Online Appendix to
The Impact of Central Bank Stock Purchases:
Evidence from Discontinuities in Policy Rules

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A Empirical Appendix

A.1 Local Nonlinear Impulse Response Function

In this section, we allow nonlinearity in the impulse response and show that our estimands can be interpreted as dynamic "local average treatment effect" in the spirit of Angrist and Imbens (1995).

We first define a potential outcome framework in our context following Rambachan and Shephard (2021). For each $t \geq 1$, the BoJ decides the amount of ETF purchases ETF_t and let us denote $ETF_{1:t} \equiv (ETF_1, \cdots, ETF_t)$. Let $w_{1:t} \equiv (w_1, \cdots, w_t)$ be a potential assignment path up to t where $w_t \in [0, \bar{w}]$ for all t. Associated with this potential assignment path, the potential outcome at day $t+l$ time h is $Y_{t+l,h}(w_{1:t+l})$.[1] Note that for any different assignment paths, there exist different outcome paths but we only observe $Y_{t+l,h}(ETF_{1:t+l})$. For any day $t+l$ time h, let us denote

$$Y_{t+l,h}(w) \equiv Y_{t+l,h}(ETF_{1:t-1}, \underbrace{w}_{t-th}, ETF_{t+1:t+l}).$$

Using this notation, the observed outcome can be denoted as $Y_{t+l,h}(ETF_t)$ by definition.

We assume that the BoJ's ETF purchasing policy rule takes the following form, in which the amount of ETF purchase at time t, ETF_t, is given by

$$ETF_t = ETF_{-,t}(\Delta p_t)\mathbb{I}(\Delta p_t < c_t) + ETF_{+,t}(\Delta p_t)\mathbb{I}(\Delta p_t \geq c_t), \tag{A.1}$$

[1] We assume that the potential outcome depends only on past and contemporaneous assignments. Rambachan and Shephard (2021) called this assumption Non-anticipating potential outcomes.

where Δp_t is the log-changes in the TOPIX value in the morning, c_t is the cut-off, and $ETF_{-,t}$ and $ETF_{+,t}$ are random functions of Δp_t which represent different policy rules depending on whether Δp_t is above or below the cutoff at time t. The following assumptions guarantee that our estimands identify the dynamic local average treatment effect.

Assumption 1. *(i)* $Y_{t+l,h}(w)$ *is bounded and continuously differentiable in* $w \in [0, \bar{w}]$ *with probability one and, (ii)* $ETF_{-,t}(\Delta p)$ *and* $ETF_{+,t}(\Delta p)$ *are bounded and continuous at* c_t *with probability one.*

Assumption 2 (Monotonicity). $ETF_{-,t}(c_t) \geq ETF_{+,t}(c_t)$ *with probability one.*

Assumption 3 (Relevance). $\int \Pr(ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)|\Delta p_t = c_t)dw > 0$.

Assumption 4 (Local Independence). *For each* $t+l$ *and* h*, there exists a neighborhood* $N_{t+l,h}$ *of* c_t *such that* $\Delta p_t \perp (\{Y_{t+l,h}(w)\}_w, ETF_{-,t}(c_t), ETF_{+,t}(c_t))|\Delta p_t \in N_{t+l,h}$.

Theorem 1. *If Assumptions 1-4 hold, then*

$$\begin{aligned}
&\frac{\lim_{\Delta p \uparrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p]}{\lim_{\Delta p \uparrow c_t} \mathbb{E}[ETF_t|\Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[ETF_t|\Delta p_t = \Delta p]} \\
&= \int \mathbb{E}[\frac{\partial Y_{t+l,h}(w)}{\partial w}|\Delta p_t = c_t, ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)]\bar{\omega} dw,
\end{aligned}$$

where $\bar{\omega} = \Pr(ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)|\Delta p_t = c_t) / \int \Pr(ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)|\Delta p_t = c_t)dw$.

Proof. First, observe that

$$\begin{aligned}
\lim_{\Delta p \uparrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p] &= \lim_{\Delta p \uparrow c_t} \mathbb{E}[Y_{t+l,h}(ETF_{-,t}(\Delta p))|\Delta p_t = \Delta p] \\
&= \mathbb{E}[Y_{t+l,h}(ETF_{-,t}(c_t))|\Delta p_t = c_t],
\end{aligned}$$

and

$$\begin{aligned}
\lim_{\Delta p \downarrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p] &= \lim_{\Delta p \downarrow c_t} \mathbb{E}[Y_{t+l,h}(ETF_{+,t}(\Delta p))|\Delta p_t = \Delta p] \\
&= \mathbb{E}[Y_{t+l,h}(ETF_{+,t}(c_t))|\Delta p_t = c_t],
\end{aligned}$$

follow from Assumptions 1 and 4. Therefore,

$$\begin{aligned}
&\lim_{\Delta p \uparrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[Y_{t+l,h}|\Delta p_t = \Delta p] \\
&= \mathbb{E}[Y_{t+l,h}(ETF_{-,t}(c_t)) - Y_{t+l,h}(ETF_{+,t}(c_t))|\Delta p_t = c_t] \\
&= \mathbb{E}[\int \frac{\partial Y_{t+l,h}(w)}{\partial w} \mathbb{I}\{ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)\} dw | \Delta p_t = c_t] \\
&= \int \mathbb{E}\left[\frac{\partial Y_{t+l,h}(w)}{\partial w} | \Delta p_t = c_t, ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)\right] \\
&\quad \times \Pr(ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)|\Delta p_t = c_t) dw,
\end{aligned}$$

where second equality follows from Assumptions 1 and 3, and the third equality follows from 1. Similarly,

$$\begin{aligned}
&\lim_{\Delta p \uparrow c_t} \mathbb{E}[ETF_t|\Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[ETF_t|\Delta p_t = \Delta p] \\
&= \int \Pr(ETF_{-,t}(c_t) \geq w \geq ETF_{+,t}(c_t)|\Delta p_t = c_t) dw,
\end{aligned}$$

and Assumption 2 guarantees that the denominator is positive. Combining these, we have the stated result. □

Since $Y_{t+l,h}(w) \equiv Y_{t+l,h}(ETF_{1:t-1}, w, ETF_{t+1:t+l})$, the local independence assumption requires that falling below the cutoff at day t is not correlated with the future or past ETF purchases. We test this in Appendix A.4.

A.2 Details on Cutoff Estimation

We first split the sample based on six announcements by the BoJ that publicized changes in the target amount of ETF purchases on April 4, 2013, October 31, 2014, December 18, 2015, July 29, 2016, July 31, 2018, and March 16, 2020. We then divide each sample based on whether TOPIX value falls below zero for the past two consecutive days. For the case with consecutive drops in the past two days, we further split on April 1, 2019, for the reason that we describe below.

In each sample split, we proceed as follows. We take grid points for the cutoff candidates from -1% to 0% with 0.05% interval, $\mathbb{C} = \{-1.0\%, -0.95\%, \ldots, -0.05\%, 0.0\%\}$. For each of $c \in \mathbb{C}$, we estimate the following linear probability model separately on both sides of the candidate cutoff, c:

$$\Pr_{-,t}(ETF_t > 0|\Delta p_t) = \begin{cases} \alpha_- + \beta_- \Delta p_t & \text{for } \Delta p_t \in [c-k, c] \\ \alpha_+ + \beta_+ \Delta p_t & \text{for } \Delta p_t \in [c, c+k] \end{cases}, \tag{A.2}$$

where we take the bandwidth to be 1% around the cutoff, $k = 1\%$. Given the estimates, we can compute the jump around the cutoff as follows:

$$J_t(c) \equiv \lim_{\Delta p \uparrow \bar{c}} \widehat{\Pr}_t(ETF_t > 0|\Delta p) - \lim_{\Delta p \downarrow \bar{c}} \widehat{\Pr}_t(ETF_t > 0|\Delta p),$$

where $\widehat{\Pr}_t$ denote the fitted value of equation (A.2). We select the cutoff that maximizes square of the jump:

$$c_t^* \in \arg\max_{c \in \mathbb{C}} J_t^2(c).$$

Whenever there is a tie, we choose the largest cutoff.

