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Macroeconomic Effects and Spillovers from Bank of Japan Unconventional Monetary Policy

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ABSTRACT: We provide empirical evidence on the impact of the Bank of Japan's unconventional monetary policies on domestic economic variables and their spillovers to international sovereign yields. Using high-frequency asset price surprises to Bank of Japan (BOJ) policy announcements, we identify shocks to forward guidance (FG) and large-scale asset purchase (LSAP) policies. We show that expansionary LSAP and FG shocks increase Japanese activity and stock prices, lower unemployment, and depreciate the yen. We find that FG and LSAP shocks produce spillovers to sovereign bond yields in other countries. Spillovers from BOJ LSAP shocks seem to transmit through term premia, and the strength of spillovers is strongest to those markets where Japanese investors have a larger participation.

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WORKING PAPERS

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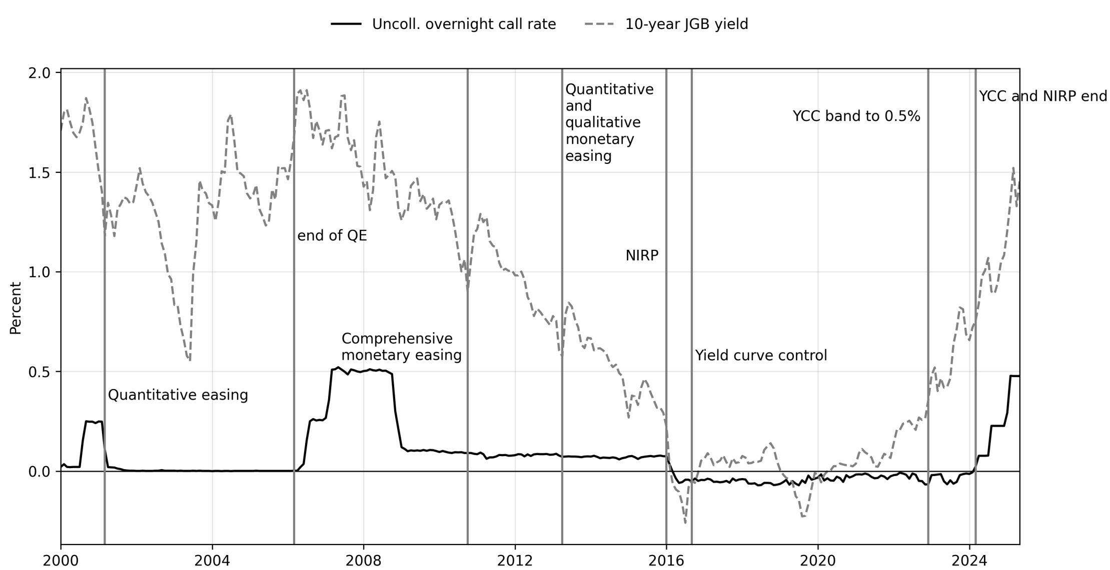
1 Introduction

This paper provides empirical estimates of the effects of the Bank of Japan's (BOJ) unconventional monetary policy instruments on the domestic economy and foreign asset prices. Having faced a 25-year period of low inflation—inflation turned negative in late 1998 and hovered at very low levels until 2022—the Bank of Japan has been at the vanguard of developing unconventional monetary policy instruments to boost aggregate demand. The BOJ first lowered its policy interest rate to the effective lower bound in February 1999, and this constraint was binding for most of the period until 2023. Shortly after first reaching the effective lower bound, the BOJ started using forward guidance to shape expectations about the future path of its policy rate setting, and introduced a number of policy tools aimed at influencing longer-term interest rates over the two following decades.

Figure 1: Interest rates and the Bank of Japan's unconventional policies



Sources: Bank of Japan and Haver Analytics.

Figure 1 shows the evolution of short- and long-term interest rates in Japan since 2000—the period of study we focus on in this paper—and indicates changes to the BOJ's unconventional policy toolkit.[1] In March 2001, the BOJ became the first major central bank to deploy a quantitative easing program. The program was ended in March 2006 before initiating a series of policy rate hikes. After the onset of the Global Financial Crisis, the BOJ returned the policy rate to the effective lower bound in December 2008, and broadened its asset purchase program in October 2010 with "Comprehensive Monetary Easing" to include riskier assets like exchange-traded funds and real estate investment trusts. This was followed by "Quantitative and Qualitative Monetary Easing (QQE)" in April 2013, significantly expanding the monetary base through large government bond purchases and other asset acquisitions, alongside a formal 2% inflation target. Despite these efforts, inflation remained subdued, leading to

[1] Ueda (2012) offers a more comprehensive discussion of the BOJ's policy measures between 1999 and 2011, including an account of decisions to raise the policy rate in 2000 and 2007 that were followed by returns to the effective lower bound.

the adoption of a Negative Interest Rate Policy (NIRP) in January 2016, applying a -0.1% rate to a portion of commercial banks' reserves at the BOJ. In September 2016, the BOJ introduced "QQE with Yield Curve Control (YCC)," whereby it committed to maintaining short-term rates at -0.1% while making bond purchases that would keep the 10-year Japanese Government Bond (JGB) yield around 0%. This policy was complemented by a stated willingness to allow inflation to overshoot the target temporarily, such that easing would continue until inflation stably exceeded 2%. In the face of a sustained surge in global inflation following the pandemic, the BOJ began to normalize its monetary policy toolkit, first by adjusting the YCC parameters in 2022-23 to allow for an increase in the level and volatility of long-term rates, and then by ending YCC and raising the policy rate in March 2024.

To estimate the effects of monetary policy on the economy, a large literature has set out to identify monetary policy shocks that are exogenous to domestic economic conditions. Since the seminal contributions of Kuttner (2001) and Gürkaynak, Sack, and Swanson (2005), identification of monetary policy shocks has mostly relied on high-frequency asset price developments surrounding monetary policy announcements. A growing literature has estimated their macroeconomic implications (including Gertler and Karadi (2015)), with further contributions and refinements from Nakamura and Steinsson (2018), Miranda-Agrippino and Ricco (2021), and Bauer and Swanson (2023) to account for the 'central bank information effect', by which a policy surprise may reveal the central bank's private information about the true state of the economy.

For the United States, refinements to the high frequency identification approach have been proposed to separate asset price news into the contribution of different instruments in the monetary policy toolkit, allowing for the study of the effectiveness of unconventional policies. The methodology proposed by Swanson (2021)—which we build on and apply to Japan in this paper—separately identifies shocks to policy rates, forward guidance, and large-scale asset purchase programs following Federal Reserve policy meetings. Kim, Laubach, and Wei (2023) employ the same methodology to assess the macroeconomic impact of different dimensions of monetary policy shocks. Lewis (2023) exploits heteroskedasticity in intraday asset price movements following a monetary policy announcement to identify structural innovations, using economic theory to label these shocks. For the Euro Area, Altavilla et al. (2019) apply the methodology from Swanson (2021) to identify multi-dimensional ECB monetary policy shocks and estimate their impacts on asset prices.

For Japan, there have also been several attempts to identify monetary policy shocks and estimate their macroeconomic effects. In an early example, Miyao (2002) uses a recursive ordering in a VAR to estimate the impact of BOJ interest rate shocks on output. Schenkelberg and Watzka (2013) use identifying restrictions in an SVAR to estimate the impacts of quantitative easing shocks on Japanese long-term interest rates, output, and prices, while Michaelis and Watzka (2017) use sign restrictions in a VAR with time-varying parameters to estimate the changing effectiveness of BOJ quantitative easing policies over a long period.[2] More recently, Nakamura, Sudo, and Sugisaki (2024)

[2] Hanisch (2017) compares the impacts of the BOJ's conventional and unconventional policies since 1985 using a dynamic factor model. He finds that the former have stronger effects on output, while the latter have stronger effects on inflation.

use short-term interest rate futures in a 30-minute window around monetary policy meetings to identify policy shocks, finding that movements within this window are strongly correlated with other financial asset prices and produce theory-consistent macroeconomic responses in an Instrumental Variables SVAR. Kubota and Shintani (2022) also use high-frequency asset price news to identify policy shocks, structurally identifying a 'path' factor of policy shocks and a 'target' factor of longer-run yield curve responses following monetary policy announcements. In a recent contribution, Kubota and Shintani (2025) extend this approach to establish the effects of monetary policy shocks identified by the 'target' factor on macroeconomic variables. Nakashima, Shibamoto, and Takahashi (2024) use the max-share methodology in combination with daily asset price changes to establish the effects of quantitative easing as the shock that drives the largest share of forecast error variance for balance sheet variables.[3]

This paper's first contribution is to extend the literature identifying monetary policy shocks in Japan. We use high-frequency intraday financial data to measure asset price surprises around monetary policy decisions.[4] Previous literature has assigned an interpretation to a factor-based decomposition of asset price news that primarily affected long-term or short-term rates (Kubota and Shintani, 2022), or an identification procedure that can contain information from a range of structural drivers other than policy rate shocks (Nakashima, Shibamoto, and Takahashi, 2024). Our paper is the first to structurally identify shocks to BOJ unconventional monetary policy instruments by applying the methodology of Swanson (2021) to the Japanese context. This allows us to identify distinct policy shocks related to large-scale asset purchase programs (LSAP) and forward guidance (FG), even in the many instances when BOJ policy announcements contained decisions making use of both instruments. To our knowledge, we are the only paper to apply a high-frequency identification procedure to estimate the macroeconomic impacts of monetary policy shocks that primarily affect long-term interest rates (reflecting LSAP policies), with the existing literature focusing on high-frequency asset price movements at the short end of the curve (Kubota and Shintani, 2025; Nakamura, Sudo, and Sugisaki, 2024).

Monetary policy decisions in one economy can also have impacts across borders. Rey (2015) and Miranda-Agrippino and Rey (2020) popularized the idea that US monetary policy drives an international financial cycle that manifests as strong spillovers from Federal Reserve policy to yields and financial conditions in other economies.[5] While an earlier estimate by Fratzscher, Lo Duca, and Straub (2016) using daily data did not find significant financial spillovers from ECB unconventional monetary policy, Miranda-Agrippino and Nenova (2022) use a high-frequency identification approach to document significant and comparable financial spillovers from Federal Reserve and ECB unconventional monetary policies, and underscore the role of the risk-taking channel in their transmission to inter-

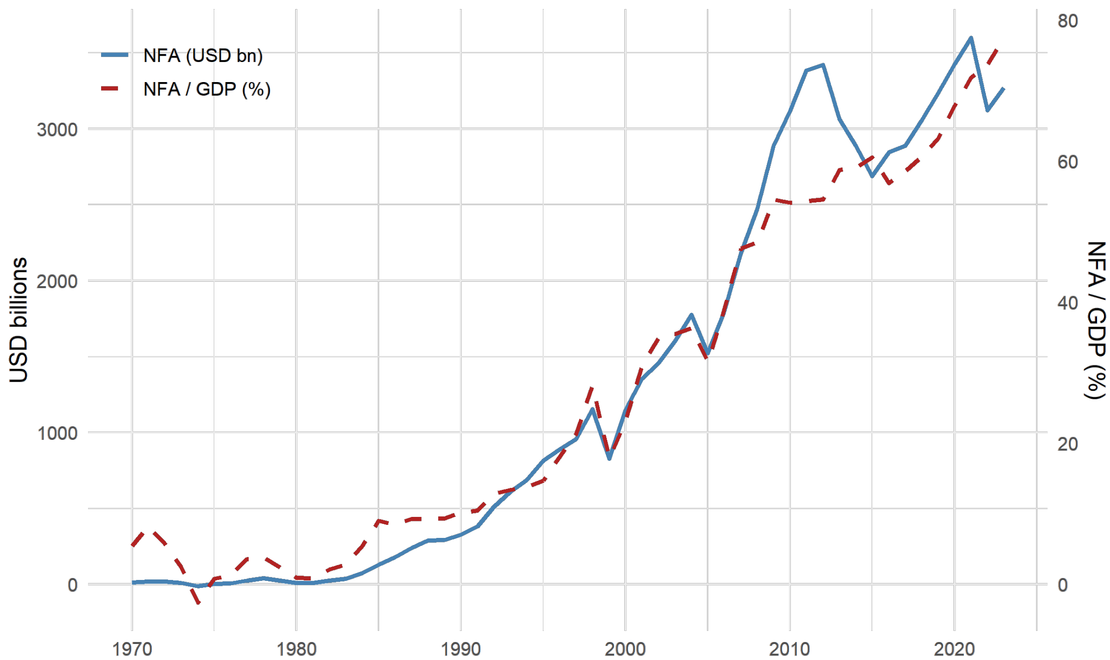
[3] Recent literature has cautioned against interpreting shocks using the max-share methodology as a single structural shock. Francis and Kindberg-Hanlon (2022) show that the shock is actually a linear combination of potentially quite different structural shocks.

[4] Earlier literature had generally relied on daily-frequency data that are subject to confounding factors that call into question the identifying assumption of the high-frequency approach: that the measured asset price reaction can be directly attributed to the news of the policy decision.

[5] The empirical literature on spillovers from US monetary policy is large, also including Bluedorn and Bowdler (2010), Caceres et al. (2016), Kalemli-Özcan (2019), Georgiadis and Jarociński (2025), and Arbatli-Saxegaard et al. (2024).

national asset prices. Albagli et al. (2019) provide estimates of spillover effects from US monetary policy to long-term yields in advanced and emerging economies, and find that spillovers to the latter are dominated by the response of term premia.

