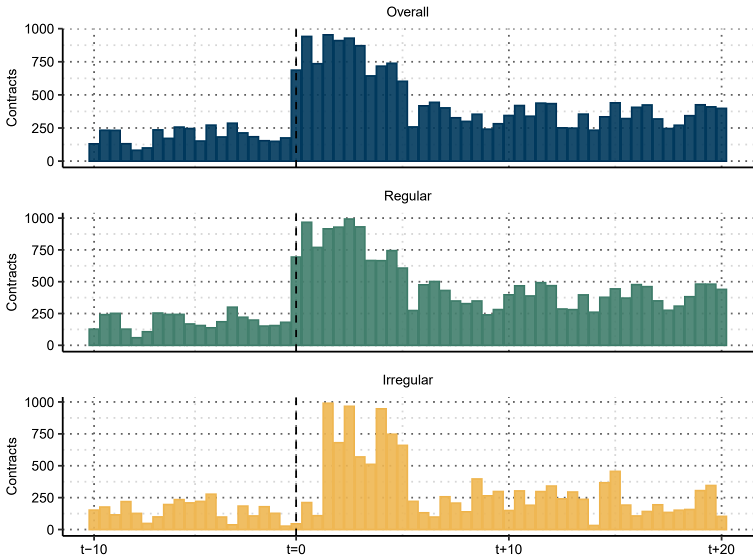
[20] These coinciding sharp rate movements and pronounced increased volume traded patterns are observable for non-zero monetary surprises throughout the sample.

Third, for irregular (i.e., non-pre-announced) policy announcements, the expectation adjustment process sets in with a one-minute to one-and-a-half-minute delay, i.e., markets have been shocked and need some time to react.[21]

Therefore, variations in rates and especially in volumes reflect high-frequency dynamics in the expectation adjustment process of market participants in response to monetary policy announcements.

The *Markov* part identifies the systematic expectation adjustment phases – As high-frequency data reveals how market participants adjust expectations within the 30-minute window around policy announcements, the question arises as to whether there are systematic intensity phases in the adjustment processes. To study this, I divide trading volumes within the 30-minute windows into 30-second buckets and inspect bucket volatilities. The volatility patterns provide valuable insights into market participants' behaviour and sentiment, eventually capturing changes in dynamics in expectation adjustment during policy announcements. Figure 5 plots the bucket volatilities on policy announcements for each type of announcement separately.

Figure 5: Expectation Adjustment Behaviour around Policy Announcements



Notes: The 30-second bucket volatility around policy announcements. The CHF 3M LIBOR futures and SARON futures are based on a CHF one million notional, high-frequency data obtained from *TickDataMarket*. The X-axis shows a 30-minute window, where *t=0* marks the release of the announcement and where 10-minute steps are marked from 10 minutes before (*t-10*) to 20 minutes after (*t+20*) the policy announcement.

Figure 5 shows that the observations for the different types of announcements in Figure 4 reflect a more systematic pattern. Overall, the expectation adjustment behaviour is low in the 10 minutes before the announcement. Then, with the announcement, it abruptly transitions into high-intensity expectation adjustment behaviour, which persists

[21] See Fleming & Remolona (1999) and Balduzzi, Elton & Green (2001) for early studies identifying such time-delays on policy announcements days in US treasury and bond markets. The authors documented that such delays typically occur for large trades as they go through a "work-up" stage in which traders mediate the trading ticket size. With irregular policy announcements, this stage can be prolonged, as traders cannot simply calibrate their reaction function to pre-defined policy scenarios (which they can do so for regular announcements).

for five minutes, before decreasing again but still staying at an elevated level compared to the pre-announcement window for the remaining 15 minutes. The same is observed for regular announcements. For irregular announcements, the same patterns are observed for the 10 minutes before the announcement and the last 15 minutes of the 30-minute window. However, market participants need up to one-and-a-half minutes to adjust their expectations after an irregular policy announcement.[22]

However, it further needs to be clarified whether there are indeed three systematic phases of adjustment process intensity and, if so, at which point phase transitions occur. As Figure 5 suggests that phase transitions happen relatively quickly, I use the basic *Markov switching model (MSM)* without lags (Engel & Hamilton (1990)) to test this. This model allows for changes in the underlying data-generating process based on state variables, which follow a Markov process, i.e.,

$$Y_t = \mu_{S_t} + \sigma_{S_t}\epsilon_t \tag{2}$$

where Y_t denotes the observed variable (e.g., the 30-second bucket volatility of the trading volume) and S_t denotes the state at time t, which can take values of $\{1, 2, ..., X\}$, where X refers to the number of states to which the model will be calibrated and $\epsilon_t \sim \mathcal{N}(0, 1)$.[23]

To test for the appropriate number of states, I calibrate the first order *MSM* separately on two to five states for each type of policy announcement and use common information criterion (IC) for model selection, which is shown in Table 1.

Table 1: Markov Switching Model - Number of Regimes Selected by the ICs

	Overall			**Regular**			**Irregular**		
	AIC	BIC	LogLik	AIC	BIC	LogLik	AIC	BIC	LogLik
k=2	69.06	81.31	-32.53	80.66	92.90	-38.33	126.12	138.36	-61.06
k=3	52.82	71.18	-23.41	67.69	86.05	-30.84	104.12	128.61	-48.06
k=4	61.08	85.56	-26.54	70.78	95.26	-31.39	117.08	135.44	-55.54
k=5	59.86	90.47	-24.93	77.37	107.97	-33.68	100.83	131.43	-45.41

Notes: The columns refer to the ICs, and the rows refer to the number of states the *MSM* is calibrated with.

[22] Whereas for regular policy announcements, the trading activity in the ten minutes before the announcement reflect some last betting behaviour, for irregular announcements, this might reflect random noise.

[23] Specifically, the state S_t follows a first-order Markov process with transition probabilities $P(S_t = j|S_{t-1} = i) = p_{ij}$, where p_{ij} is the probability of transitioning from state i to j and $\sum_j p_{ij} = 1$. The observed variable Y_t is modelled conditionally on state S_t as $Y_t|S_t = i \sim f_i(Y_t; \theta_i)$, where f_i refers to the distribution of Y_t in state i with parameters θ_i. The likelihood function of the observed data can then be written as the sum over all possible sequences of states, i.e., $L(\theta, P \mid Y) = \sum_S P(S_1) f_{S_1}(Y_1; \theta_{S_1}) \prod_{t=2}^{T} p_{S_{t-1}S_t} f_{S_t}(Y_t; \theta_{S_t})$, where $P(S_1)$ is the initial state distribution, and the sum is taken over all possible state sequences. The state-specific parameters θ_i and the transition probabilities p_{ij} can then be estimated using maximum likelihood estimation. I model the 30-second bucket volatilities of the trading volume with an intercept only, implying that within each state, the volume is assumed to follow a normal distribution with a state-specific mean and variance, i.e., $Y_t|S_t = i \sim \mathcal{N}(\mu_i, \sigma_i^2)$ and $\theta_i = (\mu_i; \sigma_i^2)$.

The results suggest that, indeed, a three-state model should be selected. Next, I estimate the three-state no-lag *MSM* and obtain the state-dependent parameters that capture the distinct statistical properties of the underlying process when in a certain regime. Table 2 shows the results.

Table 2: Markov Switching Model - Estimation Results

	Overall	Regular	Irregular
Phase 1	188.0***	183.9***	107.9***
	(13.1)	(13.7)	(11.6)
Phase 2	792.9***	808.9***	674.4***
	(37.3)	(41.1)	(49.4)
Phase 3	346.7***	383.9***	194.2***
	(12.7)	(15.1)	(11.1)
Observations	60	60	60

Notes: Model results showing the mean trading volume volatility levels per identified phase based on 30-second bucket volatilities within 30-minute windows around policy announcements. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. The number of announcements in the sample period is 114 overall, of which 97 are regular and 17 are irregular.

The results in Table 2 confirm the previous observations. Overall, expectation adjustment intensity is the lowest in *Phase 1*, followed by an almost four-fold abrupt increase in the intensity in *Phase 2*, which then decreases again in *Phase 3* but stays almost two-fold greater than that in the first phase. This systematic pattern is confirmed for regular and irregular announcements.

Finally, to find the points in time that indicate regime switches, I use the smoothed and filtered probabilities from the model output to inspect the likelihood of the system being in a particular state at a particular time.[24] I define a regime switch to occur when the smoothed and filtered probability of being in the next regime for the first and thereafter permanently exceeds the probability of remaining in the current regime.[25]

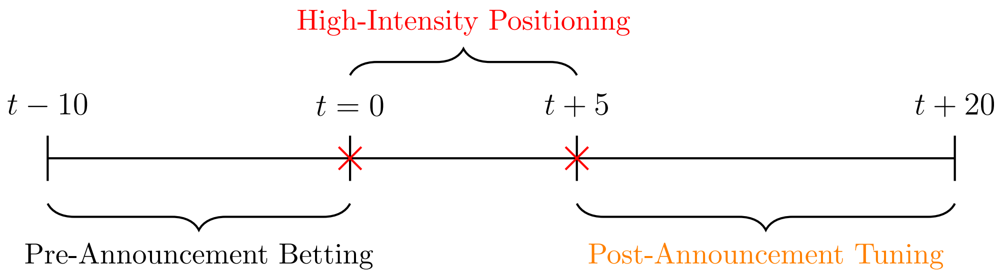
Based on 30-second bucket volatilities of trading volumes as a measure of the expectation adjustment intensity, I define the following systematic phases around policy announcements: *Phase 1*, the *pre-announcement betting phase*, which is the 10-minute pre-announcement window with hardly any rate movement and lowest volatility in the trading volume; *Phase 2*, the *high-intensity positioning phase*, which is the 5-minute post-announcement window, characterised by abrupt rates movements and the highest volatility in trading volume; and *Phase 3*, the *post-announcement tuning phase*, which is the last 15-minute window, characterised by some rates movement and considerable volatility in the trading volume.[26] Figure 6 summarises this in a schematic illustration.

[24]Filtered probabilities perform this conditional on the information up to specific points in time; smoothed probabilities use the information from all the data, i.e., from past and future observations.

[25]Appendix A.2 shows the transition probabilities of the *MSM*.

[26]I use the term *betting* to stress that contrary to the post-announcement phase, the trading in the first phase has a speculative nature.

Figure 6: Systematic Expectation Adjustment Phases around Policy Announcements



Notes: The red crosses correspond to the points of transition to the next phase, identified as the point in time where the subsequent phase's smoothed probability exceeds the preceding phase's smoothed probability. The smoothed probabilities are estimated by the *MSM*. The X-axis shows a 30-minute window, where *t=0* marks the release of the announcement.