Table B.2 shows the estimated cutoff, and Table B.3 shows the discontinuity in the probability of the Bank of Japan's intervention around the estimated cutoff. As argued in the main text, the estimated cutoffs align well with what is commonly argued among media. The discontinuity around the cutoff is always over 50%, is often over 80%, and they are highly statistically significant. We made a choice to split the sample with consecutive drops in the past two days on April 1, 2019, because there was an apparent change in the cutoff around this period. If we do not split the sample at this point in time, the resulting discontinuity is -0.744 . If we split the sample, the discontinuity is -1.000 in the first half, and it is -0.853 in the second half of the sample. This choice does not materially affect any of our empirical results.

Figure B.1 graphically displays the discontinuity in the probability of intervention for each period. While the magnitude of discontinuity is more apparent in the beginning and the end of the sample period, the sharp discontinuity shows up in all subsamples.

A.3 Manipulation Test

A typical concern in regression discontinuity-based identification strategies is manipulation (McCrary, 2008). We first note that this concern is unlikely in our context since there is little room for investors to precisely manipulate the stock price index. Having said this, we formally test the presence of manipulation by examining the continuity of the density function of TOPIX changes in the morning. We estimate the density function using the local polynomial density estimator by Cattaneo et al. (2020) and test the presence of discontinuity around our estimated cutoff.

Figure 2C shows the estimated density and histogram, and Table B.4 reports the estimates and test statistics for discontinuity. While there is a small mass on the right side of the cutoff, the p-value of testing the discontinuity is 0.447. Therefore, there is no statistical evidence of manipulation.

A.4 (Dis)continuity of ETF Purchases across Days

In this section, we argue that the effects we are identifying are the effects of a one-time shock of ETF purchases. As discussed in A.1, $y_{t+l,h}$ is clearly affected by the BoJ's ETF purchases up to l days later. Therefore, if falling below the cutoff today is correlated with future and past purchases, our empirical estimates cannot be interpreted as the causal effect of one-time BoJ ETF purchases (Rambachan and Shephard, 2021). In order to address this concern, we estimate the discontinuity in the amount of ETF purchases around the cutoff across days. Formally, we estimate the following term,

$$\lim_{\Delta p \uparrow c_t} \mathbb{E}[ETF_{t+l}|\Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[ETF_{t+l}|\Delta p_t = \Delta p]. \tag{A.3}$$

Figure B.2 shows the estimates of discontinuity in the amount of ETF purchases at date $t + l$ around $\Delta p_t = c_t$. Reassuringly, we find significant discontinuity only at $l = 0$. Therefore, our identified effects are the causal effects of one-time BoJ's ETF purchases and are not contaminated by future or past ETF purchases.

B Additional Tables and Figures

Table B.1: Major Announcements by the BoJ

Date	Announcement
October 28, 2010	Intention to purchase 450 billion yen of ETFs
October 30, 2012	Intention to purchase 2.1 trillion yen of ETFs annually
October 31, 2014	Annual purchase target increased to 3 trillion yen
December 18, 2015	Annual purchases target increased to 3.3 trillion yen
July 29, 2016	Annual purchases target increased to 6 trillion yen
March 16, 2020	Annual purchases target increased to 12 trillion yen

Notes: Table B.1 shows the six major announcements by the BoJ regarding the target ETF purchase amounts. Source: Fukuda and Tanaka (2022).

Table B.2: Estimated Cutoff

No Consecutive Drops		Consecutive Drops	
Period	Cutoff	Period	Cutoff
2010/12/15 - 2013/04/03	-1%	2010/12/15 - 2013/04/03	-1%
2013/04/04 - 2014/10/30	-0.35%	2013/04/04 - 2014/10/30	0%
2014/10/31 - 2015/12/17	-0.15%	2014/10/31 - 2015/12/17	0%
2015/12/18 - 2016/07/28	-0.4%	2015/12/18 - 2016/07/28	0%
2016/07/29 - 2018/07/30	-0.3%	2016/07/29 - 2018/07/30	0%
2018/07/31 - 2020/03/15	-0.5%	2018/07/31 - 2020/03/15	-0.25%
2020/03/16 - 2020/12/31	-0.5%	2020/03/16 - 2020/12/31	-0.25%

Notes: Table B.2 shows the estimated cutoff for each of the subsamples.

Table B.3: Discontinuity in Probability of Intervention around the Estimated Cutoff

	No Consecutive Drops			Consecutive Drops		
	Discontinuity estimates	Sample size Left	Sample size Right	Discontinuity estimates	Sample size Left	Sample size Right
2010/12/15 - 2013/04/03	-1.011	43	158	-1.000	15	47
	(0.012)			(0.000)		
2013/04/04 - 2014/10/30	-0.576	60	146	-0.931	25	30
	(0.100)			(0.072)		
2014/10/31 - 2015/12/17	-0.683	72	98	-1.122	11	17
	(0.099)			(0.117)		
2015/12/18 - 2016/07/28	-0.811	20	36	-1.000	8	11
	(0.119)			(0.000)		
2016/07/29 - 2018/07/30	-0.604	78	243	-0.945	40	33
	(0.069)			(0.053)		
2018/07/31 - 2020/03/15	-0.978	49	163	-0.744	30	34
	(0.022)			(0.130)		
2020/03/16 - 2020/12/31	-0.930	29	71	-0.985	13	14
	(0.070)			(0.022)		

Notes: Table B.3 shows the discontinuity in the probability of the BoJ intervention around the estimated cutoff. We estimate the discontinuity using the local linear regression with bandwidth 1% around the cutoff and uniform kernel. The standard errors are reported in parentheses.

Table B.4: Density Discontinuity Test

	Density estimates		Discontinuity test	
	Left	Right	Difference	p-value
	0.423	0.506	0.083	0.373
	(0.065)	(0.067)	(0.093)	
Sample size	667	1790		
Bandwidth	0.512	0.512		
Effective sample size	358	719		

Notes: Table B.4 reports the density estimates on the left and the right of the cutoff and test statistics for the discontinuity test. We use the local polynomial density estimator by Cattaneo et al. (2020) with order 2. Robust standard errors are reported in parenthesis.