Figure 2: Japan's rising net foreign assets position



Source: Japan Ministry of Finance; IMF, WEO database.

This paper's second contribution is to offer empirical estimates of BOJ unconventional monetary policy's spillover effects on foreign asset prices. Japan's financial integration into global markets provides a potential transmission mechanism for spillovers from Bank of Japan policy decisions, but there has been a surprising lack of attention in the literature to their measurement. Dekle and Hamada (2015) study a reduced form global VAR and find that innovations to Japanese short-term rates or monetary base have significant impacts on both Japanese and US growth and inflation. Ganelli and Tawk (2016) use a similar global VAR methodology to estimate the impact of Bank of Japan unconventional monetary policy on emerging Asia, concluding that QQE stimulus tended to have a positive impact on output in these economies. In contrast, our study of spillovers builds on our identification of policy shocks using high-frequency asset price movements, and focuses on the short-term response of foreign yields, which allows us to compare our results to recent scholarship on spillovers from the US and ECB.

With the rate of return on domestic bonds and risk assets kept low for an extended period, Japanese investors accumulated a substantial net foreign investment position by directing their savings towards foreign equities, bonds, and FDI (Figure 2). The annual current account balance has been in surplus each year since 1996, boosted by substantial inflows from its primary income account. Japan's Net International Investment Position exceeded 3 trillion US dollars in 2024, including over 1 trillion USD in holdings of US government debt, making Japan the world's largest net holder of foreign assets (Lane and Milesi-Ferretti, 2018, 2025). Japan is also one of the world's primary issuers of safe assets, with the JGB sovereign debt market the world's second-largest by total outstanding amount (1,223.6 trillion yen or 8.5 trillion US dollars at end-September 2024).[6] Commensurate with this important role in global financial markets, our findings suggest that the Bank of Japan's unconventional policy decisions—from both FG and LSAP policies—also impact foreign asset prices, with a magnitude that is similar to what the literature has documented for spillovers from the US Federal Reserve and ECB.

The paper is organized as follows. Section 2 describes our measurement of surprises surrounding BOJ policy announcements, and presents our strategy for identifying shocks to different UMP instruments. Section 3 presents our SVAR model and estimates the impact of BOJ policy shocks on domestic macro variables. Section 4 then estimates the impact of these shocks on foreign sovereign yields, and explores possible channels of transmission. Section 5 concludes.

2 Identifying BOJ Unconventional Monetary Policy Shocks from Multiple Instruments

2.1 High-Frequency Asset Price Surprises

While the policy decisions described above were taken by the BOJ in response to domestic macroeconomic conditions, many of these decisions were not fully anticipated by market participants. To measure monetary policy surprises in Japan, we use intraday data on the evolution of asset prices surrounding all 151 Bank of Japan monetary policy meetings (MPM) conducted between January 2010 and December 2023.[7] Our dataset does not include asset price responses to communications outside of monetary policy meetings (such as ad hoc speeches by Board members or statements). Our dataset includes intraday (minute-by-minute) data from Refinitiv Eikon for six asset price series: the 10-year, 2-year, and 1-year JGB sovereign bond yields, the 1-month and 3-month Overnight Interest Swap yields, and the dollar-yen spot exchange rate. For each policy meeting, we measure asset price changes in a window starting 5 minutes before the announcement and ending 30 minutes after the announcement, following the literature (Gertler and Karadi, 2015).[8]

The BOJ's policy rate instrument was constrained by the effective lower bound for much of the period between January 2010 and December 2023. Throughout the early 2010s, the Bank of Japan maintained its policy rate at 0.00-0.10% until the implementation of negative interest rate policy (NIRP) in January 2016, when rates were lowered to -0.1%. The NIRP remained in place through the

[6] About 46.7% of this total was held by the Bank of Japan, while foreign investors held 12.0%. In terms of the stock of government debt net of central bank claims on the public sector, Japan remains the third largest issuer globally, behind the US and China.

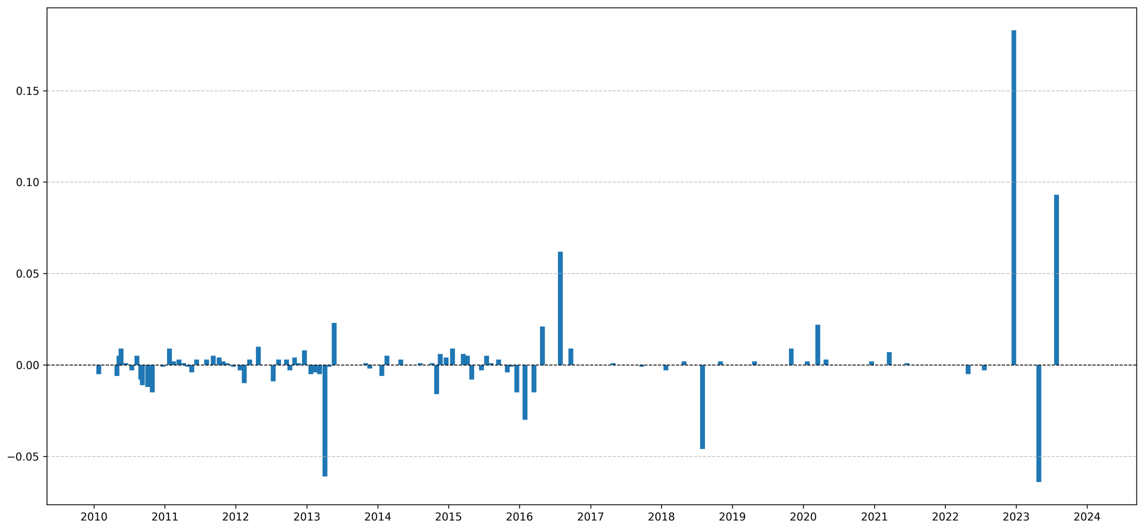
[7] A full list of monetary policy meeting dates and policy announcement times is provided in Appendix Table A.1. The sample period is constrained by our access to high frequency data.

[8] The Bank of Japan's policy decisions are typically announced in the late morning or early afternoon on the second day of the MPM, but the exact time varies from meeting to meeting. In two cases documented in Table A.1, we adjust the width of our event windows to accommodate pre-announcement press reports that triggered strong market reactions.

rest of our sample period, and was abandoned only when the policy rate was hiked in March 2024.

While surprises to short-term rates following MPMs were relatively small over our sample period, monetary policy was most active through its influence on longer-term rates. A range of time- and state-contingent forward guidance strategies and balance sheet policies were implemented between 2010 and 2023 that influenced interest rates at longer maturities. Figure 3 shows the measured surprises to the 10-year JGB yield surrounding Bank of Japan policy announcements from January 2010 to December 2023. Surprises are generally quite small—the median across the 151 meetings is 0.1 bps—but they are punctuated by fairly large surprises of 2 to 10 bps surrounding adjustments to the policy framework in 2013, 2016, and 2023. This fat-tailed distribution of BOJ policy surprises is similar to the distribution of Fed shocks documented by Jarociński (2024).

Figure 3: Surprises to 10-year JGB yields surrounding BOJ policy announcements



Source: Authors' calculations based on data from Bloomberg and Refinitiv Eikon.

One challenge to identifying monetary policy surprises using high-frequency asset price changes in Japan is related to the use of the YCC framework from September 2016 to March 2024. This initially implemented a target of 'around 0%' for the 10-year JGB yield, one of the assets we use for high frequency identification, which was subsequently adjusted multiple times. Operationally, the yield was allowed to fluctuate around or up to some indicative level, with the reference rate and the tolerance band modified on several occasions before the end of the YCC framework in March 2024. While asset price changes following a policy meeting would still capture changes in the calibration of monetary policy through LSAP operations, they may not correspond to surprises. The reason is that an anticipated decision may not have been allowed to be priced by markets in advance, since market intervention or the threat of intervention could have restricted interest rate movements ahead of policy announcements under this framework.

Figure 4: JGB yields ahead of monetary policy announcements and YCC tolerance level

In practice, 10-year yields were rarely constrained by these YCC reference rates immediately ahead of policy announcements, such that prices were generally free to adjust ahead of meetings (Figure 4). The exception to this was during 2022, ahead of the adjustment to the YCC tolerance band in the December 2022 meeting. Inflation accelerated rapidly in Japan during 2022—with headline CPI inflation exceeding the BOJ's 2-percent target starting in April—resulting in 10-year JGB yields rising to within a few basis points of the 25 bps tolerance level ahead of policy announcements from April to December. During this period, BOJ purchases of 10-year JGBs increased significantly to defend the YCC range, suggesting that market participants were anticipating a coming rise in yields. But even then, there is only one meeting (December 2022) for which the size of the JGB yield surprise exceeds the pre-meeting distance between the market yield and the YCC tolerance level. In the appendix, we include a robustness check that estimates the VAR and spillover specification (1) excluding shocks from April 2022 to December 2023, during which yields were occasionally constrained by YCC.

2.2 Identification of Unconventional Monetary Policy Shocks

As we have described, the BOJ employed a variety of instruments to set monetary policy during the sample period. Indeed, multiple instruments were at times adjusted during the same policy meetings. To identify monetary policy shocks to these separate instruments, we propose a procedure that builds on Swanson (2021) by adapting the identifying assumptions to the Japanese context. This involves a structural transformation of a small number of factors that explain the majority of the variation in asset price movements following MPMs.

We start by identifying three factors based on changes in the six asset prices outlined above in the window following MPMs:

$$X = F\Lambda + \epsilon,$$

where X is a $T \times N$ matrix of each asset price response across all MPMs, F is a $N \times k$ matrix of factors, Λ is a $k \times N$ matrix of factor loadings, and ϵ is a matrix of residuals $(T \times N)$. k is set at 3, which is supported by the Cragg-Donald test for the appropriate number of factors. This allows the identification of up to three structural shocks, as in Swanson (2021).

Our identification assumptions differ from those used by Swanson (2021) in a key respect. In Swanson's procedure, LSAP shocks are identified as those that minimize the variance of asset price surprises in the periods before quantitative easing (QE) was implemented. However, this is not feasible in Japan given the BOJ's much longer history of using large scale asset purchase policies, which spans our entire sample period of 2010-23.

To identify the LSAP and forward guidance shocks, we impose restrictions on the factor loadings using the orthonormal matrix Q, such that:

$$FQQ'\Lambda = F\Lambda.$$

Restrictions on the columns of Q are imposed as follows:

- The LSAP shock cannot influence the 1-month OIS rate.
- Forward guidance shocks cannot influence the 1-month OIS rate. That is, forward guidance is defined as announcements that impact asset pricing beyond the current monetary policy meeting.
- The LSAP shock is identified as the shock that maximizes the variance of 10-year JGB yields, subject to the restriction that it cannot drive more of the variance of the 1-year JGB yield than the forward guidance shocks.

These three restrictions uniquely identify three structural shocks given that $k = 3$. Table 1 shows the factor loadings on each of the asset price series (equivalent to $Q'\Lambda$), normalized by the primary target in the identification. The forward guidance shock is normalized by the loading onto the 1-year JGB yield, while the LSAP shock is normalized by the loading onto the 10-year JGB.[9]

The unconventional policy tools deployed by the BOJ over this period included both quantitative purchase programs as well as explicit yield targets. And within the quantitative purchase programs, different schemes focused on expanding the size and altering the composition and riskiness of the assets

[9] The residual is normalized by its loading onto the one-month OIS rate, since it explains most of the variance at the short end of the curve.

on the BOJ's balance sheet. In the rest of the paper, we do not set out to distinguish between the impacts of these different balance sheet policies, and refer to them collectively as 'large scale asset purchase' (LSAP) policies. The identifying assumption that LSAP policies maximize the variance of 10-year JGB yields is justified on the basis that these policies have been overwhelmingly implemented through bond purchases in the medium- and long-end of the JGB curve—with the YCC policy exclusively focused on the 10-year maturity—with limited purchases realized at shorter maturities.

Table 1: Factor loadings for the identified BOJ policy shocks

Shock	**10-year JGB**	**2-year JGB**	**1-year JGB**	**3m OIS**	**1m OIS**	**Yen-Dollar**
Forward guidance	0.45	1.26	1.00	0.51	0.00	0.63
LSAP	1.00	0.21	0.40	-0.15	0.00	-1.64
Residual	-0.16	-0.17	0.02	0.75	1.00	-0.18

In US applications of similar identification procedures (Swanson, 2021), shocks related to LSAP policy, forward guidance, and shocks to the policy rate are identified. Due to Japan's unique history of being constrained by the effective lower bound for the majority of our sample, the policy rate shock is more challenging to identify than it is in US data. Between 2010 and 2023, the policy rate was only adjusted once, with the introduction of the negative interest rate policy (NIRP) in January 2016. While this does not rule out shocks to very short-term rates having taken place—market participants may expect a policy rate change that does not materialize—surprises of this type have tended to be small and infrequent. In addition, we cannot rule out other factors influencing news to the short-term OIS rate, such as liquidity changes that influence money market rates. For these reason, we do not provide a structural interpretation for the third identified shock over this sample period, and do not use it in the remainder of the analysis. This limits the scope of our analysis to a study of the BOJ's unconventional policy instruments.

Figure 5 shows the contribution to the variance of asset price surprises from the two identified shocks. The contributions across the yield curve are broadly as expected. The LSAP shock explains more than half of all variation in the 10-year JGB yield surprises, while forward guidance explains an additional tenth of the variation. Forward guidance shocks explain about one third of the variation in the 3-month OIS surprises, and explain the overwhelming majority of variance in the one-year JGB yield surprises.

