Stock market evidence on the international transmission channels of US monetary policy surprises[*]

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Abstract

This paper evaluates the economic sources of the stock market responses of 40 countries to surprises in the fed funds rate (FFR), the Fed's forward guidance (FG) and large-scale asset purchases (LSAP). We use decompositions of stock market returns into different components reflecting investors' revisions in expectations (news) about future cash flows, expected returns, real interest rates and the real exchange rate to show that FFR and LSAP surprises affect foreign stock markets because they influence foreign countries' real economic outlook. FG surprises seem to convey non-monetary information, such as the Fed's risk assessment, to which foreign stock markets react.

JEL: E44, E52, F36, G15

KEYWORDS: international spillovers, news, monetary policy, stock returns, vector autoregression

1 Introduction

Expansionary US monetary policy surprises tend to be associated with rising stock prices worldwide (Ammer et al., 2010; Brusa et al., 2020; Ehrmann and Fratzscher, 2009; Jiang et al., 2020; Miranda-Agrippino and Rey, 2020; Thorbecke, 1997; Wongswan, 2009). While this evidence is persuasive, the underlying reasons for foreign stock markets' responses to US monetary policy surprises remain elusive. According to the dividend discount model the value of a stock is the sum of all future dividends discounted by expected stock returns. Hence, US monetary policy surprises can transmit to foreign stock prices by either changing expected stock returns, i.e. the investors risk perception, or expectation about future dividends, i.e. the outlook of the real economy.

In a textbook world, monetary policymakers set the short-term interest rate, influence expectations about future short-term interest rates and thus affect investment and spending decisions of firms and consumers. However, there is growing evidence, based on high-frequency data, that non-monetary information, e.g., the central bank's growth outlook or risk assessment, is an important part of central bank communication to which financial markets respond (Campbell et al., 2012; Campbell et al., 2017; Cieslak and Schrimpf, 2019; Degasperi et al., 2020; Jarocinski and Karadi, 2020; Kroencke et al., 2019; Nakamura and Steinsson, 2018; Miranda-Aggripino and Ricco, 2019).[1] Indeed, Bernanke and Kuttner (2005) show that federal funds rate surprises affect US stock markets to a large extent through their impact on expectations of future excess returns (risk premia).

This background raises the question of the channels through which US monetary policy surprises influence foreign stock markets. Do foreign stock markets respond to US monetary policy surprises because US monetary policy affects expectations of future dividends (i.e., cash flows) or about future returns? Do unconventional monetary policy measures, e.g., LSAP, affect stock markets through the same channels as conventional measures, such as changes in the federal funds rate?

To shed light on these issues, we first quantify the stock market responses of 40 emerging and developed countries to US monetary policy surprises in the period from 1991 to 2019.[2] Therefore, we integrate the US monetary policy surprises

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[1] Madeira and Madeira (2019) show in a high-frequency event study that even the degree of consent among members of the Fed's Federal Open Market Committee affects stock prices.

[2] We use the MSCI classification of developed and emerging markets as of December 2018 for this distinction and use MSCI standard stock market indices in our empirical analysis. Note that inclusion of a firm's stock in the MSCI indices requires the stock to fulfil certain quality criteria and to offer the opportunity for both domestic and foreign investors to invest in it. Therefore,

as exogenous variables into vector autoregressive (VAR) models in which the US dollar (USD)-denominated monthly excess stock return is the response variable of interest. We run country-specific VAR models similar to Bernanke and Kuttner (2005) as well as panel VAR models based on Vuolteenaho (2002).

Second, we analyse the underlying sources of the responses of foreign stock market returns to US monetary policy surprises. We assess this question using the VAR framework of Ammer and Mei (1996) that decomposes unexpected variation in USD-denominated excess stock returns into revisions in expectations (news) about future cash flows (i.e., dividends), expected returns as well as real interest rates and the real exchange rate. This assessment boils down to evaluating whether US monetary policy surprises are significantly associated with the four different news components of foreign stock market excess returns. The distinction between the different return news has important implications for our understanding of the economic sources of stock market reactions to US monetary policy. For example, firms' aggregate cash flows are related to national or global economic growth (Ammer and Mei, 1996). Hence, a link between monetary policy surprises and cash-flow news suggests that a stock market responds because of the implications of the monetary policy surprise for economic growth of that economy.[3]

As our sample period covers the zero lower bound (ZLB) period for the FFR, we not only focus on stock market responses to FFR surprises but also assess the responses to forward guidance and LSAP surprises. Hence, we can evaluate whether there are differences in the impact on foreign stock markets among the three different types of US monetary policy tools used during our sample period. In our empirical analysis, we employ the proxies of fed funds rate, forward guidance and LSAP surprises proposed by Swanson (2020). These surprises reflect the unanticipated high-frequency price changes in interest rate futures of different maturity around Federal Open Market Committee (FOMC) announcements and are therefore well suited as exogenous variables in our preferred VAR setups.[4]

Our detailed country-level results reveal that federal funds rate surprises are primarily associated with real interest rate news in foreign stock markets. This finding is particularly pronounced in the post-ZLB period from November 2015 to June 2019 and it mostly pertains to the developed markets in our sample. For

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using the MSCI indices allows us to directly compare evidence for developed markets with that for emerging markets.

[3]Three transmission channels of US monetary policy to foreign real economies have been pointed out by the literature (e.g., Rey (2016) and Degasperi (2020)). There are the standard demand and exchange rate channels as well as and an international credit channel that operates through the balance sheets of global banks.

[4]We are grateful to Eric Swanson for sharing the monetary policy surprise series with us.

some emerging markets, surprise changes in the federal funds rate also constituted cash-flow news. This finding already reveals that the responses of foreign stock markets to a particular type of US monetary policy surprise are not confined to one specific news component and thus not to one specific economic source. Every type of monetary policy surprise has a multifaceted impact on foreign stock markets.

Forward guidance surprises are only associated with unexpected movements in some of the foreign stock market returns under study. In addition, there is no clear country-level evidence of a particular channel through which forward guidance transmits to foreign stock markets.

LSAP surprises during the ZLB period mainly affected foreign stock markets through revisions in expectations about the future stream of dividends (cash-flow news), which are related to the growth prospects of an economy (Ammer and Mei, 1996; Campbell, 1991; Campbell and Vuolteenaho, 2004; Lucas, 1978). This finding also suggests that LSAP surprises persistently affect foreign stock markets.

The results from the panel VAR analysis provide statistically significant evidence that looser than expected US monetary policy, irrespective of the type of surprise, leads to an unexpected increase in foreign stock market returns. The monthly stock market returns of developed markets on average rise in response to a standardized expansionary surprise in FFR by 4.4% and by 3.8% and 6.6% to standardized FG and LSAP surprises respectively. Emerging market returns seem to respond more sensitively to US monetary policy surprises than their developed market counterparts. The panel results also corroborate the main patterns highlighted in the context of the country-level assessments.

In addition, the panel estimates reveal that surprisingly accommodative forward guidance during the ZLB period constituted adverse news for foreign stock markets. It was associated with an upward revision in expectations of future returns on the stock markets of developed and emerging economies. We observe a similar pattern for developed markets and LSAP surprises in the post-ZLB period. These observations are mainly driven by the association of forward guidance and LSAP surprises with news about future excess returns. These findings could reflect the stock market reactions to the risk assessment in Fed statements (e.g., Cieslak and Schrimpf, 2019). In this case, looser than expected monetary policy might reflect a more negative risk assessment of the Fed, which then translates into upwards revisions in expectations about future excess returns (risk premia). Risk premia news also seem to become more important over time. This could be due to an increasing role of global banks in the transmission of US monetary policy to foreign countries. The associated international credit channel of US monetary pol-

icy transmission works through the balance sheet of global banks, which provide credit to businesses abroad. An increase in the US policy rate increases funding costs of these intermediaries and deteriorates their balances sheets. These has adverse effects on lending conditions and real economies abroad and thus increase the riskiness of stocks.

Moreover, the panel estimates for the ZLB period suggest that LSAP surprises reflect more than commitment to forward guidance (Swanson, 2020). At the ZLB, forward guidance and LSAP surprises affected foreign stock markets through news about excess returns and cash-flow news respectively and additionally pushed unexpected foreign stock market returns in different directions. Expansionary LSAP surprises during the ZLB period are associated with higher than expected foreign stock market returns, while expansionary forward guidance surprises at the ZLB are associated with unexpectedly falling foreign stock market returns.

Finally, the results from the panel analysis highlight that US monetary policy surprises lead to revisions in expectations about future real exchange rates. This is especially true for the emerging markets in our sample. However, real exchange rate news only explains a small proportion of the unexpected variation in stock market returns. Thus, our findings are in line with the recent event study evidence by Brusa et al. (2020) and suggest that the impact of US monetary policy surprises on foreign stock markets through real exchange rate news is very small. This does not mean that the overall exchange rate effects of US monetary policy surprises on foreign economies are negligible. Our paper focuses on unexpected movements in stock market returns and not on macroeconomic aggregates.

The remainder of the paper is organized as follows. Section 2 highlights the main contributions of our paper in the context of the related literature. Section 3 provides the background for the decomposition of unexpected stock market returns into different news components. Section 4 introduces the empirical framework to obtain the effects of monetary policy surprises on the news components. Details on the data are outlined in section 5. Section 6 presents the main empirical results, and section 7 concludes. The appendix at the end of the paper provides supporting information.

2   Main contributions and related literature

The empirical analyses of our paper rely on the VAR models of Campbell (1991) and Ammer and Mei (1996) to decompose unexpected movements in asset returns into components reflecting revisions in expectations about cash flows, expected

returns, real interest rates and the real exchange rate. Distinguishing between different news components is important because cash-flow news reflects a revision in expectations about the entire stream of dividends and is thus related to the growth prospects of an economy (Lucas, 1978). Cash-flow news hence has a persistent impact on asset returns. Expected return news reflects changes in the expected risk premium applied to discount the cash flows (Ammer and Mei, 1996). Expected return news has a temporary impact because a capital loss due to adverse expected return news today will be compensated by the expectation of higher returns in the future. In addition, real interest rate news also reflect changes to the discount rate for cash flows. Since we are working with USD-denominated stock market returns, news about real USD-exchange rates affect future discount rates as well.

To link the different return news components to monetary policy surprises, we employ a VAR with exogenous variables that is similar to the empirical framework of Bernanke and Kuttner (2005). However, we do not focus on the US but analyse a sample of 40 developed and emerging markets. Furthermore, we evaluate the responses of different stock return news components to three different types of monetary policy surprises (fed funds rate, forward guidance, and LSAP) because our sample includes the ZLB period during which the Fed resorted to unconventional measures. We thus complement Rogers et al. (2018), who use a VAR framework with exogenously approximated monetary policy surprises related to the different facets of the Fed's monetary policy to study the impact of US monetary policy surprises on bond premia and forward exchange rate premia (relative to USD) in the euro area, Japan and the UK. We focus on stock markets and employ a similar, but slightly different, VAR framework that allows for a detailed distinction between different international transmission channels of US monetary policy. Furthermore, our sample includes more countries and covers the post-ZLB period.

Moreover, Paul (2020) uses monetary policy surprises as exogenous variables in a VAR system that includes macroeconomic aggregates as well as US stock and house prices. He shows that fed funds rate surprises are directly interpretable as monetary policy shocks while other monetary policy surprises, e.g., forward guidance, cannot be taken as a direct proxy of monetary policy shocks. In this context, it is important to note that we do not attempt to look at monetary policy shocks. We focus on surprises that are, by construction, orthogonal to each other, such that we can assess differences in the responses of the stock return news components to the different surprises.

Furthermore, we do not look explicitly at macroeconomic aggregates in our

VAR setting, but we note that the different stock market return news components are interpretable in a macroeconomic way. For example, Ammer and Mei (1996) analyse the cross-country correlations of cash-flow news and expected return news between the US and the UK to evaluate the degree of real and financial integration between the two countries. They argue that cash-flow news can be interpreted as news about the real economy, i.e., economic growth, while news about future returns reflects news about the price of risk. Our findings that US monetary policy surprises are associated with cash-flow news is in line with evidence of Degasperi et al. (2020) who find that US monetary policy shocks affect real economic variables in developed and emerging markets.

In addition, our paper complements event studies of the effects of US monetary policy on foreign economies' bond and stock markets as well as the responses of foreign exchange rates to US monetary policy surprises (Albagli et al., 2019; Ammer et al., 2010; Ehrmann and Fratzscher, 2009; Hausman and Wongswan, 2011; Swanson, 2020; Wongswan, 2009). Unlike these studies, our monthly VAR estimations allow us to distinguish the effects of monetary policy surprises on different components of asset returns. These components reflect revisions in expectations and are thus not directly comparable to simple changes in stock prices. In addition, our decompositions of stock market return news reveal that the responses of foreign stock markets to a particular type of US monetary policy surprise are not confined to one specific news component and thus not to one specific economic source. Reactions of simple stock price changes to monetary policy surprises do not capture this multifaceted impact of monetary policy on stock markets. However, our stock return decompositions have to include short-term real interest rates and real exchange rates directly into the VAR system. Therefore, we need information about consumer price indices. The highest frequency at which these data are available is monthly.

