Australian National University

Crawford School of Public Policy

AJRC

Australia – Japan Research Centre

The term structure of credit spreads and business cycle in Japan

AJRC Working Paper 03/2016
May 2016

Tatsuyoshi Okimoto
The Australian National University
Australia-Japan Research Centre

Sumiko Takaoka
Seikei University
Faculty of Economics

Abstract

This paper investigates the usefulness of the term structure of credit spreads to predict the business cycle in Japan. Our analyses provide clear evidence that the term structure of credit spreads has more predictive power than the government bond yield. Specifically, the paper shows that the credit spread curve of medium-grade corporate bonds with an A or BBB rating has more useful information than the government bond yield curve for predicting the business cycle in Japan. However, our results indicate that the increase in the BBB-rated credit spread is associated with future economic growth, contradicting the theoretical prediction in the existing literature. Our Markov-switching analysis demonstrates that this peculiar relationship holds only during the global financial crisis regime, and the 1-year government bond yield and the term spread of A-rated credit spread information have significant predictive power for the business cycle in Japan regardless of the economic state.

Keywords

Business cycle; corporate bond spreads; government bond yields; Markov-switching model

JEL Classification

E32, E43, E44, G12

Suggested Citation:

Okimoto, T. & Takaoka, S., 2016. 'The term structure of credit spreads and business cycle in Japan'. AJRC Working Paper No. 3, May 2016. Australia-Japan Research Centre, Crawford School of Public Policy, The Australian National University**.**

Address for correspondence:

(E) ajrc@anu.edu.au

ISSN 0 728 8409
ISBN 978-0-86413-017-4

The term structure of credit spreads and business cycle in Japan

Tatsuyoshi Okimoto* and Sumiko Takaoka†

April 26, 2016

Abstract

This paper investigates the usefulness of the term structure of credit spreads to predict the business cycle in Japan. Our analyses provide clear evidence that the term structure of credit spreads has more predictive power than the government bond yield. Specifically, the paper shows that the credit spread curve of medium-grade corporate bonds with an A or BBB rating has more useful information than the government bond yield curve for predicting the business cycle in Japan. However, our results indicate that the increase in the BBB-rated credit spread is associated with future economic growth, contradicting the theoretical prediction in the existing literature. Our Markov-switching analysis demonstrates that this peculiar relationship holds only during the global financial crisis regime, and the 1-year government bond yield and the term spread of A-rated credit spread information have significant predictive power for the business cycle in Japan regardless of the economic state.

JEL classification numbers: E32, E43, E44, G12

Keywords: Business cycle, Corporate bond spreads, Government bond yields, Markov-switching model

*Associate Professor, Crawford School of Public Policy, Australian National University, 132 Lennox Crossing, ANU, Acton, ACT 2601, Australia. E-mail: tatsuyoshi.okimoto@anu.edu.au

†Professor, Faculty of Economics, Seikei University, 3-3-1, Kichijoji Kitamachi, Musashino, Tokyo 180-8633, Japan. E-mail: takaoka@econ.seikei.ac.jp.

I Introduction

Two disasters, the 2008 global financial crisis and the 2011 Great East Japan earthquake, have struck the Japanese economy since 2000. Although these two events are different types of disasters, a financial disaster and a natural disaster, they caused turmoil in the credit market. The impacts of the subprime mortgage crisis and the Lehman Brothers bankruptcy on Japanese financial institutions were not as severe as on American financial institutions. However, the credit crunch and the rapid appreciation of the Japanese yen resulted in a severe impact on economic activity. In 2008, the Japanese straight corporate bond market experienced its first straight corporate bond default in seven years during this period of turmoil. For the period 2008-2010, eleven cases of straight corporate bond defaults caused a sharp increase in credit spreads, which is the difference in the yields between defaultable debt instruments and risk-free government securities of comparable maturity. Then the Bank of Japan's efforts to support market liquidity and the bank's policy-based financing to facilitate corporate financing calmed the turmoil in the market.

In contrast to the global financial crises, which were an external shock to the Japanese economy, the 2011 Great East Japan earthquake followed by the tsunami, which was unpredictable, caused huge capital stock losses and increased uncertainty about future macroeconomic fundamentals. This negative shock to the economy raised the credit spreads. In addition, the nuclear disaster that occurred at Tokyo Electric Power Co.'s (TEPCO's) Fukushima Daiichi Nuclear Power Plant on March 11, 2011, had a severe impact on TEPCO, which was Japan's largest corporate bond issuer at that time. The credit spreads for outstanding TEPCO corporate bonds jumped to about 400-500 basis points after the earthquake and tsunami, from just 8 basis points before the disaster.[1] The downgrading of electric power companies resulted in the widening of credit spreads in the market. That is, the credit spreads in Japan respond directly or indirectly to changes in economic fundamentals and monetary policy.

