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JGB Yield Curve and Macro-Financial Stability:

How Would a Steeper JGB Yield Curve Affect Bank Profitability?

Japan

Salih Fendoglu

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JGB Yield Curve and Macro-Financial Stability: How Would a Steeper JGB Yield Curve Affect Bank Profitability?

Prepared by Salih Fendoglu*

Authorized for distribution by Ranil Salgado
May 2023

ABSTRACT: Given that there is exceptionally high uncertainty around the domestic inflation outlook, allowing for greater flexibility in long-term Japanese Government Bond (JGB) yields by the Bank of Japan (BoJ) could be considered going forward. Against this background, this study empirically finds that a steeper JGB yield curve helps improve banks' profitability, especially after a year lag, and the overall impact hinges on macroeconomic and financial market responses. A steeper JGB yield curve could also have spillovers on global yields. Financial sector policies to mitigate short-term vulnerabilities in case the JGB yield curve steepens could be considered, including by further strengthening engagement with financial institutions with relatively high exposure to interest rate movements, to better harness the benefits in the medium term.

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Prepared by Salih Fendoglu [1]

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JGB YIELD CURVE AND MACRO-FINANCIAL STABILITY: HOW WOULD A STEEPER JGB YIELD CURVE AFFECT BANK PROFITABILITY?[1]

A. Introduction

1. The macroeconomic landscape recently has changed, compared to when the BoJ started its unconventional policies a decade ago. To fight decade-long deflation and support the financial system, the BoJ has employed a series of unconventional monetary policies (UMP) since 2013, including the Yield Curve Control (YCC) policy that caps the 10-year rates at 0 percent within a narrow band (Westelius, 2020). A key change in the macroeconomic landscape is the acceleration in inflation in 2022. While headline inflation has been above the central bank's target of 2 percent y/y since April, there continues to be considerable uncertainty around the inflation outlook given still uncertain spring wage negotiations and the implications of a potential global economic slowdown, which calls for greater policy flexibility going forward. Concurrently, continuing monetary policy divergence with other advanced economy central banks has led to deterioration in long-term JGB market functioning, prompting the BoJ to widen the target band for 10-year JGB yields in its Monetary Policy Meeting in December 2022. Depending on data realizations, achieving a sustained increase in prices and wages could imply allowing for higher long-term yields.

2. To this end, this note analyzes how changes in the slope of the JGB yield curve could impact profitability of banks in Japan. In particular, the note starts with characterizing the JGB yield curve with a few parameters (including the slope) using a state-space model. It then utilizes bank-level financial statements data and estimates how banks' profitability reacts to changes in the slope of the yield curve, using a fixed-effects panel estimation based on historical data. The note examines other issues, including lagged effects, heterogeneity across banks, spillovers from the JGB yield curve to the US Treasury yield curve (and vice versa), and concludes with policy implications.

B. Data and Characterization of JGB Yield Curve

3. The JGB yield curve has in general been lower compared to earlier periods, with the curve flattening over time and then steepening more recently (Figure 1 chart 1). The data comprises of constant-maturity yields of JGBs, with maturities ranging from 3 months to 30 years, starting from January 2000 till October 2022.[2] Chart 1 shows that the JGB yield curve as a whole is lower compared to previous periods, and the slope of the curve (the difference between long- and short-end of the curve) flatter over time, especially after the BoJ's UMPs, but increasing more recently amid the rise in overseas yields.

[1] Prepared by Salih Fendoglu (MCM).

[2] The data source is Bloomberg and includes all available maturities (except 40 years, which is much less traded than shorter maturity bonds).

4. The yield curve can be characterized by a small set of factors. Using a Nelson-Siegel representation of cross-section of yields at a given time, one can write a dynamic latent factor model that characterizes the level, slope, and curvature of the yield curve, following Diebold, Rudebusch, and Aruoba (2008). In particular, the following state-space model is estimated,

$$y_t(\tau) = L_t + S_t\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + C_t\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right) \quad (1)$$

$$\begin{pmatrix} L_t - \mu_L \\ S_t - \mu_S \\ C_t - \mu_C \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} L_{t-1} - \mu_L \\ S_{t-1} - \mu_S \\ C_{t-1} - \mu_C \end{pmatrix} + \begin{pmatrix} \eta_t(L) \\ \eta_t(S) \\ \eta_t(C) \end{pmatrix} \quad (2)$$

where y(τ) denotes the vector of yields, and τ denotes maturity. The yields are driven by three latent factors, L_t, S_t, and C_t, which can be interpreted as level, slope, and curvature of the yield curve at time *t,* respectively. The parameter λ governs the decay factor on factor loadings, which is estimated jointly with the latent factors.[3] The model is estimated by maximizing Gaussian likelihood, with Kalman smoothing to extract the optimal values for the factors.