Moreover, our assessment of the link between the three different types of US monetary policy surprises and the four news components of emerging economies' stock market returns gives us a better understanding of the channels through which monetary policy surprises in the US affect emerging markets. This assessment complements studies that assess the impact of US monetary policy on emerging markets' macroeconomic aggregates (e.g., Vicondoa, 2019) and financial markets (e.g., Akinci, 2013; Fratzscher et al., 2018), and it corroborates that US monetary policy has important real economic implications, through cash-flow news in our setting, for emerging markets.

Finally, our paper contributes to and is consistent with the growing literature

on the emergence of a global financial cycle and its importance for the valuation of assets. Miranda-Aggripino and Rey (2020) show that one global risk factor accounts for non-negligible amounts of the variation in a broad set of risky asset prices around the world. This global factor in asset prices responds to US monetary policy changes. Jiang et al. (2020) provide a theoretical mechanism for this empirical finding. The mechanism is based on the notion that there is special demand for USD-denominated safe assets from financial intermediaries worldwide (e.g., McCauley and McGuire, 2009). US monetary policy, e.g., LSAP, affects the supply of these safe assets, such that the risk-bearing capacity and hence the risk appetite of financial intermediaries are affected. Our results of a statistically significant link between US monetary policy surprises and unexpected variation in the stock market returns of both developed and emerging countries are consistent with this economic mechanism.

3 Economic background: decomposing unexpected variation in stock market returns

Our empirical assessments of the effects of US monetary policy surprises on foreign stock markets are based on a decomposition of unexpected variation in stock market returns into different components. This decomposition relies on a dynamic accounting identity that relates asset returns to expected cash flows and discount rates (Campbell and Shiller, 1988; Campbell, 1991). This accounting identity is based on the two-period version of the present value model that links current stock prices to dividends and returns, i.e.,

$$1 + r_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t} \tag{1}$$

with r, denoting the net return on the stock, P, the stock price excluding dividends, and D, dividends.

To allow for time variation in returns, Campbell and Shiller (1988) propose a log-linear approximation of equation (1) around the mean dividend-price ratio. This approximation yields

$$r_{t+1} \approx k + \rho p_{t+1} + (1 - \rho)d_{t+1} - p_t \tag{2}$$

in which except for r lower-case letters denote logarithms of the variables. The letter k summarizes the constant terms that result from the Taylor expansion, and $\rho = 1/(1 + \exp(d - p))$ is a weight that follows from the log-linearization. This

weight depends on the long-run mean of the log dividend-price ratio, d–p, around which equation (1) is linearized. Rearranging equation (2) for the stock price, $p_t \approx k + \rho p_{t+1} + (1 - \rho)d_{t+1} - r_{t+1}$ and expanding to the infinite horizon gives a representation of unexpected variation in stock returns. This expansion imposes the condition that discounted stock prices cannot grow forever, $\lim_{j \to \infty} \rho^j p_{t+j} = 0$.

Taking expectations on both sides of the equation gives

$$p_t = \frac{k}{1 - \rho} + E_t \left[\sum_{j=0}^{\infty} \rho^j ((1 - \rho)d_{t+1+j} - r_{t+1+j}) \right] \tag{3}$$

with E being the expectation operator conditional on information at time t. Substituting equation (3) into equation (2), Campbell (1991) highlights that unexpected changes in stock returns reflect either news (revisions in expectations) of dividend growth or future discount rates, i.e.,

$$r_{t+1} - E_t r_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{t+1+j} \tag{4}$$

To study excess returns, i.e., stock returns in excess of a short-term debt rate, equation (4) can be rewritten as

$$rx_{t+1} - E_t rx_{t+1} = (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - \sum_{j=0}^{\infty} \rho^j rr_{t+1+j} - \sum_{j=1}^{\infty} \rho^j rx_{t+1+j} \right\} \tag{5}$$

Here, we decompose the discount rate, r, into the short-term real interest rate, rr, and a risk premium term, rx.

For notational convenience, equation (5) can be rewritten as

$$\eta_{t+1}^{T} = \eta_{t+1}^{cf} - \eta_{t+1}^{rr} - \eta_{t+1}^{rx} \tag{6}$$

with $\eta_{t+1}^{T} \equiv rx_{t+1} - E_t rx_{t+1}$ being the unexpected stock market excess return, $\eta_{t+1}^{cf} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j}$, being the news of future cash flows (dividends), $\eta_{t+1}^{rr} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j rr_{t+1+j}$, being the news of the real interest rate, and finally $\eta_{t+1}^{rx} \equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j rx_{t+1+j}$ being the news of future excess returns (risk premia). Following from this accounting identity, a positive surprise movement in the excess stock market return is associated with positive dividend news, lower than expected real interest rates, lower than expected future excess returns or an arbitrary combination of the three.

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Equation (5) also holds for foreign stock returns and can be written as

$$
rx^*_{t+1} - E_t rx^*_{t+1} = (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d^*_{t+1+j} - \sum_{j=0}^{\infty} \rho^j rr^*_{t+1+j} - \sum_{j=1}^{\infty} \rho^j rx^*_{t+1+j} \right\}
\tag{7}
$$

with asterisk superscripts denoting a foreign variable. Following Ammer and Mei (1996), we focus on the foreign stock return denominated in USD in excess of the US short-term interest rate, frx.

The innovation in foreign excess stock returns can be expressed as

$$
\begin{aligned}
frx_{t+1} - E_t frx_{t+1} = (E_{t+1} - E_t) \Big[& \sum_{j=0}^{\infty} (\rho^*)^j \Delta d^*_{t+1+j} - \sum_{j=0}^{\infty} (\rho^*)^j rr_{t+1+j} \\
& - \sum_{j=0}^{\infty} (\rho^*)^j \Delta q_{t+1+j} - \sum_{j=1}^{\infty} (\rho^*)^j rx^*_{t+1+j} \Big]
\end{aligned}
\tag{8}
$$

Here, q represents the real exchange rate, which is denominated in foreign currency as a unit of domestic currency (USD). Again for the purpose of notational convenience, equation (8) can be rewritten as

$$
f^T_{t+1} = f^{cf}_{t+1} - f^{rr}_{t+1} - f^q_{t+1} - f^{rx}_{t+1}
\tag{9}
$$

in which $f^T_{t+1} \equiv frx_{t+1} - E_t frx_{t+1}$ denotes the unexpected foreign stock market excess return denominated in US dollars, $f^{cf}_{t+1} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} (\rho^*)^j \Delta d^*_{t+1+i}$ is the news of future foreign cash flows (dividends), $f^{rr}_{t+1} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} (\rho^*)^j rr_{t+1+j}$ represents the news about the US real interest rate, $f^q_{t+1} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} (\rho^*)^j \Delta q_{t+1+i}$ gives the news about the exchange rate and finally $f^{rx}_{t+1} \equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} (\rho^*)^j rx^*_{t+1+j}$ denotes the news about future foreign excess returns.

The effect of f^{cf}, f^{rr} and f^{rx} on unexpected excess returns can be interpreted analogously to their corresponding news term in equation (6). The intuition behind the negative sign on exchange rate news f^q is that, ceteris paribus, news about a future USD appreciation must have an adverse impact on the returns of foreign assets denominated in USD.

4 Empirical framework

4.1 The VAR

Estimates of all news terms defined in section 3 can be computed using a VAR that includes the excess return on a stock market and variables that predict returns. In the literature, this has been done by a VAR specification as in equation (10). For notational flexibility, this process is stated in first order. This notation also represents a higher-order process written as a first-order VAR in companion form

$$z_{t+1} = \Gamma z_t + \epsilon_{t+1} \tag{10}$$

Here, z_{t+1} is a vector of the endogenous variables, Γ denotes the companion matrix and ϵ is an i.i.d. error vector. As we are interested in the effect of monetary policy surprises, abbreviated with M_t^u, on the different news terms, we include the surprise series as exogenous variables in the VAR

$$z_{t+1} = \Gamma z_t + \phi M_{t+1}^u + \Psi_{t+1}, \tag{11}$$

where ϕ captures the response of the endogenous variables in the VAR to the contemporaneous monetary policy surprises and Ψ_{t+1} is the new error term. This error term is, by construction, orthogonal to our monetary policy surprise series M^u. This splits our baseline error term ϵ_{t+1} in equation (10) into innovations in monetary policy and innovations in all other factors unrelated to monetary policy.

The estimated regression model has the form

$$A(L)y_{t+1} = y_{t+1} - \sum_{l=0}^{p-1} A^{l+1} y_{t-l} - \phi M_{t+1}^u = \Psi_{t+1} \tag{12}$$

where $A(L)$ is a polynomial of order p and $y_{t+1} = [y_{1,t+1}, y_{2,t+1}, \ldots, y_{K-1,t+1}, y_{K,t+1}]'$ is a column vector with K endogenous variables in the VAR.

In the subsequence, we report the results from estimating equation (11). Alternatively, one could apply a two-step procedure. Bernanke and Kuttner (2005) argue that vector M_{t+1}^u represents a prediction error from a rational forecast at time t and should therefore be orthogonal to the endogenous variables z_t. Thus, one can obtain consistent estimates of both Γ and ϕ from a two-step estimation. The first step is to run the baseline VAR in equation (10) without the exogenous monetary policy surprises to estimate Γ and to extract ϵ_{t+1}. To obtain an estimate of ϕ, one has to regress the VAR's one-month-ahead forecast error ϵ_{t+1} in a sec-

ond step on the monetary policy surprises M_{t+1}^u. Applying the two-step procedure leads to qualitatively similar results as our preferred direct, one-stage estimation of equation (11).

4.2 The news

To estimate the domestic (US) news terms $\eta^T, \eta^{cf}, \eta^{rr}$ and η^{rx}, we stack four endogenous variables into the VAR. The first variable in the VAR is the US excess return rx_{t+1}, the second variable is the US real interest rate rr_{t+1}, the third variable is the US yield spread ys_{t+1} and finally the fourth variable is the dividend-price ratio δ_{t+1}.[5] In addition, we include three different exogenous monetary policy surprise series $M_{t+1}^u = [\Delta i_{t+1}^u, \Delta g_{t+1}^u, \Delta l_{t+1}^u]'$. These series are based on the high-frequency identification proposed by Swanson (2020), with Δi_t^u representing unanticipated changes in the fed funds rate, Δg_t^u representing unanticipated changes in forward guidance and Δl^u representing unanticipated changes in large-scale asset purchases.[6]

The identification of Swanson (2020) obtains the three different monetary policy surprises from unanticipated changes in interest rate futures in a short time window around FOMC announcements. Even if past stock market movements influenced expectations about Fed policy, the fact that the surprises reflect the unexpected/unanticipated changes in interest rates makes them well suited as exogenous variables in the context of our paper.

With $\epsilon_{t+1} \equiv (\phi M_{t+1}^u + \Psi_{t+1})$ and using Γ and ϕ, one can then calculate the different domestic news terms as follows

$$\eta_{t+1}^T = \lambda_1' \epsilon_{t+1} \tag{13}$$

$$\eta_{t+1}^{rx} = \lambda_1' \rho \Gamma (I - \rho \Gamma)^{-1} \epsilon_{t+1} \tag{14}$$

$$\eta_{t+1}^{rr} = \lambda_2' (I - \rho \Gamma)^{-1} \epsilon_{t+1} \tag{15}$$

$$\eta_{t+1}^{cf} = \eta_{t+1}^T + \eta_{t+1}^{rx} + \eta_{t+1}^{rr}, \tag{16}$$

where ρ is a discount factor. In addition, we define $\lambda_1 = [1, 0, 0, 0]'$ to pick rx and λ_2 in an analogous fashion.

Based on the approach proposed by Ammer and Mei (1996), we stack seven endogenous variables into the VAR for foreign stock market returns to estimate for-

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[5]The data section presents the exact definitions of the variables.

[6]Appendix B briefly describes the high-frequency identification strategy and section 5 describes how we convert the high-frequency surprises on event days into a monthly time series for the empirical analysis.

eign news terms $f^T, f^{cf}, f^{rr}, f^{rx}$ and f^q. In addition to the four variables used to estimate domestic news terms, we include the foreign stock market excess retun rx^*_{t+1}, the change in the log real exchange rate Δq_{t+1} and the foreign dividend-price ratio δ^*_{t+1}. The variables are ordered such that $z_t = [rx_{t+1}, rx^*_{t+1}, rr_{t+1}, \Delta q_{t+1}, \delta^*_{t+1}, ys_{t+1}, \delta_{t+1}]'$.
[7] Again using Γ and ϕ, one can then calculate the different foreign news terms as follows

$$f^T_{t+1} = \Lambda'_2 \epsilon_{t+1} \tag{17}$$

$$f^{rx}_{t+1} = \Lambda'_2 \rho^* \Gamma (I - \rho^* \Gamma)^{-1} \epsilon_{t+1} \tag{18}$$

$$f^{rr}_{t+1} = \Lambda'_3 (I - \rho^* \Gamma)^{-1} \epsilon_{t+1} \tag{19}$$

$$f^q_{t+1} = \Lambda'_4 (1 - \rho^*)(I - \rho^* \Gamma)^{-1} \epsilon_{t+1} \tag{20}$$

$$f^{cf}_{t+1} = f^T_{t+1} + f^{rx}_{t+1} + f^{rr}_{t+1} + f^q_{t+1} \tag{21}$$

Here, we define $\Lambda_2 = [0, 1, 0, 0, 0, 0, 0]'$ to pick rx^* and define Λ_3 and Λ_4 in an analogous fashion.