Figure 5: Shock contribution to the variance of asset price surprises following MPMs

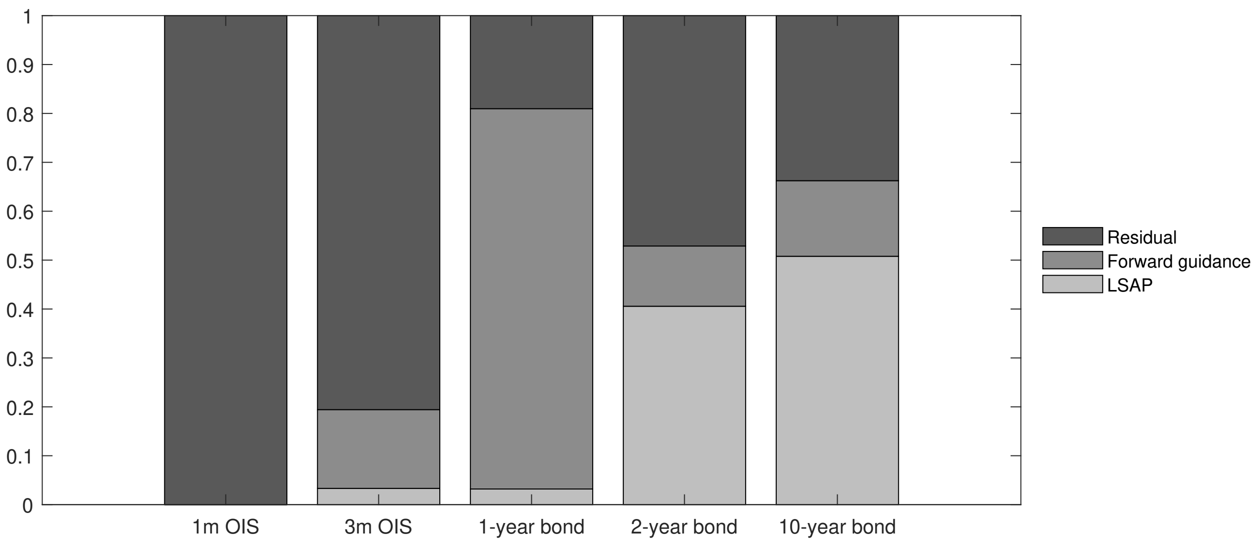
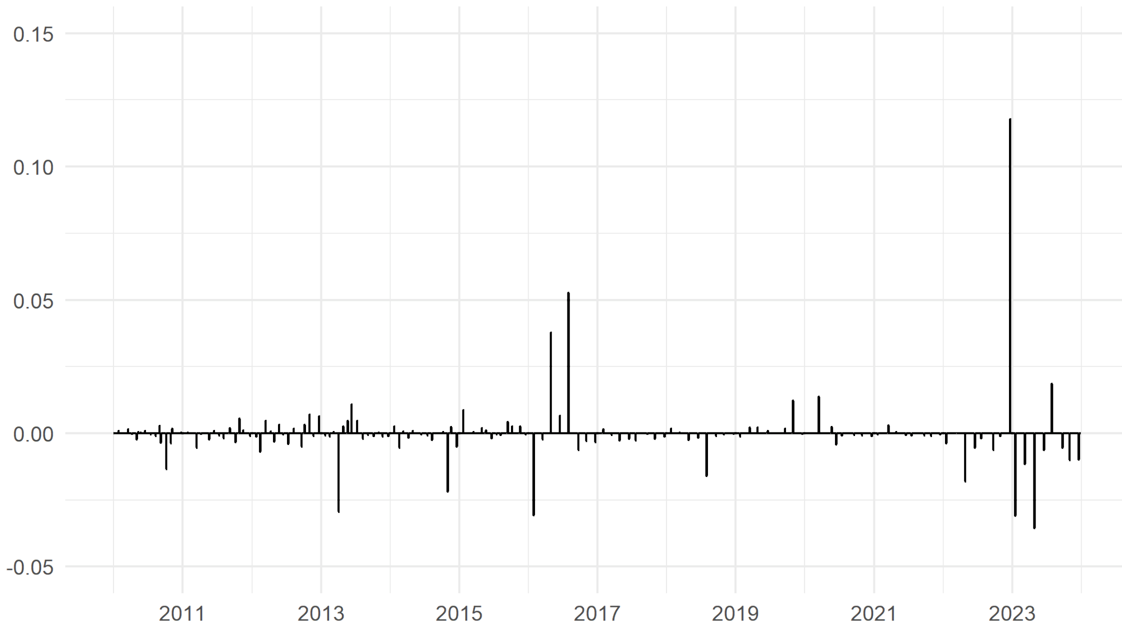


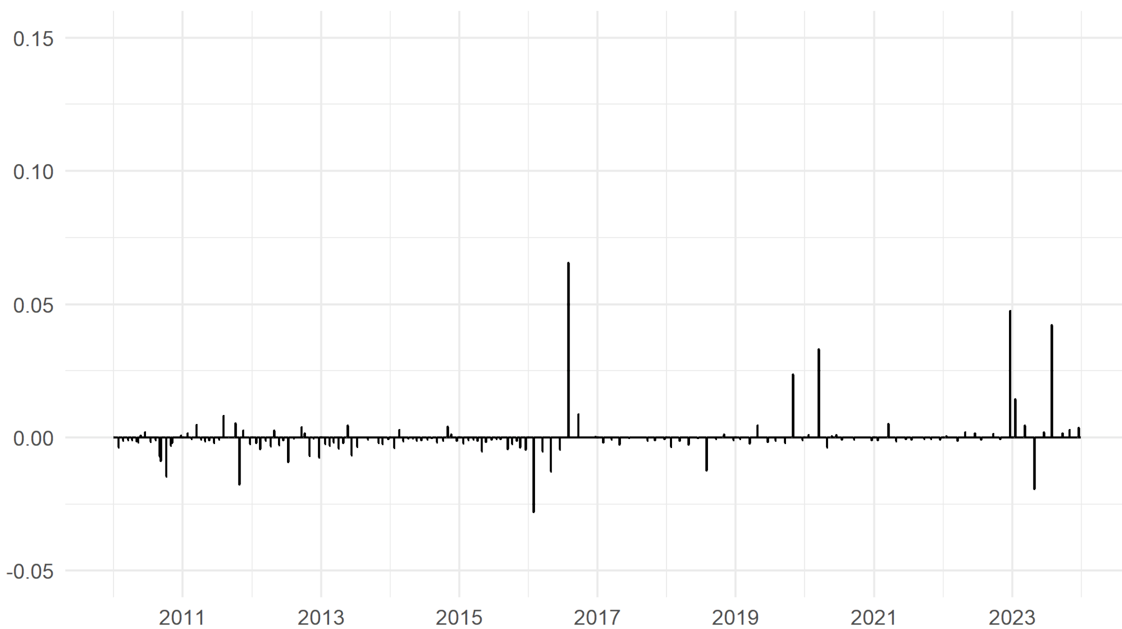
Figure 6 shows the time series for the LSAP and forward guidance policy shocks identified using the procedure described above. Policy shocks are generally small, but LSAP shocks are most pronounced in 2016 at the outset of YCC and in 2022-23 when the YCC parameters were modified as the BOJ prepared to normalize its policy framework. Forward guidance shocks are more evenly distributed over the sample period, and are most notable in 2016, when the BOJ adopted its willingness to allow inflation to overshoot and delivered a firmer commitment to keep the policy rate at the NIRP level of -0.1% as part of YCC.

Few papers have estimated similar high-frequency-based shock series for Japan. To our knowledge, only Kubota and Shintani (2022) publicly provide high-frequency asset price news following Bank of Japan policy announcements. In Table 2, we show the correlation matrix between our surprises to the 10-year JGB yield, our identified LSAP and forward guidance shocks, and several variables from Kubota and Shintani (2022). These include the 'path' and 'target' factors, and the high-frequency surprises to 10-year JGB futures prices. The path factor reflects changes to the path of future rates, while the target factor reflects news to short-term interest rate futures, largely following the methodology of Gürkaynak, Sack, and Swanson (2005). We make several notable observations. The first is that our LSAP shocks and 10-year JGB surprises are highly correlated with the KS series surprises to 10-year JGB futures, as expected. However, all three variables have little correlation with the KS 'path' factor, which should reflect monetary policy shocks primarily affecting expectations of future interest rate. This may provide one reason that we find statistically-significant macroeconomic impacts from our LSAP shock series in contrast to Kubota and Shintani (2025), who focus on the target shock instrument only given a lack of statistically relevant impact from their 'path' shock.

Figure 6: Identified Bank of Japan unconventional monetary policy shocks



(a) LSAP shocks



(b) Forward guidance shocks

Note: Figures show the contribution of the identified forward guidance and LSAP shocks to 10-year JGB yields following BOJ monetary policy meetings.

Table 2: Correlation matrix between shocks and asset price surprises

	From our paper			From Kubota and Shintani (2022)		
	10yr JGB surprise	LSAP shock	FG shock	Path factor	Target factor	JGB futures surprise
10-year JGB surprise	1.00	0.82	0.63	-0.10	0.48	0.77
LSAP shock		1.00	0.58	-0.18	0.69	0.64
FG shock			1.00	-0.16	0.55	0.54
K+S path factor				1.00	-0.39	-0.14
K+S target factor					1.00	0.49
K+S JGB futures surprises						1.00

2.3 Verification of Shock Exogeneity

To provide a true representation of monetary policy actions, identified shocks should be exogenous with respect to information on the state of the economy and prospects for growth and inflation, as well as other shocks unrelated to monetary policy. Measuring asset price surprises immediately following MPMs limits the possible influence of other factors affecting policy expectations. However, the literature examining US monetary policy shocks has argued that high-frequency asset price responses following MPMs may also include a 'Fed information effect' (Miranda-Agrippino and Ricco, 2021; Bauer and Swanson, 2023). This can be interpreted as the central bank revealing private information about their perception of the state of the economy in their policy statement and press conferences. In order to orthogonalize high-frequency asset price responses to MPMs from this information effect, Miranda-Agrippino and Ricco (2021) use internal staff 'blue book' forecasts presented to FOMC members ahead of their MPMs, which are only externally published with a delay. To our knowledge, no such forecast exists publicly for the Bank of Japan policy meetings. However, Bauer and Swanson (2023) argues that the information effect also reflects the central bank revealing its interpretation of recent data surprises, which can be distinct from market views. They find that monetary policy surprises are partly predictable by data surprises in the run-up to the meeting.

To test whether our high-frequency shocks could also reflect revealed information about the state of the economy, we regress our monetary policy shocks on changes in the Citi Economic and Inflation surprise indices for the yen-dollar exchange rate. These indices are defined as weighted historical standard deviations of data surprises, measured by the difference between the outturn and the median expectation reported in the Bloomberg survey of analysts. For the economic surprise index, different activity indicators are weighted together by their typical relative impacts on exchange rates. The indices are available at daily frequency, and we regress each of our identified shock series on the change in the economic series ahead of the meeting for multiple horizons. For the inflation surprise index, we use only the most recent change in the surprise index, since CPI data is only released once a month.

Table 3 shows that the data surprise indices generally have no predictive power over the identified high-frequency shocks. The one exception is the inflation surprise at the 10% significance level, although the sign is inconsistent the information shock concept (a positive surprise on the inflation data should be positively correlated with the monetary policy shock if it reflects an information effect). This suggests that the identified shocks do not tend to react to recent information about the economic situation that could confound our analysis of the macroeconomic effects of policy shocks.[10]

While we cannot rule out a central bank information effect given our lack of data on internal forecasts ahead of meetings, the exercise suggests that asset prices are not generally responding to a revealed BOJ assessment of recent data. Furthermore, as discussed in the following section, our identified expansionary shocks result in a statistically significant rise in stock prices, which is unlikely to occur if they reflect information effects rather than exogenous changes to the monetary policy stance (Jarociński and Karadi, 2020).

Table 3: Exogeneity tests for identified shocks

	Dependent variable:			
	FG shocks		LSAP shocks	
	(1)	(2)	(3)	(4)
Citi econ. surprise 5-day	0.00002		0.00000	
	(0.0001)		(0.0001)	
Citi econ. surprise 30-day		0.00000		−0.00003
		(0.00002)		(0.00003)
Inflation 30-day	−0.0001*	−0.0001	−0.0001	−0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Citi infl. surprise 30-day	−0.00003	−0.00004	−0.00002	−0.00004
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	151	151	151	151
Adjusted R^2	0.005	0.005	−0.010	−0.002
Residual Std. Error	0.009	0.009	0.013	0.013

Note: *p<0.1; **p<0.05; ***p<0.01

3 Macroeconomic Impacts of BOJ Unconventional Monetary Policy Shocks

3.1 Construction of External Instruments

We now use the exogenous monetary policy shock series as external instruments to identify structural shocks in a VAR.

Take the following reduced-form VAR representation:

$$Y_t = \sum_{j=1}^{p} B_{t-j} Y_{t-j} + u_t.$$

The reduced form residuals (u) can be written in the standard notation as a linear combination (S) of the structural shocks (of unit variance, ϵ), such that:

$$u_t = S\epsilon_t,\ S'S = \Sigma = E[u_t' u_t].$$

[10] A separate analysis—available upon request—shows that the shocks are not predictable by historical shocks, and display little autocorrelation.