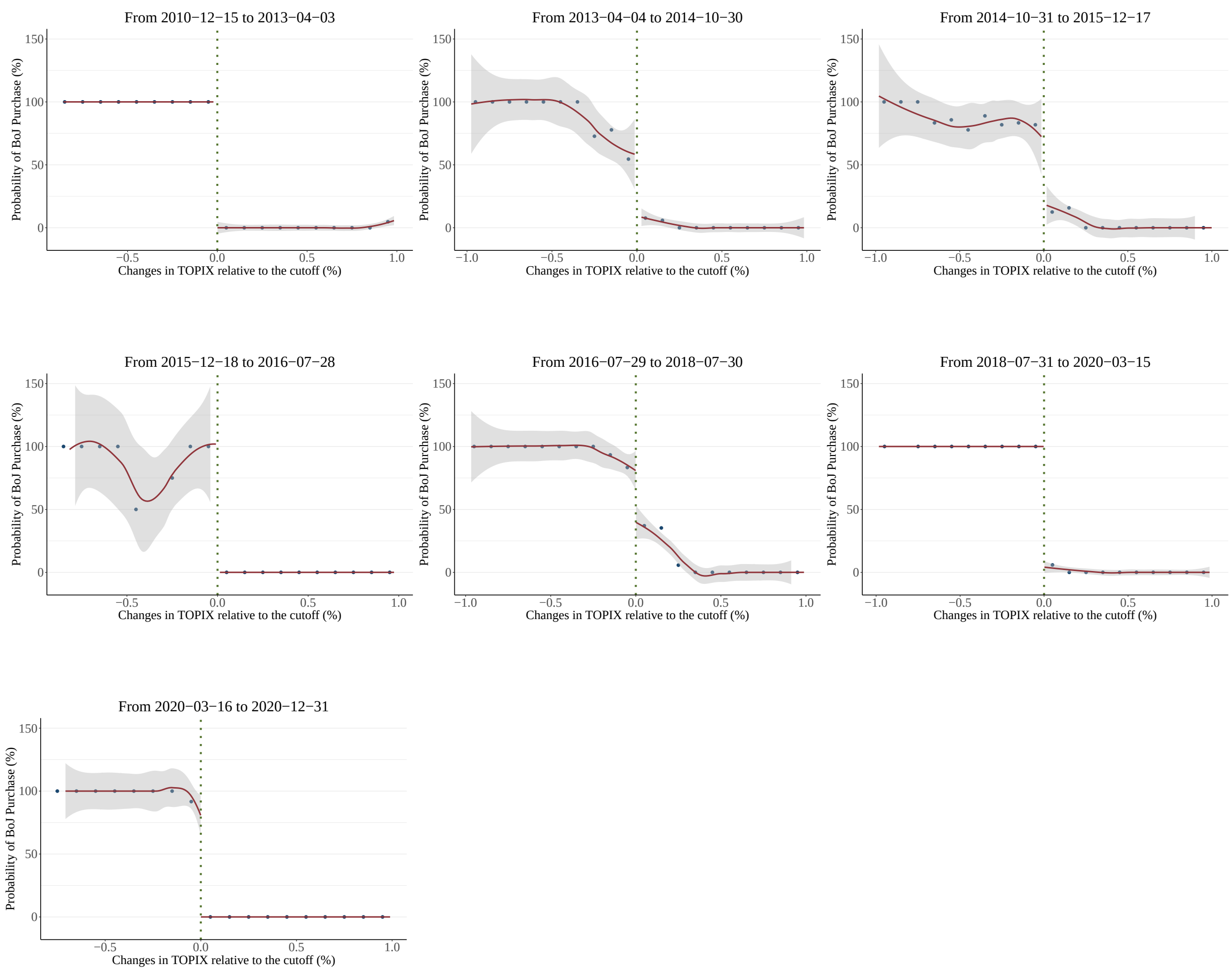

Figure B.1: Discontinuity in the Probability of the BoJ Intervention for each Period

Notes: Figure B.1 shows the discontinuity in the probability of the BoJ intervention around the estimated cutoff for each period. The blue scatter plot is the binned scatter plot with bin width 0.1%, and the red line indicates the LOESS fit with the shaded gray area being the 95% confidence interval.

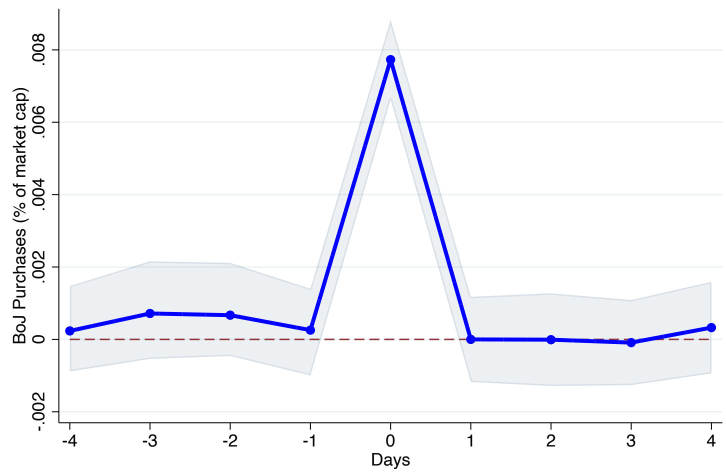

Figure B.2: (Dis)continuity of ETF Purchases across Days

Notes: Figure B.2 shows the estimates of (A.3) across days. The shaded areas represent 90% confidence intervals, which accounts for heteroskedasticity and autocorrelation.

(A) Absolute Amount **(B)** Fraction of Market Capitalization

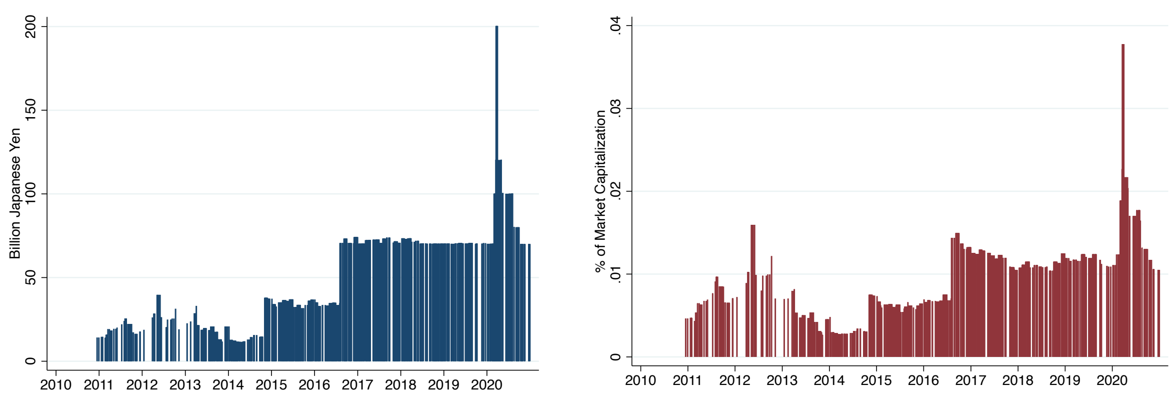

Figure B.3: The Amount of the BoJ Purchases

Notes: Figure B.3 plots the amount of stock purchases by the BoJ in each intervention. Figure B.3A shows the absolute amount of purchases in billion Japanese Yen (approximately 10 million US dollars). B.3B express it as a fraction of market capitalization.