We need rx^*_{t+1}, rr_{t+1} and Δq_{t+1} to estimate the different news components. All of the other variables should be predictors of foreign stock market returns. The choice of variables in our VAR system for all of the foreign (non-US) stock markets reflects our aim of basing the empirical results for developed and emerging markets on similar VAR systems to make the results comparable. That is why, for example, we do not include foreign markets' yield spreads into the system, because data on government bond yields for a sufficiently long time span are not available for most of the emerging markets in our sample.[8] In addition, based on the advice of Engsted et al. (2012), we include foreign stock markets' dividend-price ratios in the VAR systems to address criticism related to the practice of obtaining cash-flow news indirectly from the VAR, which possibly overstates its importance (Chen and Zhao, 2009). Engsted et al. (2012) show that by including the dividend-price ratio (and thus the stock price) into the VAR system, it does not matter whether cash-flow news or discount rate news is obtained directly from the VAR estimates because the dividend-price ratio incorporates information about the stock price level. The stock price level has to be part of the VAR system because the return decomposition only holds conditional on the stock price itself being a part of the information set. Moreover, we include not only the US stock

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[7] The ordering of the variables does not affect the results.

[8] Including foreign yield spreads for those countries for which these data are available does not affect the qualitative results.

market return but also the US yield spread and the US dividend-price ratio in the VAR system because Rapach et al. (2013) show that US stock market returns predict foreign stock market returns both in sample and out of sample, whereas foreign stock markets do not lead the US stock market. More generally, their results suggest that US financial market variables observed today are informative about future foreign stock market returns but not vice versa.

4.3 The effect of monetary policy surprises

To assess what news components (revisions in expectations) account for the reaction of foreign stock market excess returns to the US monetary policy surprises, we exploit that the error ϵ_{t+1} from our baseline VAR in equation (10) can be decomposed into innovations in monetary policy M_{t+1}^u and innovations related to all possible factors other than monetary policy. This allows us to rewrite equations (17)-(21), which define how we calculate the different news terms, as follows

$$f_{t+1}^T = \Lambda_2'(\phi M_{t+1}^u + \Psi_{t+1}) \tag{22}$$

$$f_{t+1}^{rx} = \Lambda_2'\rho^*\Gamma(I - \rho^*\Gamma)^{-1}(\phi M_{t+1}^u + \Psi_{t+1}) \tag{23}$$

$$f_{t+1}^{rr} = \Lambda_3'(I - \rho^*\Gamma)^{-1}(\phi M_{t+1}^u + \Psi_{t+1}) \tag{24}$$

$$f_{t+1}^q = \Lambda_4'(1 - \rho^*)(I - \rho^*\Gamma)^{-1}(\phi M_{t+1}^u + \Psi_{t+1}) \tag{25}$$

$$f_{t+1}^{cf} = f_{t+1}^T + f_{t+1}^{rx} + f_{t+1}^{rr} + f_{t+1}^q \tag{26}$$

The effect of US monetary policy surprises on the foreign excess stock market return (e.g., total news f_{t+1}^T) becomes

$$\Lambda_2'\phi. \tag{27}$$

The sources that account for this stock market reaction are the effects of US monetary policy surprises on the news terms that reflect revisions about the discounted sums of expected future excess returns, real interest rates, real exchange rate changes, and cash flows. The response of excess return news to US monetary policy surprises is

$$\Lambda_2'\rho^*\Gamma(I - \rho^*\Gamma)^{-1}\phi, \tag{28}$$

the response of real interest rate news is

$$\Lambda_3'(I - \rho^*\Gamma)^{-1}\phi, \tag{29}$$

the response of real exchange rate news is

$$\Lambda_4'(1 - \rho^*)(I - \rho^*\Gamma)^{-1}\phi, \tag{30}$$

and finally, the response of cash-flow news is

$$\left[\Lambda_2' + \Lambda_2'\rho^*\Gamma(I - \rho^*\Gamma)^{-1} + \Lambda_3'(I - \rho^*\Gamma)^{-1} + \Lambda_4'(1 - \rho^*)(I - \rho^*\Gamma)^{-1}\right]\phi. \tag{31}$$

To make inferences on the responses of foreign stock markets' news components to US monetary policy surprises, we employ a bootstrap procedure. We need to take into account that the news terms are estimated variables and depend on the VAR parameters. Moreover, the regression in equation (11) uses monetary policy surprises as regressors generated by a separate estimation. We need to take this, additional uncertainty into account as well. The details are presented in section 6 and in appendix C.

5 Data

Our empirical assessments are based on data measured at monthly frequency.[9] The US monetary policy surprises are identified through a high-frequency analysis of various US financial market prices in a narrow time window (30 minutes) around FOMC announcements (Gürkaynak et al., 2005; Swanson, 2020). These surprises are measured on the day of the FOMC announcement, and they are, by construction, orthogonal to each other. To perform the VAR-based decompositions, we have to convert these event-day data into periodic time series data at the monthly frequency. To do so, we follow Romer and Romer (2004) and Gertler and Karadi (2015) and first calculate the cumulative daily surprise series. In a second step, we take monthly averages of these series. The first differences (month by month) of these series are our monthly measures of US monetary policy surprises. A negative value of a surprise series reflects surprisingly looser monetary policy in that particular dimension of the monetary policy stance. Monetary policy is then more expansionary than expected. The surprise series are estimated for the period from July 1991 to June 2019 (Swanson, 2020) distinguishing between surprises related to the level of the fed funds rate, those related to forward guidance for the fed funds rate's future path, and those related to the LSAP. Figure (1) presents the

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[9]In principle, one could run the VARs at daily frequency. However, to perform our preferred decomposition of unexpected stock market returns, one has to directly include real interest rates and real exchange rates into the VAR system. One needs consumer price indices (CPI) to compute these variables. The highest frequency at which CPI data are available is monthly.

time series of the monthly surprises series, which all have a mean of 0 and standard deviation of 1. According to Swanson (2020), a one-standard-deviation change in the fed funds rate surprise factor can be thought of as an 8.4-basis-point surprise change in the Fed funds rate, a one-standard-deviation change in the forward guidance surprise factor corresponds to a 6-basis-point change in the 4-quarters-ahead Eurodollar futures rate, and a one-standard-deviation change in the LSAP surprise factor roughly corresponds to a 215 billion USD surprise LSAP announcement.[10]

[Figure 1 about here]

We use end-of-month values of USD-denominated MSCI stock market indices to compute log returns on the 40 developed and emerging economies' stock markets in our sample. Using end-of-month values helps to ensure that the (monthly) monetary policy surprises occur before the monthly stock return reaction. We use the MSCI classification to distinguish between developed and emerging markets. Furthermore, inclusion in MSCI market indices requires the stock to fulfil certain quality criteria and the opportunity for both domestic and foreign investors to invest in it. Therefore, using the MSCI indices allows us to directly compare evidence for developed markets with evidence for emerging markets. Table (1) provides an overview of the economies under study and the start and end dates of the stock market return data.

The MSCI indices are also used to compute log dividend-price ratios. We compile the log dividend-price ratio as the log of the sum of monthly dividends over the past year minus the log of this month's MSCI price index. Dividend series are obtained from the difference between the returns on the MSCI gross (i.e., total return) index and the returns on the MSCI price index. The MSCI indices are available on the MSCI website.

Excess returns are the difference between the log stock market return and the one-month US treasury bill rate. The US yield spread is defined as yield on ten-year US government bonds minus the one-month treasury bill rate. US real interest rates are calculated as the one-month treasury bill rate in t minus realized consumer price inflation in month t. Real USD exchange rates are constructed from nominal, bilateral USD exchange rates measured at the end of the month and monthly consumer price indices. The source for the exchange rate, interest rate and consumer prices series is the IMF's International Financial Statistics.

[Table (1) about here]

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[10]For more details see appendix B.

6   Empirical results

This section presents our main results. We start with the evidence from country-level VARs. The discussions of the results focus on foreign stock markets but we present the results for the US as a benchmark for the developed markets as well. Appendix A additionally provides a summary of the main results of the VAR estimations. The second subsection shows the corresponding results from a panel analysis.

6.1   US monetary policy surprises and stock market news: country-level evidence

6.1.1   Full sample period: July 1991 to June 2019

This section presents the empirical assessment of the link between the different components of the unexpected stock market returns of the 40 countries under study and US monetary policy surprises over our sample period.

Tables (2) and (3) contain the estimates of the effects of US monetary policy surprises on the different news series defined in equations (27)-(31) for every country. These estimates are obtained by running equation (11) separately for each country. Statistical significance is assessed using an error resampling bootstrap procedure applied to equation (11). The appendix C provides more details on the bootstrap procedure.

The responses of the total unexpected variation in the returns on stock markets of developed economies to federal funds rate surprises have the expected sign (left panel of table (2)). A surprisingly lower fed funds rate is associated with an upward revision of expected returns. However, these responses are imprecisely measured and only significant for four countries.

Nonetheless, the estimates show that fed funds rate surprises affect the stock markets of 14 out of 21 developed economies through US real interest rate news. A lower than expected Fed funds rate leads to downward revisions of future real interest rate levels, which boosts stock prices and returns through lowering the discount rate of future cash flows. This finding is in line with the textbook view of how conventional monetary policy affects asset prices. It is also in line with the use of US interest rates as an approximation of a world interest rate because we find this effect for the majority of developed markets (Akinci, 2013; Uribe and Yue, 2006). As seen from the left panel of table (2), the impact of a one-standard-deviation surprise decline in the fed funds rate varies between 0.3% (New Zealand) and 1%

p.a. (Switzerland). Using the metrics of the size of surprises from Swanson (2020), this finding implies that a surprise lowering of the fed funds rate by 25 basis points (bp) translates into a 0.9% to 3% p.a. increase in unexpected, monthly foreign stock market returns.[11]

The responses of expected future cash flows or future excess returns are larger than the real interest rate news reaction, but there is no evidence of statistical significance. This finding explains why total stock market return news appears to be unrelated to the fed funds rate surprises. Moreover, real exchange rate news appears to be unrelated to the fed funds rate surprises as well.

Similar to the federal funds rate surprises, surprisingly accommodative forward guidance tends to be associated with unexpectedly high excess returns on developed stock markets. However, the statistical significance is weak. In addition, there is no clear pattern when we zoom in on the responses of the different return news components to forward guidance surprises.

LSAP surprises constitute cash-flow news, i.e., they affect expectations about economic growth. For 15 out of the 21 developed markets, the responses of the cash-flow news have the expected negative sign, i.e., higher than expected large-scale asset purchases increase expected stock market returns because investors interpret LSAP surprises as positive signal for future economic growth. This result also means that LSAP surprises have persistent effects on foreign stock market returns. They influence revisions in expectations about the entire future stream of dividends. Interestingly, LSAP surprises also influence foreign stock market returns through real interest rate news. These responses, however, exhibit a counterintuitive sign. Looser than expected LSAP are associated with higher expected real interest rates and thus lower future returns. This observation could reflect that surprisingly accommodative LSAP are associated with a more positive economic outlook (cash-flow news) and thus higher expected real interest rates because agents desire to smooth consumption over time. This finding highlights the multifaceted nature of the impact of each US monetary policy surprise on foreign stock markets. Overall, however, looser than expected LSAP today leads to positive unexpected foreign stock market returns.

[about here Table (2)]

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[11]Table (2) gives the coefficients in terms of a one-unit surprise in the Fed funds rate, which corresponds to an 8.4bp change in the first fed funds rate futures contract. Thus, to calculate the effect of a lowering of the fed funds rate by 25 bp, the coefficients in the first five columns must be multiplied by 3. See appendix B for more details on Swanson's (2020) metric of the size of the monetary policy surprises.

The full sample evidence for emerging markets is similar to that for developed markets. Overall, surprisingly loose US monetary policy tends to be associated with positive unexpected excess returns on stock markets of emerging economies.

We find significant responses of total unexpected return variation to federal funds rate surprises for 8 out of 19 countries. The channels are real interest rate news and cash-flow news. Moreover, LSAP surprises transmit to unexpected stock market returns of emerging markets through cash-flow news. However, both forward guidance and LSAP surprises again affect foreign stock markets through real interest rate news with the "wrong" sign. As discussed before, the LSAP response of real interest rate news could reflect more positive expectations of future growth (cash-flow news), which lead to the expectations of higher real interest rate in the future. The link between FG surprises and real interest rate news could reflect the information effect of Fed communication (Nakamura and Steinsson, 2018). According to the information effect, surprisingly expansionary forward guidance is a bad signal about future economic prospects. If precautionary savings motives rather than the desire to smooth consumption over time dominate, then investors revise their expectations about future real interest rates levels upwards. Hence, even though the responses of real interest rate news to FG and LSAP surprises have the same sign, the economic interpretation to make sense of these responses markedly differ.

[about here Table (3)]

In sum, the evidence presented in this section highlights that the different types of US monetary policy surprises primarily affect foreign stock markets through altering expectations about economic growth (cash-flow news) and future real interest rates. We next check whether the responses of unexpected variation in stock market returns to the monetary policy surprises vary across subsample periods. We divide the subsamples based on the prevalence of the different policy measures of the Fed.

