Transmission of Long Term Interest Rates in Japan : Government Bond and Swap Markets under Negative Interest Rate Policy

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Abstract

The transmissions from JGB to swap in the maturities of four, five and 10 years are confirmed before the introduction of YCC. This means that the market function only works in the maturities of four and five years under negative interest rate policy regime. After the BOJ introduces YCC policy under negative interest rate policy, the transmissions from JGB to swap are confirmed in all maturities except for two years. This means that the market function works in the maturities of three, four, five, seven, seven and 10 years under YCC policy with negative interest rate policy regime. Comparing before and after the introduction of YCC, the transmissions from JGB to swap are stronger after the introduction of YCC. The market function gradually recovers with the introduction of YCC because market participants assume that long-term interest rates will move above the level of 0% with more volatilities.

Keywords: Japanese Government Bond, Interest Rate Swap, Market Function, Negative Interest Rate Policy, Yield Curve Control

1. Introduction

This paper focuses on the formation of long term interest rates in Japan by analyzing the transmission of Japanese Government Bond (JGB) and interest rate swap (hereinafter swap) markets in Japan in negative interest rate period. Currently JGB and swap markets are representative of long term interest rates because corporate bond market is very illiquid in Japan.

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The Bank of Japan (BOJ) introduces negative interest rate on January 29, 2016. They introduce yield curve control (YCC) policy on September 21, 2016 while maintaining negative interest rate policy. They indicate that "the target of the 10-year Japanese JGB yields is around 0%" as in the BOJ (2016b). There is a consensus in the market that the BOJ would permit 10 year JGB to move from -0.1% to 0.1% with the introduction of YCC. They strengthen the framework for continuous powerful monetary easing while maintaining negative interest rate and YCC policy on July 31, 2018[1]. Mr. Haruhiko Kuroda, Governor of the BOJ, indicates at a press conference on July 31, 2018 that "the 10-year JGB yield would move within the range of -0.2% to 0.2%".

So far, the relationship of government bond yield and swap rate has mainly been analyzed in the framework of swap spreads. In this paper, the Granger causality approach is used to analyze the transmission of the JGB and swap as Ito (2009). Ito (2009) uses this method for an analysis of JGB and swap. In Ito's (2009) study, "the whole sample is divided into two sub-periods: Sample A is from January 4, 1994 through to February 12, 1999; Sample B is from February 15, 1999 through to February 27, 2009". In Sample A except for five years, "swap and JGB affect mutually. In five years, the causality from Japanese swap rate to JGB is not observed".

In Sample B, "swap and JGB affect mutually in all maturities except for seven and 10 years. In the maturities of seven years and 10 years, causalities of JGB to swap rate are not confirmed. In the maturities of five and seven years, causalities of swap to JGB are very strong". The BOJ applies traditional monetary policy from 1994 to 2000. They adopt weak non-traditional monetary policy from 2001 to 2009 in comparison with negative interest rate policy. The results of Ito (2009) suggests that the market function works in the two markets.

Related studies, such as Andresen et al (2015), Jackson (2015), Arteta et al. (2016), Bech and Malkhozov (2016), Turk (2016), Ito (2017) and Ito (2019) analyze the short term interest rates under negative interest rate policy. None of them focuses on the long term interest rates.

[1] For the details of monetary policy, see BOJ (2013), BOJ (2016a), BOJ (2016b) and BOJ (2018).

This paper provides two outstanding points to the literature. Firstly, it is the first paper to analyze the transmission of JGB and swap in Japan under the monetary policy regime of negative interest rate. Secondly, it divides the negative interest rate regime into two. Thus, it is possible to examine the influence of different negative interest policy regimes on long-term interest rates.

2. Data

JGB yields and swap rates are used on a daily basis from January 29, 2016 to November 14, 2018. The maturities are two years, three years, four years, five years, seven years, and 10 years. These data are provided by Datastream. The movements of two-year, five - year and 10-year JGB yields are shown in Figure 1.