The identified systematic expectation adjustment phases are then used for every policy announcement for the following purposes.

First, I construct a measure reflecting the phase-specific expectation adjustment intensities, which I call the *trading Markov (TM) weights*, $w^{TM}_{i,t}$. This measure is designed to reflect changes in the trading intensity induced by the policy announcement, while ignoring the dynamics during the pre-announcement phase when the central bank remains silent. To achieve this, a zero restriction is imposed on the phases before the policy announcement, whereas the phases thereafter can take non-zero values. Additionally, the *TM weights* consider the unequal durations of the systematic expectation adjustment phases, as previously identified for the SNB's policy announcements. Ignoring these would cause a skewed measure in the case of unequal phase durations. To address this, a normalisation by phase duration is conducted to ensure comparability as the measure is expressed in time units (e.g., per minute). This normalisation is applied to variables that can be considered a proxy of trading activity and expectation adjustment intensity. While movements in rates answer the question of to what level the expectations have shifted, changes in the trading volumes show how intensively market participants have engaged in repositioning their trades and, thereby, their expectations. The latter is, therefore, used as the variable of choice. The *TM weights* can be considered phase-duration-adjusted volume weights that measure the trading intensity, which are expressed as volume per minute and normalised across phases i as follows:

$$w^{TM}_{i,t} = \begin{cases} 0, & \text{if } i = 1, \\ \dfrac{\sum_{t' \in \{t' | S_{t'} = i\}} V_{t'}}{\text{Duration}_{i,t} \cdot \sum_{i=2}^{3} \frac{\sum_{t' \in \{t' | S_y, f\}} V_{t'}}{\text{Duration}_{i,t}}}, & \text{if } i > 1. \end{cases} \tag{3}$$

where $w^{TM}_{i,t}$ is the *TM weight* for phase $i \in \{1, 2, 3\}$ at policy announcement t. This weight takes the value of zero if the respective phase corresponds to the pre-announcement phase ($i = 1$) and otherwise represents the phase-duration-adjusted volume weight. Specifically, $\sum_{t' \in \{t' | S_{t'} = i\}} V_{t'}$ is the total trading volume (sum over ticks t') in phase i and $\text{Duration}_{i,t}$ is the duration of phase i in minutes (five minutes for $i = 2$, 15 minutes for $i = 3$). Finally, the denominator normalizes the duration-adjusted volume of phase i by the total duration-adjusted volume across the considered phases. This normalisation ensures that the weights sum to one across $i = 2$ and $i = 3$, while excluding the pre-announcement phase ($i = 1$) in which the central bank remains silent.

Second, I compare the trading directions on the interest rate futures and the stock market to perform phase-specific sign-restriction; this is the last part of the *TMSR*.

The *Sign Restriction* part does what it promises – In addition to trading volume volatilities, considering movements in rates and prices, the discussion regarding the motive identification of the policy announcement on 17 June 2004 showed that trading dynamics within the 30-minute window matter. The *TMSR* accounts for this by separately considering the expectation adjustment phases identified by the *Markov* part to perform classification by sign restriction based on the trading directions. To evaluate the trading directions per identified expectation adjustment phase, I run simple time trend regressions in the spirit of Hamilton (1994) and Tsay (2005)

$$y_{i,t} = \alpha_i + \beta_i t + \epsilon_{i,t} \quad \text{for} \quad t' \in \{t' \mid S_{t'} = i\} \tag{4}$$

where $y_{i,t} \in \{r_{i,t}, p_{i,t}\}$, i.e., the implied rate from interest rate futures or the stock market price, α_i is the phase-specific intercept, β_i the phase-specific slope (i.e., the time trend) and $\epsilon_{i,t}$ is the phase-specific error term. As the sign of the phase-specific slope coefficient β_i reflects the phase-specific trading direction of the respective markets, the sign restriction indicates that

$$SR_{i,t} = \begin{cases} \text{Pure monetary policy (PMP) motive} & \text{if } \beta_{r,i,t} \cdot \beta_{p,i,t} < 0 \\ \text{Central bank information (CBI) motive} & \text{if } \beta_{r,i,t} \cdot \beta_{p,i,t} > 0 \end{cases} \tag{5}$$

Revisiting the 17 June 2004 announcement visualised in Figure 3, during the 10 minutes before the policy announcement, both markets traded in the same direction; thus, $SR_1 > 0$. However, with the policy announcement, this co-movement in the trading direction reversed, and the markets traded in different directions, indicating a predominating pure monetary policy motive, i.e., $SR_2, SR_3 < 0$. Therefore, the latter two sign restrictions carry the relevant information reflecting the market reaction in response to the policy announcement, while SR_1 does not represent any such behaviour. Furthermore, although they contain relevant information, these phase-specific sign restrictions per se do not reflect how intensively market participants engaged in expectation adjustment behaviour.

This is where the *TM* weights $w^{TM}_{i,t}$ from the *Markov* part come into play. By the zero restriction ($w^{TM}_{1,t} = 0$), only the phases reflecting the changes in the expectation adjustment intensities induced by the policy announcement itself are considered. By multiplying the respective *TM* weights by designated vectors reflecting the phase-specific sign restrictions obtained via the classification of the central bank information and pure monetary policy motives, the overall weights can be constructed as follows:

$$\begin{aligned} W_{\text{PMP},t} &= \sum_{i=1}^{3} w^{TM}_{i,t} \cdot \mathbf{1}_{\{SR_{i,t}=\text{PMP}\}} \\ W_{\text{CBI},t} &= \sum_{i=1}^{3} w^{TM}_{i,t} \cdot \mathbf{1}_{\{SR_{i,t}=\text{CBI}\}} \end{aligned} \tag{6}$$

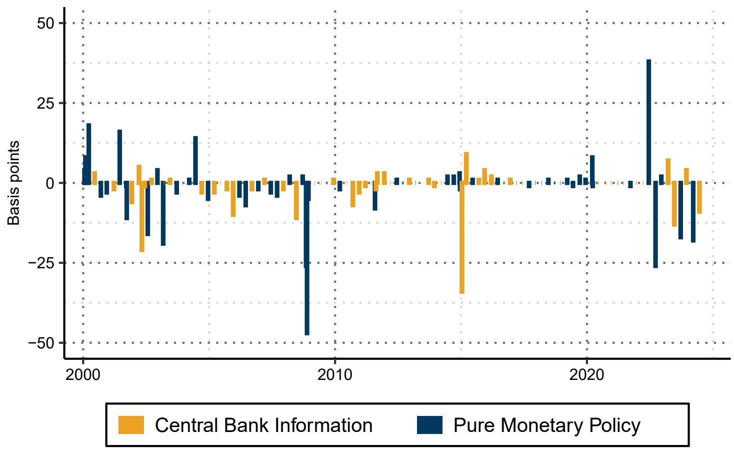
where $\mathbf{1}_{\{SR_{i,t}=\text{PMP}\}}$ and $\mathbf{1}_{\{SR_{i,t}=\text{CBI}\}}$ are indicator functions that equal 1 if $SR_{i,t} = CBI$ and $SR_{i,t} = PMP$, respectively, and 0 otherwise.

The motive with the predominant share is then used to assign the overall motive tendency on policy announcement t, which essentially is the result of the *TMSR*:

$$\text{TMSR}_t = \begin{cases} \text{PMP} & \text{if } W_{\text{PMP},t} > W_{\text{CBI},t} \\ \text{CBI} & \text{if } W_{\text{CBI},t} > W_{\text{PMP},t} \end{cases} \tag{7}$$

Mapping the obtained motives to the monetary surprises produces the final result, which is visualised in Figure 7.[27]

Figure 7: TMSR – Monetary Policy Surprises



Notes: The monetary surprise series is constructed using the CHF 3M LIBOR futures and SARON futures high-frequency data obtained from *TickDataMarket*. Positive values indicate higher policy rates than expected (i.e., contractionary shocks); negative values indicate lower policy rates than expected (i.e., expansionary shocks).

Positively, the *TMSR* and *PMSR* agree on the motive classification of the six largest monetary surprises ($\geq |20$ bps$|$) in the sample and classify a pure monetary policy motive for 6 and 20 November 2008 and 16 June and 22 September 2022, whereas for 2 May 2002 and 15 January 2015, a central bank information motive is classified. However, unfortunately (arguably for the *PMSR*), the two methods disagree for 50% of all non-zero surprises.[28] In half of these cases, the *TMSR* assigns pure monetary policy motives to monetary surprises before the *GFC*. Among those are large monetary surprises ($> |10$ bps$|$ and $< |20$ bps$|$), such as the -19 bps, -16 bps and +14 bps monetary surprises of 6 March 2003 (irregular MPA), 26 July 2002 (irregular MPA) and 17 June 2004 (regular MPA), respectively. Interestingly, the opposite is true for the other half of such cases, which are smaller monetary surprises ($\leq |10$ bps$|$) where the *TMSR* assigns central bank information motives to the post-*GFC* period.

Overall, the *TMSR* classifies roughly 60% of non-zero monetary surprises as pure monetary policy motives, which is almost 10% more compared to the *PMSR* and of which rather larger pre-*GFC* surprises are affected. Therefore, using a truly high-frequency motive identification strategy exploiting dynamics in trading and expectation adjustments can be considered a refinement to standard approaches, increasing robustness and confidence about motive classification. In that sense, the *trading Markov ain't no poor man*.

[27] A summary of the steps to implement the *TMSR* is provided in Appendix A.3.

[28] There are 85 non-zero monetary surprises in the sample.

These results are used in the next section to study the effects of classified pure monetary policy and central bank information surprises on various asset prices.

4 Response of asset prices to surprises by motives

I proceed by estimating the immediate and persistent effects separately. I use daily data and divide the financial assets into three categories, namely, *Target rate & futures*, *Bond yields* and *Other assets*. The first category consists of the CHF 3M LIBOR and SARON as the relevant operational target rates and the implied rates from future contracts up to 24 months in the future. The second category consists of yields of Swiss government bonds with a maturity from 2 years to 30 years in the future. The third category consists of other noteworthy assets such as the $MSCI_{Switzerland}$ and the USD/CHF and EUR/CHF nominal exchange rates.[29]

4.1 Immediate effects

Table 3 reports the responses of daily changes in assets from all three categories to changes in overall, pure monetary policy and central bank information surprises on announcement days. Each column of Table 3 reports the coefficients from separate OLS regressions in the following form:

$$\Delta y_t = \alpha + \beta z_t + \epsilon_t \tag{8}$$

where Δy_t denotes the daily change of an asset's particular rate, yield or price at the policy announcement t, z_t denotes the type of monetary surprises by motive classification (no classification, pure monetary policy motive only and central bank information motive only), and ϵ_t is the regression residual.[30] The β coefficient of this regression measures the strength of the pass-through of the monetary surprises onto the financial asset of interest. For example, a coefficient with a value of 1 in absolute terms indicates that the monetary surprise is perfectly transmitted to the financial asset. Thus, a 25 bps monetary surprise translates into a 25 bps interest rate change of the financial asset on policy announcement days.