The credit cycle has been supposed to affect the business cycle at least since Fisher (1933), and asset prices are recognized as useful predictors of output growth because they are forward-looking (see Stock and Watson (2003) for the survey). Among a number of asset prices, including dividend yields, exchange rates, interest rates, stock returns and term spreads, which is the difference between the longest yield and the shortest maturity yield, the usefulness of credit spreads as predictors of economic activity has been shown empirically (see, e.g., Gilchrist et al. (2009), Gilchrist and Zakrajšek (2012), Faust et al. (2013), Mueller (2009)) and theoretically (for the general equilibrium framework, see Bernanke et al. (1999), Miao and Wang (2010)). Gilchrist and Zakrajšek

[1] Uranaka, T. (2011, May 2). Japan says no limits to Tepco liability from nuclear disaster. *Reuters*.

(2012) show that a reduction in the credit supply by a deterioration in the capital position of financial intermediaries caused an increase in the cost of debt financing (the widening of credit spreads) and a subsequent reduction in spending and production. In addition, Philippon (2009) documents that the predictive content of corporate bond credit spreads for economic activity could be more precise than the equity prices by showing that a market-based measure of q based on corporate bond prices outperforms the traditional one using equity prices. One possible explanation for this result is that the bond market is less susceptible to bubbles than the equity market as discussed by Philippon (2009) (see Shiller (2015) for financial market mispricing).

As Bernanke and Blinder (1992) demonstrate the channels of monetary transmission, the slope of the yield curve or the term spread is informative. In recessions, the central bank lowers yields on short-term bonds in order to stimulate the economy, while the yields on long-term bonds are higher reflecting the investor's unwillingness to take on risk in hard times. Thus, recessions have upward sloping yield curves that reflect the monetary policy. If the monetary policy is effective, recessions are followed by expansions; thus, upward sloping yield curves in recessions also predict better times tomorrow. On the other hand, during times of strong economic growth, monetary tightening raises short-term interest rates, which produces an economic slowdown with flattening yield curves. A number of works (e.g., Harvey (1989), Stock and Watson (1989), Dotsey (1998), Hamilton and Kim (2002)) show the predictive power of the term spread, in a sense, an indication of an effective monetary policy. On the other hand, Ang and Piazzesi (2003) and Ang et al. (2006) develop dynamic models for gross domestic product (GDP) growth and yields by shedding light on the behavior of the yield curve and find that the short-term rate has more predictive power for U.S. GDP growth than the term spread.

Few studies have shown the usefulness of credit spreads to predict future economic activity in Japan. Kobayashi (2015) estimates the credit spreads' global factors for Japan from 26 firm data based on Diebold et al. (2008) and confirms that they have significant predictive power for the macro economy. However, the study does not compare the predictive power of credit spread curve and the government bond yield curve or use any rating information. This could be critical, as the premium for external funds, which is the difference between the cost of obtaining external finance and the opportunity cost of internal finance, depends inversely on the financial strength of the borrowers, as suggested by Bernanke and Gertler (1989) and Bernanke et al. (1996) along the lines of the theory of the financial accelerator. Gertler and Lown (1999) use U.S. data on high-yield corporate bonds, whose market was developed in the mid-1980s, and show a strong inverse relationship between the high-yield spread and the output gap for the period 1985-1999. Similarly, Mody and Taylor (2004) test the predictive ability of the high yield spread for real economic activity and document that this was a significant predictor of economic activity during the 1990s.

The main contribution of this paper is to examine the predictive power of credit spreads for the business cycle in Japan for the period from June 2000 to September 2015 focusing on the term structure of the credit spread and taking the rating information into account. This could be a significant contribution to the existing literature investigating the predictive power of credit spreads on future economic activity such as Gilchrist et al. (2009) and Gilchrist and Zakrajšek (2012), as research showing the usefulness of credit spread curve information and its dependence on credit ratings is scarce. Our dynamic model for business activity incorporates short-term rates and the term spreads of Japanese government bonds and rated corporate bond spreads. To highlight the differences in the premium stemming from the financial health of the borrowers, we provide evidence using the yields/rating matrix of corporate bonds traded over-the-counter, which is calculated by the Japan Securities Dealers Association (hereafter JSDA).