5. The estimated factors confirm declining yields, flattening of the yield curve over the past decade, and the steepening of the curve recently, and perform well in predicting yields (Figure 1 charts 2-5). The level factor recovers from historically low levels in 2016 after the introduction of the YCC and increases further since end-2021 amid rising longer-term yields domestically and abroad. The estimated slope factor confirms that there had been sustained flattening of the yield curve over the past decade. Given YCC, the recent increase in the slope mostly pertains to the rise in yields for maturities beyond 10 years. The curvature of the yield curve (i.e., yields at medium-term maturities relative to short- and long-term maturities) has been negative over the sample period, and exhibits a sharp (and later sustained) increase with the introduction of YCC. The model also performs well in predicting yields, especially at shorter maturities.[4]

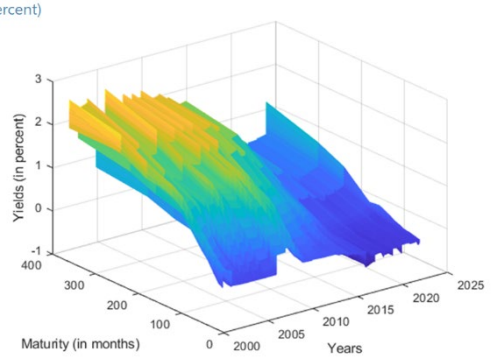
[3] The loading on L_t does not decay (constant at 1), implying that L_t reflects long-term factors. The loading on S_t starts at 1 and decays monotonically and fast to zero as τ increases, hence can be viewed as a short-term factor. The loading on C_t has an inverse U-shape, starting at zero initially (hence not short-term), increasing up to a level of τ, and decaying to zero afterwards for higher τs (hence not long-term). The slope in the model is defined as short minus long, and hence a negative slope factor means yields are increasing as maturity increases.

[4] Based on the standard deviation of residuals from the fitted model, the in-sample forecast performance of the model is highest for 4-year yields (0.7 basis points). For 10-year yields, standard deviation of residuals is 3 basis points.

Figure 1. Japan: Characterization of the JGB Yield Curve

1. JGB Yields over Time

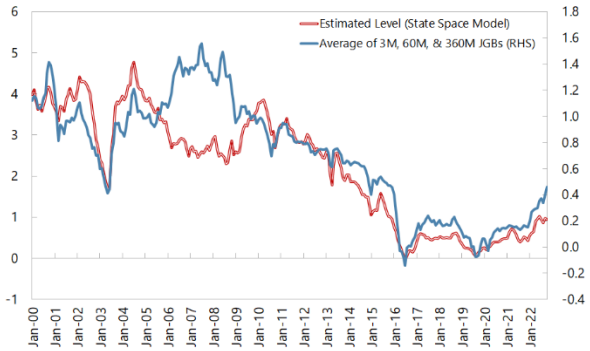
(In percent)



Sources: Bloomberg L.P. and IMF staff estimates.

2. Estimated Level of the JGB Yield Curve

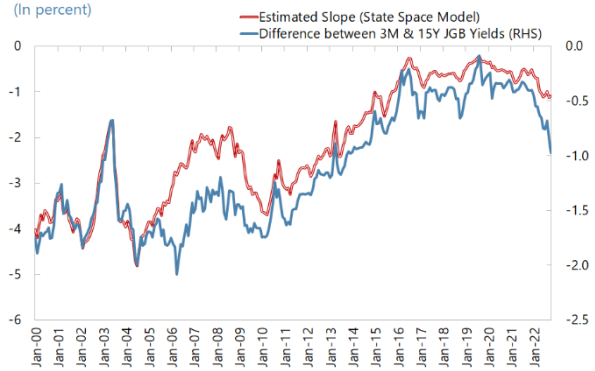
(In percent)



Sources: Bloomberg L.P. and IMF staff estimates.