I run the regressions using two samples – one including the introduction and discontinuation of the minimum exchange rate to the euro (full sample) on 9 September 2011 and 15 January 2015, respectively, and one excluding these events (reduced sample).[31]

[29]The $MSCI_{Switzerland}$ measures the performance of 46 large to mid cap segment companies and therefore represents a broader stock market index than the SMI. The daily data are from Bloomberg. For the exchange rates, I use the *bilateral exchange rates dataset* (Bank for International Settlements (2024)). This dataset records the nominal value of one US dollar (USD) relative to a given currency and thus allows for the calculation of the nominal values of other currency pairs.

[30]For a related application, see Swanson (2021).

[31]Appendix A.4 shows the regression results of the *PMSR* motive classification.

Table 3: Immediate Effects of Monetary Surprises

		Full Sample			Reduced Sample		
		Overall	PMP	CBI	Overall	PMP	CBI
Target rate & futures							
	Target Rate	0.79***	0.77***	0.78***	0.79***	0.78***	0.84**
		(0.13)	(0.15)	(0.29)	(0.14)	(0.15)	(0.40)
	15M Futures	0.65***	0.66***	0.59***	0.66***	0.66***	0.57**
		(0.06)	(0.08)	(0.17)	(0.07)	(0.08)	(0.24)
	18M Futures	0.57***	0.58***	0.52***	0.57***	0.58***	0.49**
		(0.07)	(0.08)	(0.17)	(0.07)	(0.08)	(0.24)
	21M Futures	0.55***	0.56***	0.49***	0.55***	0.56***	0.45*
		(0.07)	(0.08)	(0.16)	(0.07)	(0.08)	(0.24)
	24M Futures	0.54***	0.56***	0.47***	0.55***	0.56***	0.43*
		(0.07)	(0.08)	(0.17)	(0.07)	(0.08)	(0.23)
Bond yields							
	2Y Gov. Bond	0.51***	0.49***	0.54***	0.51***	0.49***	0.58***
		(0.05)	(0.07)	(0.13)	(0.05)	(0.06)	(0.19)
	5Y Gov. Bond	0.28***	0.27***	0.29**	0.25***	0.27***	0.07
		(0.06)	(0.07)	(0.12)	(0.06)	(0.06)	(0.17)
	10Y Gov. Bond	0.17***	0.13**	0.30***	0.12**	0.13**	0.05
		(0.05)	(0.06)	(0.10)	(0.05)	(0.05)	(0.13)
	15Y Gov. Bond	0.12**	0.08	0.24**	0.06	0.08	-0.06
		(0.05)	(0.05)	(0.10)	(0.05)	(0.05)	(0.12)
	20Y Gov. Bond	0.07	0.03	0.18*	0.01	0.03	-0.14
		(0.05)	(0.06)	(0.10)	(0.05)	(0.05)	(0.12)
	30Y Gov. Bond	0.12**	0.10	0.19	0.07	0.10	-0.11
		(0.06)	(0.07)	(0.13)	(0.06)	(0.07)	(0.17)
Other assets							
	$\text{MSCI}_{Switzerland}$	0.04**	0.01	0.15***	0.01	0.01	0.02
		(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.05)
	USD/CHF	0.02	-0.04	0.21***	-0.03***	-0.04***	-0.03
		(0.02)	(0.02)	(0.04)	(0.01)	(0.01)	(0.03)
	EUR/CHF	0.03	-0.03	0.22***	-0.03***	-0.03***	-0.02
		(0.02)	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)

Notes: The coefficients of β from the regression $\Delta y_t = \alpha + \beta z_t + \epsilon_t$, where the entries within columns refer to the particular z_t used in the regression. The reduced sample excludes the surprises on 9 September 2011 and 15 January 2015. Robust standard errors in brackets. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. The number of announcements in the full and reduced sample is 114 and 112, respectively.

The estimated regression coefficients shown in Table 3 reveal that monetary surprises with different motive classifications significantly affect asset prices and yields on policy announcement days.

For the assets in the *Target rate & futures* category, all three types of monetary surprises exhibit the most pronounced effects at the shortest end (i.e., the target rate), monotonically decaying with longer maturities. This is true for both the full and reduced sample configurations. While for the surprises without motive classification (the column *'Overall'*), the results are in line with Koeniger et al. (2022), the point estimate on the target rate is strongest for central bank information surprises. However, for 15M to 24M futures, pure monetary policy surprises seem to exhibit somewhat of a stronger impact, as reflected by the respective point estimates.[32] However, as the standard errors of assets' point estimates in response to central bank information surprises are much larger than the difference in point estimates between pure monetary and central bank information surprises, this points to the fact that the effects are not statistically different.

For the *Bond yields* category, the results in the column *'Overall'* again point to monotonically decaying strengths of effects, as also found in Nitschka & Ramelet (2023). However, two aspects are worthy to be pointed out. First, in general, the effects on bond yields exhibit statistical significance for longer maturities ($>$ 10 years) only in the full sample, whereas for the reduced sample, this is only true for yields up to 10 years of maturity. Second, central bank information surprises have the most pronounced effects on Swiss government bonds with a maturity of two years. This might not be surprising as central bank information surprises represent instances where investors responded to policy announcements in a way that caused a *"wrong-signed"* reaction on the stock market, indicating that a news component (such as economic outlook) other than the policy stance predominated. If such an economic news component indeed predominated, this should also be visible in the bond markets.[33] However, as for the previous category, the standard errors of assets' point estimates in response to central bank information surprises exceed the difference in point estimates of the two surprise categories, reflecting the fact that the effects are not statistically different from each other.

However, the results of the *Other assets* category suggest notable insights. Using the full sample calibration, central bank information surprises seem to cause strong reactions in the stock market and the exchange rates. In detail, a +25 bps central bank information surprise translates into an increase of the $MSCI_{Switzerland}$ by 3.75%, whereas the Swiss franc depreciates against the US dollar by 5.25% and against the euro by 5.50%. However, when using the reduced sample calibration, the results suggest that rather pure monetary policy surprises have statistically significant but less pronounced effects on exchange rates only, while central bank information surprises do not. In detail, a +25 bps pure monetary policy surprise causes the Swiss franc to immediately appreciate against the US dollar by 1% and against the euro by 0.75%. This points to the fact that the type of information being revealed in the policy announcement indeed plays an important role and can lead to the different behaviour of stock prices and exchange rates (Gürkaynak, Kara, Kısacıkoğlu & Lee (2021)). However, these strong differences in effects being driven by the inclusion of the policy announcements of 9 September 2011 and 15 January 2015 indicate that these two events might distort the analysis of assets in this category when interested in the average effects of monetary surprises by classified motives. For the remainder of this paper, I therefore choose to focus on the reduced sample calibration.

[32] Specifically, a +25 bps pure monetary policy surprise translates on average to a +19.25 bps to +14 bps effect over the maturities for the full sample and to a +19.5 bps to +14 bps effect over the maturities for the reduced sample. On the other hand, a +25 bps central bank information surprise translates on average to a +19.5 bps to +11.75 bps effect over the maturities for the full sample and to a +21 bps to +10.75 bps effect over the maturities for the reduced sample.

[33] Balduzzi et al. (2001) showed that participants in government bond markets react strongly to new information (as also presented in the policy statements of central banks) about economic conditions. Government bonds are typically considered safer investments, attracting risk-averse investors such as pension funds and insurance companies.

4.2 Persistent effects

To assess the persistence of the effects of different types of monetary surprises, I estimate the local projection models proposed in Jordà (2005). To do so, I run a series of regressions at multiple horizons, indexed by h, of the following form:

$$\Delta y_{t+h} = \beta_h z_t + \epsilon_{t,h} \tag{9}$$

where t denotes the policy announcement date, $\Delta y_{t+h} = y_{t+h} - y_{t-1}$ represents the change in asset prices or yields between day $t+h$ and the day before the announcement and z_t is again the different types of monetary surprises. The coefficient β_h can then be plotted as a function of the horizon h to see whether the estimated effects diminish over time.[34] I compute robust standard errors and use the Holm (1979) step-down procedure to obtain appropriate refinements controlling for the *family-wise error rate (FWER)*.[35] Figures 8 to 10 report the results of the local projections for the three asset categories using the monetary surprises.[36]

Figure 8 reveals that pure monetary policy surprises persistently move interest rates of all regarded maturities from the *Target rate & futures* category. Although all interest rates immediately react on the policy announcement date, the effects build up until they reach the full effect after 70 working days. Furthermore, the light and dark areas, representing the 95% and 90% robust confidence intervals, indicate that these effects remain significant at the 5% level for the entire horizon for the target rate and for 100 working days for futures contracts. For central bank information surprises, the effects on futures contracts take approximately 60 days to exhibit statistically significant persistence. After 110 days, the full effect is reached, which is almost twice as high as the full effect of pure monetary policy surprises. However, the wide confidence intervals around the assets' point estimates in response to central bank information surprises indicate that these effects are not statistically different from the effects of pure monetary policy surprises.

For the *Bonds yields* category, Figure 9 shows that pure monetary policy surprises have a persistent effect on Swiss government bonds up to a maturity of five years. While the effects persist for the whole horizon for government bonds with a maturity of two years, the effect persists only for 85 working days for government bonds with a maturity of five years. Similar to the results of the previous category, for central bank information surprises, the effect on two-year government bonds takes approximately 60 days to exhibit statistically significant persistence; however, the full effect is reached just before 120 days with an order of magnitude that is 1.5 times the size of that of pure monetary policy surprises. Nevertheless, considering the confidence intervals, the assets' responses to pure monetary and central bank information surprises do not exhibit statistical differences.