Given the nature of our identified high-frequency asset price reaction instrument (Z), we assume that

$$E[Z_t \epsilon^p] = \alpha$$

$$E[Z_t \epsilon^q] = 0,$$

where p represents the monetary policy shock of interest (LSAP; forward guidance) and q denotes other shocks that are not of interest in this exercise. As in Gertler and Karadi (2015), the column of S reflecting the policy shock is identified using a two-stage procedure, regressing the reduced-form residual of the policy variable on the instrument and then these fitted reduced form residuals on the remaining reduced form residuals. In the case of the LSAP shock, the policy variable of interest is the 10-year JGB yield.

The initial first-stage regression takes the form:

$$u_t^p = s^p z_t + \psi_t.$$

This establishes the reaction of the reduced-form error on the policy variable to a structural policy shock ϵ^p. The ratio between this response and the response of other variables to the policy shock is established using a second-stage regression of the reduced form errors of the other variables and the fitted value of u^p, $\hat{u}^p$:

$$u_t^q = \frac{\mathbf{s}^q}{s^p} \hat{u}^p + \psi_t,$$

where u^q represents the errors of the other non-policy endogenous variables. Once these ratios ($\frac{\mathbf{s}^q}{s^p}$) are established, each row of the vector of S representing the policy shock can be ascertained using the methodology described in Gertler and Karadi (2015).

3.2 SVAR Specification

Our baseline specification includes seven endogenous variables: the 10-year JGB yield, the 1-year JGB yield, log industrial production, the unemployment rate, the log of the TOPIX stock market index, the log of core CPI (excluding food, non-alcoholic beverages and energy), and the log of the yen-dollar exchange rate (expressed as JPY per USD, such that an increase corresponds to a depreciation). The VAR is estimated at monthly frequency using data from January 1999 to December 2023. This sample is longer than the availability of our instrument (2010-2023), providing more precise estimates of VAR parameters. The starting year of 1999 is when Japanese inflation first turned negative and the BOJ's policy rate first reached the effective lower bound.

Our external instrument is identified on specific MPM days, in contrast to the monthly frequency of the endogenous variables in the VAR. To transform the instrument into monthly frequency, we take a rolling sum of monetary policy surprises over the previous month, and then calculate the average value of the instrument in each month.[11] To ensure consistency, our endogenous interest rate variables (10-year and 1-year JGB yields) are also reported as monthly average values. The VAR includes four lags, as suggested by the Akaike information criterion.

Our identified LSAP and FG policy shocks do not appear to suffer from the weak instrument problem, which can lead to issues around confidence intervals and inference (Montiel Olea, Stock, and Watson, 2021). The F-statistic for the explanatory power of the forward guidance instrument on the VAR residuals is 41, while the statistic for the LSAP instrument is 22. Both instruments' F-statistics are well above the standard threshold cited in the literature of 10-15 (Andrews, Stock, and Sun, 2019).

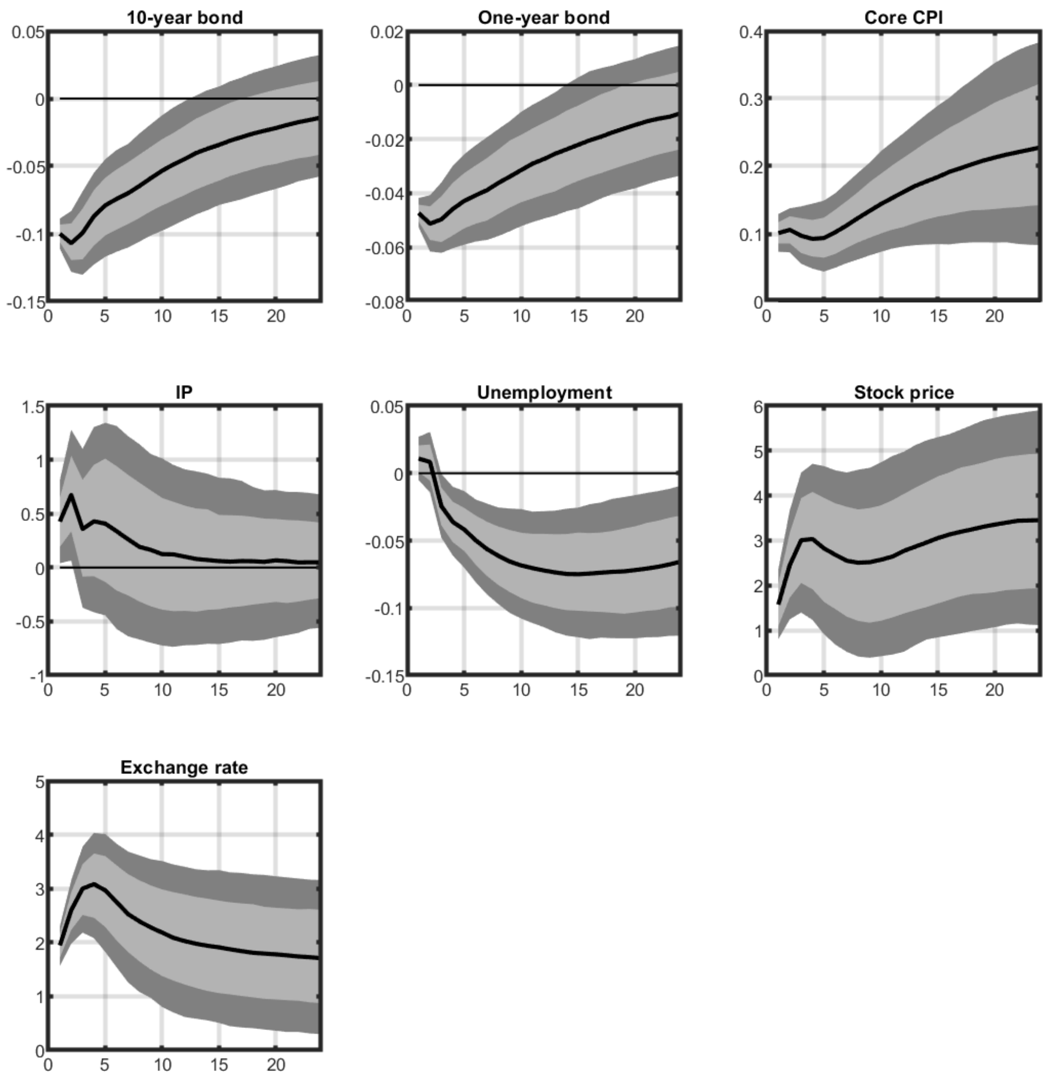
Figure 8 shows the response of the endogenous variables over two years following an expansionary LSAP policy shock, scaled to lower the 10-year JGB yield by 10 bps on impact. The exchange rate depreciates, stock prices rise, core CPI rises, industrial production increases, and unemployment falls in the medium term. We take these results to be broadly consistent with theoretical predictions, and suggest that balance sheet policies in Japan have been effective in supporting the real economy and prices. In contrast, in a meta-analysis of SVAR evidence, Ferreira-Lopes et al. (2022) find weak evidence of a significant impact on output from quantitative easing in Japan. The survey of Aoki and Ueda (2025) documents a range of estimated impacts of BOJ asset purchases on output, with a median effect that is economically small. Note that these previous estimates have generally not relied on a high-frequency shock identification scheme like ours.

In Figure 9, we show the response of the endogenous variables following an expansionary forward guidance shock, scaled to result in a 10 bps fall in the one-year JGB yield. The responses are broadly consistent with those following the LSAP shock, although two of the responses differ to some extent. The impact on core CPI is not statistically different from zero, suggesting a reduced effectiveness in boosting prices relative to the LSAP shock. Secondly, the exchange rate effect is somewhat smaller and only remains statistically significant in the first few months. The larger effect on the exchange rate of the LSAP shock relative to the forward guidance shock is consistent with evidence from the US, where Erceg et al. (2024) have documented a significant impact of Federal Reserve LSAP shocks on the dollar exchange rate, but smaller impacts from shocks affecting the short end of the curve.

As previously discussed, one potential issue with our instrument is that the YCC framework may have constrained 10-year JGB yields ahead of some policy meetings, including the period of April to December 2022 before the tolerance band was widened to 50 bps. This constraint could mean that the asset price news following these meetings does not reflect a true surprise from exogenous changes in monetary policy. However, we find that our results are robust to excluding the instrument for the period of April 2022 to December 2023 (see Appendix Figure A.7).

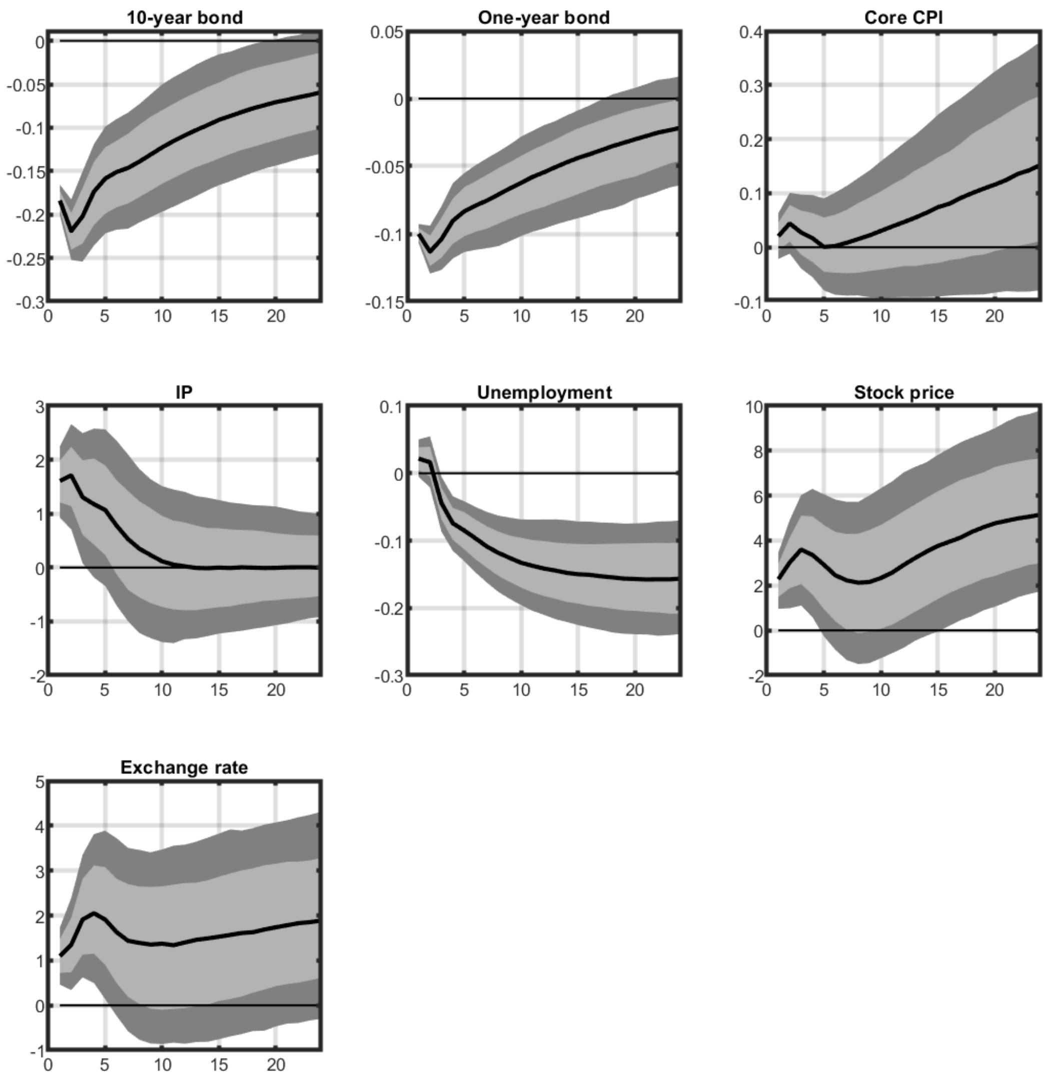
[11] Using a rolling sum before calculating the monthly average corrects for issues associated with the timing of the MPM within a calendar month. Asset price responses to an MPM occurring at the end of a month are unlikely to be a strong instrument for the average bond yield in that month.

Figure 8: Response to expansionary BOJ LSAP shock



Note: Estimated responses to an expansionary shock to BOJ large-scale asset purchases that lowers the 10-year JGB yield by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals.

Figure 9: Response to expansionary BOJ forward guidance shock



Note: Responses to an expansionary shock to BOJ forward guidance that lowers the 1-year JGB yield by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals.

4 Spillovers from Bank of Japan Unconventional Monetary Policy to Foreign Yields

In this section, we estimate spillovers from identified BOJ unconventional policy shocks to international sovereign yields using a local projections specification.