Figure 1

The whole sample period is divided into two. The former period, Sample A, runs from January 29, 2016 to September 20, 2016. The latter period, Sample B, runs from September 21, 2016 to November 14, 2018. It introduces YCC policy with negative interest rate policy on September 21, 2016.

3. Methodology and Results

3.1 Unit Root Test

Initially, two kinds of unit root tests proposed by Dickey and Fuller (1979, 1981), and Kwiatkowski et al (1992), are used to check the non-stationarity of the original series. The results indicate that unit roots are contained in the original data.

Table 1

Table 2

Secondly, unit root tests are used for the first differenced data. The results indicate that

all first differenced data are stationary. All variables are I (1) variables.

Table 3

Table 4

3.2 Granger Causality Test and Transmission

Toda and Yamamoto (1995) develop the Granger causality test in which non-stationary data are directly tested. As Ito (2009) mentions, “the Granger causality test checks whether swap rate (y_t) affects JGB yield (jy_t) or jy_t affects y_t or y_t and jy_t affect mutually’. As Toda and Yamamoto (1995) states, “the original data are usually transformed into the change ratio to avoid a problem of spurious regression. But using these data is considered to cause an error”.

According to their method, “the null hypothesis H_0 is tested as for the influence from jy_t to y_t and for the influence from y_t to jy_t. But trend term *t* and *p + 1* (original lag plus one) are added for the estimation”.

$$y_t = \kappa_0 + \lambda t + \sum_{i=1}^{p+1} \alpha_i y_{t-i} + \sum_{i=1}^{p+1} \beta_i jy_{t-i} + u_t \qquad (1)$$

$H_0 : \beta_1 = \beta_2 = \cdots \beta_p = 0$

$H_1 : \text{Either } \beta_i \neq 0 \quad (i = 1,2,\cdots, p)$

$$jy_t = \varsigma_0 + \eta t + \sum_{i=1}^{p+1} \gamma_i y_{t-i} + \sum_{i=1}^{p+1} \delta_i jy_{t-i} + v_t \qquad (2)$$

$H_0 : \gamma_1 = \gamma_2 = \cdots \gamma_p = 0$

$H_1 :$ Either $\gamma_i \neq 0 \quad (i = 1,2,\cdots, p)$

y_t = Japanese swap rate

jy_t = JGB yield

According to Ito (2009), “The *F* test is conducted by estimating (1) and (2) through OLS and summing the squared error. If the null hypothesis of H_0 in the equation (1) is rejected, jy_t is considered to explain y_t. If the null hypothesis of H_0 in the equation

(2) is rejected, y_t is considered to explain jy_t". When no causality is found, the market function does not work because two markets are separated. When one side or mutual causalities are found, the market function works because two markets are related.

In Sample A, the causalities from JGB to swap in the maturities of four, five and 10 years are confirmed. On the other hand, no transmission from swap to JGB is confirmed in all maturities before the introduction of YCC. In Sample B, the causalities from JGB to swap are confirmed in all maturities except for two years after the introduction of YCC. On the other hand, no transmission from swap to JGB is confirmed in all maturities. The results are reported in Table 5.

Table 5

4. Concluding Remarks

This paper examines the transmission of JGB and swap markets in Japan under negative interest rate period. The transmissions from JGB to swap in the maturities of four, five and 10 years are confirmed under negative interest rate policy before the introduction of YCC. On the other hand, no transmission from swap to JGB is confirmed in all maturities. This means that the market function only works in the maturities of four, five and 10 years under negative interest rate policy.

After the BOJ introduces YCC policy under negative interest rate policy, the transmissions from JGB to swap are confirmed in all maturities except for two years. On the other hand, no transmission from swap to JGB is confirmed in all maturities after the introduction of YCC. This means that the market function works in the maturities of three, four, five, seven, seven and 10 years under YCC policy with negative interest rate policy regime.

Comparing before and after the introduction of YCC, the transmissions from JGB to swap are stronger after the introduction of YCC except for 4 years. The market function gradually recovers with the introduction of YCC because market participants assume that the long-term interest rates will move above the level of 0% with more volatilities.