Finally, Figure 10 shows that for assets in the *Other assets* category, the effect of pure monetary policy surprises on the exchange rates exhibits statistically significant persistence—the effect on the USD/CHF exchange rate exhibits persistence for the first 20 working days after the surprise, whereas the full effect is reached after 10 working

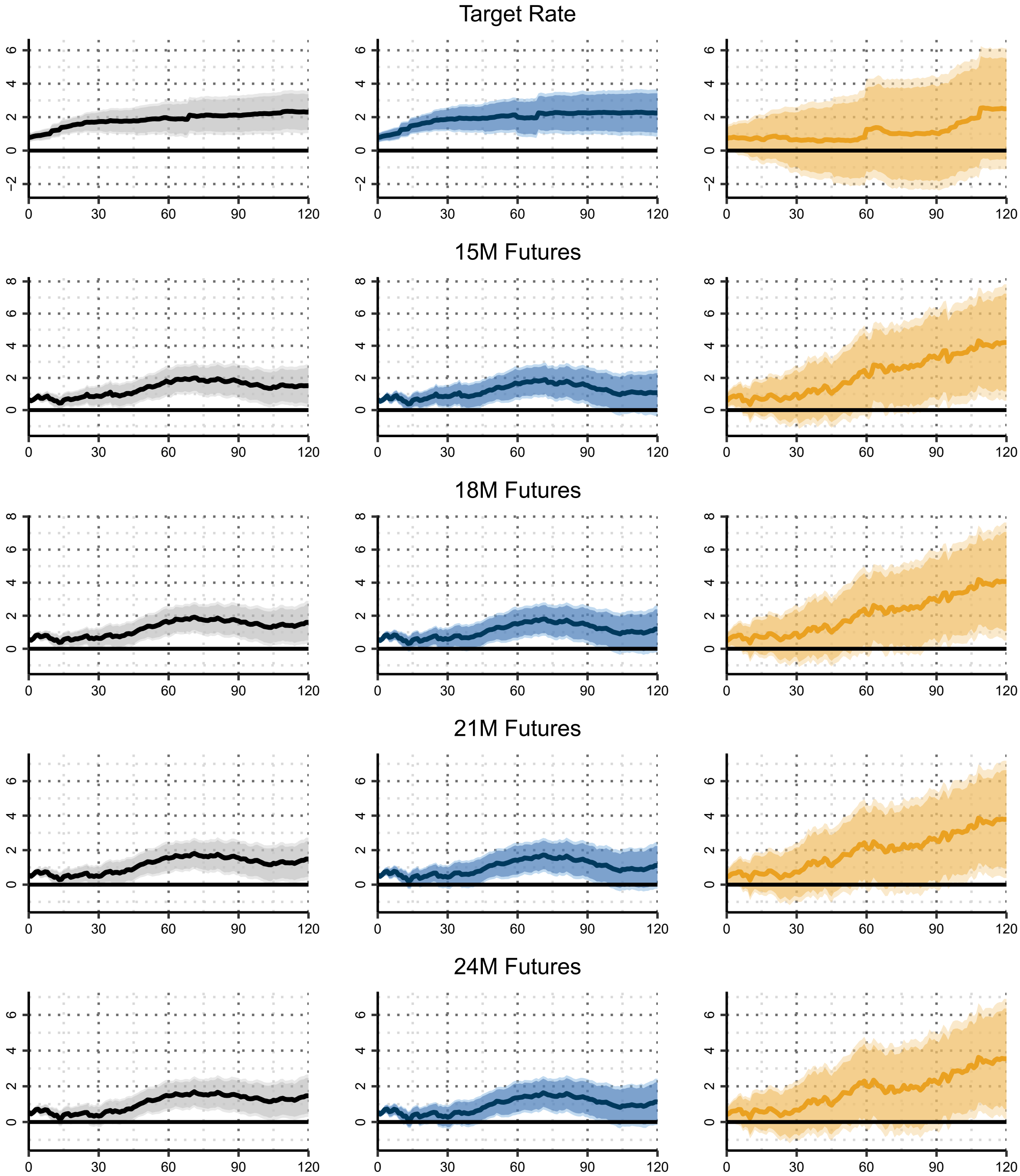
[34] See Swanson (2021) and Nitschka & Ramelet (2023) for related studies following the same local projection approach.

[35] Essentially, with this methodology, multiple hypothesis tests across different assets are performed, with each test assessing the effect of a specific shock variable. Therefore, in such a setting, the risk of α error is increased due to multiple comparisons. The *Holm correction* controls for this. For a related application, see Jordà & Marcellino (2010).

[36] Appendix A.5 provides the results using the full sample calibration. Additionally, Sections A.6-A.8 in the Appendix present the results using a literature extension to the monetary surprise terminology.

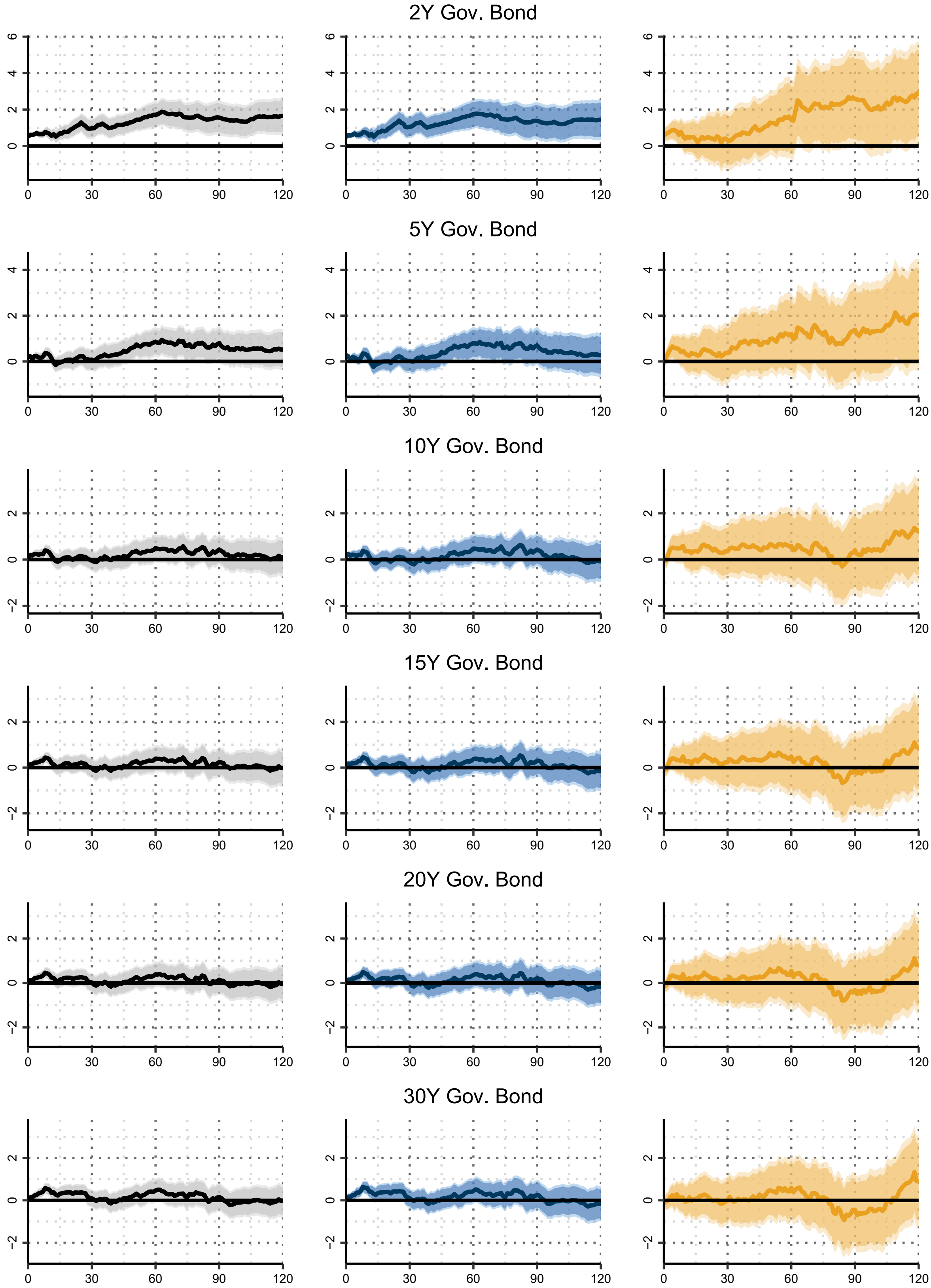
days – at this point, the Swiss franc appreciates 2.1% in response to an +25 bps pure monetary policy surprise. In contrast, the effect on the EUR/CHF exchange rate persists throughout the whole horizon and reaches its full effect after 89 working days – at this point, the Swiss franc appreciates 2.6% in response to a +25 bps pure monetary policy surprise. Central bank information surprises, on the other hand, do not persistently affect exchange rates. However, with a delay of 58 working days, the effect on the $MSCI_{Switzerland}$ exhibits statistical significance, reaching its full effect after 110 days.

Figure 8: Persistence of Effects - Target Rate & Futures



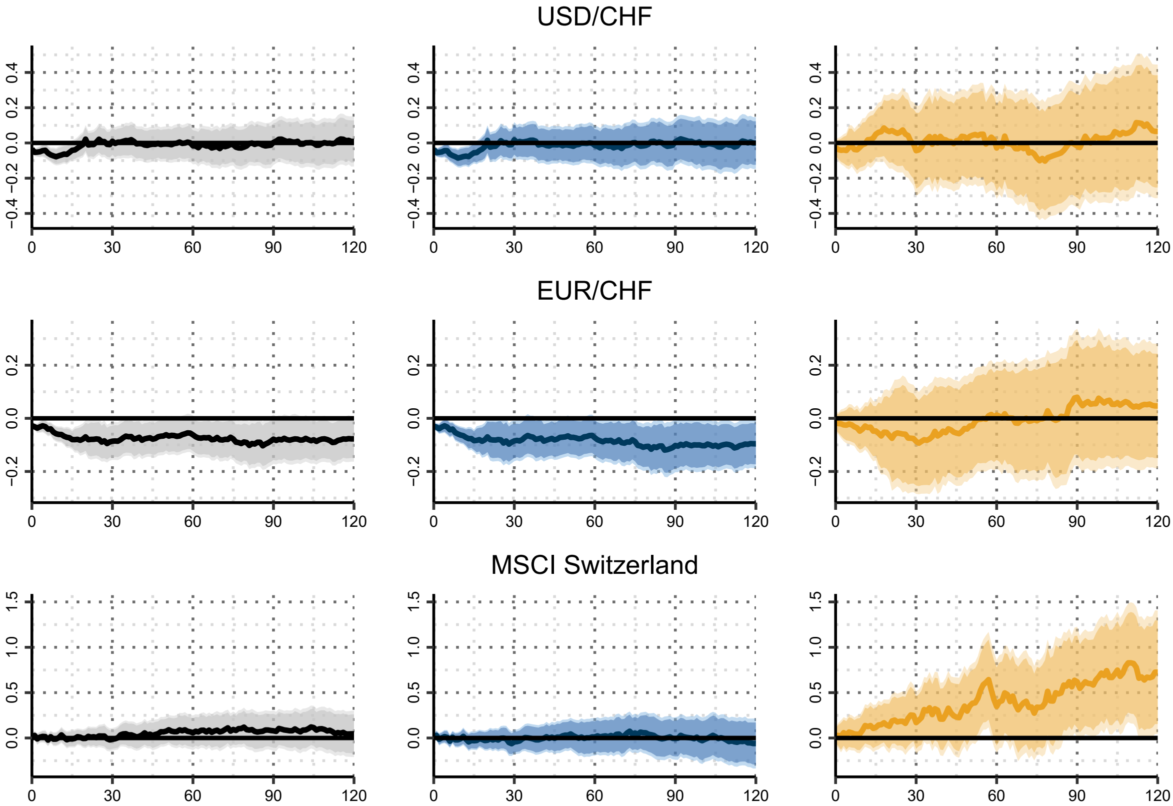
Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure 9: Persistence of Effects - Bond Yields