3. Estimated Slope of the JGB Yield Curve

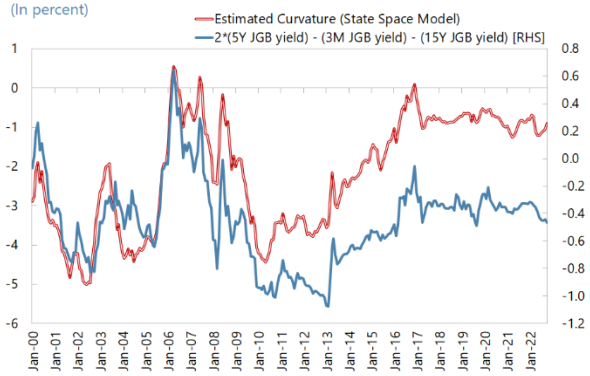
(In percent)



Sources: Bloomberg L.P. and IMF staff estimates.

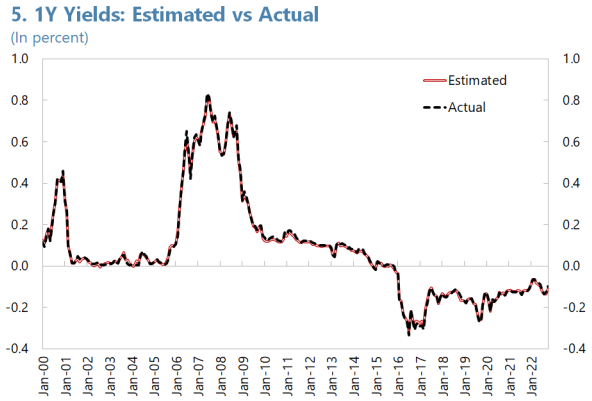
4. Estimated Curvature of the JGB Yield Curve

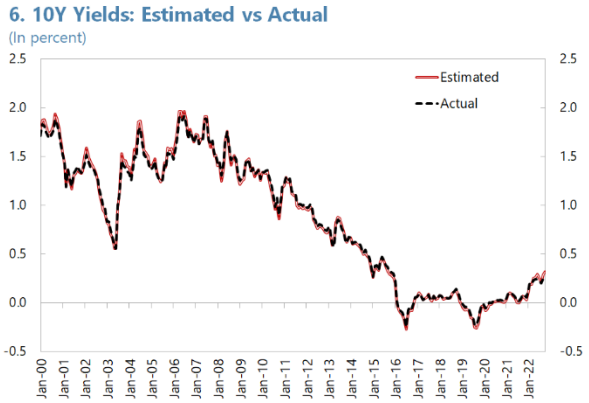
(In percent)

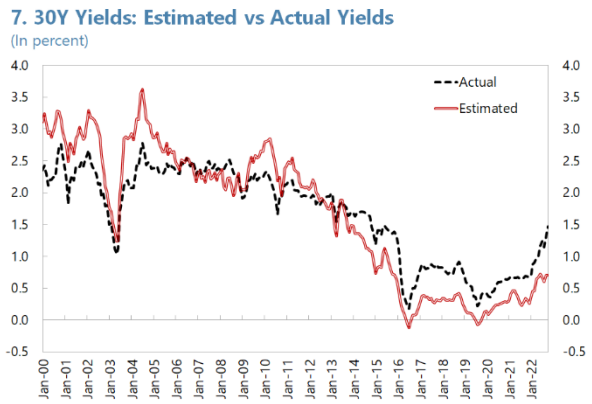


Sources: Bloomberg L.P. and IMF staff estimates.

Figure 1. Japan: Characterization of the JGB Yield Curve (concluded)







C. Empirical Results

6. Bank profitability is tightly linked to the term structure of interest rates, given banks' maturity transformation. Yield curve flattening is generally associated with compressed interest margins (Claessens and others 2018; IMF, 2020), as deposit rates (a key component of funding) are generally sticky, whereas lending rates tend to reprice faster (with the pace depending on contractual environment and competition within the industry). However, a flatter yield curve, especially if not prolonged, can improve credit portfolio quality, bring in valuation gains on securities holdings, and improve the economic outlook, all of which would contribute positively to banks' capital (Altavilla and others, 2018; Demiralp and others, 2021). From this perspective, a steeper yield curve may improve net interest margins, but would lead to valuation losses on bond holdings in the short term and could induce higher provision expenses. The overall impact on profitability is ambiguous in principle and depends on how the overall economy (e.g., borrower creditworthiness and demand for credit) and financial markets react to a steeper yield curve.