6.1.2 The pre-ZLB period: July 1991 to December 2008

This section presents our estimates of the responses of different return news components to US monetary policy surprises for the sample period before the fed funds rate hit the zero lower bound. Tables (4) and (5) present the results for developed and emerging markets respectively. The estimates are obtained by estimating equation (11) for the specific subsample period.

The estimates for the developed markets broadly corroborate the pattern obtained over the full sample period. Federal funds rate surprises and forward guidance surprises tend to represent good news for foreign stock market returns. Federal funds rate surprises are mainly associated with real interest rate news, while there is no clear pattern for forward guidance surprises. However, the statistical significance of the estimates is lower than for the full sample results.

[about here Table (4)]

In our sample of emerging markets, the responses of unexpected stock market returns to US monetary policy surprises are broadly similar to those in their developed market counterparts. Surprisingly loose US monetary policy seems to be good news for stock markets. However, the estimates are even more imprecisely measured than in the case of developed markets.

[about here Table (5)]

6.1.3 The ZLB period: January 2009 to October 2015

The responses of developed and emerging markets to US monetary policy surprises in the period from January 2009 to October 2015 show clear differences from those in the previous period of conventional monetary policy.

Table (6) presents the sensitivities to US forward guidance and LSAP surprises for the different stock return news components of the developed markets under study. These results suggest that forward guidance surprises in the ZLB period are primarily associated with real interest rate news. We find a statistically significant link for all developed markets, but the responses show the "wrong" (negative) sign. This observation is also reflected in the positive estimates of the responses of total return news. These estimates could reflect the information effect of the Fed's monetary policy communication (Nakamura and Steinsson, 2018). According to the information effect, Fed communication of tightening (loosening) monetary policy constitutes good (bad) news about the economic outlook. As a response to this unexpectedly deteriorated outlook, real interest rate expectations rise because of precautionary savings motives.

By contrast, the overwhelming majority of the stock market returns of developed markets react to LSAP surprises with the expected sign and in a statistically significant way. Surprisingly loose monetary policy, in the form of more asset purchases than expected, is associated with an increase in unexpected foreign stock market returns. This finding applies to 16 of the 21 developed economies in our

sample and the significant responses to a surprise one-standard-deviation change in LSAP range from 10% p.a. to 34% p.a. LSAP surprises influence foreign stock markets through cash-flow news, i.e., news about economic growth. This finding supports Swanson (2020), who argues that LSAP represents more than just the Fed's commitment to its forward guidance. This result also means that LSAP surprises have persistent effects on foreign stock market returns. They influence revisions in expectations about the entire future stream of dividends.

[about here Table (6)]

We observe similar patterns in our sample of emerging markets (see table (7)). Forward guidance surprises are associated with real interest rate news. The sizes of the real interest rate news responses to forward guidance surprises are comparable to those of the responses reported for developed markets. They also exhibit the "wrong" sign.

LSAP surprises also constitute good news for emerging markets' stock returns and influence stock markets through revisions in expectations about future cash flows. Finally, we find a statistically significant association between LSAP surprises and emerging stock markets' real exchange rate news. However, revisions in expectations about future real exchange rates contribute little to the overall variation in unexpected stock market returns (see the brief summary in appendix A). This does not mean that the impact of US monetary policy on the real exchange rates of emerging markets is unimportant per se. It is simply relatively small in the context of the stock market return decomposition presented in this paper.

[about here Table (7)]

6.1.4 The post-ZLB period: November 2015 to June 2019

The post-ZLB results for developed markets are broadly in line with the full sample results (Table (8)). Federal funds rate surprises primarily affect unexpected variation in foreign stock market returns because these surprises constitute real interest rate news. We also observe forward guidance surprises being associated with real interest rate news. Again, the responses to the forward guidance surprises have the opposite sign compared with the responses to federal funds rate surprises. LSAP surprises do not significantly affect unexpected varation in foreign stock market returns.

[about here Table (8)]

21

We observe similar patterns in our sample of emerging markets (Table (9)). Federal funds rate surprises affect emerging stock markets with the expected sign and are associated with revisions in expectations about future real interest rates. Forward guidance surprises constitute real interest rate news as well, but push unexpected foreign stock market returns in the opposite direction. LSAP surprises have no significant impact on stock market return news of emerging economies.

[about here Table (9)]

6.2 US monetary policy surprises and stock market news: evidence from panel VARs

The country-level VAR in (11) allowed us to back out country-specific news terms. In order to focus on the average effects of US monetary policy suprises on both developed and emerging markets and to improve the precision of estimates of the sensitivities of the return news to monetary policy surprises, we follow Vuolteenaho (2002) in estimating a pooled-panel VAR. This panel VAR pools the data used in country-level VARs and stacks them into a VAR of the following structure:

$$\begin{bmatrix} z_{i,t+1} \\ x_{us,t+1} \end{bmatrix} = \Gamma \begin{bmatrix} z_{i,t} \\ x_{us,t} \end{bmatrix} + \phi M_{t+1}^u + u_{i,t+1} \tag{32}$$

where index i represents a specific non-US country. The vector $z_{i,t}$ consists of the three country-specific endogenous variables, while the vector $x_{us,t}$ consists of four exogenous US variables.[12] We restrict the coefficients in Γ to be homogenous across markets. Given this restriction, the news term decomposition is the same, irrespective of whether we estimate a country-specific VAR or the panel VAR. We run the panel VAR estimations for the two samples of developed and emerging markets separately.

In addition, as a robustness check, we report results based on a different US monetary policy surprise series proposed by Bu et al. (2020).[13] These authors use the whole term structure of US government bond yields to extract a single measure of US monetary policy shocks. Unlike the policy surprise measures of

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[12]The country-specific endogenous variables are (1) the foreign stock market excess return rx_{t+1}^*, (2) the change in the log real exchange rate Δq_{t+1} and (3) the foreign dividend-price ratio δ_{t+1}^*. The four exogenous US variables are (1) the US excess return rx_{t+1}, (2) the US real interest rate rr_{t+1}, (3) the US yield spread ys_{t+1} and (4) the dividend-price ratio δ_{t+1}.

[13]We also repeated our country-level estimations with the Bu et al. (2020) single US monetary policy shock. The general conclusions from this assessment corroborate the results from the panel analysis. The country-level results with the Bu et al. (2020) monetary policy shock are available upon request.

Swanson (2020), their single monetary policy shock series (abbreviated BRW) does not contain any feature that could be interpreted as reflection of the information effect of Fed communication. The downside of this measure is that, in contrast to the Swanson (2020) monetary policy surprises, we cannot distinguish between the difference facets of US monetary policy.

Table (10) summarizes the main results from the panel VARs with one lag.[14] The upper panel presents the results for the developed markets. The panel estimates show that all three monetary policy surprises from Swanson (2020) significantly affect unexpected variation in foreign stock market returns. In addition, the estimates in the column "total" show that looser than expected monetary policy in the US increases expectations of foreign stock market returns.

A one-standard-deviation surprise decline in the federal funds rate is associated with a 4.3% p.a. increase in monthly unexpected stock market returns over the entire sample period. More than 10% of this effect can be attributed to real interest rate news and one third to revisions in expectations about future excess returns. Again using the metrics of the size of surprises from Swanson (2020), this estimate translates into an increase in monthly, unexpected foreign stock market returns of 12.9% p.a. as response to a surprise lowering of the fed funds rate by 25 bp. This finding seems to be mostly driven by the pre-ZLB period. In the post-ZLB period, our panel estimates suggest that federal funds rate surprises are mainly associated with real interest rate and real exchange rate news, but do not affect unexpected variation in foreign stock market returns in a statistically significant way.

According to the metrics provided by Swanson (2020), a forward guidance surprise that leads to a surprise 25 bp decline in the expected fed funds rate one-year ahead is associated with an increase in unexpected, monthly returns on foreign stock markets by 16.6% p.a. over the full sample period. Forward guidance surprises affect foreign stock markets predominantly because of their association with cash-flow news. This is one difference to the country-level results presented in the previous subsections, in which we do not find a significant association of forward guidance surprises with cash-flow news, i.e., economic growth news. The subsample analysis additionally highlights that looser than expected forward guidance constituted bad news for foreign stock markets in the ZLB period and primarily transmitted through revisions in expectations of future excess returns. This could be evidence for the finding that financial market participants respond to risk assessments in central bank communication (e.g., Cieslak and Schrimpf, 2019). Looser

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[14]The qualitative results do not depend on reasonable variation of the lag length. The results are available upon request.

than expected forward guidance might thus reflect a more negative risk assessment of the Fed, leading to upwards revisions in expectations about future excess returns (risk premia). The results in table (10) also indicate that these risk premia news become more important over time in explaining variation in excess stock return. This observation could reflect that global financial intermediaries have increasingly played a key role in international lending and the associated international credit channel of US monetary policy transmission. An increase in the US policy rate raises funding costs of these intermediaries and impairs their balances sheets. This has negative effects on lending conditions and real economies abroad. Hence, the value of risky assets fall and risk premia rise.

The panel results further corroborate that LSAP surprises affect returns on developed stock markets because they represent cash-flow news. This finding is most pronounced in the ZLB period. In the post-ZLB period, the sensitivity of the expected return news to LSAP surprises exhibit the "wrong" sign. Again, this finding could be evidence of financial market reactions to the risk assessment of the Fed.

The lower panel of table (10) reports the corresponding results for the panel of emerging markets. The full sample results are similar to the evidence for developed markets but suggest that emerging markets' stock returns react more sensitively to US monetary policy surprises. This is particularly true for federal funds rate surprises.

In addition, the panel estimates highlight that federal funds rate surprises influence cash-flow news in both the pre-ZLB period and the post-ZLB period. Moreover, both forward guidance surprises and LSAP surprises affect emerging stock markets through cash-flow news and expected return news. Furthermore, we also observe the "wrong" sign of emerging markets' stock return responses to forward guidance surprises in the ZLB period because of expected return news. As for developed markets, this finding suggests that the Fed's forward guidance entailed non-monetary information, such as its risk assessment, to which emerging countries' stock markets reacted.

Finally, the estimates highlight that US monetary policy surprises are associated with revisions in expectations about future real exchange rates. Even though real exchange rate news only explains a small proportion of the unexpected variation in stock market returns, this does not necessarily mean that the overall exchange rate effects of US monetary policy surprises on emerging markets are negligible.

[about here Table (10)]

24

Taken together, the results from the panel VARs corroborate the main findings from the country-level estimations and additionally highlight that LSAP represent more than commitment to forward guidance because forward guidance and LSAP surprises during the zero lower bound period influenced foreign stock markets through different channels (news about excess returns versus cash-flow news) and in opposite directions.

The rows with heading "BRW" present the sensitivities of the unexpected stock market return components to the Bu et al. (2020) US monetary policy shock. The estimates corroborate the impression that US monetary policy surprises have persistent effects on foreign stock markets. The BRW shock tends to be associated with cash-flow news. Moreover, these results confirm that looser than expected US monetary policy constitutes good news for foreign stock markets. Furthermore, the estimates highlight two additional interesting findings. First, in the ZLB period, there is no evidence that BRW shocks are associated with bad news for foreign stock markets. Since this monetary policy shock series does not include any information effect, in contrast to the Swanson (2020) forward guidance and LSAP surprise series (Bu et al., 2020), these estimates suggest that indeed expansionary US monetary policy surprises constitutes good news during the ZLB. Bauer and Swanson (2020) argue that such stock market reactions are inconsistent with an information effect. Second, we do observe the "wrong" sign of the sensitivity of unexpected stock market returns of developed markets to the BRW shock in the post-ZLB period. However, answering the question of whether this observation is consistent with financial markets reacting to non-monetary components of central bank communication (Cieslak and Schrimpf, 2019; Jarocinski and Karadi, 2020; Nakamura and Steinsson, 2018) or a reflection of both Fed and private agents reacting to economic news (Bauer and Swanson, 2020) is beyond the scope of this paper.

7   Conclusions

This paper has used a VAR-based decomposition of unexpected variation in the stock market returns of developed and emerging markets into different news components to assess why foreign stock markets react to US monetary policy surprises. We distinguish between surprises related to the federal funds rate, the Fed's forward guidance and its large-scale asset purchases.

Our main results highlight that US monetary surprises influence foreign stock markets through their impact on cash-flow news, i.e., they lead to revisions in

expectations about economic growth. This finding also means that US monetary policy surprises have persistent effects on foreign stock markets because they affect the expectations about the entire stream of dividends. Furthermore, we find that the responses of real interest rate news to forward guidance and LSAP surprises exhibit a counterintuitive sign. In the case of forward guidance surprises, this observation seems to reflect the information effect of US monetary policy. In the case of LSAP surprises, this observation seems to reflect the implications of an unexpectedly positive or negative economic outlook on real interest rate expectations. Moreover, our results suggest that LSAP constitutes more than just commitment to forward guidance. This finding is most clearly visible during the ZLB period when forward guidance and LSAP surprises affected unexpected foreign stock market returns through different channels and in different directions.

The main results of this paper are in line with theory and evidence of a global financial cycle, that is influenced by US monetary policy and affects risky asset prices worldwide. This observation raises the question of whether the effects of US monetary policy surprises on foreign stock markets are stronger or weaker than local monetary policy surprises. Answering this question is beyond the scope of this paper, but shedding light on this issue could help to assess constraints on domestic monetary policy due to the global financial cycle. This question is of particular interest for the emerging markets under study and a fruitful avenue for future research.