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure 10: Persistence of Effects - Other Assets



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

5 Conclusion

In this paper, I identify monetary surprises using high-frequency data on interest rate futures for the 30-minute window around monetary policy announcements. Furthermore, I show that simple motive classification strategies based on sign restriction of movements in interest rate futures and stock markets such as the *PMSR* can lead to the misclassification of motives. This is because a simple two-point change around a policy announcement fails to capture trading dynamics within the 30-minute window, which entails valuable information about the expectation adjustment behaviour of market participants in response to the release of the policy announcement.

With the *TMSR*, I propose a motive classification strategy that solves this issue by explicitly considering the high-frequency dynamics in trading and the intensity of the expectation adjustment behaviour on interest rate futures and stock markets. This strategy consists of several steps. First, using a *Markov switching model*, I show that for the SNB's monetary policy announcements, three systematic expectation adjustment phases can be observed: the *pre-announcement betting phase*, which is the 10-minute pre-announcement window characterised by hardly any rate movement and the lowest volatility in the trading volume; the *high-intensity positioning phase*, which is the 5-minute post announcement window characterised by abrupt rate movements and the highest volatility in the trading volume; and the *post-announcement tuning phase*, which is the last 15-minute window characterised by some rate movement and considerable but less pronounced volatility in the trading volume. Second, based on these identified systematic expectation adjustment windows, the trading directions of the interest rate futures and stock market index are used to classify motives by sign restriction. Third, the phase-specific sign restrictions are then multiplied by the phase-duration-adjusted trading volume weights, the *TM weights*, to reflect the different expectation adjustment intensities when determining the overall motive tendency; this is the result of the *TMSR*.

By mapping the classified motives to monetary surprises, I investigate the effects of pure monetary policy and central bank information surprises on various financial assets. The results reveal that pure monetary policy and central bank information surprises similarly affect the target rate, interest rate futures contracts and Swiss government bonds, whereas in the Swiss case, statistical differences in the effects are recorded only for the exchange rate and stock market responses.

For pure monetary policy and central bank information surprises, the target rate and futures contracts show similarly strong and immediate responses at the shorter end, with effects decreasing in size along maturity. The effects on futures contracts reach their peak after 70 working days and persist for up to 100 days. Pure monetary policy and central bank information surprises also have similarly pronounced and sustained impacts on Swiss government bonds, especially at the shorter end. The effects persist for the entire observation horizon for two-year Swiss government bonds, while five-year bonds maintain significant responses for approximately 85 working days. For the exchange rates, only pure monetary policy surprises show significant responses; in response to a +25 bps pure monetary policy surprise, the Swiss franc immediately appreciates by 1% and 0.75% and the effect persists for 15 working days and for the entire horizon against the US dollar and euro, respectively. For central bank information surprises, however, only the stock market's reaction exhibits statistical significance with a delay of 58 working days after such announcements.

Further research needs to be conducted to assess the relevance of central bank information effects in Switzerland.

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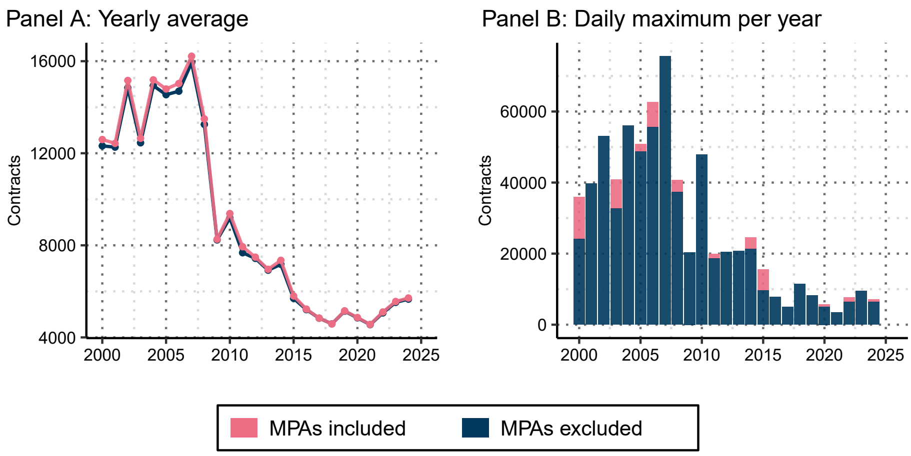
A Appendix

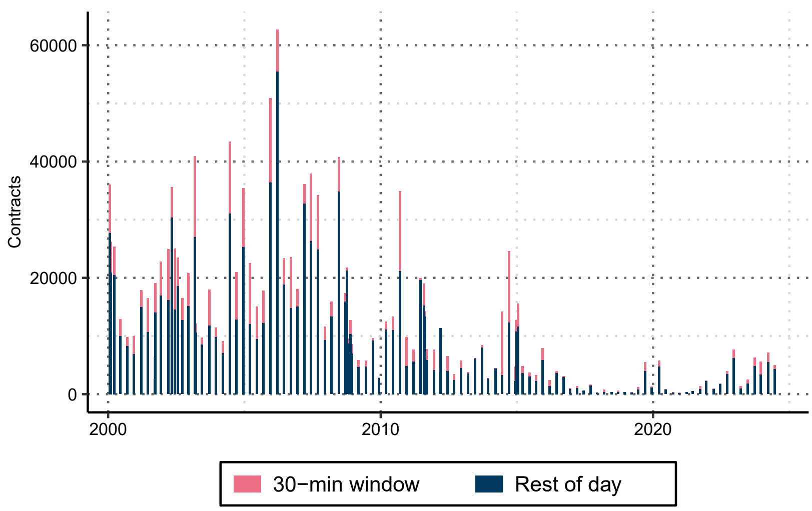
A.1 Expectation adjustment on the CHF 3M LIBOR futures and SARON futures markets

Figure A.1: MPAs and Trading Activity



Notes: Number of contracts traded on policy announcement days. The CHF 3M LIBOR futures and SARON futures are based on a CHF one million notional, high-frequency data obtained from *TickDataMarket*.

Figure A.2: Contracts Traded on Announcement Days



Notes: Number of contracts traded on policy announcement days. The CHF 3M LIBOR futures and SARON futures are based on the CHF one million notional, high-frequency data obtained from *TickDataMarket*.

A.2 Markov switching model

Table A.1: Markov Switching Model - Transition Probabilities

		Phase 1	*Phase 2*	*Phase 3*
Overall	*Phase 1*	1.00	0.00	0.00
	Phase 2	0.00	0.91	0.09
	Phase 3	0.00	0.03	0.97
Regular	*Phase 1*	1.00	0.00	0.00
	Phase 2	0.00	0.90	0.10
	Phase 3	0.00	0.03	0.97
Irregular	*Phase 1*	0.80	0.00	0.20
	Phase 2	0.00	0.89	0.11
	Phase 3	0.14	0.01	0.85

Notes: Model results based on 30-second bucket volatilities within the 30-minute window around policy announcements. The number of announcements in the sample period is 114 overall, of which 97 are regular and 17 are irregular.

A.3 TMSR - Manual

Step 1:

- Obtain high-frequency data for interest rate futures and stock market prices, rates and contracts (volumes)
- Focus on the 30 minutes around policy announcements

Step 2:

- Identify the expectation adjustment phases of a typical policy announcement using the volatilities of futures' contracts (volumes) traded by regime-switching type models such as the *Markov switching model*

Step 3:

- Using the obtained phases, calculate the expectation adjustment intensities, i.e., the TM phase weights $w_{i,t}^{TM}$ per phase i and policy announcement t:

$$w_{i,t}^{TM} = \begin{cases} 0, & \text{if } i = 1, \\ \frac{\sum_{t' \in \left\{ t' | S_{t'} = i \right\}} V_{t'}}{\text{Duration }_{i,t} \cdot \sum_{i=2}^{3} \frac{\sum_{t' \in \left\{ t' | S_y, f \right\}} V_{t'}}{\text{Duration }_{i,t}}}, & \text{if } i > 1. \end{cases}$$

Step 4:

- Using the obtained phases, perform time trend regressions for $y_{i,t} \in \{r_{i,t}, p_{i,t}\}$ and each phase i and policy announcement t

$$y_{i,t} = \alpha_i + \beta_i t + \epsilon_{i,t} \quad \text{for} \quad t' \in \{t' \mid S_{t'} = i\}$$

- Determine the phase-specific sign restrictions $SR_{i,t}$ per policy announcement

$$SR_{i,t} = \begin{cases} \text{PMP} & \text{if } \beta_{r,i,t} \cdot \beta_{p,i,t} < 0 \\ \text{CBI} & \text{if } \beta_{r,i,t} \cdot \beta_{p,i,t} > 0 \end{cases}$$

Step 5:

- Weight phase-specific motives to obtain the overall weights for every policy announcement t

$$W_{\text{PMP},t} = \sum_{i=1}^{3} w_{i,t}^{TM} \cdot \mathbf{1}_{\{SR_{i,t} = \text{PMP}\}}$$

$$W_{\text{CBI},t} = \sum_{i=1}^{3} w_{i,t}^{TM} \cdot \mathbf{1}_{\{SR_{i,t} = \text{CBI}\}}$$

Step 6:

- Determine the overall motive tendency; this is the result produced by the *TMSR*

$$\text{TMSR}_t = \begin{cases} \text{PMP} & \text{if } W_{\text{PMP},t} > W_{\text{CBI},t} \\ \text{CBI} & \text{if } W_{\text{CBI},t} > W_{\text{PMP},t} \end{cases}$$