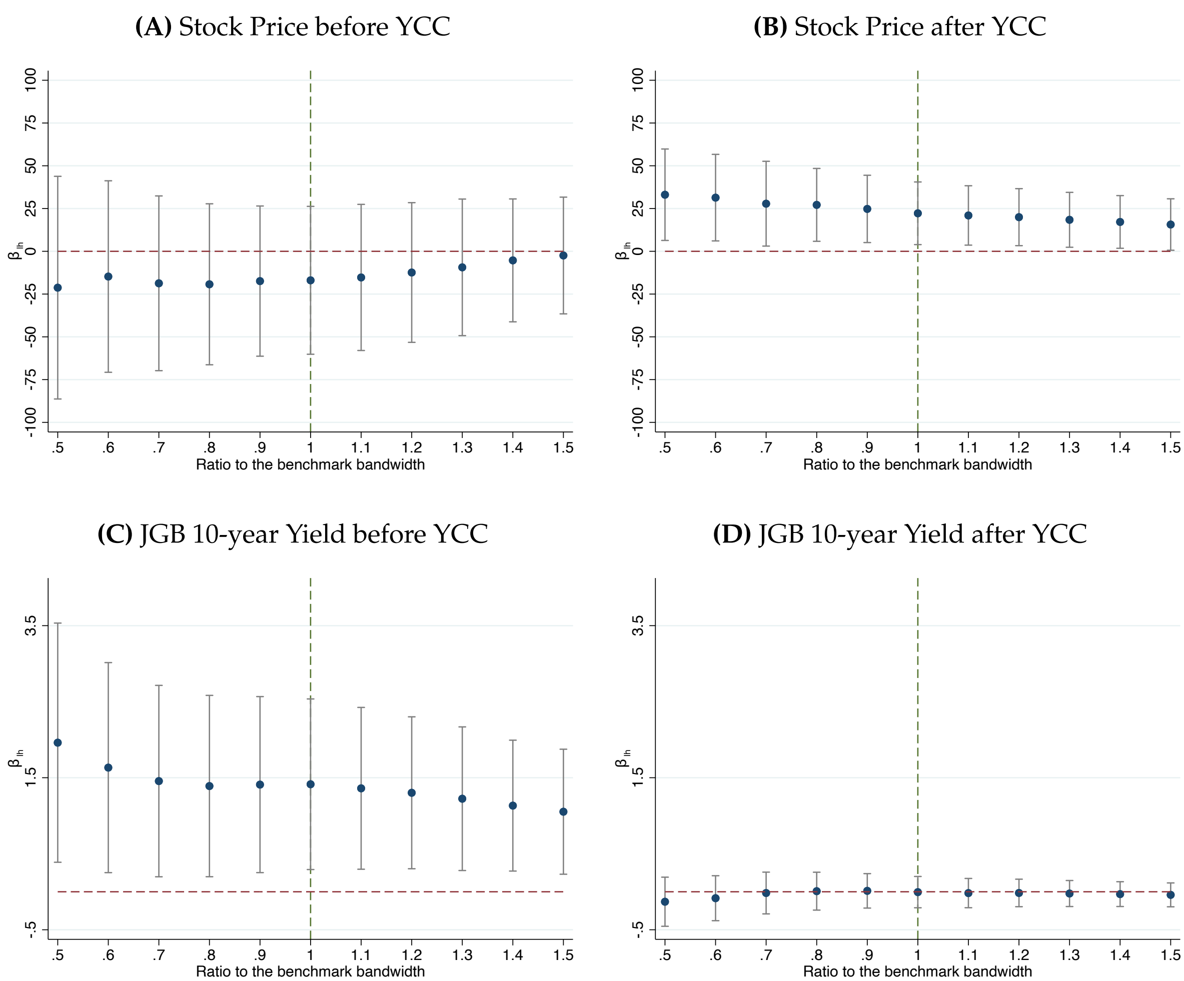

Figure B.4: Robustness to Bandwidth Selection

Notes: Figure B.4 shows the robustness of our estimates with respect to the size of the bandwidth. Each dot represents the point estimates of the response from 11AM of the intervention day to 9AM on the next day. The vertical line represents the 90% confidence interval, which accounts for heteroskedasticity and autocorrelation. The dashed green line is the optimal bandwidth proposed by Calonico, Cattaneo, and Titiunik (2014), which is our benchmark. Figures B.4A and B.4B show the response of stock price before and after YCC, respectively. Figures B.4C and B.4D show the response of 10-year JGB yield before and after YCC, respectively.

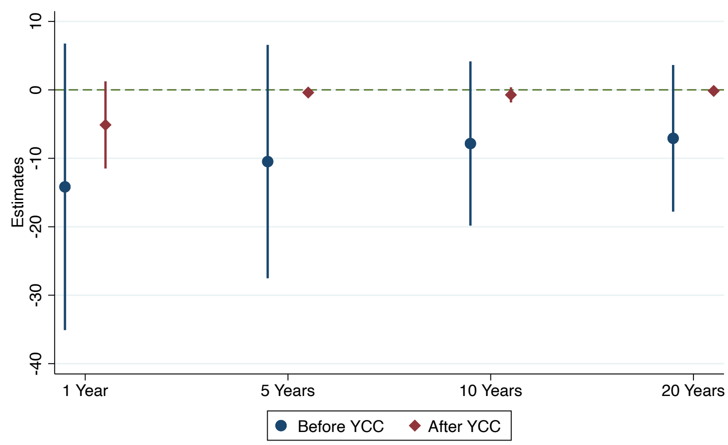

Figure B.5: Response of Inflation Swaps

Notes: Figure B.5 shows the response of the inflation swap rate across different maturities from 11AM of the day of the intervention to 9AM of the next day. The circle dot represents the point estimates before yield curve control, and the diamond dot represents the point estimates after yield curve control. The coefficient measures the percentage point changes in the inflation swap rate in response to the purchase of 1% of market capitalization. The vertical lines represent the 90% confidence interval, which accounts for heteroskedasticity and autocorrelation. We obtained the tick-by-tick inflation swap rate from the Bloomberg.

C Placebo Tests

One might worry that our results are not driven by the discontinuous changes in BoJ's policy intervention, but rather by some other factors such as investors' sentiments that sharply respond to the stock price changes in the morning session. Some investors might employ simple trading strategies that respond *discontinuously* to stock price changes during the morning session, independent of the BoJ's interventions (e.g., because of behavioral heuristics among investors). For instance, if stock prices drop by more than 1% in the morning, investors may heuristically speculate a market rebound and adjust their portfolios accordingly, regardless of any potential BoJ actions. This kind of behavior introduces a separate, discontinuous reaction that coincides with the BoJ's intervention threshold, which could potentially confound our RDD estimates.

To address this concern, we conduct placebo tests by testing the presence of discontinuity in outcome variables around an arbitrary cutoff for which we do not expect to find any discontinuity. Specifically, for each value of placebo cutoffs $c^{placebo} \in \{-1\%, -0.95\%, \ldots, -0.05\%, 0\%\}$, we test whether there is a discontinuity in our outcome variables when the stock prices fall below the placebo cutoff $c^{placebo}$. Namely, we estimate

$$\gamma_{l,h} \equiv \lim_{\Delta p \uparrow c^{placebo}} \mathbb{E}[\Delta y_{t+l,h} | \Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c^{placebo}} \mathbb{E}[\Delta y_{t+l,h} | \Delta p_t = \Delta p], \tag{C.1}$$

where Δp_t is the percentage change in TOPIX in the morning session, and we focus on within-day changes (from 11AM to 3PM) in the outcome variables. Importantly, when estimating $\gamma_{l,h}$, we exclude periods for which the actual cutoff is identical to the placebo cutoff $c^{placebo}$ under consideration. We are interested in the estimates of $\gamma_{l,h}$, and we expect that $\gamma_{l,h}$ to be indistinguishable from zero for any value of $c^{placebo}$.

Figures C.6A and C.6B show the estimated values of $\gamma_{l,h}$ across the placebo cutoffs, as well as the baseline estimates (red lines) obtained by using the true cutoff c_t instead of the placebo cutoff $c^{placebo}$ in Equation (C.1): i.e., $\lim_{\Delta p \uparrow c_t} \mathbb{E}[\Delta y_{t+l,h} | \Delta p_t = \Delta p] - \lim_{\Delta p \downarrow c_t} \mathbb{E}[\Delta y_{t+l,h} | \Delta p_t = \Delta p]$. Reassuringly, while the baseline estimates are statistically significant, we find that the estimates of $\gamma_{l,h}$ are indistinguishable from zero in almost all cases. Even in cases where the estimates are significant, they consistently exhibit the opposite sign compared to the baseline estimates. Moreover, in every case, the estimates deviate substantially from the baseline estimates that use the actual cutoff. These results strongly suggest that our results are indeed driven by the BoJ's policy intervention rather than by unrelated investor behavior.

(A) Placebo Test for Stock Response

(B) Placebo Test for 10-year JGB Response

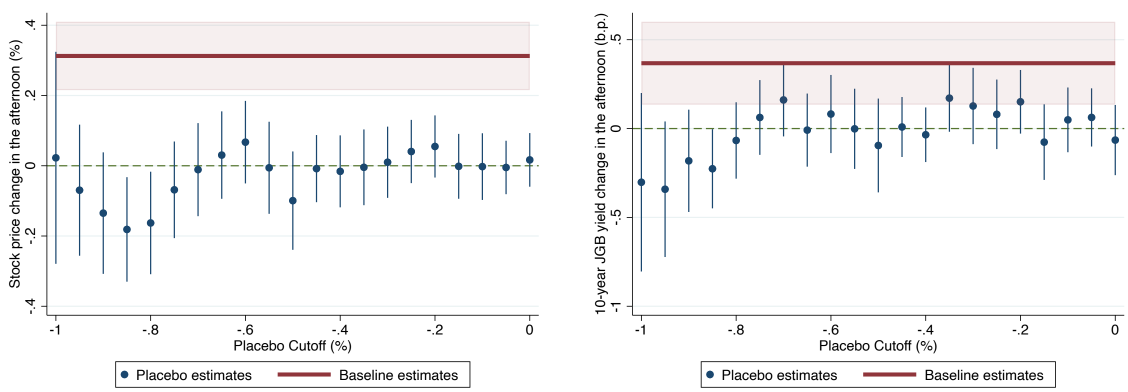

Figure C.6: Placebo Tests

Notes: Figure C.6A plots the estimates of $\gamma_{l,h}$ in equation (C.1) as the blue dots for each placebo cutoff, where the outcome variable is the stock price. The estimates are the response within the day of intervention (changes from 11AM to 3PM). We exclude the periods where the placebo cutoff coincides with the actual cutoff. The red line indicates our estimates using the actual cutoff. Figure C.6B is analogous to Figure C.6A, where the outcome variable is now the 10-year JGB yield. The line and the shaded area represent 90% confidence interval.