Declaration of Interest

Declaration of interest: none.

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Tables

Table 1: Country overview and sample dates

Developed stock markets			
country	acronym	start date	end date
United States of America	USA	July 1991	June 2019
Australia	AUS	July 1991	June 2019
Austria	AUT	July 1991	June 2019
Belgium	BEL	July 1991	June 2019
Canada	CAN	July 1991	June 2019
Denmark	DNK	July 1991	June 2019
Finland	FIN	July 1991	June 2019
France	FRA	July 1991	June 2019
Germany	DEU	July 1991	June 2019
Ireland	IRL	July 1991	June 2019
Israel	ISR	February 1993	June 2019
Italy	ITA	July 1991	June 2019
Japan	JPN	July 1991	June 2019
Netherlands	NLD	July 1991	June 2019
Norway	NOR	July 1991	June 2019
Portugal	PRT	July 1991	June 2019
Spain	ESP	July 1991	June 2019
Sweden	SWE	July 1991	June 2019
Switzerland	CHE	July 1991	June 2019
United Kingdom	GBR	July 1991	June 2019
Emerging stock markets			
Brazil	BRA	July 1991	June 2019
Chile	CHL	July 1991	June 2019
Colombia	COL	February 1993	June 2019
Czech Republic	CZE	May 1995	June 2019
Egypt	EGY	April 1995	June 2019
Greece	GRC	July 1991	June 2019
Hungary	HUN	June 1995	June 2019
India	IND	February 1993	June 2019
Indonesia	IDN	July 1991	June 2019
Korea	KOR	July 1991	June 2019
Malaysia	MYS	July 1991	June 2019
Mexico	MEX	July 1991	June 2019
Pakistan	PAK	March 1993	June 2019
Peru	PER	February 1993	June 2019
Philippines	PHL	July 1991	June 2019
Poland	POL	May 1993	June 2019
South Africa	ZAF	February 1993	June 2019
Thailand	THA	July 1991	June 2019
Turkey	TUR	July 1991	June 2019

Table 2: Reaction of stock market news to US monetary policy surprises from 1991 to 2019: developed markets

	Fed funds rate surprise					Forward guidance surprise				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
USA	-4.14	-0.82	2.66	0.65*		0.32	-0.73	-0.43	-0.62*	
AUS	-4.46	-1.56	2.15	0.61*	0.14*	-7.14*	-5.24	1.71	0.00	0.19*
AUT	-0.99	-0.73	-0.28	0.57	-0.03	-7.62	-9.63*	-1.52	-0.54	0.05
BEL	-2.76	-0.91	1.69	0.17	-0.02	-5.07	-7.03	-1.61	-0.41*	0.07
CAN	-7.85**	-5.65	1.64	0.52*	0.05	-2.40	-2.84	0.06	-0.58	0.08**
DNK	-7.29*	-9.88*	-2.50	-0.08	-0.01	-0.80	-2.41	-1.02	-0.62*	0.04
FIN	-1.80	2.18	3.40	0.67**	-0.08	-2.68	-6.87	-3.80	-0.49	0.10
FRA	-5.00	-0.32	4.27	0.46	-0.04	-2.03	-4.13	-1.64	-0.53	0.07
DEU	-3.56	-0.82	2.13	0.64*	-0.03	0.54	-2.45	-2.50	-0.54	0.06
IRL	-6.29	-5.09	0.64	0.60*	-0.03	-5.76	-9.39	-3.26	-0.43*	0.07
ISR	-8.64*	-6.32	1.90	0.50	-0.07	2.23	0.94	-0.65	-0.62*	-0.02
ITA	-3.17	-2.12	0.63	0.41*	0.01	-2.85	-4.56	-1.32	-0.50	0.11*
JPN	-2.02	-2.86	-1.61	0.75***	0.03	-4.38	-1.37	4.18	-1.17**	0.00
NLD	-3.74	-0.77	2.70	0.30	-0.03	-3.73	-5.05	-0.86	-0.55*	0.10
NZL	-3.00	-2.66	-0.11	0.32*	0.12	-10.88***	-9.32**	1.76	-0.27	0.06
NOR	-7.76	-6.53	0.75	0.46	0.02	-5.28	-5.90	-0.34	-0.39	0.11
PRT	-1.25	1.44	2.34	0.35	0.00	-2.08	-4.11	-1.76	-0.42	0.15
ESP	-4.09	-0.73	2.97	0.44*	-0.05	-1.85	-3.73	-1.58	-0.43	0.14
SWE	-9.04*	-6.76	1.59	0.67***	0.02	1.45	1.05	-0.04	-0.43	0.07
CHE	-0.24	2.61	1.90	0.98**	-0.02	-4.36	-4.92	0.14	-0.75	0.04
GBR	-3.01	-0.58	1.99	0.44**	0.00	-3.34	-4.08	-0.38	-0.43	0.06

	LSAP				
	Total	CF	ER	RIR	RFX
USA	-5.46*	-5.87**	0.43	-0.84***	
AUS	-3.08	-2.69	0.85	-0.51**	0.04
AUT	-9.02*	-10.85*	-1.05	-0.77**	-0.02
BEL	-7.66**	-7.87**	0.45	-0.65**	0.00
CAN	-5.71	-7.41*	-0.92	-0.80***	0.01
DNK	-5.12	-3.51	1.75	-0.12**	-0.02
FIN	-13.36**	-18.99***	-5.02	-0.64**	0.02
FRA	-6.51*	-8.66***	-1.38	-0.74**	-0.02
DEU	-8.93**	-10.97***	-1.31	-0.72**	-0.01
IRL	-9.23**	-13.77***	-3.85	-0.71**	0.01
ISR	-0.99	-1.90	-0.21	-0.65**	-0.05
ITA	-12.06***	-15.61***	-3.08	-0.56**	0.10
JPN	-3.35	1.13	6.00	-1.46***	-0.07
NLD	-5.26	-6.28**	-0.29	-0.72***	-0.01
NZL	-5.63	-2.23	3.87	-0.53**	0.06
NOR	-3.59	-5.86	-1.71	-0.62**	0.06
PRT	-4.65	-7.22**	-1.99*	-0.61**	0.02
ESP	-6.37	-9.28**	-2.35	-0.61**	0.05
SWE	-9.20**	-8.01**	1.67	-0.54*	0.07
CHE	-3.84	-3.41*	1.12	-0.63**	-0.06
GBR	-3.94	-3.81**	0.74	-0.65***	0.05

Notes: This table presents estimates from equation (27) to (31), i.e., the coefficients that link unexpected variation in stock market returns ("Total") and their components reflecting news about future cash flows ("CF"), expected excess returns ("ER"), expected US real interest rates ("RIR") and USD real exchange rate changes ("RFX") to US monetary policy surprises in the form of fed funds rate, forward guidance and LSAP surprises. The sample period runs from July 1991 or the earliest date for which foreign stock market data are available to June 2019. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. ***, ** and * denote significance of the regression coefficients at the 1%, 5% and 10% level based on the empirical distribution of the VAR coefficients from 10000 bootstrap samples. The coefficient estimates are linked through: Total = CF - ER - RIR - RFX.

Table 3: Reaction of stock market news to US monetary policy surprises from 1991 to 2019: emerging markets

	Fed funds rate surprise					Forward guidance surprise				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
BRA	-14.20*	-8.96	4.73	0.40	0.11	-4.85	-6.64	-1.38	-0.47*	0.07
CHL	-7.54*	-5.85	1.28	0.37	0.05	-1.95	-0.91	1.37	-0.39	0.07
COL	-19.26***	-23.50***	-4.92	0.46	0.22*	-9.05	-6.22	3.27	-0.45*	0.01
CZE	-13.24**	-15.08**	-1.89	-0.01	0.06	-1.87	-2.47	-0.16	-0.51**	0.07
EGY	-7.69	-8.08	-0.51	0.16	-0.03	-4.87	-3.83	1.62	-0.56**	-0.02
GRC	0.38	2.50	1.85	0.34*	-0.07	-9.83	-14.21**	-4.02	-0.48	0.12
HUN	-10.92	-9.14	1.59	0.12	0.06	-3.06	-8.66	-4.77	-0.91**	0.08
IND	-4.43	-2.16	1.59	0.70	-0.02	-4.27	-4.90	-0.02	-0.66	0.05*
IDN	-30.26***	-45.07***	-15.62	0.48*	0.33	-7.71	-3.13	5.05	-0.52*	0.04
KOR	-13.95**	-16.06**	-2.98	0.77*	0.10*	-7.92	-7.10	1.41	-0.62	0.02
MYS	-4.44	-6.06	-2.21	0.56**	0.04	1.19	2.93	2.30	-0.58**	0.01
MEX	-9.42	-9.29	-0.70	0.78*	0.04	-2.46	-2.76	0.38	-0.76*	0.08
PAK	3.44	2.38	-1.13	0.10	-0.03	1.93	0.79	-0.88	-0.32*	0.06
PER	-8.90	-5.87	2.57	0.45	0.01	-12.46**	-11.38	1.68	-0.57*	-0.03
PHL	-11.33**	-4.50	6.62	0.14	0.06	-7.94	-1.95	6.89**	-0.91**	0.02
POL	4.39	3.77	-1.28	0.60	0.06	1.74	-1.13	-2.45	-0.49**	0.07
ZAF	-9.05	-6.97	1.63	0.42	0.03	-8.20	-5.98	2.72	-0.54*	0.05
THA	-12.19*	-13.92*	-2.38	0.55**	0.10	-4.51	-0.19	4.89	-0.53*	-0.04
TUR	-18.49**	-19.89**	-2.05	0.47*	0.17	-7.58	-7.41	0.50	-0.50*	0.17

			LSAP		
	Total	CF	ER	RIR	RFX
BRA	-7.50	-6.32	1.78	-0.65***	0.04
CHL	-3.28	1.01	5.03	-0.71***	-0.03
COL	-4.29	2.95	7.69	-0.55***	0.10
CZE	-13.23**	-9.92*	3.89	-0.67**	0.09
EGY	-15.27**	-13.31*	2.76	-0.79***	-0.02
GRC	-14.25**	-21.36***	-6.38*	-0.72***	-0.01
HUN	-16.71**	-7.79**	9.92	-1.02**	0.02
IND	-6.43	-1.51	5.76	-0.81***	-0.03
IDN	-17.64**	-13.35	4.95	-0.76***	0.11
KOR	-13.99*	-11.56	3.20	-0.83***	0.07
MYS	-9.23*	-6.38	3.61	-0.80***	0.05
MEX	-4.84	-5.78	-0.15	-0.85***	0.06
PAK	-5.95	-1.43	5.04	-0.47***	-0.05
PER	-2.96	2.49	6.00	-0.57***	0.02
PHL	-3.68	5.56	10.36	-1.09***	-0.03
POL	-7.90	-6.93	1.51	-0.63**	0.09*
ZAF	-5.59	0.56	6.64	-0.55**	0.05
THA	-4.31	3.89	8.89	-0.70***	0.01
TUR	-15.57	-12.17	3.86	-0.61***	0.15

Notes: See notes of table 2 for more details

Table 4: Reaction of stock market news to US monetary policy surprises from 1991 to 2008: developed markets

| | Fed funds rate surprise | | | | | Forward guidance surprise | | | | |
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
USA	-4.86*	-0.25	4.04	0.57		-0.79	-0.37	0.52	-0.10	
AUS	-6.13*	-4.27	0.69	0.94*	0.23	-10.04**	-8.87*	-0.02	0.83	0.36***
AUT	-1.21	-4.99	-4.32	0.55	-0.01	-10.88**	-15.23*	-4.60	0.20	0.05
BEL	-3.06	-2.35	0.48	0.22	0.01	-7.43	-8.28	-0.96	0.01	0.11
CAN	-8.04**	-6.29	0.97	0.72	0.05	-3.54	-2.47	0.80	0.17	0.11***
DNK	-7.34**	-11.80	-4.98	0.54**	-0.01	-0.86	-3.62	-2.92	0.09	0.06
FIN	-2.12	4.46	6.02	0.60	-0.04	-4.15	-3.80	0.31	-0.06	0.09
FRA	-4.96	0.13	4.63	0.47	-0.02	-3.92	-3.37	0.37	0.10	0.08
DEU	-3.00	0.17	2.75	0.43	0.00	-1.87	-1.80	0.02	0.01	0.05
IRL	-6.32	-13.35	-7.52	0.43	0.05	-7.76	-19.59	-12.08	0.08	0.16
ISR	-9.16*	-8.03	0.77	0.42	-0.07	0.43	0.15	-0.28	0.02	-0.03
ITA	-2.63	-1.83	0.45	0.35	0.01	-5.00	-4.32	0.73	-0.15	0.11*
JPN	-1.80	-3.39	-2.31	0.70**	0.02**	-5.11	-3.32	1.93	-0.09	-0.05
NLD	-5.61	-1.53	3.80	0.30	-0.02	-4.78	-4.84	-0.18	0.00	0.12
NZL	-2.98	-5.29	-2.88	0.36*	0.21*	-11.42**	-13.29**	-2.26	0.14	0.25
NOR	-7.55	-7.56	-0.55	0.51	0.03	-4.97	-4.78	-0.02	0.12	0.08
PRT	-0.73	0.12	0.50	0.33	0.02	0.16	1.70	1.29	0.09	0.17*
ESP	-3.71	-1.02	2.37	0.36	-0.03	-3.56	-2.60	0.75	0.05	0.17
SWE	-9.85*	-7.34	1.91	0.58***	0.02	0.66	2.40	1.57	0.07	0.09
CHE	-0.52	2.53	2.44	0.61*	0.01	-6.68*	-4.61	2.21	-0.16	0.02
GBR	-3.62	-1.60	1.65	0.28*	0.09	-5.08*	-5.14	-0.06	-0.17	0.17

Notes: This table presents estimates from equation (27) to (31), i.e., the coefficients that link unexpected variation in stock market returns ("Total") and their components reflecting news about future cash flows ("CF"), expected excess returns ("ER"), expected US real interest rates ("RIR") and USD real exchange rate changes ("RFX") to US monetary policy surprises in the form of fed funds rate and forward guidance surprises. The sample period runs from July 1991 or the earliest date for which foreign stock market data are available to December 2008. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. ***, ** and * denote significance of the regression coefficients at the 1%, 5% and 10% level based on the empirical distribution of the VAR coefficients from 10000 bootstrap samples. The coefficient estimates are linked through: Total = CF - ER - RIR - RFX.