But even after the introduction of YCC, the market function of JGB and swap does not work as well as in the period from 1994 to 2009 when mutual transmissions are confirmed

in many maturities as in Ito (2009). In these periods, the BOJ applies traditional monetary policy from 1994 to 2000. They adopt weak non-traditional monetary policy from 2001 to 2009 in comparison with negative interest rate policy. It paralyzes the market function of long term interest rates in Japan.

This paper analyzes the transmission of JGB and swap. It is necessary to analyze swap spreads (swap rate minus JGB yield) in terms of the factors influencing them. I would like to point out them as further research.

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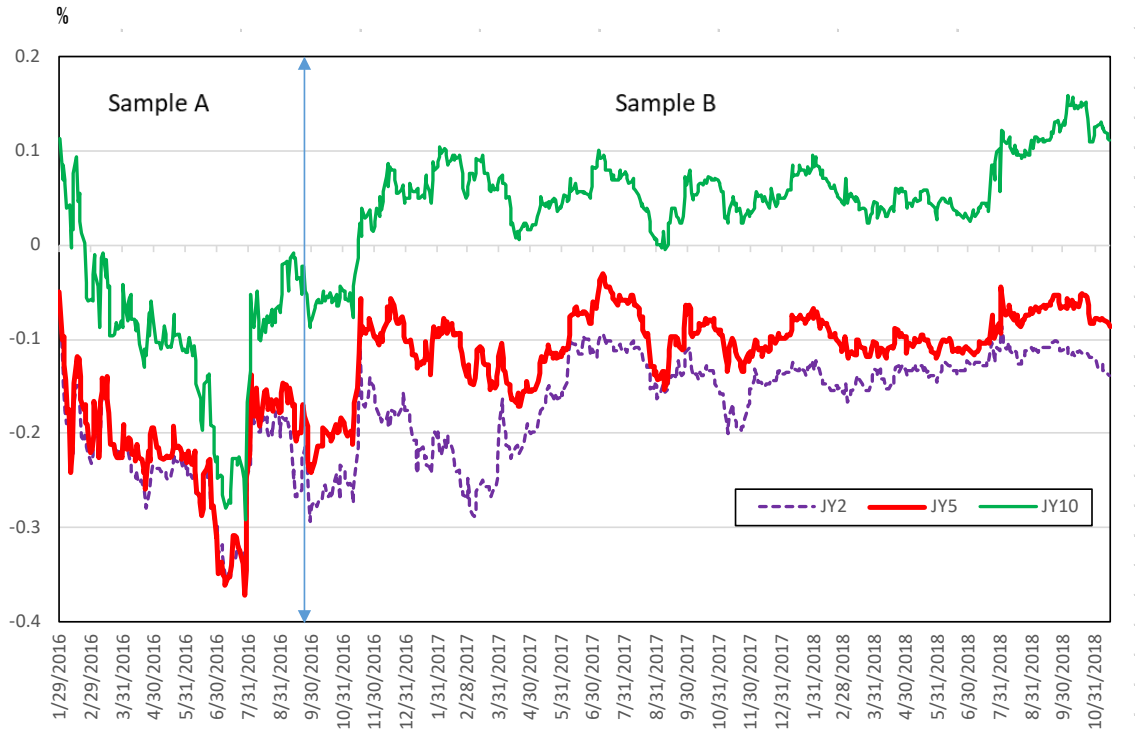

Fgure 1 Movement of Three Series

Notes : Data Source is Datastream

Sample A is from January29, 2016 to September 20, 2016.

Sample B is from September 21, 2016 to November 14, 2018.