4.1 Data and Local Projection Specification

We construct a daily panel dataset of 10-year government bond yields for 38 economies over the period 2010 to 2023 using data from Haver Analytics.[12] Yields are constructed from either constant maturity benchmarks or market mid yields, depending on country practices and data availability from national authorities or financial market data providers.[13] Our high-frequency identified shocks to the BOJ's unconventional policy instruments ($\epsilon^{\text{LSAP}}, \epsilon^{\text{FG}}$) are merged at daily frequency.[14]

Let $y_{i,t}$ be the 10-year sovereign yield in country i. For horizons $h = 0, \ldots, 5$ days, we estimate a panel local projection specification:

$$\begin{aligned} y_{i,t+h} - y_{i,t-1} = \; & \alpha_i + \boldsymbol{\beta}_h' \boldsymbol{\epsilon}_t + \sum_{j=1}^{4} \gamma_j^h \left(y_{i,t-j} - y_{i,t-j-1} \right) \\ & + \sum_{j=1}^{4} \delta_j^h \Delta \text{US10Y}_{t-j} + \psi_j \text{X}_t + \varepsilon_{i,t+h}, \end{aligned} \tag{1}$$

where α_i are country fixed effects and $\boldsymbol{\epsilon}_t \in \{\epsilon_t^{\text{LSAP}}, \epsilon_t^{\text{FG}}\}$ includes the identified shocks to BOJ LSAP and forward guidance instruments. Control variables include past changes of yields in country i and lagged daily changes in the 10-year US Treasury yield ΔUS10Y_{t-j}. The vector of additional controls X_t includes contemporaneous monetary policy shocks for the Federal Reserve and ECB identified by Miranda-Agrippino and Nenova (2022) at daily frequency, as well as their leads from periods t to $t + h$.[15] In our baseline specification, equation (1) is estimated on the full panel (section 4.2), and estimated standard errors are clustered by country.[16]

[12] The sample includes Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Hungary, India, Indonesia, Ireland, Israel, Italy, Malaysia, Mexico, Netherlands, Norway, Peru, Philippines, Poland, Portugal, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Türkiye, the United Kingdom, and the United States. These are the top sovereign bond issuers by market size, excluding Argentina and Saudi Arabia due to data availability. Tickers for the data series retrieved from Haver are reported in Table A.2.

[13] We prioritize using local-currency denominated bond instruments, but for a few countries (for example, Brazil and Mexico) we use US dollar-denominated instruments that are more actively traded in offshore markets.

[14] Because time-zone and calendar differences imply that some markets are closed while others are open, individual intraday series contain gaps. We forward-fill missing observations for each country using the last available trading day observation. This preserves the cross-section on every BOJ announcement date without introducing artificial volatility and avoids persistent gaps in the IRF estimation that could be caused by the timing of the BOJ meetings being scheduled for certain days of the week.

[15] We include shocks to all three identified factors for each central bank (*target*, *path*, and *LSAP* components). It is quite common for these major central banks to have meetings within a few days: 37 out of the 151 BOJ meetings we study had a Federal Reserve or ECB meeting in the following 5 business days.

[16] Montiel Olea and Plagborg-Möller (2021) show that the use of heteroskedasticity and autocorrelation corrected standard errors is not needed to avoid bias in a lag-augmented local projection specification such as ours.

4.2 Average Spillovers from BOJ Policy Shocks

Table 4 presents the results from the baseline regression estimated using equation (1) for each horizon h. The first two rows correspond to the estimated impulse-response functions of foreign sovereign yields following Bank of Japan LSAP and forward guidance shocks. Like Georgiadis and Jarociński (2025) for the case of the US Federal Reserve, we find that BOJ shocks to both unconventional policy instruments generate statistically significant responses in foreign yields.

Table 4: Linear projection baseline results

	Dep. Var.: Cumulative change in 10-year sovereign yield					
	$h = 0$	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$
LSAP shock	-0.771***	-0.920***	-0.453***	-0.365**	-0.630***	-1.002***
	(0.107)	(0.159)	(0.175)	(0.154)	(0.123)	(0.138)
Forward Guidance shock	0.258*	0.370**	-1.020***	-1.595***	-1.053***	-0.908***
	(0.144)	(0.175)	(0.224)	(0.280)	(0.256)	(0.229)
Policy shocks from Federal Reserve	Yes	Yes	Yes	Yes	Yes	Yes
Policy shocks from ECB	Yes	Yes	Yes	Yes	Yes	Yes
Lags of dependent variable	Yes	Yes	Yes	Yes	Yes	Yes
Lags of 10-year US Treasury yield	Yes	Yes	Yes	Yes	Yes	Yes
Observations	132,829	132,791	132,753	132,715	132,677	132,639
Countries	38	38	38	38	38	38
R^2	0.013	0.014	0.012	0.013	0.013	0.013

Note: Country fixed effects included; standard errors clustered by country. *, **, *** denote significance at 10%, 5%, and 1% levels.

To aid interpretation of these spillover effects, in Figure 10 we rescale the estimated coefficients by the impact of the shocks on the 10-year JGB yield at the same horizon. The resulting spillover coefficients represent the elasticity of the response of the foreign yields with respect to the response of the JGB yield: $\hat{\beta}_h = \frac{\beta_h}{\beta_h^{JGB}}$, where β_h^{JGB} is estimated from a Japan-specific regression.[17] The standard errors are calculated based on the first-order Taylor approximation of the variance of a ratio of two random variables: $Var(\hat{\beta}_h) = \left(\frac{1}{\beta_h^J}\right)^2 Var(\beta_h) + \left(\frac{\beta_h}{\beta_h^{J2}}\right)^2 Var(\beta_h)$.

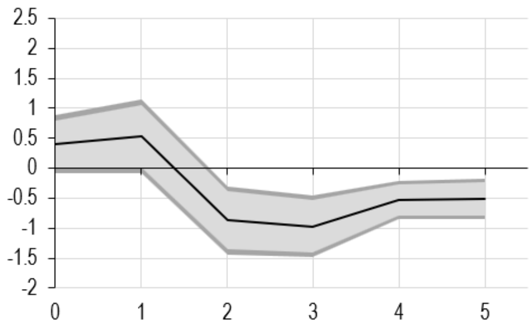
Both LSAP and FG shocks generate statistically significant spillover coefficients of about 0.5, though the latter are not statistically significant until two days following the announcement. An expansionary LSAP policy shock provoking a 10 bps decline in 10-year JGB yields lowers foreign yields by about 5 bps on the next business day, and this response remains statistically significant for the following week. We see this result as consistent with the predictions of the model proposed by Gourinchas, Ray, and Vayanos (2024), where the presence of bond market segmentation and constrained arbitrageurs mean that LSAP policies affect foreign bond yields. Expansionary forward guidance shocks also result in a significant and persistent fall in foreign yields of approximately 5 bps.

These results are consistent under several robustness checks, which are described in the Appendix. First, we verify that the spillover estimates are not overly sensitive to the identifying assumptions

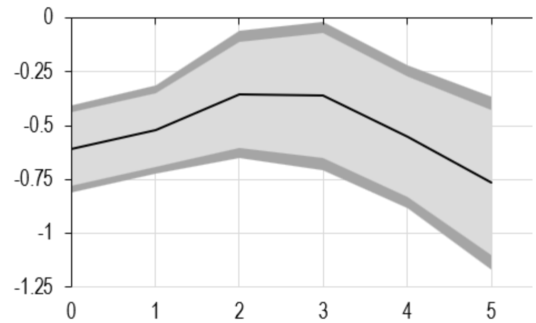
[17]The IRF for the unscaled β_h^{JGB} is reported in Appendix Figure A.11.

described in Section 2 to identify shocks to forward guidance and LSAP instruments. In Figure A.3, we report consistent spillover estimates when using JGB yield surprises as external instruments without imposing any additional identifying assumptions. Second, we check that the results are not driven by a small number of large shocks or by the period during which YCC could have potentially constrained yields surrounding policy announcements (April 2022 to December 2023). Finally, we confirm that the result is robust to excluding countries with low capital account openness from the sample (Figure A.9).

Figure 10: Estimated response of foreign bond yields following BOJ unconventional monetary policy shocks



(a) Forward Guidance



(b) LSAP

Note: The responses are normalized by the response of 10-year JGB yields at each horizon h. Shaded areas denote 90% and 95% confidence intervals.

The size of these estimated spillovers from BOJ LSAP and FG shocks are in line with results found in the literature for spillovers from Federal Reserve policy shocks. Arbatli-Saxegaard et al. (2024) find that a policy shock that raises 10-year US Treasury yields by 10 bps provokes spillovers of about 5 bps on 10-year yields abroad. Caceres et al. (2016) estimate a response of between 5 and 8 bps in two-thirds of their sample of 46 advanced and emerging economies. Similarly, Albagli et al. (2019) estimate a response of 4.3 and 5.6 bps in their samples of advanced and emerging economies, respectively. The size of BOJ LSAP spillovers we estimate are also closely aligned with the quantification predicted by Gourinchas, Ray, and Vayanos (2024). Reassuringly, the estimated coefficients on the externally identified US LSAP shocks in equation (1) also align closely with the literature, with a pooled fall of global yields of 5 bps following a 10 bps reduction in US yields.

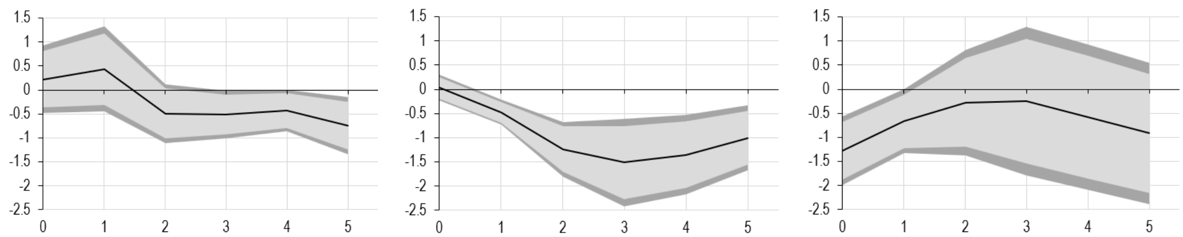
4.3 Spillover Transmission Channels: Term Premia and Investor Exposure

Following the literature on the transmission of monetary policy shocks to global asset prices (Miranda-Agrippino and Rey, 2020), we estimate the impact of BOJ unconventional policy shocks on term premia. Figure 11 shows the impact of BOJ forward guidance and LSAP shocks on the term premia priced into Japanese and US 10-year government bonds.[18] As expected, a shock to BOJ forward

[18]We use the Adrian, Crump, and Moench (2013) methodology to estimate the term premium priced into 10-year sovereign bonds. For US Treasuries, estimates are obtained from the Federal Reserve Bank of New York. For JGBs, we estimate the model of the term structure using the same approach, but make the following adjustment: given that

guidance does not have a significant impact on JGB term premia, and rather affects 10-year JGB yields by influencing risk-free rates. In contrast, an expansionary BOJ LSAP shock that lowers the 10-year JGB yield by 10 bps leads to a decrease of the JGB term premium by around 12 bps after two days. That is, the LSAP shock lowers JGB yields almost exclusively by lowering the domestic term premium. Similarly, the US term premium falls by about 10 bps on impact, though the response weakens and looses statistical significance at longer horizons. This result is consistent with the findings of Albagli et al. (2019), who document that spillovers from Federal Reserve policy shocks to emerging markets transmit largely through foreign term premia.

Figure 11: Effects of BOJ forward guidance and LSAP shocks on term premia



(a) FG on 10-year JGB **(b)** LSAP on 10-year JGB **(c)** LSAP on 10-year US Treasury

Note: Response of term premia priced into 10-year Japanese Government Bonds (Panels a and b) and 10-year US Treasuries (Panel c) estimated using Adrian, Crump, and Moench (2013). The responses are normalized by the contemporaneous response of 10-year JGB yields to the same shock at each horizon. Shaded areas denote 90% and 95% confidence intervals.

To test for the possible role of a portfolio channel based on the presence of Japanese investors in foreign sovereign bond markets, we compute for each economy the average share of its sovereign debt held by Japanese investors using data from the BIS International Debt Securities database. For each economy, we divide Japanese investor holdings by the stock of general government debt securities to compute the share of debt held by Japanese residents, $W_{J,i}$. The analysis covers 2010–2023 and we use the period-average share as a single exposure metric for each country. As the exposure to Japanese investors is an endogenous outcome that may respond to BOJ monetary policies, we treat the exposure measure as time-invariant. The values of the mean exposure for each economy, $\overline{W}_{J,i}$, are listed in Table A.2.

We estimate a modified specification that includes interactions $\varepsilon_t^{\text{LSAP}} \times L_i$ and $\varepsilon_t^{\text{FG}} \times L_i$ for both BOJ policy shocks, where $L_i \equiv \log(\overline{W}_{J,i})$:

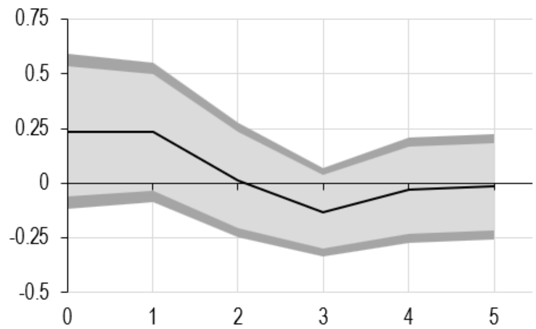
$$\begin{aligned} y_{i,t+h} - y_{i,t-1} = \alpha_i + \sum_{s \in \mathcal{S}} \left(\beta_{h,s}\, \varepsilon_{s,t} + \theta_{h,s}\, \varepsilon_{s,t}\, L_i\right) + \sum_{j=1}^{4} \gamma_j^h \left(y_{i,t-j} - y_{i,t-j-1}\right) \\ + \sum_{j=1}^{4} \delta_j^h\, \Delta \text{US10Y}_{t-j} + \psi_j\, \mathbf{X}_t + \varepsilon_{i,t+h}, \end{aligned} \tag{2}$$

Figure 12 plots the estimated coefficients from the interaction terms, $\theta_{h,s}$ along with its 90% and

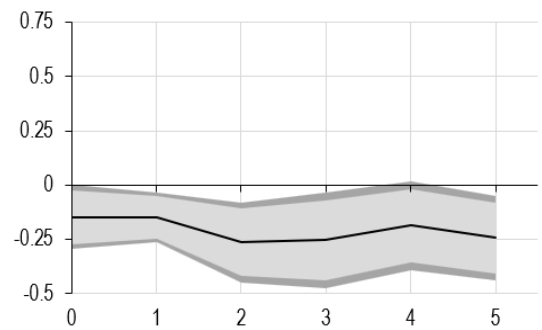
the Bank of Japan's yield curve control policy explicitly targeted the 10-year JGB yield (but not bonds with adjacent maturities), we substitute this series with yields on other long-term government bonds with similar remaining maturity.