Table 5: Reaction of stock market news to US monetary policy surprises from 1991 to 2008: emerging markets

	Fed funds rate surprise					Forward guidance surprise				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
BRA	-12.27	-7.54	4.25	0.35	0.13	-0.64	-0.63	0.10	-0.13	0.04
CHL	-6.05	-5.76	-0.21	0.45	0.06	0.67	1.19	0.53	-0.07	0.05
COL	-16.26***	-21.40**	-5.65	0.33	0.18	-7.44	-7.57	-0.11	-0.03	0.00
CZE	-10.90*	-14.25*	-3.61	0.21	0.04	-3.81	-5.61	-1.80	-0.08	0.07
EGY	-5.73	-7.95	-2.65	0.41	0.01	-4.08	-4.53	-0.37	-0.04	-0.04
GRC	1.83	0.85	-1.16	0.26	-0.08	-8.27	-8.48	-0.39	0.01	0.16
HUN	-10.09	-10.45	-0.74	0.32	0.07	-7.33	-9.01	-1.65	-0.12	0.09
IND	-3.04	-3.94	-1.34	0.46	-0.03	-4.01	-7.28	-3.31	-0.01	0.05
IDN	-29.85***	-54.33***	-25.38	0.52	0.37	-9.45	-11.71	-2.27	-0.07	0.08
KOR	-11.89*	-13.63	-2.48	0.63*	0.11	-6.07	-7.60	-1.46	-0.11	0.03
MYS	-2.87	-4.69	-2.38	0.55*	0.01	3.81	4.75	1.08	-0.12	-0.01
MEX	-9.26	-8.25	0.35	0.63	0.03	-4.45	-4.78	0.01	-0.43	0.09
PAK	4.19	-0.88	-5.12	0.13	-0.09	0.77	-2.09	-2.86	-0.14	0.14
PER	-8.97	-7.64	1.05	0.30	-0.01	-12.31*	-12.06	0.38	-0.08	-0.04
PHL	-11.41*	-2.38	8.57	0.44	0.03	-10.77*	-3.32	7.68*	-0.24	0.01
POL	4.89	3.89	-1.50	0.43	0.06	0.97	-0.71	-1.84	0.10	0.06
ZAF	-9.07	-7.81	0.92	0.30	0.04	-7.85	-6.73	1.09	-0.05	0.07
THA	-12.58	-14.40	-2.44	0.53*	0.09	-5.60	-3.50	2.31	-0.14	-0.06
TUR	-15.75	-19.20	-4.03	0.40	0.18	-7.39	-10.08	-2.83	-0.09	0.23

Notes: See notes of table 4 for more details.

Table 6: Reaction of stock market news to US monetary policy surprises from 2009 to 2015: developed markets

	Forward guidance surprise					Large scale asset purchases				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
USA	19.27**	5.00	-13.01	-1.26***		-12.86***	-11.13***	1.38	0.35	
AUS	11.41	0.80	-10.33	-0.29**	0.01	-10.88*	-0.23	10.63	0.08***	-0.06
AUT	29.42	-5.30	-33.69	-1.14***	0.11	-23.22**	-16.65**	6.25	0.31	0.01
BEL	20.35*	0.02	-19.33	-1.07***	0.08	-13.71**	-8.02**	5.53	0.10	0.07
CAN	15.35*	6.76	-7.59	-0.86**	-0.13	-10.81**	-2.42***	8.18	0.27	-0.05*
DNK	22.65	2.20	-19.61	-0.93***	0.09	-19.43*	-19.35**	-0.43	0.48	0.03
FIN	29.23	6.24	-22.02	-1.10***	0.13	-33.91***	-37.49***	-3.93	0.29	0.06
FRA	28.75*	3.29	-24.39*	-1.09***	0.02	-19.39**	-16.44**	2.65	0.30	0.00
DEU	38.22**	11.70	-25.32*	-1.23***	0.03	-24.93***	-25.95***	-1.39	0.34	0.04
IRL	25.26	-0.29	-24.23	-1.33***	0.01	-23.99**	-21.85**	1.72	0.37	0.06
ISR	20.60	3.26	-16.19	-1.27***	0.11	-4.83	-1.48	3.11	0.37	-0.12
ITA	42.18**	6.73	-34.32**	-1.13***	0.00	-30.60***	-29.70**	0.42	0.32	0.16
JPN	3.68	4.20	1.59	-1.08***	0.01	-4.62	-4.20	0.10	0.30	0.02
NLD	30.70**	2.94	-26.71*	-1.17***	0.11	-19.30**	-17.55**	1.38	0.25	0.11
NZL	5.12	-1.74	-6.16	-0.86***	0.16	-6.85	-2.94**	3.90	0.20	-0.19*
NOR	0.96	-9.71	-11.15	0.24***	0.25	-10.27	-1.09*	9.29	-0.02	-0.09
PRT	6.40	-13.14	-18.47	-1.05***	-0.02	-7.02	-2.82	3.84	0.25	0.11
ESP	37.01*	2.60	-33.65*	-1.01***	0.24	-26.27***	-14.47**	11.40	0.34	0.06
SWE	22.65*	1.19	-20.38	-1.04***	-0.04	-19.52***	-4.16***	15.21	0.06	0.09***
CHE	17.98*	4.33	-12.82	-0.99***	0.17	-10.16*	-8.13**	1.90	0.21	-0.08
GBR	15.21	-0.18	-15.20	-0.23**	0.04	-11.78**	-4.10**	7.33	0.44	-0.09

Notes: This table presents estimates from equation (27) to (31), i.e., the coefficients that link unexpected variation in stock market returns ("Total") and their components reflecting news about future cash flows ("CF"), expected excess returns ("ER"), expected US real interest rates ("RIR") and USD real exchange rate changes ("RFX") to US monetary policy surprises in the form of forward guidance and LSAP surprises. The sample period runs from January 2009 to October 2015. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. ***, ** and * denote significance of the regression coefficients at the 1%, 5% and 10% level based on the empirical distribution of the VAR coefficients from 10000 bootstrap samples. The coefficient estimates are linked through: Total = CF - ER - RIR - RFX.

Table 7: Reaction of stock market news to US monetary policy surprises from 2009 to 2015: emerging markets

	Forward guidance surprise					Large scale asset purchases				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
BRA	4.69	-0.70	-4.76	-0.72***	0.09	-15.05*	4.89***	20.07	0.22	-0.35
CHL	9.42	4.11	-4.75	-0.74***	0.18	-8.87	-0.31*	8.61	0.07	-0.12
COL	13.80	8.85	-3.41	-1.27***	-0.28	-10.57	13.36**	23.56	0.37	0.00**
CZE	44.94***	28.38	-15.24	-1.20***	-0.12	-36.93***	-36.74***	-0.51	0.51	0.18*
EGY	9.13	6.17	-1.70	-1.20***	-0.05	-17.00*	-9.33***	7.23	0.44	0.01*
GRC	47.45	-13.96	-60.62	-1.08***	0.30	-37.61**	-20.61**	16.68	0.30	0.03
HUN	33.91	-9.12	-42.00	-1.04***	0.01	-30.43*	-18.04***	11.83	0.42	0.14**
IND	24.85	-1.18	-24.71	-1.40***	0.08	-15.76*	5.43**	20.69	0.54	-0.04
IDN	28.30*	13.03*	-14.08	-1.21***	0.02	-21.56***	0.25***	21.66	0.17	-0.02*
KOR	23.97	1.91	-20.64	-1.43***	0.01	-34.43***	-20.12**	13.33	0.83	0.15**
MYS	2.85	-0.53	-2.62	-0.86***	0.10	-13.00**	8.78***	22.03	-0.13	-0.11
MEX	20.05	4.97	-14.10	-0.93***	-0.06	-11.45*	0.15***	11.48	0.12	0.00*
PAK	12.86	-0.78	-12.50	-0.98***	-0.16	-9.79	3.85	13.37	0.19	0.09
PER	-9.02	-11.83	-1.42	-1.23***	-0.16**	-6.96	11.58*	18.12	0.29	0.12***
PHL	9.61	8.50	0.22	-1.27***	-0.05	-5.33	-0.70	4.03	0.56	0.04
POL	35.75*	7.67	-26.90	-1.11***	-0.07	-30.47***	-21.34***	8.51	0.35	0.27**
ZAF	8.42	2.63	-4.88	-0.82***	-0.10	-14.75**	-3.45***	11.28	0.13	-0.10**
THA	18.23	13.51	-3.59	-1.09***	-0.04	-11.03	-0.30**	10.48	0.26	-0.01
TUR	31.93*	7.25	-23.19	-1.34***	-0.15	-24.55**	-11.71***	12.41	0.31	0.13**

Notes: See notes of table 6 for more details

Table 8: Reaction of stock market news to US monetary policy surprises from 2015 to 2019: developed markets

	Fed funds rate surprise					Forward guidance surprise				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
USA	24.78	15.90	-15.46	6.58***		7.19	-1.96	-7.45	-1.70**	
AUS	-7.85	14.86	14.25	5.62***	2.85	-0.20	-6.41	-5.56	-0.68	0.02
AUT	-47.96	-207.40*	-169.21*	7.78***	2.00	-2.14	19.34	22.77	-1.18**	-0.12
BEL	33.25	31.62	-8.72	5.35**	1.73	6.73	0.71	-5.32	-0.70**	0.01
CAN	-15.10	-18.11	-8.19	4.35***	0.82	3.39	-8.85	-11.02	-1.25**	0.03
DNK	5.85	34.30	25.14	2.71	0.60	0.16	10.92	12.38	-1.44***	-0.18
FIN	64.38*	-32.11	-103.25*	4.94***	1.82	0.51	12.84	13.51	-1.08***	-0.10
FRA	3.54	-29.16	-39.64	5.26***	1.68	3.07	-2.39	-4.15	-1.16**	-0.15
DEU	8.25	-30.03	-45.15	5.55***	1.33	6.72	0.37	-5.02	-1.22*	-0.11
IRL	77.96*	39.64	-46.31	6.80**	1.19	4.36	-3.42	-5.93	-1.69**	-0.17
ISR	124.37*	3.68	-127.98	6.93***	0.36	3.28	10.96	9.12	-1.44	0.00
ITA	-1.14	-8.11	-14.09	5.45***	1.66	14.10	-0.52	-13.41	-1.03**	-0.18
JPN	12.93	-12.84	-28.79	3.53**	-0.51	11.68	4.62	-5.60	-1.50**	0.04
NLD	21.44	-9.16	-37.82	5.75***	1.46	0.99	-0.95	-0.37	-1.41**	-0.15
NZL	36.05	7.84	-33.56	4.39***	0.95	-12.35	-16.94	-3.44	-0.96***	-0.19
NOR	-33.65	-44.76	-18.68	5.57***	2.00	17.93	2.69	-14.38	-0.98	0.12
PRT	0.10	-36.39	-44.17	4.88***	2.80*	-8.40	-5.12	4.12	-0.96**	0.12
ESP	-33.70	-94.91	-69.21	6.08***	1.91*	-4.24	4.09	9.76	-1.39**	-0.04
SWE	10.95	-29.90	-47.17	4.61***	1.71	4.99	4.00	0.28	-1.04**	-0.22
CHE	14.87	3.38	-17.75	5.05***	1.21	-1.15	-7.52	-5.14	-1.31***	0.08
GBR	23.52	4.41	-25.64	5.87***	0.66	0.92	-1.64	-1.26	-1.10***	-0.20

	LSAP				
	Total	CF	ER	RIR	RFX
USA	19.49	3.18	-16.43	0.12	
AUS	35.84	9.67	-27.03	0.39	0.47
AUT	7.62	-1.98	-9.43	-0.19	0.02
BEL	21.66	2.02	-19.62	-0.08	0.05
CAN	20.88	0.03	-20.48	0.01	-0.37
DNK	38.07	12.81	-25.87	0.58	0.02
FIN	31.52	16.45	-15.63	0.27	0.29
FRA	18.34	8.38	-9.91	-0.25	0.20
DEU	16.08	-0.11	-15.57	-0.51	-0.11
IRL	-7.31	-47.46	-41.79	1.07	0.57
ISR	49.29	-12.12	-63.06	1.47	0.19
ITA	35.20	17.94	-17.22	-0.17	0.13
JPN	2.43	-5.76	-8.41	0.08	0.14
NLD	13.54	-1.17	-14.84	0.06	0.07
NZL	19.58	-20.55	-40.12	0.03	-0.04
NOR	14.32	4.51	-10.08	-0.01*	0.28
PRT	6.51	-2.28	-9.03	0.04*	0.20
ESP	0.24	-8.35	-8.45	-0.12	-0.02
SWE	20.24	0.72	-19.57	-0.20	0.24
CHE	34.47**	22.79	-11.65	0.06	-0.09
GBR	25.75	7.36	-18.78	0.27	0.12

Notes: This table presents estimates from equation (27) to (31), i.e., the coefficients that link unexpected variation in stock market returns ("Total") and their components reflecting news about future cash flows ("CF"), expected excess returns ("ER"), expected US real interest rates ("RIR") and USD real exchange rate changes ("RFX") to US monetary policy surprises in the form of fed funds rate, forward guidance and LSAP surprises. The sample period runs from November 2015 to June 2019. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. ***, ** and * denote significance of the regression coefficients at the 1%, 5% and 10% level based on the empirical distribution of the VAR coefficients from 10000 bootstrap samples. The coefficient estimates are linked through: Total = CF - ER - RIR - RFX.