7. This section presents evidence of how slope of the yield curve affects banks' profitability, with a focus on different drivers of profitability, potential lagged impacts, and heterogeneity across banks. The dataset includes annual unconsolidated financial statements for

95 banks for a sample period of 2003-2021, obtained from Fitch-Bankscope; macroeconomic variables from IMF World Economic Outlook database; and NIKKEI stock market volatility from Thomson Reuters. The following fixed-effects panel model is estimated:

$$Y_{i,t} = \beta\, Y_{i,t-1} + \gamma Slope_{t\ or\ t-1} + \delta r_{i,t} + \theta X_{i,t-1} + \theta Z_{t-1} + \mu_i + \epsilon_{it}$$

where $Y_{i,t}$ denotes (i) net interest margin (relative to assets); (ii) net non-interest income (relative to gross revenues), (iii) provision expenses-to-total loans ratio; or (iv) return on assets, of an individual bank i at year t. $Slope_t$ is the (annual average of) slope of the JGB yield curve estimated above (Figure 1 chart 3), and $r_{i,t}$ denotes 3-month constant-maturity JGB yields (annual average).[5] $X_{i,t-1}$ denote a large set of bank-specific controls ((log) total assets, equity-to-assets, liquid assets-to-total assets, non-performing loans-to-gross loans, securities-to-total assets, and deposits-to-total liabilities ratios, all one-year lagged to mitigate potential endogeneity). Z_t denote macroeconomic variables (real GDP growth, inflation) and financial market volatility (NIKKEI volatility index). The model also includes bank fixed effects (μ_i) which absorb any bank characteristics that do not change over time. The model is estimated via ordinary least squares, and standard errors are clustered at the bank level.[6]

8. The results suggest that a steeper yield curve improves bank profitability (Table 1). A higher slope of the JGB yield curve is estimated to improve net interest margins (NIMs), though weigh on banks' overall profitability by reducing net non-interest income (which mainly reflect valuation losses on securities holdings and commission/fee incomes reflecting in part aggregate demand conditions) and increasing provision expenses (reflecting higher credit risks going forward) (columns (1), (3), (5) and (7)). Economically, a 100-basis-points (close to 1-standard-deviation) increase in the slope of the JGB yield curve is estimated to improve NIMs by 2 basis points (or 8 basis points in the long-run) (column (3)).

9. The positive impact of a steeper yield curve on bank profitability is stronger after one-year lag. The impact of a steeper yield curve on non-interest income and provision expenses is moderated after a year (columns (2), (4), (6), and (8)), as losses on non-interest income and provisions expenses moderate. The results are robust to excluding large banks (available upon request).

10. That said, the impact hinges importantly on how real economic activity or financial market volatility reacts (Table 2). Lower economic growth or higher stock market volatility is associated with a reduction in the impact of a steeper yield curve on banks' profitability, mainly through lowering banks' non-interest income (e.g., lowering unrealized/realized gains on securities holdings) and increasing their provision expenses (amid potential rise in credit risks).

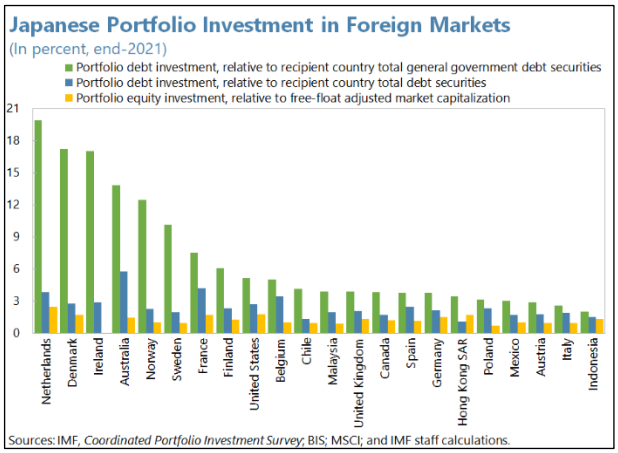
11. The results should be read with the limitation that a better identification requires granular data. While banks are assumed to have equal exposures to changes in the yield curve

[5] Controlling for short-term yields helps to better identify the impact of a change in the slope.