95% confidence intervals. While the interaction with the forward guidance shock shows no statistically significant effect at any horizon, the LSAP interaction is statistically significant at all horizons. An increase in exposure from 1 to 10 percent raises the strength of spillover by approximately 0.2.[19] This result is suggestive of a strong portfolio rebalancing channel in the transmission of BOJ LSAP shocks, which is well aligned with the Georgiadis and Jarociński (2025) finding that Fed LSAP shocks trigger international portfolio rebalancing between US and foreign bonds that are relatively close substitutes.

Figure 12: Differential spillover effects of BOJ shocks on foreign yields, by exposure to Japanese investors



(a) Forward guidance



(b) LSAP

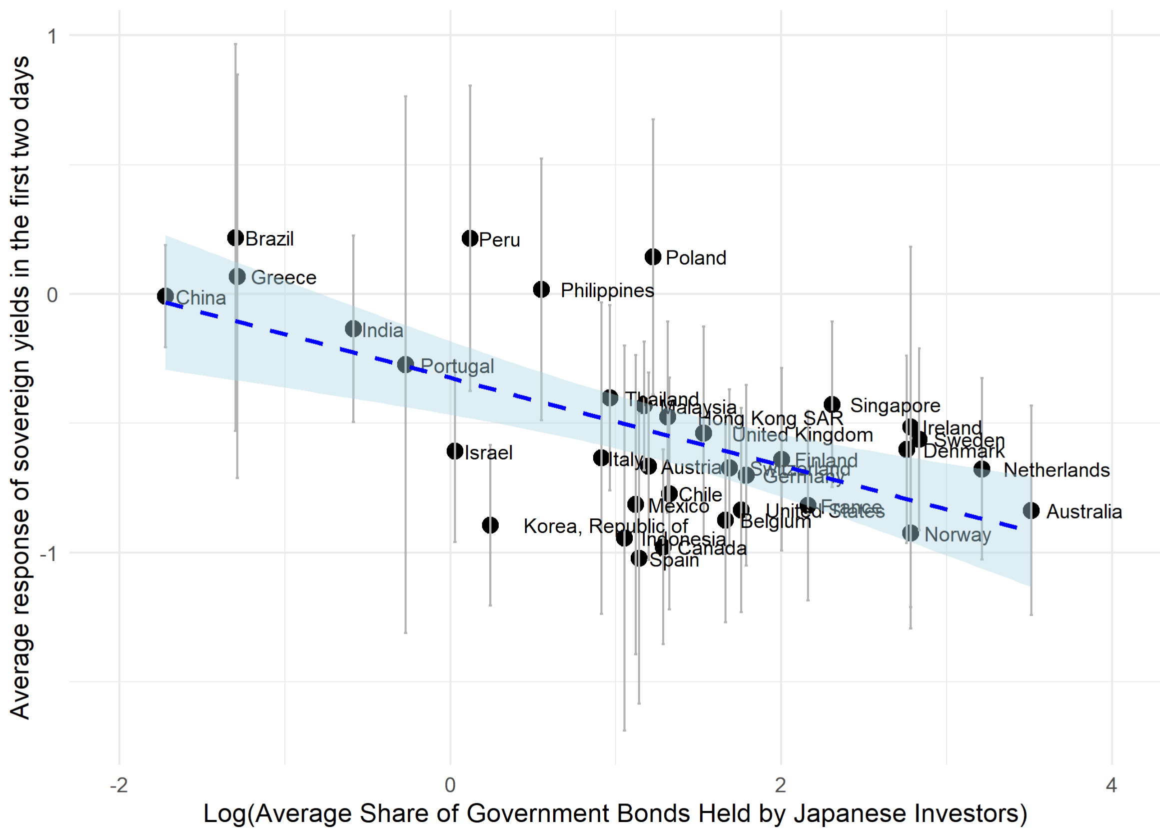
Note: Impact of each shock is normalized by the contemporaneous response of 10-year JGB yields. Shaded areas denote 90% and 95% confidence intervals.

As a complementary exercise to further explore the relationship between the magnitude of spillovers and the participation of Japanese investors in sovereign bond markets, we estimate country-specific versions of equation (1). For each economy, we record the short-term response by taking the average coefficient over the first two days. Figure 13 provides a scatter plot of these short-run responses to BOJ LSAP shocks against the log exposure to Japanese investors reported in Table A.2. A fitted linear regression line is shown in dashed blue.[20] Again, the evidence is suggestive that spillovers from BOJ LSAP shocks are larger for sovereign bond markets with greater participation of Japanese investors, underscoring the importance of financial interconnectedness in the transmission of monetary policy shocks.

[19] In Appendix Figure A.10, we report consistent results from an interaction with a high-exposure indicator that denotes economies in the top quintile of average exposure.

[20] Country-specific error bars are computed as an average over the same horizon as the coefficient.

Figure 13: Foreign yield response to BOJ LSAP shocks vs. market exposure to Japanese investors



Note: The fitted OLS regression line has slope = -0.158 with s.e. = 0.070. Country-specific error bars show +/- one standard error. Outlier estimates for Hungary and Türkiye are not shown on the plot to improve its readability.

5 Conclusion

This paper has presented empirical estimates of the effects of Bank of Japan unconventional monetary policies since 2010. We begin by using high-frequency intraday data to measure surprises in asset prices surrounding 151 BOJ policy announcements. We then apply the methodology introduced by Swanson (2021) to identify shocks to Bank of Japan unconventional policy instruments—forward guidance and large-scale asset purchases—and estimate their effects on domestic macroeconomic variables.

We show that Bank of Japan forward guidance and LSAP shocks have generally theory-consistent impacts on domestic activity, stock prices, core CPI, unemployment, and the exchange rate. These impacts are broadly similar across policy instruments, though the response of core CPI to forward guidance shocks is not statistically significant.

We then estimate spillovers from BOJ unconventional policy shocks to foreign sovereign bond yields. We find that shocks from BOJ forward guidance and LSAP policies generate significant and comparable spillovers to foreign bond yields. In a panel of 38 advanced and emerging economies, we estimate that BOJ LSAP and forward guidance shocks that lower the 10-year JGB yield by 10 bps lead to declines of approximately 5 bps in foreign 10-year sovereign yields. The strength of these international spillovers is similar to what the literature has found for spillovers from US monetary policy shocks. Importantly, our results do not necessarily imply that BOJ policies have been as important in driving global yields as Federal Reserve policy decisions have been. Indeed, we document that identified BOJ policy shocks have generally been small over the sample period. This is one of the reasons that yields on Japanese government bonds have been much less volatile than US Treasury bond yields over 2010-23, with daily-frequency sample variances of 0.18 and 0.70 percent, respectively.

While the size of spillovers from BOJ LSAP and FG policy shocks are comparable, their transmission mechanisms appear to differ. We show suggestive evidence that BOJ LSAP policy shocks transmit to foreign yields by influencing term premia, but this is not the case for BOJ forward guidance shocks. Finally, we show that the strength of spillovers from BOJ LSAP policy shocks is increasing in the presence of Japanese investors in local government bond markets, while spillovers from BOJ forward guidance shocks do not vary in this dimension.

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Appendix

Table A.1: BOJ monetary policy meeting dates and statement announcement times

Date	Time	Date	Time	Date	Time	Date	Time
01/26/2010	12:26	07/12/2012	12:51	04/08/2015	12:36	06/20/2019	11:45
02/18/2010	11:45	08/09/2012	12:19	04/30/2015	13:04	07/30/2019	11:55
03/17/2010	12:49	09/19/2012	12:44	05/22/2015	11:49	09/19/2019	11:49
04/07/2010	12:03	10/05/2012	12:14	06/19/2015	12:04	10/31/2019	12:32
04/30/2010	13:18	10/30/2012	14:46	07/15/2015	12:18	12/19/2019	11:45
05/10/2010	12:11	11/20/2012	12:14	08/07/2015	12:18	01/21/2020	12:01
05/21/2010	12:42	12/20/2012	13:01	09/15/2015	12:07	03/16/2020	14:06
06/15/2010	12:56	01/22/2013	12:47	10/07/2015	12:00	04/27/2020	12:08
07/15/2010	12:45	02/14/2013	12:39	10/30/2015	12:22	05/22/2020	10:01
08/10/2010	12:28	03/07/2013	12:24	11/19/2015	12:17	06/16/2020	11:33
08/30/2010	12:11	04/04/2013	13:40	12/18/2015	12:50	07/15/2020	11:57
09/07/2010	12:39	04/26/2013	13:35	01/29/2016	12:38	09/17/2020	11:51
10/05/2010	13:38	05/22/2013	12:07	03/15/2016	12:35	10/29/2020	12:12
10/28/2010	13:31	06/11/2013	11:48	04/28/2016	12:01	12/18/2020	12:13
11/05/2010	11:36	07/11/2013	11:47	06/16/2016	11:45	01/21/2021	11:38
12/21/2010	12:55	08/08/2013	11:59	07/29/2016	12:44	03/19/2021	12:39
01/25/2011	12:29	09/05/2013	11:42	09/21/2016	13:18	04/27/2021	12:00
02/15/2011	12:37	10/04/2013	11:49	11/01/2016	11:55	06/18/2021	12:30
03/14/2011	14:48	10/31/2013	13:14	12/20/2016	11:51	07/16/2021	11:56
04/07/2011	13:10	11/21/2013	12:15	01/31/2017	11:56	09/22/2021	11:49
04/28/2011	13:31	12/20/2013	11:57	03/16/2017	11:54	10/28/2021	11:45
05/20/2011	12:14	01/22/2014	12:20	04/27/2017	12:14	12/17/2021	11:57
06/14/2011	12:42	02/18/2014	12:28	06/16/2017	11:54	01/18/2022	11:46
07/12/2011	13:20	03/11/2014	12:00	07/20/2017	12:10	03/18/2022	11:51
08/04/2011	14:00	04/08/2014	11:50	09/21/2017	12:15	04/28/2022	12:09
09/07/2011	12:21	04/30/2014	12:51	10/31/2017	12:05	06/17/2022	11:43
10/07/2011	12:37	05/21/2014	11:41	12/21/2017	11:46	07/21/2022	12:04
10/27/2011	13:31	06/13/2014	11:41	01/23/2018	12:14	09/22/2022	11:51
11/16/2011	12:49	07/15/2014	11:58	03/09/2018	11:46	10/28/2022	11:50
11/30/2011*	22:00	08/08/2014	12:08	04/27/2018	12:03	12/20/2022**	12:01
12/21/2011	12:16	09/04/2014	12:07	06/15/2018	11:41	01/18/2023	11:40
01/24/2012	12:31	10/07/2014	13:54	07/31/2018	13:03	03/10/2023	11:30
02/14/2012	12:43	10/31/2014	13:44	09/19/2018	11:47	04/28/2023	13:00
03/13/2012	14:07	11/19/2014	12:24	10/31/2018	12:08	06/16/2023	11:47
04/10/2012	12:09	12/19/2014	12:28	12/20/2018	11:52	07/28/2023**	12:28
04/27/2012	12:46	01/21/2015	12:29	01/23/2019	11:59	09/22/2023	11:52
05/23/2012	11:37	02/18/2015	11:49	03/15/2019	11:39	10/31/2023	12:27
06/15/2012	11:52	03/17/2015	12:04	04/25/2019	12:27	12/19/2023	11:49

Source: Bank of Japan.

Notes: Announcement times are reported in local Japan Standard Time. The news window for asset price changes starts 5 minutes before a policy announcement and ends 30 minutes afterwards. There are two exceptions to this, which are marked by double asterisks in the table. On 12/20/2022 and 7/28/2023, there were substantial asset price changes ahead of the BOJ announcements in anticipation of policy changes. In both cases, repricing followed reports in the local financial press about the likely outcome of policy deliberations. For both meetings, we have started the news window at market opening (8:00 AM) to capture the full repricing. For the meeting on 12/20/2022, we have ended the window 60 minutes after the BOJ announcement, since a market circuit breaker prevented trading in the 30 minutes after the meeting. The policy decision following the meeting on 11/30/2011 was announced at 22:00, when local financial markets were closed, so this meeting has been excluded from our dataset.