D Bond Yield Responses Across Different Maturities

We show that the effect on the interest rate is not specific to the 10-year JGB yield, but rather is widespread across the entire yield curve.

Figure D.7 shows the point estimates of the effect on the JGB yield across maturities of 1, 2, 5, 10, 20, and 30 years. Before yield curve control, yields rose at all maturities, but the effect was larger at longer maturities. Our preferred interpretation is that the zero lower bound on the policy rate has been binding during this period, and therefore the shorter-maturity bonds had less room to respond relative to longer-maturity bonds. After yield curve control, all interest rates entirely stopped responding. Although yield curve control was intended to specifically control the 10-year yield, it can prevent the other maturities from responding because they are interconnected through arbitrage. For example, it is the natural prediction of the preferred habitat model of the term structure by Vayanos and Vila (2021).

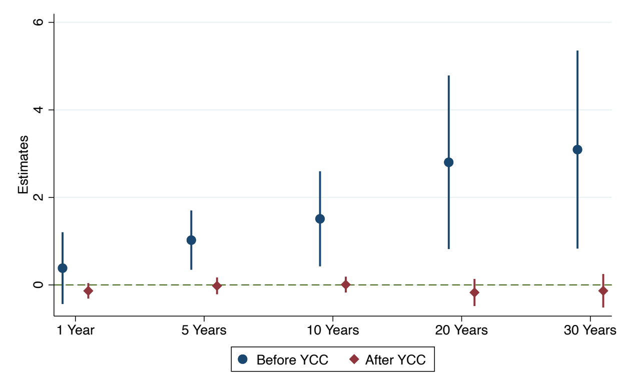

Figure D.7: Response of JGB Yields Across Maturities

Notes: The figure shows the response of the JGB yield across different maturities from 11AM of the day of the intervention to 9AM of the next day. The circle dots represent the point estimates before yield curve control, and the diamond dots represent the point estimates after yield curve control. The coefficient measures the percentage point changes in the JGB yield in response to the purchase of 1% of market capitalization. All confidence intervals account for heteroskedasticity and autocorrelation.

E Structural Model

We lay out a theoretical model to provide structural interpretations of our empirical results. We consider a model with two assets: stocks and bonds. We do not make a distinction between money and bonds. Bonds include all money-like assets that are liquid and risk-free.[2] We show that a model with an inelastic stock market and an even more inelastic bond market can qualitatively and quantitatively account for our findings.

E.1 Environment

Time is discrete, and the horizon is infinite, $t = 0, 1, \ldots, \infty$. The economy is populated by a representative household, a representative firm, investment funds, and a consolidated central bank and government. The only factor of production in the economy is capital in fixed supply, and firms own the capital. The supply of capital is normalized to one, and a unit of capital produces Y units of consumption goods. We assume that Y is constant over time and is exogenously given.

There are two assets in the economy, stocks and bonds. Stocks are claims to capital (firms). Let Q_t denote the ex-dividend price of stocks. Its gross return is given by

$$R^s_{t+1} = \frac{Q_{t+1} + Y}{Q_t}. \tag{E.1}$$

There is also a risk-free asset in zero net supply. Its objective gross return is denoted as R^b_{t+1}. We assume only the government can issue bonds.

An investment fund manages a part of a household's wealth and invests in stocks and bonds. The fund consists of a continuum of members $i \in [0, 1]$ with heterogenous beliefs over asset returns. Each member manages an equal amount of assets and invests in assets that they believe to have the highest return. A member i with belief shock $\boldsymbol{\epsilon}_i \equiv (\epsilon^b_i, \epsilon^s_i)$ at time t believes the return from investing in bonds and stocks are given $\epsilon^b_i R^b_{t+1}$ and $\epsilon^s_i R^s_{t+1}$. Therefore the faction of savings invested in asset a, s^a_t, is given by the fraction of fund members that believe asset a has a higher return than the other:

$$s^a_t = \int_0^1 \mathbb{I}\left[a = \arg\max_{\tilde{a}} \epsilon^{\tilde{a}}_i R^{\tilde{a}}_{t+1}\right] di, \tag{E.2}$$

where $\mathbb{I}[\cdot]$ is an indicator function.

[2] This is a valid assumption if the elasticity of substitution between near-money assets like bonds and money is high, which is empirically the case (Nagel, 2016; Krishnamurthy and Li, 2023).

Building on the discrete choice literature, we assume the beliefs are drawn from independent type II extreme value (Fréchet) distribution:

$$\text{Prob}\left[\epsilon_i^b \leq \epsilon^b, \epsilon_i^s \leq \epsilon^s\right] = \exp\left(-\sum_{a\in\{b,s\}} \mu^a (\epsilon^a)^{-\theta}\right), \tag{E.3}$$

where μ^a is the scale parameter, $\theta > 0$ is the shape parameter. The distribution of belief is independent across fund members and over time. Under the above functional form assumptions, the portfolio shares of a fund are given by

$$s_t^a = \frac{\mu^a \left(R_{t+1}^a\right)^\theta}{\sum_{l\in\{s,b\}} \mu^l \left(R_{t+1}^l\right)^\theta} \quad \text{for} \quad a \in \{b,s\}. \tag{E.4}$$

The asset demand system (E.4) takes constant elasticity of substitution (CES) form, as in for example Koijen and Yogo (2020), which we micro-found through heterogeneous beliefs. We choose to microfound through heterogenous belief given the empirical evidence on the importance of belief in portfolio allocation (Giglio et al., 2021). However, the underlying microfoundation is not important as long as it delivers an inelastic portfolio choice. Other micro-foundations that lead to the same asset demand system include risks (Okawa and Van Wincoop, 2012), heterogenous returns (Kleinman et al., 2023), and rational inattention (Pellegrino et al., 2021).

The parameter $\theta > 0$ in equation (E.4) captures the elasticity of relative asset demand with respect to return differences. With our microfoundation, θ has a structural interpretation as the inverse of belief heterogeneity. As belief heterogeneity vanishes, $\theta \to \infty$, the relative asset demand is infinitely elastic to return differences, a standard assumption in the macroeconomics literature. Given the portfolio share, the portfolio return of the fund is

$$R_{t+1}^p = \sum_a s_t^a R_{t+1}^a. \tag{E.5}$$

We assume households invest in bonds and the funds, but the funds are illiquid in the sense that households do not actively trade the funds. The households can freely trade bonds and we assume that the bonds provide liquidity services to the households in the form of utility. The household's preferences are given by

$$\sum_{t=0}^{\infty} \beta^t \left[u(C_t) + v\left(B_t + s_t^b A_t\right)\right], \tag{E.6}$$

where C_t is the consumption, B_t is the direct bond holdings of the households, $s_t^b A_t$ is the indirect bond holdings through the fund, and $u(\cdot)$ and $v(\cdot)$ are both increasing and concave. Here we assumed that both the direct and indirect bond holding provide liquidity services. Although we do not provide a microfoundation of liquidity service that bond provides, existing literature (Angeletos et al., 2023; Auclert et al., 2024; Di Tella et al., 2024) show that models with uninsurable income or liquidity risk give representation that is similar to (E.6).