JY2 = two years Japanese Government Bond Yield, JY5 = five years Japanese Government Bond Yield

JY10 = 10 years Japanese Government Bond Yield

Table 1 ADF Test Original Series

Sample A

Variable	Without Trend	With Trend
JY2	-0.268	-2.806
JY3	0.319	-2.505
JY4	-0.382	-2.692
JY5	-0.395	-2.649
JY7	-0.338	-1.998
JY10	-1.083	-1.943
Y2	-0.814	-3.252
Y3	-0.832	-3.076
Y4	-0.893	-2.834
Y5	-0.108	-2.635
Y7	-2.566	-2.467
Y10	-2.173	-2.362

Sample B

Variable	Without Trend	With Trend
JY2	-1.572	-3.491*
JY3	-1.183	-3.682*
JY4	-1.228	-3.843*
JY5	-1.389	-3.987*
JY7	-2.370	-3.583*
JY10	-0.942	-3.259
Y2	-1.579	-4.749*
Y3	-1.173	-4.538*
Y4	-0.818	-4.345*
Y5	-0.515	-4.062*
Y7	-0.056	-3.690*
Y10	0.366	-3.292

Notes :* indicates significant at the 5 % level.

5% critical values are -2.89 (without trend), -3.45(with trend).

JY=Japanese Government Bond Yield ,Y=Japanese Swap Rate

Sample A is from January29, 2016 to September 20, 2016.

Sample B is from September 21, 2016 to November 14, 2018.

Table 2 KPSS Test Original Series

Sample A

	Lag=2		Lag=12	
Variable	η_μ	η_τ	η_μ	η_τ
JY2	1.192*	0.571*	0.361*	0.175*
JY3	0.865*	0.570*	0.270*	0.179*
JY4	0.933*	0.908*	0.284*	0.192*
JY5	1.051*	0.655*	0.315*	0.198*
JY7	1.486*	0.698*	0.425*	0.205*
JY10	1.993*	0.829*	0.541*	0.234*
Y2	0.891*	0.460*	0.289*	0.160*
Y3	0.850*	0.429*	0.282*	0.151*
Y4	0.502*	0.437*	0.186*	0.142*
Y5	0.505*	0.449*	0.165*	0.146*
Y7	1.567*	0.481*	0.457*	0.146*
Y10	2.738*	0.569*	0.740*	0.165*

	Lag=2		Lag=12	
Variable	η_μ	η_τ	η_μ	η_τ
JY2	10.038*	1.148*	2.477*	0.301*
JY3	8.161*	0.972*	2.063*	0.259*
JY4	6.179*	0.632*	1.587*	0.169*
JY5	4.606*	0.685*	1.203*	0.184*
JY7	4.241*	0.650*	1.091*	0.170*
JY10	5.300*	0.996*	1.336*	0.254*
Y2	6.325*	1.116*	1.609*	0.289*
Y3	7.772*	1.130*	1.966*	0.294*
Y4	8.320*	1.108*	2.097*	0.288*
Y5	8.870*	1.057*	2.204*	0.275*
Y7	10.202*	0.963*	2.536*	0.251*
Y10	11.635*	0.923*	2.861*	0.240*

Notes: * indicates significance at the 5 % level.

5% critical values are 0.463(level stationary), 0.146 (trend stationary).

η_μ indicates level stationarity. η_τ indicates trend stationarity.

Sample A is from January29, 2016 to September 20, 2016.

Sample B is from October 21, 2016 to November 14, 2018.

Table 3 ADF Test Series with First Difference

Sample A

Variable	Without Trend	With Trend
⊿JY2	-7.507*	-7.520*
⊿JY3	-7.613*	-7.260*
⊿JY4	-7.320*	-7.274*
⊿JY5	-7.551*	-7.620*
⊿JY7	-8.064*	-8.162*
⊿JY10	-8.206*	-8.299*
⊿Y2	-12.618*	-10.140*
⊿Y3	-11.515*	-10.199*
⊿Y4	-10.949*	-10.429*
⊿Y5	-10.719*	-10.466*
⊿Y7	-7.409*	-7.795*
⊿Y10	-7.262*	-7.262*

Sample B

Variable	Without Trend	With Trend
⊿JY2	-12.735*	-12.197*
⊿JY3	-22.688*	-23.098*
⊿JY4	-22.564*	-22.849*
⊿JY5	-22.758*	-22.979*
⊿JY7	-25.999*	-26.323*
⊿JY10	-10.688*	-10.289*
⊿Y2	-6.541*	-8.916*
⊿Y3	-7.592*	-9.087*
⊿Y4	-7.490*	-7.863*
⊿Y5	-7.328*	-7.683*
⊿Y7	-7.384*	-7.682*
⊿Y10	-7.452*	-7.693*

Notes :* indicates significant at the 5 % level.