Table A.2: Data used for international spillover analysis

Economy	Average exposure to Japanese investors	Chinn-Ito Index (2016)	Sovereign yields Haver code
Australia	33.4	2.29	R193GA@INTDAILY
Netherlands	24.8	2.29	T138GA@INTDAILY
Sweden	17.0	2.29	T144GA@INTDAILY
Ireland	16.1	2.29	T178GA@INTDAILY
Norway	16.1	2.29	T142GA@INTDAILY
Denmark	15.7	2.29	T128GA@INTDAILY
Singapore	10.0	2.29	R576GA@INTDAILY
France	8.7	2.29	T132GA@INTDAILY
Finland	7.4	2.29	T172GA@INTDAILY
Germany	6.0	2.29	T134GA@INTDAILY
United States	5.8	2.29	R111GA@INTDAILY
Switzerland	5.4	2.29	T146GA@INTDAILY
Belgium	5.3	2.29	R124GA@INTDAILY
United Kingdom	4.6	2.29	T112GA@INTDAILY
Chile	3.8	1.03	R228GA@INTDAILY
Hong Kong SAR	3.7	2.29	T532GA@INTDAILY
Canada	3.6	2.29	T156GA@INTDAILY
Poland	3.4	1.03	T964GA@INTDAILY
Austria	3.3	2.29	T122GA@INTDAILY
Malaysia	3.2	-0.17	R199RA@INTDAILY
Spain	3.1	2.29	R184GA@INTDAILY
Mexico	3.1	1.03	R273DA@INTDAILY
Indonesia	2.9	-0.17	R536MA@INTDAILY
Thailand	2.6	-1.25	T578GA@INTDAILY
Italy	2.5	2.29	T136GA@INTDAILY
The Philippines	1.7	-0.05	R566MA@INTDAILY
Türkiye	1.7	-0.05	T186GA@INTDAILY
South Africa	1.6	-1.25	R199RA@INTDAILY
South Korea	1.3	2.29	R542TA@INTDAILY
Peru	1.1	2.29	R293BA@INTDAILY
Israel	1.0	2.29	T436GA@INTDAILY
Czech Republic	1.0	2.29	T935GA@INTDAILY
Hungary	0.9	2.29	R944GA@INTDAILY
Portugal	0.8	2.29	T182GA@INTDAILY
India	0.6	-1.25	T534GA@INTDAILY
Greece	0.3	1.21	R174GA@INTDAILY
Brazil	0.3	-1.25	T223GA@INTDAILY
China	0.2	-1.25	R924VA@INTDAILY

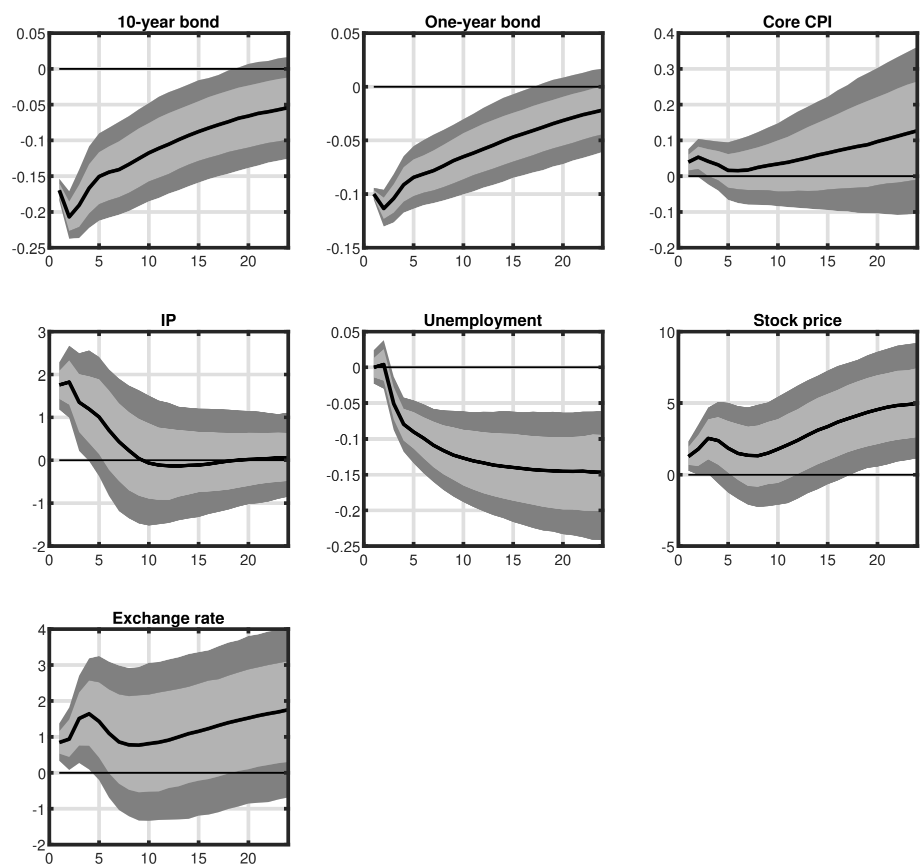
Note: 'Average exposure' is measured as the 2010-23 average share of government bonds held by Japanese investors, expressed as a percentage of total outstanding government bonds.
Sources: BIS International Debt Securities; Haver Analytics; Chinn and Ito (2006) index updated by the authors.

Robustness: Using Asset Price Surprises for External Identification

In this robustness check, we re-estimate our main results using the post-meeting surprises in the 1-year and 10-year JGB yields as instruments to achieve identification. In contrast to our identified shocks presented in section 2.2, there is no attempt to identify the drivers of these changes as specifically related to balance sheet policy or forward guidance. For example, when using the pure response of the 1-year JGB bond yield, the identification is silent on how this is correlated with yield surprises at the longer end of the curve.

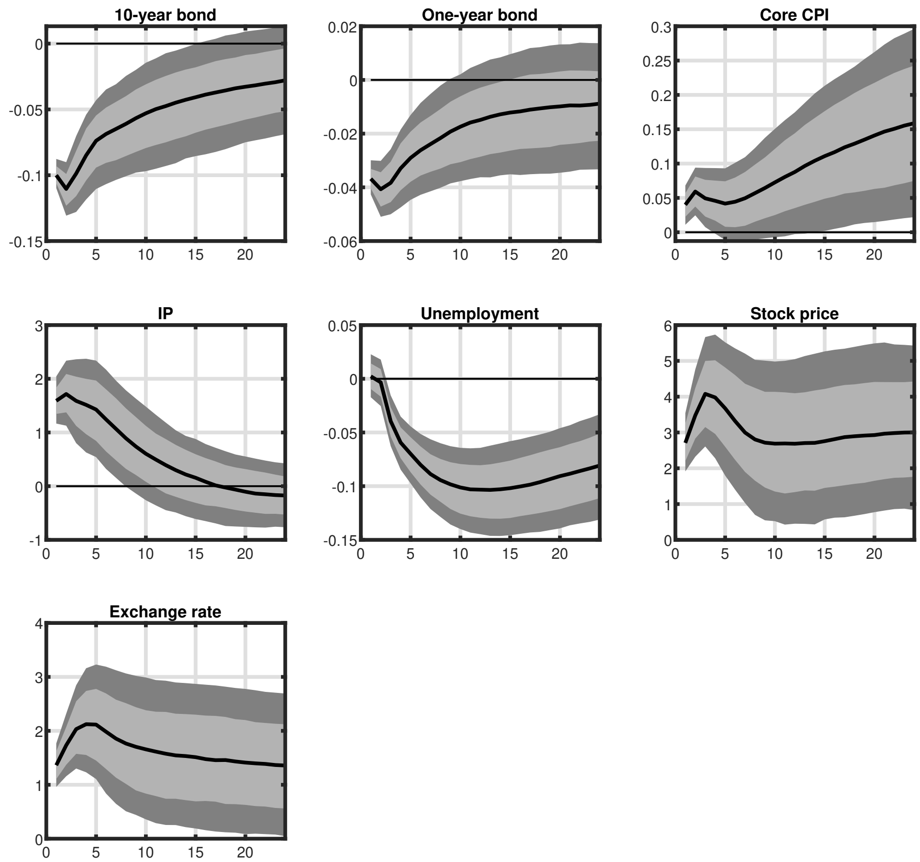
Figure A.1 shows the SVAR impulse-responses following a high-frequency surprise to the 1-year JGB yield as an instrument. These estimated dynamics are similar to those for the forward guidance shock (Figure 9). Figure A.2 shows the impulse-response following a high-frequency surprise to the 10-year JGB yield as the instrument, which also closely resembles the identified LSAP shock (Figure 8). One exception to this is the smaller and less statistically significant response of core prices. The LSAP instrument IRFs show a larger appreciation of the exchange rate relative to the 10-year news identification. This is perhaps a result of the procedure utilizing the relation between various asset prices, including the exchange rate, to identify LSAP shocks.

Figure A.1: Response to monetary policy surprise lowering 1-year JGB yields



Note: Estimated responses to an expansionary shock that lowers 1-year JGB yields by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals.

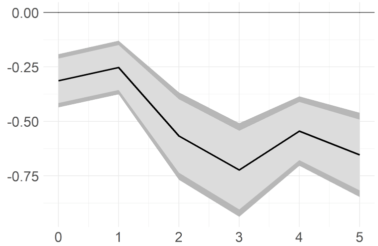
Figure A.2: Response to monetary policy surprise lowering 10-year JGB yields



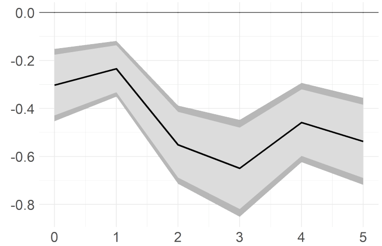
Note: Estimated responses to an expansionary shock that lowers 10-year JGB yields by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals.

Figure A.3 reports the average response of foreign 10-year bond yields to expansionary surprises in Japanese 1-, 2-, and 10-year yields in 30-minute windows surrounding BOJ policy announcements. All three trigger statistically significant declines in sovereign yields abroad, with the response to surprises at the longer end of the yield curve being largest and the most precisely estimated, averaging around 2.5 bps over two days after a shock that lowers domestic 10-year yields by 10 bps, and rising to 5 bps after four days. This effect is broadly aligned with our baseline estimation of the LSAP and forward guidance shocks.

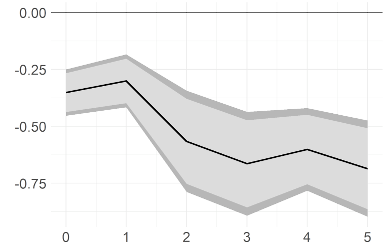
Figure A.3: Estimated response of foreign bond yields to surprises in JGB yields after BOJ meetings



(a) 1-year JGB yield surprise



(b) 2-year JGB yield surprise



(c) 10-year JGB yield surprise

Note: The solid line shows the point estimate of the response, the dark-grey band the 95% confidence interval, and the light-grey band the 90% confidence interval. The response following each surprise is normalized by the contemporaneous response of 10-year JGB yields.

Robustness: Exclusion of Meetings with JGB Yields Potentially Constrained by YCC

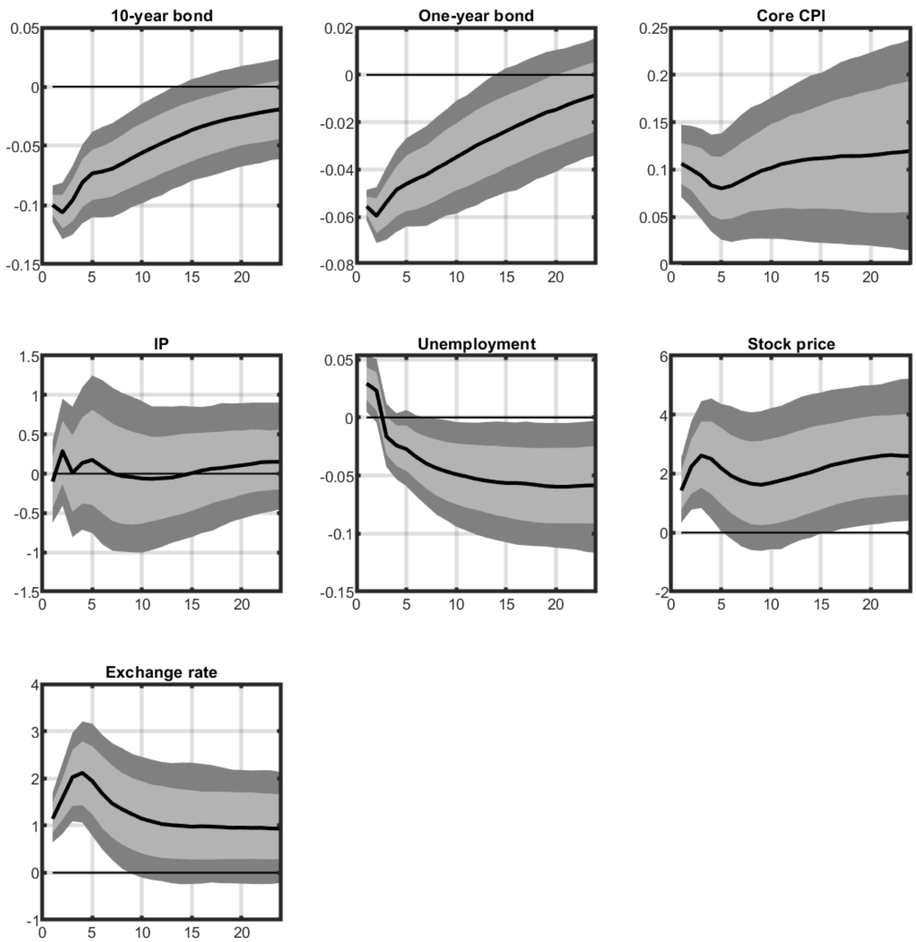
As noted in Section 2.1, there are instances starting in April 2022 where 10-year JGB yields were close to the BOJ's yield curve control tolerance threshold ahead of monetary policy meetings. This can potentially lead to mismeasurement of asset price news, since yields could be constrained ahead of or after a policy announcement. To address this potential concern, we re-estimate our SVAR and local projection equation (1) removing the instrument from April 2022 to December 2023.