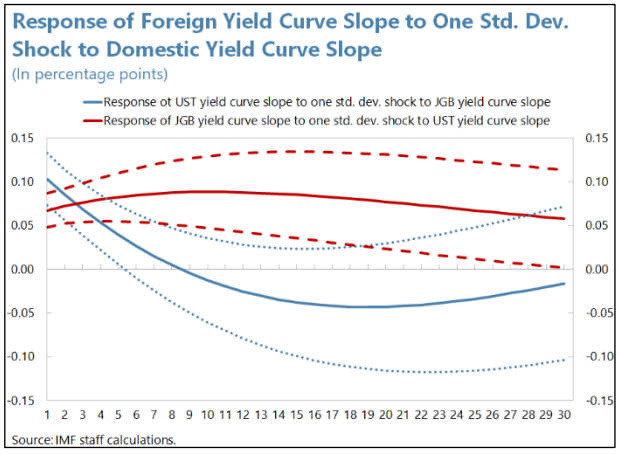
[6] Given large T and low estimated persistence for the dependent variable (in most specifications), Nickel bias is less of a concern. The results are robust to saturating the model also with city fixed effects, and alternative clusterings, including double clustering by bank and city.

slope in the above analyses, there is a large heterogeneity across banks in the exposures (maturity gaps), especially with respect to different groups of banks (e.g., major vs regional banks). Such data would not only enable a better identification but would also allow measuring how different groups of banks would differentially be affected by changes in the yield curve slope. Moreover, comparing these estimated impacts with some other peer economies is left to future research.

12. A rise in the slope of the JGB yield curve could have global spillovers. Japan has the largest net foreign asset position in the world, which amounts to 3.2 trillion US dollars as of 2022Q3 (750 billion USD as net portfolio assets, 1.5 trillion USD as net FDI, and the rest including mainly reserve assets). Relative to destination markets, gross portfolio debt holdings are meaningfully large for several markets, including the United States (US).[7] A portfolio re-allocation by Japanese investors in response to a change in the JGB yields could affect valuations of overseas assets. The impact could be larger if accompanied by elevated fiscal concerns or sharp decline in domestic equity prices (e.g., as the latter would deteriorate banks' risk-taking capacities and may force them to deleverage, including overseas positions (IMF, 2011)).



13. Analysis suggests moderate spillovers from JGB to the US Treasury yield curve slope, in line with earlier evidence (IMF, 2011; 2012), and assuming away potential non-linearities. For instance, IMF (2012) reports a 5-10 basis point increase in US and Euro-area Treasury yields in response to a 100-basis-points increase in JGB yields, assuming a mild impact on global risk aversion. A simple VAR of estimated yield curve factors (level, slope, and curvature) for JGBs and US Treasury bonds confirms this finding: a 100-basis-points increase in the JGB yield curve slope is associated with an increase in the US Treasury yield curve slope by close to 10 basis points on average (blue line). The impact appears short-lived, dissipating in five to six months. Estimated spillovers from the US Treasury to the JGB yield curve slope appear



[7] Japan is the largest foreign holder of US Treasuries, accounting for about 15 percent of all holdings outside the US (https://ticdata.treasury.gov/Publish/mfh.txt) as of end-September 2022 (down from 17 percent a year ago).

more persistent and significantly higher beyond short term (black line).[8] For instance, the one-year cumulative response of the US Treasury yield curve slope to a shock to the JGB yield curve slope is about one-third of the spillover from the US to Japan.[9]

D. Taking Stock and Policy Implications

14. The results underline that a steeper JGB yield curve would help improve banks' overall profitability,[10] the strength of which hinges on macroeconomic and financial market response. The analyses underpin the importance of clear and careful communication by the central bank on the normalization strategy to avoid excessive market volatility, and stronger efforts by policy makers and supervisors to monitor potential vulnerabilities due to higher domestic interest rates (e.g., duration risk of financial institutions, strength of borrower cash flows --especially for those hit more strongly by the pandemic and those with variable rate loans).

15. There have been early signs that some large banks have started to embrace a scenario of higher domestic rates going forward, by reducing their duration risk. However, against the backdrop of fiscal stimulus during the pandemic, banks generally have higher JGB holdings on their balance sheets compared to before the pandemic, suggesting that yen interest rate risk could be larger on banking books, especially of smaller banks. Ensuring policies and supervisory efforts to help reduce potential short-term adverse impact would help better harness the benefits of a steeper yield curve on banks' profitability.