5% critical values are -2.89 (without trend), -3.45(with trend).

JY=Japanese Government Bond Yield ,Y=Japanese Swap Rate

Sample A is from January29, 2016 to September 20, 2016.

Sample B is from September 21, 2016 to November 14, 2018.

Table 4 KPSS Test Series with First Difference

Sample A

	Lag=2		Lag=12	
Variable	η_μ	η_τ	η_μ	η_τ
⊿JY2	0.152	0.065	0.174	0.067
⊿JY3	0.191	0.056	0.226	0.070
⊿JY4	0.167	0.044	0.222	0.062
⊿JY5	0.155	0.038	0.227	0.060
⊿JY7	0.177	0.034	0.262	0.058
⊿JY10	0.245	0.032	0.345	0.057
⊿Y2	0.150	0.055	0.202	0.076
⊿Y3	0.134	0.054	0.186	0.075
⊿Y4	0.121	0.050	0.170	0.072
⊿Y5	0.111	0.049	0.156	0.071
⊿Y7	0.104	0.047	0.144	0.068
⊿Y10	0.260	0.032	0.345	0.057

	Lag=2		Lag=12	
Variable	η_μ	η_τ	η_μ	η_τ
⊿JY2	0.036	0.023	0.048	0.031
⊿JY3	0.043	0.022	0.047	0.024
⊿JY4	0.044	0.024	0.046	0.026
⊿JY5	0.038	0.024	0.043	0.027
⊿JY7	0.067	0.037	0.063	0.035
⊿JY10	0.045	0.042	0.049	0.047
⊿Y2	0.437	0.104	0.432	0.112
⊿Y3	0.425	0.097	0.415	0.102
⊿Y4	0.375	0.083	0.362	0.086
⊿Y5	0.335	0.074	0.322	0.076
⊿Y7	0.246	0.055	0.238	0.056
⊿Y10	0.169	0.041	0.166	0.041

Notes: * indicates significance at the 5 % level.

5% critical values are 0.463(level stationary), 0.146 (trend stationary).

η_μ indicates level stationarity. η_τ indicates trend stationarity.

Sample A is from January29, 2016 to October 20, 2016.

Sample B is from September 21, 2016 to November 14, 2018.

Table 5 Granger Causality Test

Sample A

Variables	Test Statistics	Variables	Test Statistics
JY2 → Y2	0.778	Y2 → JY2	1.058
JY3 → Y3	1.780	Y3 → JY3	0.413
JY4 → Y4	2.657**	Y4 → JY4	0.268
JY5 → Y5	2.312**	Y5 → JY5	0.179
JY7 → Y7	1.621	Y7 → JY7	0.123
JY10 → Y10	5.519*	Y10 → JY10	1.232

Sample B

Variables	Test Statistics	Variables	Test Statistics
JY2 → Y2	1.096	Y2 → JY2	1.946
JY3 → Y3	3.705*	Y3 → JY3	0.776
JY4 → Y4	2.486**	Y4 → JY4	0.310
JY5 → Y5	2.431**	Y5 → JY5	1.502
JY7 → Y7	5.986*	Y7 → JY7	0.568
JY10 → Y10	7.056*	Y10 → JY10	0.161

* indicates significant at the 5% level.
** indicates significant at the 10% level.
Original lag is chosen by AIC standard.
The method proposed by Toda and Yamamoto (1995) is used.
JY=Japanese Government Bond Yield ,Y=Japanese Swap Rate
Sample A is from January 29, 2016 to September 20, 2016.
Sample B is from September 21, 2016 to November 14, 2018.