A.4 PMSR – Immediate effects of monetary surprises

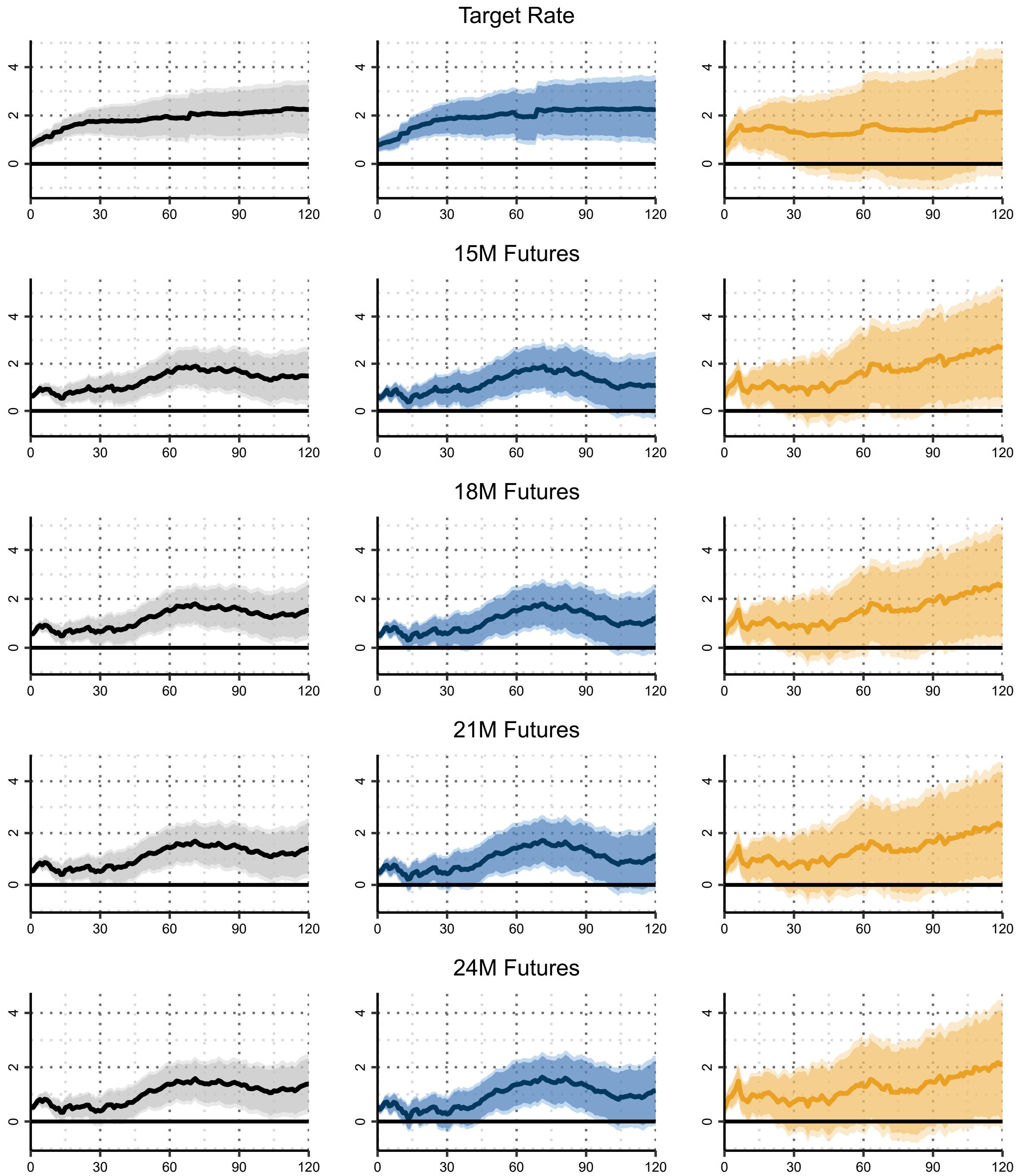
Table A.2: Immediate Effects of Monetary Surprises - PMSR

		Full Sample			Reduced Sample		
		Overall	PMP	CBI	Overall	PMP	CBI
Target rate & futures							
	Target Rate	0.79***	0.74***	0.89***	0.79***	0.74***	1.03***
		(0.13)	(0.15)	(0.28)	(0.14)	(0.15)	(0.38)
	15M Futures	0.65***	0.64***	0.66***	0.66***	0.64***	0.72***
		(0.06)	(0.08)	(0.17)	(0.07)	(0.08)	(0.23)
	18M Futures	0.57***	0.55***	0.62***	0.57***	0.54***	0.68***
		(0.07)	(0.09)	(0.16)	(0.07)	(0.08)	(0.23)
	21M Futures	0.55***	0.53***	0.59***	0.55***	0.53***	0.66***
		(0.07)	(0.09)	(0.16)	(0.07)	(0.09)	(0.22)
	24M Futures	0.54***	0.53***	0.55***	0.55***	0.53***	0.60***
		(0.07)	(0.09)	(0.17)	(0.07)	(0.08)	(0.23)
Bond yields							
	2Y Gov. Bond	0.51***	0.48***	0.55***	0.51***	0.48***	0.61***
		(0.05)	(0.07)	(0.13)	(0.05)	(0.06)	(0.18)
	5Y Gov. Bond	0.28***	0.24***	0.39***	0.25***	0.24***	0.27*
		(0.06)	(0.07)	(0.11)	(0.06)	(0.07)	(0.16)
	10Y Gov. Bond	0.17***	0.13**	0.30***	0.12**	0.13**	0.08
		(0.05)	(0.06)	(0.10)	(0.05)	(0.05)	(0.13)
	15Y Gov. Bond	0.12**	0.09*	0.19**	0.06	0.09*	-0.11
		(0.05)	(0.05)	(0.10)	(0.05)	(0.05)	(0.12)
	20Y Gov. Bond	0.07	0.04	0.15	0.01	0.04	-0.17
		(0.05)	(0.06)	(0.10)	(0.05)	(0.05)	(0.12)
	30Y Gov. Bond	0.12**	0.10	0.18	0.07	0.10	-0.10
		(0.06)	(0.07)	(0.12)	(0.06)	(0.07)	(0.16)
Other assets							
	$\text{MSCI}_{Switzerland}$	0.04**	0.02	0.13***	0.01	0.01	0.01
		(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.05)
	USD/CHF	0.02	-0.04	0.19***	-0.03***	-0.04***	-0.02
		(0.02)	(0.02)	(0.04)	(0.01)	(0.01)	(0.02)
	EUR/CHF	0.03	-0.03	0.21***	-0.03***	-0.03***	0.00
		(0.02)	(0.02)	(0.04)	(0.01)	(0.01)	(0.02)

Notes: The coefficients of β from the regression $\Delta y_t = \alpha + \beta z_t + \epsilon_t$, where the entries within columns refer to the particular z_t used in the regression. The reduced sample excludes the surprises on 9 September 2011 and 15 January 2015. Robust standard errors in brackets. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. The number of announcements in the full and reduced sample is 114 and 112, respectively.

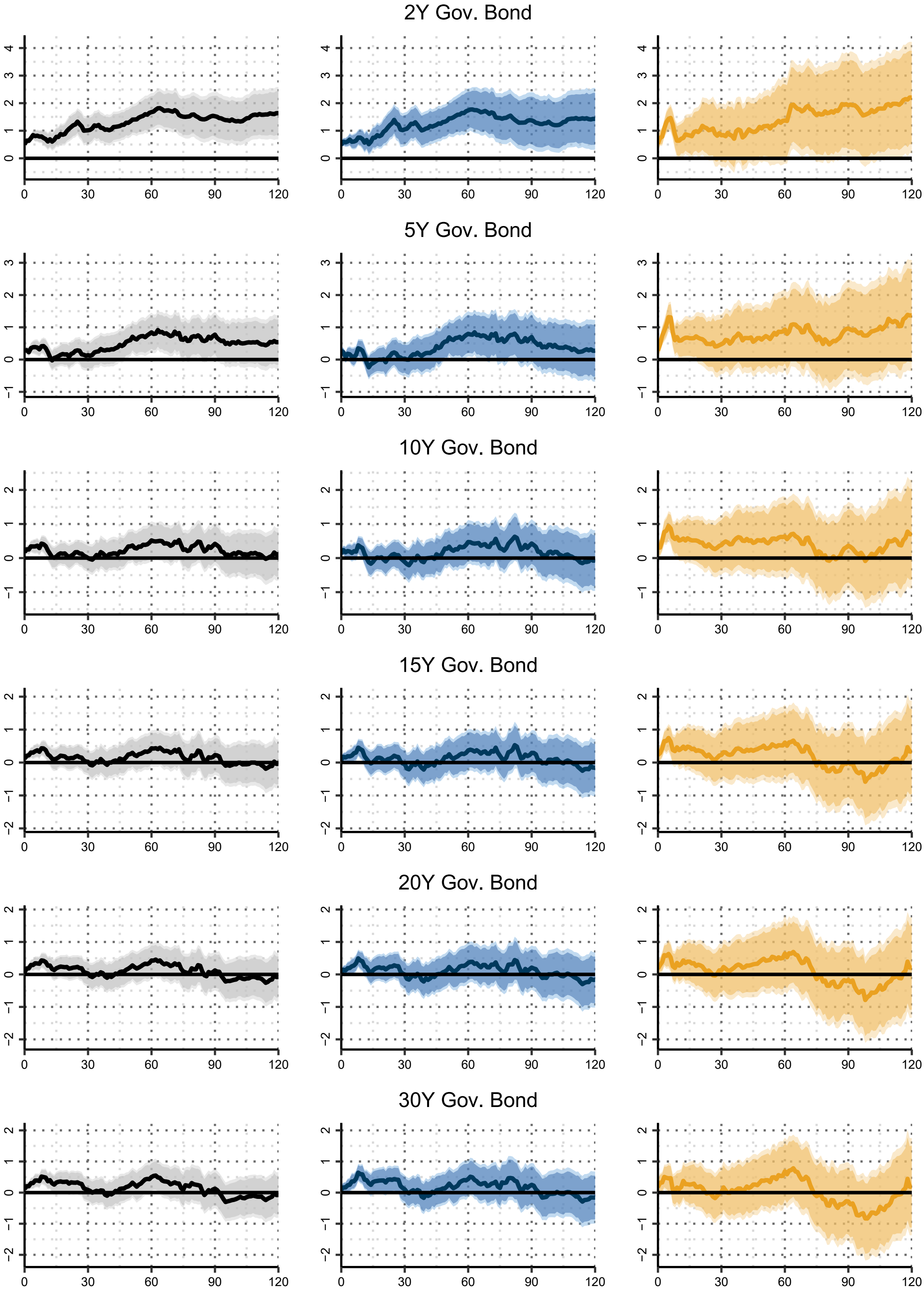
A.5 TMSR – Persistence of asset responses to monetary surprises (full sample)