Table 9: Reaction of stock market news to US monetary policy surprises from 2015 to 2019: emerging markets

	Fed funds rate surprise					Forward guidance surprise				
	Total	CF	ER	RIR	RFX	Total	CF	ER	RIR	RFX
BRA	-189.31**	-151.10	29.11	8.12***	0.97	-23.47	-10.14	14.31	-0.60	-0.37
CHL	-35.20	-297.18	-272.40	9.28***	1.14	-29.63	21.67	52.88	-1.52**	-0.05
COL	-13.54	-51.99	-47.81	8.01***	1.35	-25.15	-2.10	27.94	-4.78**	-0.11
CZE	-82.70**	-114.95**	-35.88	3.78***	-0.14	-16.82*	-9.40	8.42	-0.65**	-0.35
EGY	-38.80	880.96	938.44	-15.18***	-3.50	-67.94	-68.80	-0.35	-1.47*	0.97
GRC	57.78	-19.22	-85.41	6.92***	1.50	2.84	-24.17	-25.71	-1.22*	-0.09
HUN	-43.17	-138.06	-102.74	6.21***	1.64	14.31	38.00	24.88	-1.01**	-0.18
IND	-35.12	-63.38	-31.77	3.12**	0.38	-5.33	-1.52	4.24	-0.50	0.06
IDN	26.53	-32.55	-62.28	2.99**	0.22	-19.69	-1.07	19.45	-0.82*	-0.01
KOR	43.31	-1990.39	-2164.22	109.91**	20.61	3.21	-929.27	-993.95	51.72	9.75
MYS	-30.63	-101.98	-78.64	6.09***	1.20	-20.19	-0.73	21.04	-1.49*	-0.10
MEX	-37.35	-2.42	25.90	9.49***	-0.47	-2.98	5.82	10.41	-1.50*	-0.10
PAK	-23.38	-97.30	-80.78	4.55***	2.31	23.22	42.98*	21.56	-0.91**	-0.89
PER	-10.06	-92.51	-88.99	5.95***	0.59	-3.19	18.24	23.22	-1.78**	-0.01
PHL	34.93	185.23	132.88	18.38***	-0.97	5.77	-26.06	-29.22	-2.77*	0.16
POL	-59.85	-170.05	-119.24	7.31***	1.74	-4.18	17.45	23.20	-1.48**	-0.09
ZAF	-53.56	-110.83	-66.10	4.94**	3.89	-11.62	-5.78	6.16	-0.51	0.18
THA	6.64	-23.70	-36.68	6.37***	-0.02	1.65	5.87	5.13	-0.91	0.00
TUR	-49.25	-212.08	-170.07	4.04**	3.21	-48.90	-21.21	26.71	-0.03	1.00

... Table 9 continued

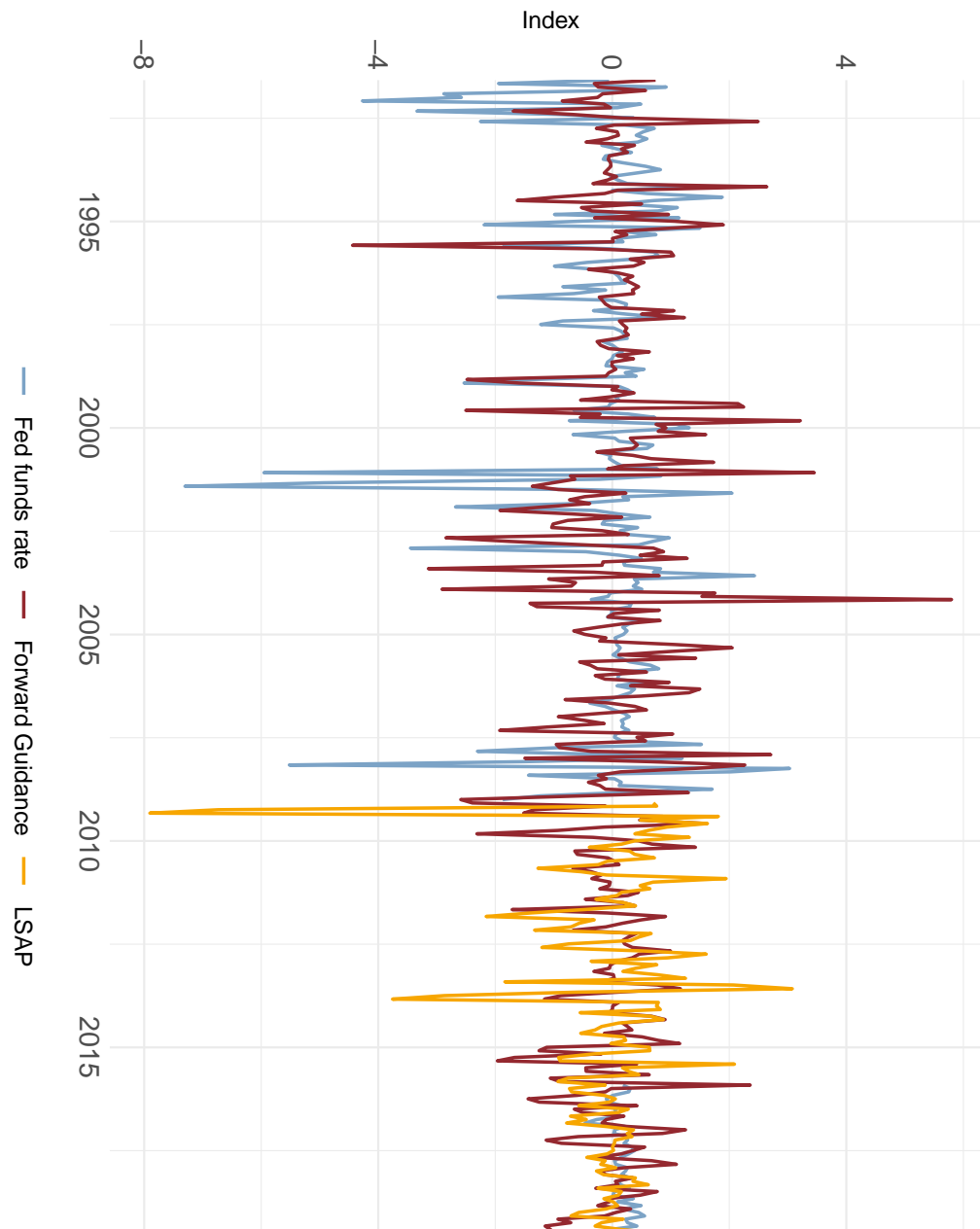|			LSAP		
	Total	CF	ER	RIR	RFX
BRA	6.80	26.34	19.82	0.23	-0.50
CHL	-24.98	-53.21	-29.25	1.05	-0.02
COL	34.80	3.17	-32.28	1.02	-0.38
CZE	17.69	14.03	-4.10	-0.10	0.54
EGY	-7.58	209.11	223.25	-5.57	-0.99
GRC	25.54	7.34	-18.82	0.59	0.03
HUN	-16.62	-41.11	-24.45	-0.17	0.13
IND	6.46	-5.31	-13.67	1.87	0.03
IDN	-19.84	-50.30	-32.45	2.01	-0.02
KOR	24.55	-1431.12	-1549.37	79.19	14.52
MYS	7.95	8.27	-0.21	0.57	-0.04
MEX	-6.90	22.06	29.05	0.44	-0.53
PAK	29.62	-25.06	-57.32	0.27	2.36*
PER	38.64*	17.87	-20.88	0.18	-0.06
PHL	0.61	41.84	37.02	4.57	-0.36
POL	3.57	-0.46	-3.97	-0.04	-0.01
ZAF	36.13	1.98	-34.37	0.54	-0.32
THA	19.85	7.96	-12.71	0.84	-0.01
TUR	-18.56	-34.83	-16.79	0.64	-0.11

Notes: See notes of table 8 for more details

Table 10: Reaction of stock market news to US monetary policy surprises based on panel VAR

	Total	CF	ER	RIR	RFX
	Developed markets				
	Total	CF	ER	RIR	RFX
Full period					
FFR	-4.33***	-2.43	1.43***	0.48***	-0.01
FG	-3.79***	-4.92***	-0.71	-0.50***	0.07***
LSAP	-6.61***	-7.54***	-0.24***	-0.69***	0.00***
BRW	-5.66***	-2.20***	2.90	0.51	0.05***
Pre ZLB period					
FFR	-4.54***	-3.13	0.97***	0.43***	0.01**
FG	-5.16***	-5.29***	-0.24	0.01	0.10***
BRW	-7.36***	-8.43***	-0.94**	-0.14	0.01**
ZLB period					
FG	20.56***	-1.17	-20.65***	-1.14***	0.06
LSAP	-15.79***	-10.07***	5.43**	0.31	-0.01***
BRW	-3.73**	0.67	3.95***	0.34	0.11***
Post ZLB period					
FFR	10.67	-17.92	-35.12	5.23***	1.31***
FG	2.48	0.64	-0.55*	-1.22***	-0.07
LSAP	21.72***	5.10*	-16.64**	-0.02***	0.05**
BRW	0.43***	8.55***	9.88	-1.49***	-0.28
	Emerging Markets				
	Total	CF	ER	RIR	RFX
Full period					
FFR	-9.91***	-9.63***	-0.22**	0.44***	0.06***
FG	-5.35***	-4.72**	1.13***	-0.55***	0.05**
LSAP	-9.33***	-5.80***	4.17**	-0.69***	0.04***
BRW	-6.21***	-5.20***	0.50	0.47	0.04***
Pre ZLB period					
FFR	-8.88***	-10.33***	-1.88**	0.38***	0.05***
FG	-5.44***	-5.60***	-0.11	-0.11*	0.06*
BRW	-6.41**	-8.16***	-1.59	-0.18	0.02
ZLB period					
FG	19.31***	3.09***	-15.01	-1.19***	-0.02**
LSAP	-17.43***	-4.09***	13.01***	0.33	0.00***
BRW	-5.98***	-2.58**	2.97	0.35**	0.08***
Post ZLB period					
FFR	-23.03*	-103.75***	-87.97**	5.94***	1.31**
FG	-15.00***	-1.97	14.23***	-1.26***	0.06
LSAP	7.87	-6.41	-14.44	0.26***	-0.10**
BRW	-4.06***	17.85**	23.88	-1.77***	-0.18

Notes: This table presents estimates from equation (27) to (31), i.e., the coefficients that link unexpected variation in stock market returns ("Total") and their components reflecting news about future cash flows ("CF"), expected excess returns ("ER"), expected US real interest rates ("RIR") and USD real exchange rate changes ("RFX") to US monetary policy surprises in the form of fed funds rate (FFR), forward guidance (FG) and LSAP surprises by Swanson (2020) as well as to the general US monetary policy surprise ("BRW") by Bu et al. (2020). The news terms are obtained from equation (32) for each panel of developed and emerging markets separately. Results in this table are based on panel VARs with one lag. The full sample covers the period from July 1991 to June 2019. The pre-ZLB period runs from July 1991 to December 2008. The ZLB period runs from January 2009 to October 2015 and the post-ZLB period covers November 2015 to June 2019. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. ***, ** and * denote significance of the regression coefficients at the 1%, 5% and 10% level based on the empirical distribution of the VAR coefficients from 10000 bootstrap samples. The coefficient estimates are linked through: Total = CF - ER - RIR - RFX.

Figures

Notes: This figure depicts the monthly time series of monetary policy surprises (Fed funds rate, forward guidance and large-scale asset purchases (LSAP)). The underlying event-day series are based on the high-frequency identification by Swanson (2020).