The household's budget constraint is given by

$$C_t + B_t = R_t^b B_{t-1} + D_t - T_t, \tag{E.7}$$

where T_t is the lump-sum tax imposed by the government and D_t is the withdrawal from the fund. The evolution of the account in the fund is

$$A_t = R_t^p A_{t-1} - D_t. \tag{E.8}$$

For simplicity, we assume the value that households maintain in the funds, A_t, follows an exogenous rule of the form

$$A_t = \kappa_0 + \kappa_1 Q_t, \tag{E.9}$$

where $\kappa_0 > 0$ captures the amount of funds that households always maintain and $\kappa_1 \in [0, 1]$ captures the response of funds value to asset price fluctuations. Abstracting away from modeling the household's optimal adjustment of illiquid funds greatly simplifies our analysis, and a similar approach is employed in Auclert et al. (2020). The household problem is to choose $\{C_t, B_t\}$ to maximize (E.6) subject to (E.7). This results in the consumption Euler equation of the following form:

$$u'(C_t) = \beta R_{t+1}^b u'(C_{t+1}) + v'(B_t + s_t^b A_t). \tag{E.10}$$

We assume the government can issue bonds, invest in stocks, and levy taxes on households. The consolidated government sets the path of stock holdings, S_t^g, bond issuance B_t^g, and lump-sum tax, T_t, that satisfy the government budget constraint:

$$Q_t S_t^g - B_t^g = T_t + (Y + Q_t) S_{t-1}^g - R_t^b B_{t-1}^g. \tag{E.11}$$

The asset market clearing conditions

$$B^g_t = B_t + s^b_t A_t \tag{E.12}$$

$$Q_t = Q_t S^g_t + s^s_t A_t. \tag{E.13}$$

The goods market clearing, $C_t = Y$, is implied by the budget constraints, (E.7) and (E.11), and the asset market clearing conditions, (E.12) and (E.13).

Given the path of government policies, $\{S^g_t, B^g_t, T_t\}$, that satisfy (E.11), the equilibrium of this economy consists of $\{\{s^a_t, R^a_{t+1}\}_{a\in\{s,b\}}, C_t, B_t, A_t, D_t, R^p_{t+1}, Q_t\}$ such that (E.1), (E.4)-(E.5), (E.7)-(E.10), and (E.12)-(E.13) hold. The steady-state equilibrium is the one where all variables are constant over time.

E.2 Central Bank Stock Purchases: Analytical Characterization

We first analytically study central bank stock purchases in the model. We assume before time $t = 0$, the economy is in the steady state, and we let all variables without time subscripts denote the steady-state values before $t = 0$. At time $t = 0$, we consider a shock to central bank stock purchases.

We model the central bank stock purchases as a small permanent increase in S^g_t at time 0. Therefore the path of S^g_t is given by $S^g_t = S^g + dS^g$ for $t \geq 0$. We consider two scenarios that differ in how the stock purchases are financed. In the first experiment, the government finances the stock purchases with an equal amount of bond issuance, $B^g_t = B^g + Q_0 dS^g$ for $t \geq 0$. This experiment aims to replicate the Bank of Japan's stock purchases before the implementation of yield curve control. In the second experiment, the government adjusts the path of $\{B^g_t, T_t\}_{t\geq 0}$ so that the interest rate on the bond is kept constant, $R^b_t = R^b$. This experiment is to mimic the Bank of Japan's stock purchases after the implementation of yield curve control.

Our first characterization of the impact of the central bank stock purchases illustrates a relatively simple case highlighted in Gabaix and Koijen (2021).

Proposition 1. *Assume $v''(B) = 0$. Then, the central bank stock purchase with and without yield curve control has no effect on the bond interest rate, $\frac{d\ln R^b_{t+1}}{dS^g} = 0$, and raises the stock price for all t,*

$$\frac{d\ln Q_t}{dS^g} = \frac{Q}{Q(1 - S^g - (1 - s^b)\kappa_1) + A\theta(1 - s^b)s^b \frac{Y}{Y+Q}} > 0. \tag{E.14}$$

All the proofs are collected in Appendix F. When the marginal utility from liquidity service that the bond provides is constant, $v'(B) = \bar{v}$, the household's consumption Euler equation (E.10), together with goods market clearing, $C_t = Y$, solely pins down the bond interest rate R^b. That is, the bond market is perfectly elastic. Note that the expression (E.14) can be rewritten as $\frac{dQ_t}{QdS^g}$, so has an interpretation as the dollar increase in stock market value in response to $1 increase in central bank's stock holdings. Note that $\frac{d\ln Q_t}{dS^g} \to 0$ as the belief heterogeneity vanishes, $\theta \to \infty$. This is the case where the stock market is also perfectly elastic, under which the central bank asset purchases are entirely neutral (Wallace, 1981).

With finite θ, the stock market is inelastic. Since the central bank stock purchases create excess demand for stocks, the stock return must fall to clear the stock market, which results in a rise in the stock price. With a perfectly elastic bond market, this is the only consequence of a flow into the stock market, as in Gabaix and Koijen (2021). As a result, this simple case fails to account for our empirical findings that interest rates respond strongly to central bank stock purchases.

To explain our empirical findings, we consider a more general case where the bonds provide liquidity services, $v''(B) < 0$. The asset returns and prices can be obtained from (E.10), (E.12), and (E.13) together with (E.4), (E.1) and (E.9). Since these equations do not involve any state variable, there are no transition dynamics, and therefore we drop the time subscript. After substituting goods market clearing, $C_t = Y$, and (E.12) into (E.10), we obtain

$$u'(Y) = \beta R^b u'(Y) + v'\left(B^g\right), \tag{E.15}$$

which pins down the bond interest rate given the bond supply, B^g. Substituting (E.4) into (E.13) and noting $s_t^s = 1 - s_t^b$, we have

$$Q = QS^g + \left(1 - s^b\right)\left[\kappa_0 + \kappa_1 Q\right]. \tag{E.16}$$

Since s^b is a function of R^b and Q, the two equations (E.15) and (E.16) fully characterize two unknowns, Q and R^b. Solving the two equations gives the following results without yield curve control ($dB^g = QdS^g$).

Proposition 2. *Assume $v''(B) < 0$. Without yield curve control, the central bank stock purchases raise both the bond interest rate,*

$$\frac{dR^b}{dS^g} = \frac{-v''(B^g)}{\beta u'(Y)} > 0, \tag{E.17}$$

and the effect on stock price is ambiguous:

$$\frac{d\ln Q}{dS^g} = Q\frac{1+\frac{v''(B^g)}{u'(Y)}A\theta s^b(1-s^b)}{\left[(1-S^g-\kappa_1(1-s^b))Q + A\theta s^b(1-s^b)\frac{Y}{Y+Q}\right]}. \tag{E.18}$$

The proposition shows that when the demand for bonds is downward sloping, $v''(B) < 0$, the central bank stock purchases financed with the issuance of bonds (central bank reserves) raise the bond interest rate. When the central increases the supply of bonds, the bonds are in excess supply. With an inelastic bond market, a rise in the bond interest rate is required to clear the bond market. This result is qualitatively consistent with our empirical finding that central bank stock purchases without yield curve control raise the bond interest rates. Moreover, expression (E.17) shows that how much the bond interest rate responds relative to the stock price is governed by the degree to which bond demand slopes down, $|v''(B)|$.

The rise in interest rates puts downward pressure on the stock price response because it discourages investment in stocks. Equation (E.18) shows that a higher value of $|v''(B)|$ dampens or even reverses the stock price response. We say the bond market is more inelastic relative to the stock market whenever $v''(B^g)/u'(Y) < -\frac{1}{A\theta s^b(1-s^b)}$ so that a flow from bonds to stocks lowers the stock price. This is what we will find in our calibration exercise below.

We next turn to the case with yield curve control.

Proposition 3. *Assume $v''(B) < 0$. With yield curve control, the central bank stock purchases have no effect on the bond interest rate and raise the stock price. The size of the stock price response is given by* (E.14) *and is larger than without yield curve control.*

The fact that there is no effect on the bond interest rate is by construction. The next part of the proposition establishes that the size of the stock price response is larger relative to the case without yield curve control. This is because when the interest rate does not rise, a further fall in stock return is required to clear the stock market, which results in a further rise in stock price. This result is qualitatively consistent with our empirical finding that after the introduction of yield curve control, we tend to see a more robust rise in the stock price in response to the central bank stock purchases.