Figure A.3: Persistence of Effects - Target Rate & Futures



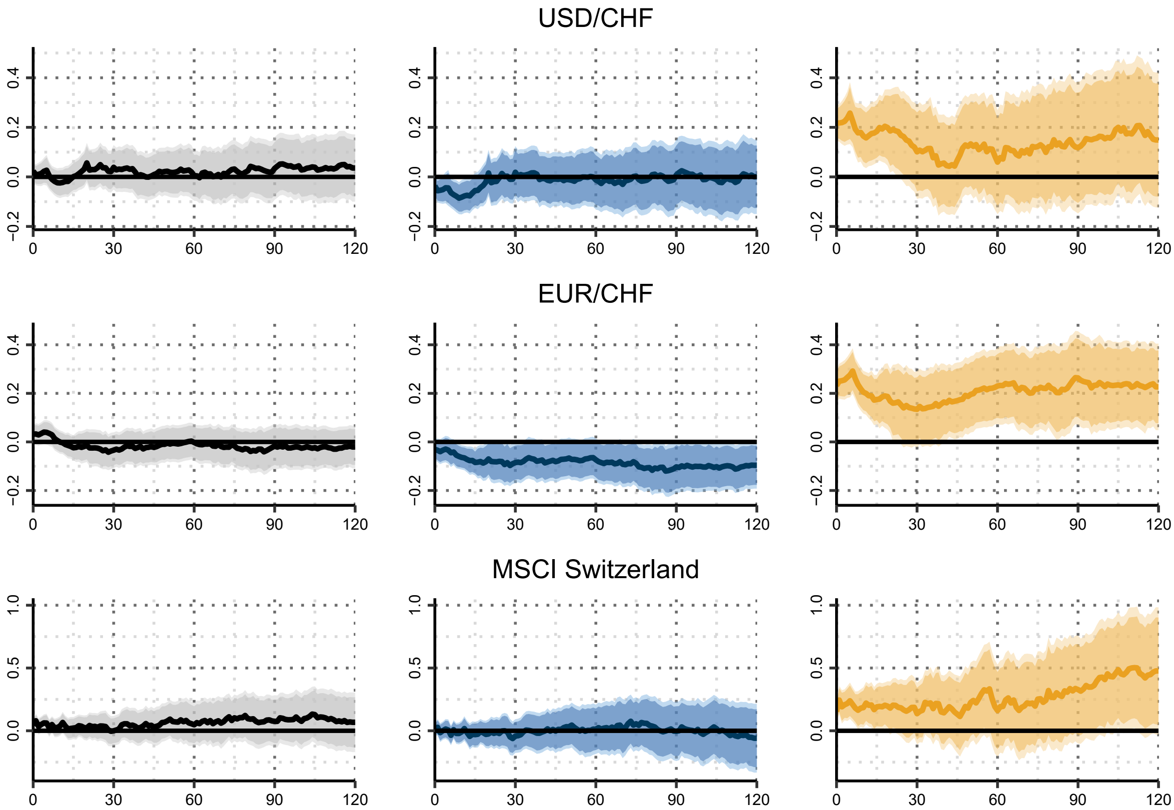
Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure A.4: Persistence of Effects - Bond Yields



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure A.5: Persistence of Effects - Other Assets



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information surprises. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the surprises. Robust 95% and 90% confidence intervals are shown as light and dark areas, respectively.

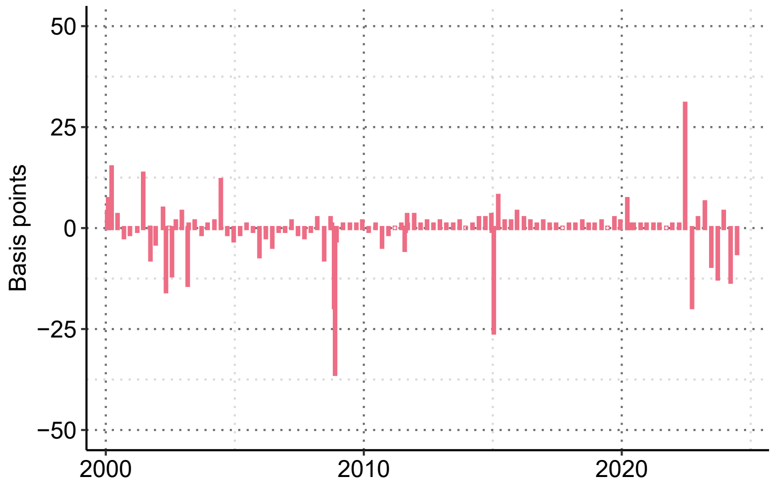
A.6 Monetary policy shocks – An extension

While in VAR frameworks, monetary surprise series are often used either as internal or external instruments to shock systems of variables, one can run a first-stage regression directly instrumenting changes in the reference rate on the monetary surprise series obtained from the high-frequency identification strategy (Amberg et al. (2022)). The fitted values from such a first-stage regression can be regarded as an extension and are referred to as a monetary policy shock series.[37]

$$\Delta i_t^{CHF3MLIBOR/SARON} = \alpha + \beta \cdot MonetarySurprise_t + \epsilon_{i,t}$$
$$MonetaryPolicyShock_t = \widehat{\Delta i}_t^{CHF3MLIBOR/SARON} \tag{10}$$

The results in Figure A.7 show that the monetary policy shock series exhibits less exogenous variation compared to the monetary surprise series.

Figure A.6: Monetary Policy Shock Series



Notes: The monetary surprise series is constructed using the CHF 3M LIBOR futures and SARON futures high-frequency data obtained from *TickDataMarket*. The monetary policy shock series is obtained from the fitted values of the first-stage regression $\Delta i_t^{CHF3MLIBOR/SARON} = \alpha + \beta \cdot MonetarySurprise_t + \epsilon_{i,t}$, where $\Delta i_t^{CHF3MLIBOR/SARON}$ denotes the daily change for the sample period relevant SNB reference rate. Positive values indicate higher policy rates than expected (i.e., contractionary shocks); negative values indicate lower policy rates than expected (i.e., expansionary shocks).

[37] The data of daily CHF 3M LIBOR and SARON are from Bloomberg.

A.7 Monetary policy shocks – Immediate effects of asset prices

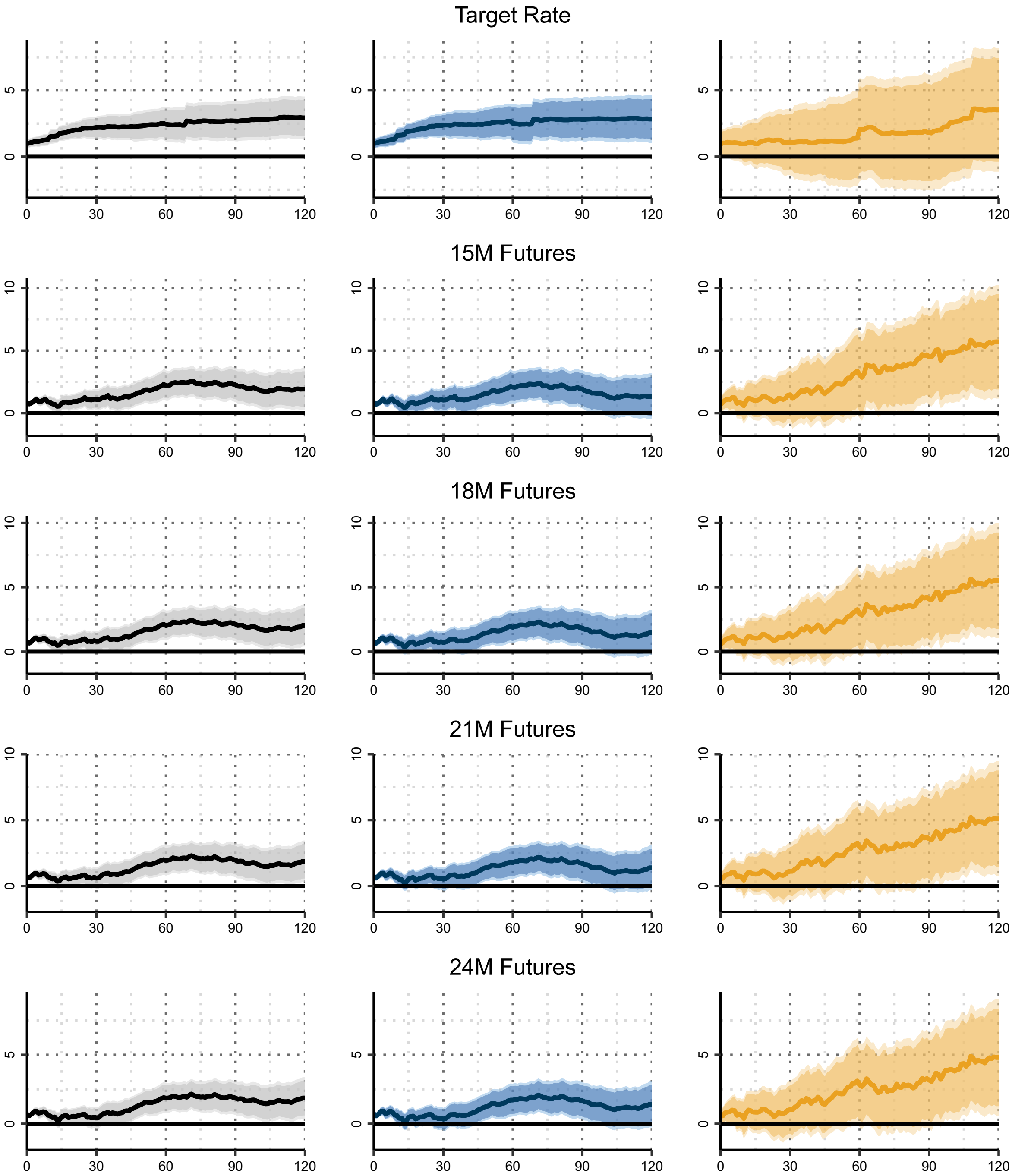
Table A.3: Immediate Effects of Monetary Policy Shocks