Figure 1: Monetary policy surprises 1991-2019

A Brief overview of VAR estimation results

This section briefly summarizes the main results from the VAR estimations to obtain the different return news components. The VAR estimates for the US show that past values of the yield spread and the dividend-price ratio forecast US stock market excess returns one month ahead. The sources of return predictability for the foreign stock markets[15] vary widely. However, US short-term real interest rates and the country's own dividend-price ratio are the variables that most often exhibit forecasting power for foreign stock market returns. The country-specific VAR coefficient estimates are not reported to conserve space, but they are readily available upon request.

Table (11) displays the adjusted R^2 statistics from the return forecasting equation of the country-specific VARs. We distinguish between R^2 statistics obtained over the full sample period and three subsample periods. Most of the full sample results are within the range of the R^2 statistics reported by Campbell (1991) and Bernanke and Kuttner (2005) for the US. The US stock market exhibits an average degree of stock return predictability compared with that of the markets in the other countries in our sample. Overall, foreign stock market returns appear to be approximately equally predictable as US stock market returns.

Finally, we perform variance decompositions of the unexpected market returns. These decompositions show that cash-flow and excess return news are the most important components of unexpected stock market returns. Real interest rate news is only of minor importance and real exchange rate news contributes virtually nothing to the variation in unexpected stock market returns. Furthermore, we find that expected return news is exceptionally important to understand variation in US stock market returns (Campbell, 1991). However, for the vast majority of the other countries, cash-flow news is the dominant driver of variation in the unexpected stock market returns. This pattern is not unique to our sample of countries or the sample period but has been documented before (e.g., Nitschka, 2010). The details of the variance decompositions are not reported to conserve space but are available upon request.

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[15]Standard information criteria suggest that one lag is optimal for all markets' VARs in the pre-ZLB period. The same number of lags is used in the periods thereafter.

Table 11: Country VAR estimation: adjusted R^2 in % from the return forecasting equation

country	pre-ZLB period		ZLB period		post-ZLB period		full period	
	incl. exo.	excl. exo.	incl. exo.	excl. exo.	incl. exo.	excl. exo.	incl. exo.	excl. exo.
USA	4.10	3.56	9.15	1.75	24.82	26.92	2.20	1.38
AUS	0.64	-2.18	11.38	11.72	15.03	14.88	0.86	0.28
AUT	9.36	8.11	7.49	3.52	11.00	16.93	2.46	1.69
BEL	10.83	10.29	7.74	4.21	-6.90	-0.54	5.18	4.44
CAN	2.14	0.78	14.60	13.58	36.08	38.84	1.38	0.25
DNK	4.28	3.48	5.88	-0.18	-5.45	-3.63	1.07	0.43
FIN	5.93	6.66	14.29	-0.40	7.27	3.88	6.36	5.61
FRA	1.68	1.31	9.82	3.69	16.31	21.73	2.04	1.52
DEU	0.26	0.94	13.21	2.03	17.55	23.23	1.70	1.09
IRL	11.57	9.98	4.49	-3.40	5.71	5.62	4.75	3.09
ISR	-0.38	-0.81	12.32	10.74	5.41	-1.73	-1.32	-1.43
ITA	-0.39	-0.04	11.45	0.46	5.01	9.58	2.10	0.85
JPN	0.23	0.51	-5.03	-3.23	13.88	18.67	0.63	0.77
NLD	6.85	6.11	11.92	3.94	4.99	11.59	1.73	1.52
NZL	4.55	2.62	2.96	4.46	11.55	14.05	3.07	1.28
NOR	1.90	1.56	2.67	3.21	10.34	11.03	1.74	1.49
PRT	2.21	3.17	11.95	13.46	-5.29	2.67	3.80	4.25
ESP	-0.69	-0.32	11.04	4.27	10.79	17.33	0.20	0.30
SWE	-0.52	-1.29	16.34	10.77	12.96	18.36	0.86	-0.33
CHE	2.42	1.60	3.80	1.48	14.55	11.91	1.58	1.43
GBR	4.50	3.55	8.39	6.07	20.49	21.74	1.51	1.33
BRA	-1.02	-1.01	10.22	9.38	19.48	14.70	1.18	0.80
CHL	-0.51	-0.31	1.92	2.74	9.07	10.19	-0.07	-0.14
COL	14.67	12.39	12.32	12.81	-2.50	0.42	6.77	4.13
CZE	2.62	1.91	22.04	2.56	16.49	14.24	2.50	0.15
EGY	10.78	11.40	8.47	6.77	2.38	1.64	2.20	0.93
GRC	1.07	1.21	10.00	5.65	6.34	13.19	3.90	2.99
HUN	3.58	3.46	12.26	7.61	5.67	9.19	5.46	4.09
IND	1.52	2.32	9.04	7.79	-10.79	-2.86	0.64	0.90
IDN	11.60	7.29	18.17	13.66	-5.38	-1.70	10.44	5.57
KOR	4.51	4.02	20.10	2.32	15.75	20.34	5.02	2.99
MYS	0.73	1.45	18.33	12.65	-11.15	-9.76	2.49	2.22
MEX	-0.23	-0.52	10.25	8.84	15.62	21.98	0.22	0.04
PAK	-3.06	-2.04	14.84	15.04	12.01	14.74	-0.79	-0.16
PER	2.22	1.00	12.06	12.11	16.79	18.23	2.00	0.84
PHL	4.02	2.21	3.52	5.25	1.56	8.29	4.92	3.75
POL	-2.97	-1.99	10.64	2.41	5.37	11.43	-1.02	-0.58
ZAF	-0.04	-0.85	12.53	9.71	11.68	13.94	1.27	0.42
THA	-1.13	-1.54	6.04	5.96	7.50	13.75	0.65	0.36
TUR	1.03	0.88	9.47	5.73	-7.98	-5.15	1.22	0.22

Notes: This table presents the R^2 statistics (adjusted for the number of regressors) of the VAR equation that forecasts the respective country's stock market return in excess of the US t-bill rate in the pre-ZLB and ZLB period with (incl. exo) as well as without (excl. exo) exogenous variables. The sample periods run from July 1991 to the end of 2008 (the pre-ZLB period), from January 2009 to October 2015 (the ZLB period) and from November 2015 to June 2019. Table (1) gives the start and end dates of the sample for each country and explains the country acronyms. We use the MSCI classification of developed and emerging stock markets. We choose a lag length of one month for all countries.

B Measuring monetary policy surprises with high-frequency data

In our analysis, we use the three US monetary policy surprise series from Swanson (2020). Here, we briefly describe the approach used to identify these three factors over the full sample period. The three factors correspond to surprises in the fed funds rate, forward guidance and LSAP. A more detailed and comprehensive description of the approach can be found in Swanson (2020).[16]

The identification of monetary policy surprises relies on collecting all price changes of federal funds futures (current and next-month maturities), Eurodollar futures ($2-$, $3-$ and $4-$quarters maturites) and treasury bond yields ($2-$, $5-$, and $10-$year maturities) on the dates of every FOMC announcement between July 1991 and June 2019 within a 30-minute window bracketing each announcement. The price changes of these assets are then gathered in a $T \times n$ matrix X, where T is the number of FOMC announcements in the covered sample period and n the number of assets. These data may then be generated by a factor model such as

$$X = F\Lambda + \epsilon, \tag{33}$$

with F being a $T \times k$ matrix of $k \leq n$ latent factors, Λ being a $k \times n$ matrix of loadings of asset price responses on the k factors, and ϵ being a $T \times n$ matrix of white noise residuals. Then, the goal is to identify three factors that correspond to surprises in (1) the fed fund rates, (2) forward guidance, and (3) LSAP. Principal component analysis shows that the first three principal components of X explain 94% of the total variance of X. These three principal components are unlikely to have the desired structural interpretation, so one needs an alternative factor model producing the same ϵ with factors $\tilde{F}$ reflecting surprise changes in the federal funds rate, forward guidance, and LSAP. Such an alternative factor model can be represented by $X = \tilde{F}\tilde{\Lambda} + \epsilon$, where $\tilde{F} \equiv FU$, $\tilde{\Lambda} \equiv U'\Lambda$ and U is any 3×3 orthogonal matrix. Three restrictions are required to identify U and the ones used by Swanson (2020) are as follows: (1) LSAP have no effect on the current federal funds rate, (2) forward guidance has no effect on the current federal funds rate, and (3) the LSAP factor is as small as possible in the pre-ZLB period between 1991 and 2008. This then allows one to uniquely identify $\tilde{F}$, with the first column corresponding to surprise changes in the federal funds rate, the second column to surprise changes in forward guidance, and the third column to surprise changes in LSAP.

The resulting estimates of the structural loading matrix $\tilde{\Lambda}$ are directly taken from Swanson (2020) and depicted in table 12. The table reveals that the fed funds rate surprise factor loads with 8.37 on the first fed funds rate future (MP1). Thus, a one-standard-deviation change in the fed funds rate surprise factor can be thought of as an 8.37-basis-points surprise change in the fed funds rate. The structural loading of the

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[16]See section 2 and appendix A in Swanson (2020) for more details.

forward guidance surprise factor on the fourth Eurodollar futures contracts (ED4) is 5.71. A one-standard-deviation change in the forward guidance surprise factor can hence be thought of as an 5.71-basis-points change of the expected fed funds rate one year ahead. Finally, Swanson (2020) suggests, based on estimates in the literature, that a one-standard-deviation change in the LSAP surprise factor roughly corresponds to a 215 billion USD surprise LSAP announcement.

Table 12: Estimated effects of conventional and unconventional monetary policy announcements on interest rates 1991-2015

	MP1	MP3	ED2	ED3	ED4	TR2y	TR5y	TR10y
Δ FFR	8.37	5.95	5.68	5.36	4.60	3.88	2.26	1.11
Δ FG	0.00	1.33	3.85	5.00	5.71	4.61	4.95	3.85
Δ LSAP	0.00	1.07	1.70	1.68	1.34	-0.10	-3.41	-5.36

Notes: This table is taken directly from Swanson (2020). The coefficients in the table correspond to elements of the structural loading matrix $\tilde{\Lambda}$, in basis points per standard deviation change in the monetary policy instrument. MP1 and MP2 denote scaled changes in the first and third federal funds futures contracts, respectively; ED2, ED3, and ED4 denote changes in the second through fourth Eurodollar futures contracts; and TR2y, TR5y, and TR10y denote changes in 2-, 5-, and 10-year treasury yields.

C Details on the bootstrap procedure

In this section, we present the bootstrap method used to make inference. The regression in equation (11) uses Swanson's monetary policy surprises as regressors. As these surprises are generated from a separate estimation procedure, we need to take this additional uncertainty into account. Thus, we have to depart from standard inference and proceed with the following bootstrap method instead. In a first step, we run our VAR $z_t = \Gamma z_{t-1} + \phi M_t^u + \Psi_t$ with T observations to estimate the companion matrix $\widehat{\Gamma}$ and to extract the estimated residuals Ψ. For each bootstrap sample i, we draw T random numbers $r_s^{(i)}$, $s = 1, \ldots, T$, between 1 and T, with replacement. We then generate a series of bootstrapped errors $\hat{\Psi}_t^{(i)}$, where the sth row of $\hat{\Psi}_t^{(i)}$ is given by the $r_s^{(i)}$th row of the original $\hat{\Psi}$. The bootstrap sample $z^{(i)}$ is then defined as follows

$$z_t^{(i)} = \widehat{\Gamma} z_{t-1} + \hat{\phi} M_t^u + \hat{\Psi}_t^{(i)}, \quad \forall t \in \{1..., T\} \tag{34}$$

We repeat this resampling procedure 10,000 times. With 10,000 bootstrap samples of z in hand we re-estimate the VAR and store the corresponding companion matrices $\widehat{\Gamma}^{(i)}$ and exogenous variables coefficient matrix $\hat{\phi}^{(i)}$. Then, we compute the bootstrapped effect of US monetary policy surprises on the foreign excess stock market return (e.g., total news f_{t+1}^T)

$$\Lambda_2' \hat{\phi}^{(i)} M_{t+1}^u, \tag{35}$$

on excess return news

$$\Lambda_2' \rho^* \widehat{\Gamma}^{(i)} (I - \rho^* \widehat{\Gamma}^{(i)})^{-1} \hat{\phi}^{(i)} M_{t+1}^u, \tag{36}$$

real interest rate news

$$\Lambda_3^{'}(I - \rho^* \widehat{\Gamma}^{(i)})^{-1} \hat{\phi}^{(i)} M_{t+1}^u, \tag{37}$$

real exchange rate news

$$\Lambda_4^{'}(1 - \rho^*)(I - \rho^* \widehat{\Gamma}^{(i)})^{-1} \hat{\phi}^{(i)} M_{t+1}^u, \tag{38}$$

and finally, cash-flow news

$$\left[\Lambda_2^{'} + \Lambda_2^{'} \rho^* \widehat{\Gamma}^{(i)}(I - \rho^* \widehat{\Gamma}^{(i)})^{-1} + \Lambda_3^{'}(I - \rho^* \widehat{\Gamma}^{(i)})^{-1} + \Lambda_4^{'}(1 - \rho^*)(I - \rho^* \widehat{\Gamma}^{(i)})^{-1}\right] \hat{\phi}^{(i)} M_{t+1}^u \tag{39}$$

for each bootstrap sample i. The resulting empirical distributions of the effects on the different news terms are then used to draw inferences about the statistical significance of the sensitivities of the return news to US monetary policy surprises.