E.3 Central Bank Stock Purchases: Model vs. Data

The previous results highlight that our model is at least qualitatively consistent with the empirical evidence we document. We now explore the model's ability to account for the data quantitatively. Throughout, we work with a first-order approximation around the steady state.

We summarize the calibration of baseline parameters in Table E.5. We calibrate our model to the Japanese economy at an annual frequency, although the frequency is irrelevant since our model does not have transitional dynamics. We normalize the output in the economy to one, $Y \equiv 1$. The household discount factor is set to $\beta = 0.86$, a value consistent with the average annual discount rate of 14% reported in Kureishi et al. (2021). We set the steady-state supply of bond to 150% of output, $B^g = 1.5$. This corresponds to the stock of Japanese government bonds averaged over the period 2010-2020, which we obtained from the Ministry of Finance website. The steady-state value of government stock holding is set to zero, $S^g = 0$. The degree to which a fund's value responds to the stock price is set to one, $\kappa_1 = 1$. Since the output is constant, we can normalize $u'(Y) \equiv 1$ without loss of generality. We parameterize the bond in utility as $v(B) = \bar{v}\frac{B^{1-\eta}}{1-\eta}$.

We then choose the three parameters $\{\bar{v}, s^b, \kappa_0\}$ to exactly match the following three moments:[3] (i) the household liquid wealth as a share of the total household wealth ($B/(A+B)$) of 10% obtained from 2014 and 2019 waves of the National Survey of Family Income and Expenditure,[4] (ii) the average net long-term interest rate of 0.4 p.p. during the period 2010-2020, (iii) the average stock return of 11 p.p. during the period 2010-2020. The latter two are obtained from the macro history database (Jordà et al., 2019).

Finally, we choose two parameters $\Theta \equiv (\eta, \theta)$, the parameters that govern the stock market and bond market inelasticity, to best fit our empirical estimates of stock price response to the central bank stock purchases with and without yield curve control and the interest rate response to the central bank stock purchases without yield curve control, which we denote in a vector format as $\boldsymbol{\alpha} \equiv [\alpha_Q, \alpha_Q^{YCC}, \alpha_{R^b}]$, and its model counterpart under the parameter Θ is denoted as $\boldsymbol{\alpha}(\Theta) \equiv [\alpha_Q(\Theta), \alpha_Q^{YCC}(\Theta), \alpha_{R^b}(\Theta)]$. Formally, we set Θ at the solution of the following problem

$$\hat{\Theta} = \arg\min_{\Theta} (\boldsymbol{\alpha}(\Theta) - \boldsymbol{\alpha})' \boldsymbol{\Sigma}^{-1} (\boldsymbol{\alpha}(\Theta) - \boldsymbol{\alpha}), \tag{E.19}$$

where $\boldsymbol{\Sigma}$ is the weighting matrix. For $\boldsymbol{\alpha}$, we use the next day response reported in the baseline row of Table 1, and we set Σ as a diagonal matrix containing the variance of our estimates in each element. We obtain $\eta = 13.7$ with a standard error of 0.86 and $\theta = 2.9$ with a standard error of 1.8, where standard errors are computed using the asymptotic covariance matrix of Θ, $\frac{\partial \boldsymbol{\alpha}(\Theta)}{\partial \Theta}' \boldsymbol{\Sigma}^{-1} \frac{\partial \boldsymbol{\alpha}(\Theta)}{\partial \Theta}$. Since two parameters are calibrated to fit three

[3] Calibrating s^b is equivalent to calibrating μ^b/μ^s.

[4] We define the checking and saving accounts as liquid wealth. We take the average of the 2014 and 2019 waves.

Parameter	Description	Value	Source/Target
β	Discount factor	0.86	Kureishi et al. (2021)
B^g	Supply of bonds	1.5	Outstanding bonds to GDP
κ_1	Fund's wealth slope	1.0	—
κ_0	Fund's wealth intercept	0.4	Liquid wealth share
s^b	Fund's bond portfolio share	0.05	Stock return
$\bar{v}$	Bond convenience yield coefficient	35.5	Bond interest rate
η	Bond convenience yield curvature	13.7	Match estimates
θ	Fund's portfolio elasticity	2.9	Match estimates

Table E.5: Calibration of Baseline Parameters

	Stock price response		Interest rate response	
	No YCC	YCC	No YCC	YCC
0. Data	-16.95	22.23	1.41	0.00
	(26.27)	(11.13)	(0.68)	(0.13)
1. Baseline Model	-12.72	16.81	1.45	0.00
2. Elastic bond market ($\eta = 0$)	16.81	16.81	0.00	0.00
3. Elastic stock market ($\theta = \infty$)	-29.52	0.00	1.45	0.00
4. Elastic stock & bond market	0.00	0.00	0.00	0.00

Table E.6: Central Bank Stock Purchases: Model vs. Data

Notes: The table reports the response of stock price and the interest rate to the central bank stock purchases, $\frac{dQ}{QdS^g}$ and $\frac{dR^b}{dS^g}$, both in the data and in the model. The data is taken from the baseline rows of Table 1 with standard errors in parenthesis.

moments, the parameters are over-identified.

Table E.6 shows the calibrated model can quantitatively replicate the impact of central bank stock purchases we have estimated. The baseline model in row 1 replicates the rise in interest rate and a fall in stock price in response to the central bank stock purchases without yield curve control as well as the rise in stock price with yield curve control. This is because our calibration features a bond market that is more inelastic than the stock market. As is made precise in Proposition 2, when $v''(B^g) < -\frac{u'(Y)}{A\theta s^b(1-s^b)}$, which is our calibration, the stock price falls in response to the central bank stock purchases without yield curve control. This does not mean the stock market is elastic. In fact, when yield curve control is in place, so that the bond market is effectively elastic, the stock

	Baseline	Re-estimated
	(1)	(2)
Portfolio elasticity, θ	2.9	15.1
Bond inelasticity, η	13.7	0.0

Table E.7: Re-estimated Parameters Ignoring Inelasticity in Bond Market

Notes: In column (1), we report the baseline parameter estimates of (θ, η). In column (2), we re-estimate parameter θ to match 8.65% stock price response over the whole sample period (row 0 and column 2 of Table 1), assuming the bond market is elastic, $\eta = 0$.

price shows a strong response. Quantitatively our model implies that a flow into the stock market of $1 leads to a rise in the stock market value of $16.81, which is roughly in line with our empirical estimates of $22.23. This is several times larger than the baseline estimates of Gabaix and Koijen (2021), which shows a stock price response of $5 to $1 inflow.

In row 2, we contrast the baseline model with a model with an elastic bond market ($\eta = 0$). With an elastic bond market, the interest rate shows no response by construction and the stock price responds exactly in the same way with and without yield curve control. As explained in Proposition 1, this is because the households' Euler equation pins down the bond interest rate, irrespective of financial flows. As a result, the impact of flows is entirely absorbed by the stock prices. In row 3, we show that a model with an elastic stock market is unable to explain the substantial positive response of stock price under yield curve control. With a perfectly elastic stock market, the stock return keeps track of the bond interest rate one-for-one. Since the yield curve control fixes the bond interest rate, the stock price does not respond either. Finally, in row 4, a model in which both the bond and the stock market are perfectly elastic predicts no effect from the central bank stock purchases. As mentioned in Proposition 1, this is the case where the central bank balance sheet is neutral (Wallace, 1981). Rows 2-4 are all inconsistent with our empirical findings, leading us to reject models in which either the stock market or the bond market, or both, are elastic.