		Full Sample			Reduced Sample		
		Overall	MP	CBI	Overall	MP	CBI
Target rate & futures							
	Target Rate	1.00***	0.99***	1.02***	1.01***	0.99***	1.11**
		(0.16)	(0.19)	(0.37)	(0.17)	(0.19)	(0.51)
	15M Futures	0.83***	0.85***	0.76***	0.83***	0.86***	0.72**
		(0.08)	(0.10)	(0.22)	(0.09)	(0.10)	(0.30)
	18M Futures	0.73***	0.75***	0.67***	0.73***	0.75***	0.61**
		(0.09)	(0.11)	(0.22)	(0.09)	(0.10)	(0.30)
	21M Futures	0.70***	0.73***	0.63***	0.70***	0.73***	0.58*
		(0.09)	(0.11)	(0.21)	(0.09)	(0.10)	(0.30)
	24M Futures	0.69***	0.72***	0.61***	0.69***	0.72***	0.56*
		(0.09)	(0.11)	(0.22)	(0.09)	(0.10)	(0.30)
Bond yields							
	2Y Gov. Bond	0.65***	0.63***	0.70***	0.65***	0.63***	0.76***
		(0.06)	(0.08)	(0.17)	(0.07)	(0.08)	(0.24)
	5Y Gov. Bond	0.36***	0.34***	0.40***	0.32***	0.35***	0.14
		(0.07)	(0.09)	(0.15)	(0.08)	(0.08)	(0.22)
	10Y Gov. Bond	0.22***	0.16**	0.42***	0.15**	0.16**	0.12
		(0.06)	(0.07)	(0.13)	(0.06)	(0.07)	(0.17)
	15Y Gov. Bond	0.15**	0.09	0.34***	0.08	0.09	-0.01
		(0.06)	(0.07)	(0.12)	(0.06)	(0.06)	(0.16)
	20Y Gov. Bond	0.09	0.04	0.26**	0.01	0.04	-0.13
		(0.06)	(0.07)	(0.13)	(0.06)	(0.07)	(0.16)
	30Y Gov. Bond	0.15**	0.13	0.25	0.09	0.13	-0.13
		(0.08)	(0.09)	(0.16)	(0.08)	(0.09)	(0.22)
Other assets							
	$MSCI_{Switzerland}$	0.06**	0.02	0.19***	0.02	0.02	0.03
		(0.02)	(0.03)	(0.05)	(0.02)	(0.03)	(0.06)
	USD/CHF	0.03	-0.05	0.27***	-0.04***	-0.05***	-0.03
		(0.03)	(0.03)	(0.05)	(0.01)	(0.01)	(0.03)
	EUR/CHF	0.04	-0.04	0.29***	-0.04***	-0.04***	-0.02
		(0.03)	(0.03)	(0.04)	(0.01)	(0.01)	(0.02)

Notes: The coefficients of β are from the regression $\Delta y_t = \alpha + \beta z_t + \epsilon_t$, where the entries within columns refer to the particular z_t used in the regression. The reduced sample excludes the surprises on 9 September 2011 and 15 January 2015. The standard errors in brackets are computed using 10,000 bootstrap repetitions, as the monetary policy shock series itself is based on the fitted values of a regression. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. The number of announcements in the full and reduced sample is 114 and 112, respectively.

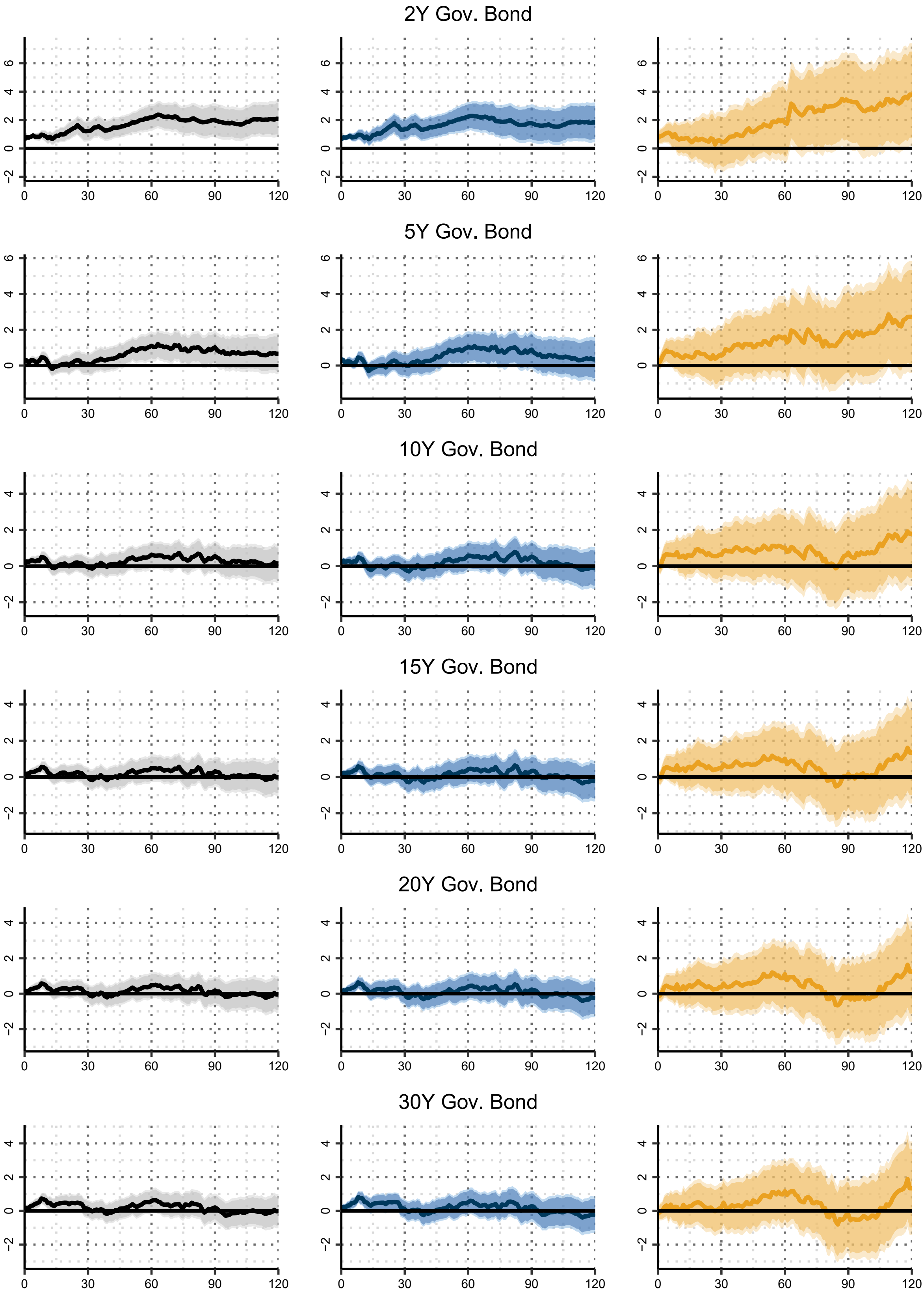
A.8 Monetary policy shocks – Persistence of asset responses (reduced sample)

Figure A.7: Persistence of Effects - Target Rate & Futures



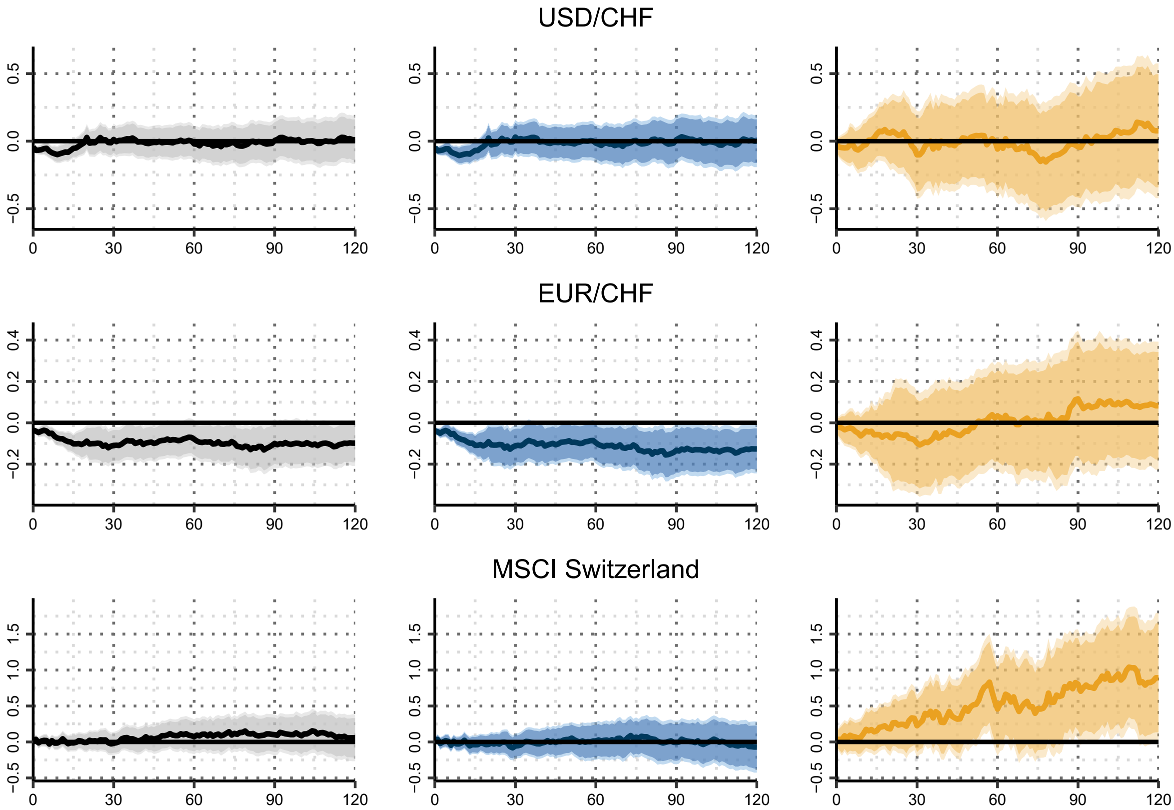
Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information shocks. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the shocks. Bootstrapped 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure A.8: Persistence of Effects - Bond Yields



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information shocks. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the shocks. Bootstrapped 95% and 90% confidence intervals are shown as light and dark areas, respectively.

Figure A.9: Persistence of Effects - Other Assets



Notes: The charts on the left (black) refer to the overall effects, those in the middle (blue) refer to pure monetary policy, and those on the right (yellow) refer to central bank information shocks. The Y-axis show the coefficients of β_h obtained from the local projections regressions, and the X-axis plots show the working days since the shocks. Bootstrapped 95% and 90% confidence intervals are shown as light and dark areas, respectively.

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