Results are largely consistent with the main text results. Figure A.4 shows the impulse-responses following an expansionary LSAP shock, which is comparable to baseline Figure 8 in the main text. Expansionary LSAP shocks continue to result in a rise in stock prices and core CPI, a fall in unemployment, and a depreciation of the yen. However, in the case of industrial production, the shock no longer results in a statistically significant expansion. Similarly, impulse-responses shown in Figure A.5 for expansionary forward guidance shocks are well aligned with those reported in Figure 9 for the baseline specification.

Similarly, Figure A.6 reports the estimation of spillover equation (1) excluding the period of April 2022 to December 2023. The results are highly consistent with the baseline estimates reported in Figure 10, confirming that they are not driven by the potential mismeasurement of asset price surprises under YCC.[21]

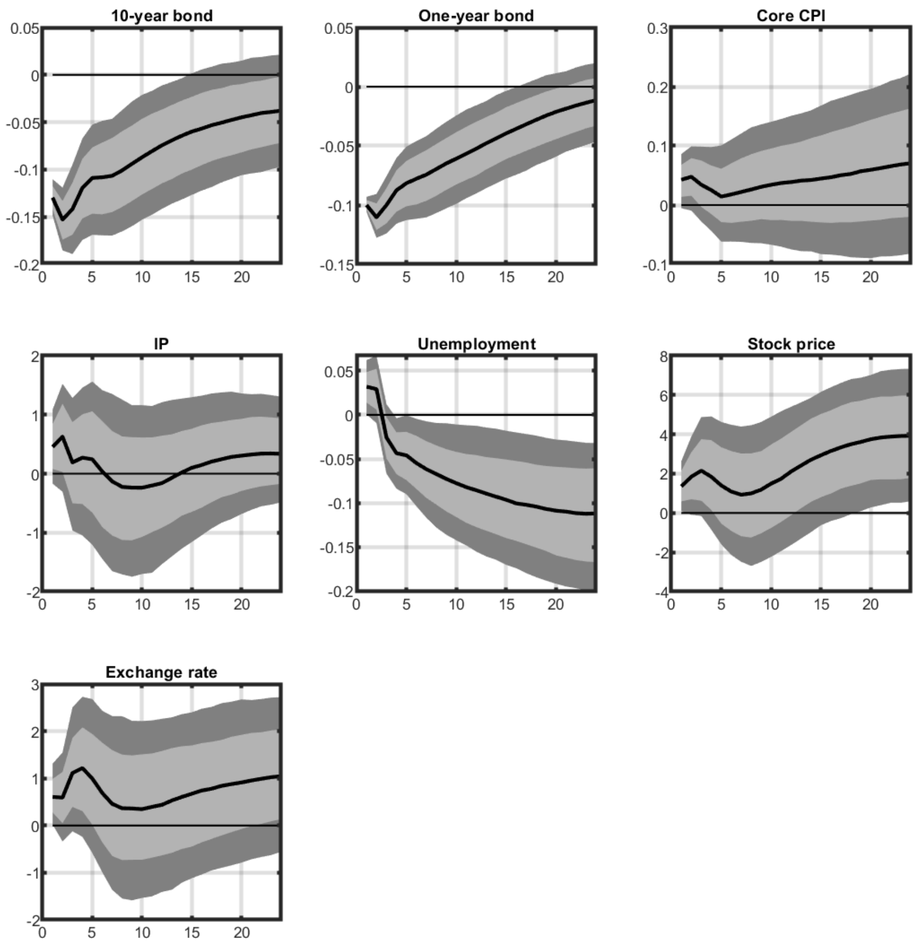
[21] These results are also robust to excluding the whole period of Yield Curve Control, starting in September 2016.

Figure A.4: Response to expansionary BOJ LSAP shock (excluding post-April 2022 period)



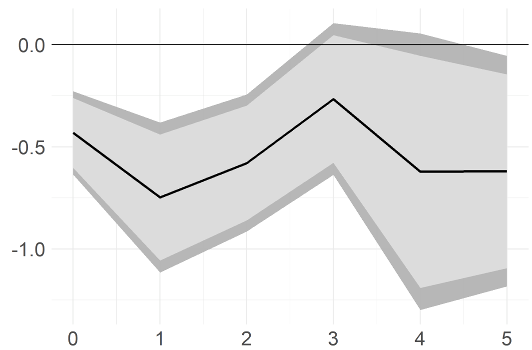
Note: Responses to an expansionary shock to BOJ large-scale asset purchases that lowers the 10-year JGB yield by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals. This robustness excludes shocks from the period of April 2022 to December 2023.

Figure A.5: Response to expansionary BOJ forward guidance shock (excluding post-April 2022 period)



Note: Responses to an expansionary shock to BOJ forward guidance that lowers the 1-year JGB yield by 10 bps on impact. Shaded areas denote 68% and 90% confidence intervals. This robustness excludes shocks from the period of April 2022 to December 2023.

Figure A.6: Estimated response of foreign bond yields to BOJ LSAP shocks (excluding post-April 2022 period)

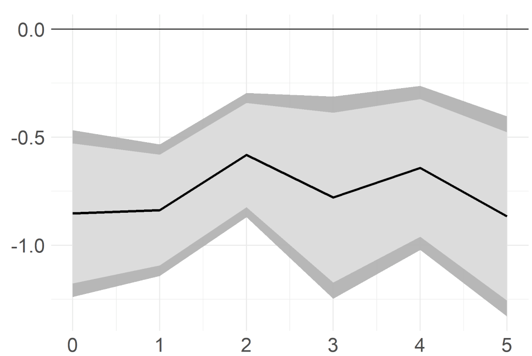


Note: Response following each shock is normalized by the contemporaneous response of 10-year JGB yields. Shaded areas denote 90% and 95% confidence intervals.

Robustness: Spillover Results Excluding Large Policy Shocks

As discussed in Section 2.1, the distribution of identified policy shocks is fat tailed and punctuated by a small number of large surprises. We re-estimate equation (1) excluding the shocks that exceed a cut-off level of $|\epsilon| > 2.5$ bps. Figure A.7 shows the estimated spillover to foreign yields following a BOJ LSAP shock that lowers the 10-year JGB yield, and is broadly consistent with the findings reported in baseline Figure 10 in the main text. This confirms that our spillover estimates are not being exclusively driven by the largest policy shocks (associated with large repricing surrounding BOJ policy decisions), but are also significant when considering smaller policy shocks.

Figure A.7: Estimated response of foreign bond yields to BOJ LSAP shocks (excluding large shocks)

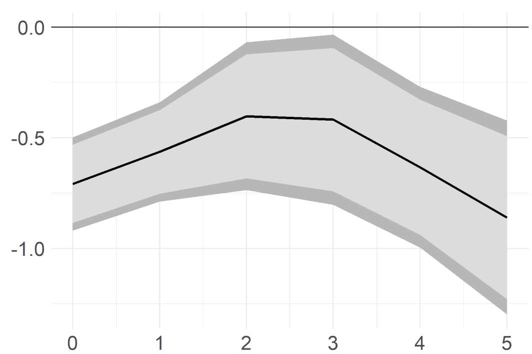


Note: Response is normalized by the response of 10-year JGB yields at each horizon h. Shaded areas denote 90% and 95% confidence intervals. In this robustness check, the sample excludes LSAP shocks with absolute size greater than 2.5 bps.

Robustness: Spillover Results Excluding Countries With Low Capital Account Openness

The transmission of spillovers through the portfolio channel could be impeded by capital account management measures. As discussed in Section 4.2, we re-estimate equation (1) excluding the economies that score below −1 on the Chinn-Ito scale in 2016 (the middle of the sample; see Table A.2). Specifically, this excludes the following economies from our sample: Brazil, China, India, South Africa, and Thailand. Figure A.8 shows the estimated spillover coefficient to foreign yields following a BOJ LSAP shock that lowers the 10-year JGB yield, and is broadly consistent with the findings reported in baseline Figure 10 in the main text. This confirms that our spillover estimates are not being exclusively driven by the low spillovers to the small set of countries.

Figure A.8: Estimated response of foreign bond yields to BOJ LSAP shocks (excluding closed capital account)



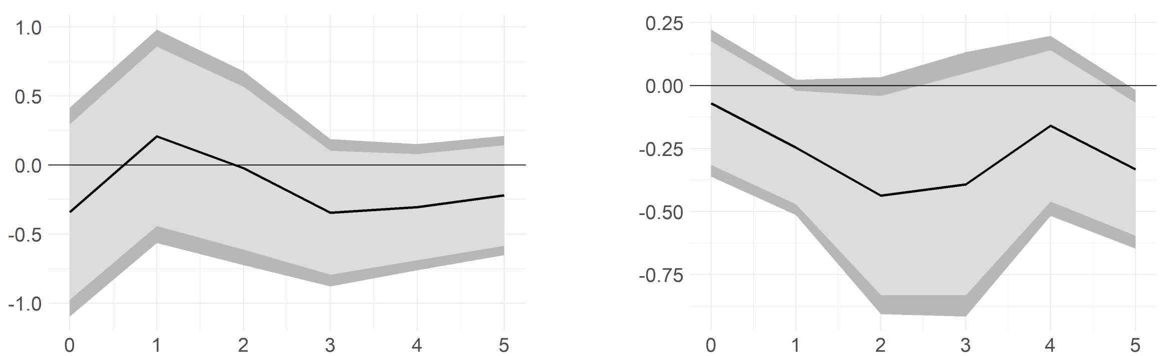
Note: Response is normalized by the response of 10-year JGB yields at each horizon h. Shaded areas denote 90% and 95% confidence intervals. In this robustness check, the sample excludes economies with the Chinn-Ito measure of openness below −1.

Robustness: High-Exposure Dummy (Top-Quintile) Interaction

In this section, we complement the continuous log-exposure specification presented in section 4.3 with a binary (group-difference) design. For each country i, we compute its time-invariant average exposure $\overline{W}_{J,i}$ and define $D_i^{\text{hi}} = \mathbf{I}\{\overline{W}_{J,i} \geq P_{80}(\overline{W}_{J,\cdot})\}$. The high-exposure group comprises: Australia, the Netherlands, Sweden, Ireland, Norway, Denmark, and Singapore, with the cutoff value of 10% corresponding to the top quintile across the 38 economies. The local projection specification includes, for all shocks $s \in \mathcal{S}$ (LSAP, FG), both main effects $\varepsilon_{s,t}$ and interaction effects $\varepsilon_{s,t} \times D_i^{\text{hi}}$ as controls; we report the interaction for the main shock of interest. Foreign responses are normalized by the contemporaneous response of 10-year JGB yields at each horizon.

The figures below plot $\theta_{h,s}$ (the high–exposure minus low-exposure differential) with 90%/95% bands. Consistent with the findings from the linear interaction term used in the main text, the FG interaction is not statistically significant, while the LSAP interaction shows a stronger spillover for high-exposure markets at short horizons that is statistically significant at the 90% confidence level.

Figure A.9: High vs. low exposure: differential spillover effects of BOJ policy shocks



(a) Forward guidance (high minus low)

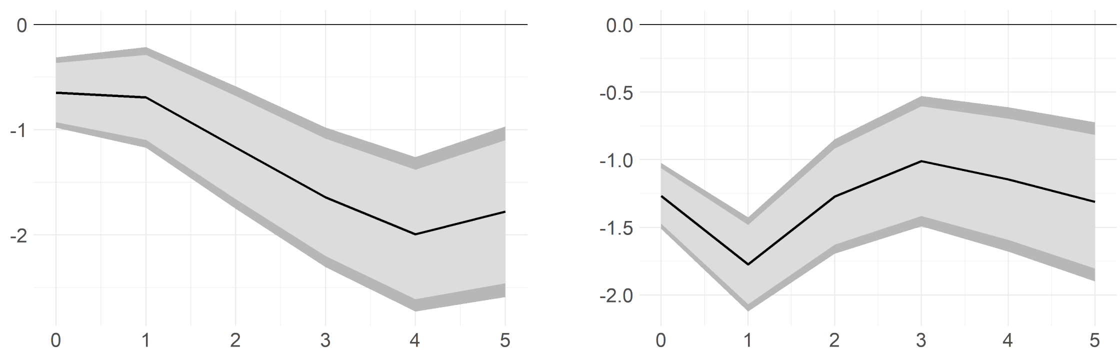
(b) LSAP (high minus low)

Note: High-exposure dummies are interacted with all shocks. Responses are normalized by the contemporaneous response of 10-year JGB yields. Shaded areas denote 90% and 95% confidence intervals.

Background: Responses of Foreign and Domestic Bond Yields

The results presented in Section 4.2 have been expressed as the ratio of the response of foreign yields normalized by the response of 10-year JGB yields at each horizon. For completeness, the following figures present the denominator used in the normalization.

Figure A.10: Estimated response of 10-year JGB yields to BOJ unconventional monetary policy shocks



(a) Forward guidance

(b) LSAP

Note: Response of the 10-year JGB yield following each shock, without rescaling. Shaded areas denote 90% and 95% confidence intervals.

PUBLICATIONS

Macroeconomic Effects and Spillovers from Bank of Japan Unconventional Monetary Policy

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