[8] US Treasury term spreads also appear as a relevant driving factor in movements in the JGB yield curve slope. The JGB yield curve slope not explained by the state space model in Section B is significantly correlated with US term spread (proxied by the difference between 30-year and 3-month US Treasury yields, the longest and shortest tenors in the sample), with a statistically significant correlation of 0.30.

[9] Incidentally, the relative size of cumulative responses (one to three) is in line with the relative size of the two economies. There are further channels through which changes in the slope of the JGB yield curve slope would have global spillovers, including via interbank exposures, foreign exchange rate, and output. Moreover, foreigners are active traders in the JGB market, and hold 7.1 percent of outstanding JGBs (14.1 percent including Treasury discount bills) as of end-September 2022. Depending on their risk-taking capacity, foreign investors could also be a source of global spillovers arising from changes in JGB yields.

[10] It should be noted that the overall impact would depend on additional factors such as maturity ladder of bank balance sheets and the degree at which banks adjust deposit rates in response to changes in market rates.

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Appendix I. Tables

Table 1. The Impact of a Steeper JGB Yield Curve on Bank Profitability and Underlying Drivers

			Underlying Drivers					
Dependent Variable:	Profitability		Net Interest Margin		Net Non-Interest Income-to-Gross revenues		Provisions-to-gross loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope of the JGB Yield Curve	0.045*		0.022***		-1.776**		0.105***	
	(0.025)		(0.007)		(0.717)		(0.019)	
Slope of the JGB Yield Curve (lagged)		0.135***		0.017***		1.905***		0.053***
		(0.022)		(0.006)		(0.493)		(0.017)
Short-term Interest Rate	-0.158**	-0.340***	0.025	0.004	5.286**	0.986	0.069	0.026
	(0.071)	(0.077)	(0.020)	(0.018)	(2.286)	(2.321)	(0.055)	(0.060)
Real GDP Growth	0.010*	0.004	0.003***	0.002	0.229	0.156	-0.012***	-0.016***
	(0.006)	(0.006)	(0.001)	(0.001)	(0.140)	(0.134)	(0.003)	(0.003)
Inflation	-0.018	-0.006	0.007**	0.005*	-1.796***	-0.924**	0.023**	0.006
	(0.019)	(0.016)	(0.003)	(0.003)	(0.446)	(0.382)	(0.009)	(0.008)
NIKKEI Volatility Index (log)	-0.315***	-0.232***	-0.005	0.013	-5.527***	-4.372**	0.128***	0.191***
	(0.049)	(0.049)	(0.009)	(0.009)	(1.832)	(1.906)	(0.041)	(0.045)
Bank Controls included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank F.E.	Included	Included	Included	Included	Included	Included	Included	Included
Observations	1,296	1,296	1,565	1,565	1,565	1,565	1,544	1,544
R-squared	0.233	0.258	0.967	0.966	0.649	0.650	0.357	0.329
Number of banks	95	95	95	95	95	95	95	95

Notes. All columns include lagged dependent variable. Standard errors are clustered at the bank level, and provided in parantheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2. Further Discussions: How Macroeconomic and Financial Markets Respond May Matter.

			Underlying Drivers					
Dependent Variable:	Profitability		Net Interest Margin		Net Non-Interest Income-to-Gross revenues		Provisions-to-gross loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope of the JGB Yield Curve	0.023	1.457***	0.022***	0.012	-1.600**	38.769***	0.101***	-0.318***
	(0.023)	(0.166)	(0.007)	(0.021)	(0.650)	(3.918)	(0.019)	(0.082)
Slope of the JGB Yield Curve* Real GDP Growth	0.050***		-0.001		1.353***		-0.013***	
	(0.007)		(0.001)		(0.152)		(0.002)	
Slope of the JGB Yield Curve*		-0.456***		0.003		-12.993***		0.136***
* NIKKEI Volatility Index (log)		(0.054)		(0.007)		(1.308)		(0.027)
Macro Controls (in levels)	Included	Included	Included	Included	Included	Included	Included	Included
Bank Controls	Included	Included	Included	Included	Included	Included	Included	Included
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,296	1,296	1,565	1,565	1,565	1,565	1,544	1,544
R-squared	0.372	0.281	0.967	0.967	0.698	0.672	0.385	0.365
Number of banks	95	95	95	95	95	95	95	95

Notes. All columns include lagged dependent variable. Standard errors are clustered at the bank level, and provided in parantheses. *** p<0.01, ** p<0.05, * p<0.1.