Our model highlights the importance of jointly taking into account stock and bond markets, even when researchers are only interested in the inelasticity of one market. Existing attempts to estimate inelasticity in the stock market typically either ignore the bond market or assume that bond markets are perfectly elastic. We argue such estimates substantially understate the true inelasticity in the stock market. To make this point, we re-estimate our model by assuming researchers misspecify that the bond market is perfectly elastic ($\eta = 0$). We estimate portfolio elasticity parameter θ by targeting 8.65%

stock price response from the overall sample period (row 0 and column 2 of Table 1).[5]

Table E.7 shows the re-estimated estimates along with our baseline estimates. We find a portfolio elasticity of 15.1, which is five times larger than our baseline estimates. This means that failing to take into account for inelasticity in the bond market leads researchers to substantially underestimate the true inelasticity in the stock market (overestimate the true elasticity). This provides empirical support for the theoretical arguments in Fuchs et al. (2023) that taking into account cross-asset spillovers is cruicial to uncover the true elasticity in the asset market.

While we focused on a particular structural model here, our empirical results provide two broader insights into theoretical models that incorporate inelastic financial markets. First, a strong response of the yield curve in times with flexible adjustments challenges the implicit assumption in the existing literature that the bond market is more elastic relative to the stock market. Second, the response of stock prices under the yield curve control is four times higher than the estimates in Gabaix and Koijen (2021), suggesting that the stock market may be more inelastic than previously thought. We failed to detect it in times with flexible interest rate adjustments because it was masked by the presence of an even more inelastic bond market.

[5] If researchers misspecify the bond markets are elastic, there is no reason to expect stock price responses to be different before and after YCC. The natural choice for such researchers is to pool the whole sample period.

F Proofs

F.1 Proof of Proposition 1

The household's Euler equation (E.10) together with goods market clearing conditions $C_t = Y$ and constant $v'(B) = \bar{v}$ imply

$$R^b \equiv \left(1 - \bar{v}/u'(Y)\right)/\beta \quad \text{for all } t. \tag{F.1}$$

This immediately implies that the bond interest rate is invariant to central bank stock purchases. The stock price Q_t solve (E.13):

$$Q_t = Q_t S_t^g + \frac{\mu^s (R_{t+1}^s)^\theta}{\sum_a \mu^a (R_{t+1}^a)^\theta} \left[\kappa_0 + \kappa_1 Q_t\right] \tag{F.2}$$

with $R_{t+1}^b = R^b$ and

$$R_{t+1}^s = (Q_{t+1} + Y)/Q_t. \tag{F.3}$$

Totally differentiating (F.2),

$$Q d\ln Q_t = Q S^g d\ln Q_t + Q dS_0^g + s^s(1-s^s)A\theta d\ln R_{t+1}^s + s^s \kappa_1 Q d\ln Q_t, \tag{F.4}$$

and totally differentiating (F.3),

$$d\ln R_{t+1}^s = \frac{1}{R^s} d\ln Q_{t+1} - d\ln Q_t. \tag{F.5}$$

Since these equations do not involve any state variable and the shocks are permanent, there are no transition dynamics, $d\ln Q_{t+1} = d\ln Q_t \equiv d\ln Q$. Imposing this, we can solve (F.4) and (F.5) to obtain

$$\frac{d\ln Q}{dS^g} = \frac{Q}{Q(1 - S^g - s^s\kappa_1) + (1-s^b)s^b A\theta \frac{Y}{Y+Q}} > 0, \tag{F.6}$$

as desired.

F.2 Proof of Proposition 2

Linearizing (E.15) yields

$$\beta R^b d \ln R^b = -\frac{v''(B^g)}{u'(Y)} dB^g. \tag{F.7}$$

Linearizing (E.16) yields

$$\left[(1 - S^g - \kappa_1 s^s) Q + A\theta s^b (1 - s^b) \frac{Y}{Y+Q} \right] d \ln Q = QdS^g - A\theta s^b (1 - s^b) d \ln R^b. \tag{F.8}$$

Plug (F.7) into (F.8) to obtain

$$d \ln Q = \frac{1}{\left[(1 - S^g - \kappa_1 (1 - s^b)) Q + A\theta s^b (1 - s^b) \frac{Y}{Y+Q} \right]} \left(QdS^g + \frac{v''(B^g)}{u'(Y)} A\theta s^b (1 - s^b) dB^g \right).$$

The statement in the propositions follows after imposing $dB^g = QdS^g$.

F.3 Proof of Proposition 3

The proposition follows from expression (F.8) after imposing $d \ln R^b = 0$.

References

ANGELETOS, G.-M., F. COLLARD, AND H. DELLAS (2023): "Public Debt as Private Liquidity: Optimal Policy," *Journal of Political Economy*, 131, 3233–3264.

ANGRIST, J. D. AND G. W. IMBENS (1995): "Two-Stage Least Squares Estimation of Average Causal Effects in Models with Variable Treatment Intensity," *Journal of the American Statistical Association*, 90, 431–442.

AUCLERT, A., M. ROGNLIE, AND L. STRAUB (2020): "Micro jumps, macro humps: Monetary policy and business cycles in an estimated HANK model," Tech. rep., National Bureau of Economic Research.

——— (2024): "The Intertemporal Keynesian Cross," *forthcoming at Journal of Political Economy*.

CALONICO, S., M. D. CATTANEO, AND R. TITIUNIK (2014): "Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs," *Econometrica : journal of the Econometric Society*, 82, 2295–2326.

CATTANEO, M. D., M. JANSSON, AND X. MA (2020): "Simple Local Polynomial Density Estimators," *Journal of the American Statistical Association*, 115, 1449–1455.

DI TELLA, S., B. M. HÉBERT, AND P. KURLAT (2024): "Aggregation, Liquidity, and Asset Prices with Incomplete Markets," Tech. rep., National Bureau of Economic Research.

FUCHS, W., S. FUKUDA, AND D. NEUHANN (2023): "Demand-System Asset Pricing: Theoretical Foundations," *Available at SSRN 4672473*.

FUKUDA, S.-I. AND M. TANAKA (2022): "The Effects of Large-scale Equity Purchases during the Coronavirus Pandemic," 30.

GABAIX, X. AND R. S. J. KOIJEN (2021): "In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis," SSRN Scholarly Paper ID 3686935, Social Science Research Network, Rochester, NY.

GIGLIO, S., M. MAGGIORI, J. STROEBEL, AND S. UTKUS (2021): "Five Facts about Beliefs and Portfolios," *American Economic Review*, 111, 1481–1522.

JORDÀ, Ò., K. KNOLL, D. KUVSHINOV, M. SCHULARICK, AND A. M. TAYLOR (2019): "The Rate of Return on Everything, 1870–2015," *The Quarterly Journal of Economics*, 134, 1225–1298.

KLEINMAN, B., E. LIU, S. J. REDDING, AND M. YOGO (2023): "Neoclassical Growth in an Interdependent World," Tech. rep., National Bureau of Economic Research.

KOIJEN, R. S. AND M. YOGO (2020): "Exchange rates and asset prices in a global demand system," .

KRISHNAMURTHY, A. AND W. LI (2023): "The demand for money, near-money, and treasury bonds," *The Review of Financial Studies*, 36, 2091–2130.

KUREISHI, W., H. PAULE-PALUDKIEWICZ, H. TSUJIYAMA, AND M. WAKABAYASHI (2021): "Time Preferences over the Life Cycle and Household Saving Puzzles," *Journal of Monetary Economics*, 124, 123–139.

MCCRARY, J. (2008): "Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test," *Journal of Econometrics*, 142, 698–714.

NAGEL, S. (2016): "The liquidity premium of near-money assets," *The Quarterly Journal of Economics*, 131, 1927–1971.

OKAWA, Y. AND E. VAN WINCOOP (2012): "Gravity in International Finance," *Journal of International Economics*, 87, 205–215.

PELLEGRINO, B., E. SPOLAORE, AND R. WACZIARG (2021): "Barriers to Global Capital Allocation," .

RAMBACHAN, A. AND N. SHEPHARD (2021): "When Do Common Time Series Estimands Have Nonparametric Causal Meaning?" .

VAYANOS, D. AND J.-L. VILA (2021): "A Preferred-Habitat Model of the Term Structure of Interest Rates," 100.

WALLACE, N. (1981): "A Modigliani-Miller Theorem for Open-Market Operations," *The American Economic Review*, 71, 267–274.