Our findings can be summarized as follows. First, our in-sample analysis confirms the usefulness of credit spread curve information for predicting the business cycle in Japan. Our benchmark model using government bond yield curve information shows that the short-term rate is significantly useful, despite the extremely low short-term rate over the last 15 years in Japan. This result is consistent with that of Ang et al. (2006) using U.S. data. In addition, the estimation results of extended models to contain the information in the term structure of credit spreads indicate a measureable improvement in predictability, and that the predictability depends on the issuers' financial strength. Credit spread curve information in corporate bonds with low credit risk does not increase the predictive power for the business cycle, because issuers with a low credit risk do not face high agency costs associated with lending, and these corporate bonds in Japan are qualitatively similar to government bonds. In contrast, the estimation results using the term structure of A- and BBB-rated credit spreads that have a relatively higher credit risk in Japan show a measureable increase in forecasting for the business cycle. Furthermore, we investigate whether the combined information from different rating classes can further improve predictability. The results suggest that the combination of the 1-year credit spreads for the BBB rating and the term spread of A-rated credit spreads has the best predictability for the business cycle in Japan.

To evaluate model performance, we compare models using the out-of-sample as well. The results based on the out-of-sample are also clear-cut that the credit spread curves of A and BBB ratings are more useful although the government bond yield can be helpful for predicting the business cycle. In addition, combining useful information from different rating classes can produce the most predictive power for future economic growth.

One concern regarding our results is that the sign of the BBB-rated credit spread is positive, contradicting the theoretical prediction in the existing literature. Thus, we introduce the Markov-switching framework in the predictive regression model to explore the possibility that a regime with this unusual relationship affects the estimation results. By taking into account Markov switching, we show different effects, in particular the relation between the BBB-rated corporate bond spread and the business cycle, during the global financial crisis period. Thus, our results indicate that two distinct regimes exist: one for the usual period and another for the global financial crisis regime. In addition, we demonstrate that the 1-year government bond yield and the term spread of A-rated credit spread information are useful for predicting the business cycle in Japan regardless of the economic state.

These findings contribute to the debate on the predictive ability of government short-rate and credit spreads, such as Ang et al. (2006), who document that the government short-term rate has more predictive power than any term spreads of government bond yields for the U.S. economy, and Gilchrist and Zakrajšek (2012), who demonstrate the considerable predictive power of their original credit spread index. Although many previous studies found a link between the term spread and the business cycle using yield data for the US and for EU countries, our results do not show a significant predictive relation. One interpretation of our results is that aggressive monetary easing in Japan loses the predictive power of the term spread over the short-term rate because the long-term interest rate movement is limited under the control of the monetary authorities. In this scenario, the information content of the medium-graded credit spread curve could be more important for predicting the future economy.

The remainder of the paper is organized as follows. The next section of the paper describes our data set and offers a brief argument about the effect of the Great East Japan earthquake on the Japanese corporate bond market. Section III explains the econometric models and describes empirical results obtained from the in-sample analysis and the out-of-sample analysis. Section IV introduces the Markov-switching framework to the predictive regression model. Section V provides our conclusions.

II Data

To highlight the differences in the financial health of the issuer, we use data on yields/rating matrix of corporate bonds traded over-the-counter that is calculated by the JSDA. The JSDA publishes the arithmetic average value daily for each rating class (AAA, AA, A, BBB, BB, and B) and maturity of 1 to 20 years, which covers yen-denominated corporate bonds publicly issued in the Japanese corporate market and excludes corporate bonds with share options, such as convertible bonds and bonds with warrants. For the calculation of the yield, the sample is limited to corporate bonds with a fixed coupon schedule and bullet bonds. As Gilchrist and Zakrajšek (2012) limit their sample to issues with a fixed coupon schedule, these selection criteria ensure the yields of the corporate bonds in this data set are comparable. Data on month-end yields of corporate bonds published by the JSDA for each rating class and term to maturity and that of comparable-maturity government bonds were drawn from Thomson Reuters Eikon. In terms of the issuer's financial health, we use the rating by Rating and Investment Information (hereafter R&I) due to its wide coverage of ratings for Japanese firms.

To calculate the credit spreads of corporate bonds for each rating class and term to maturity, we match the yields of the corporate bond y_{kt}, where k is the individual rating from AAA through B, and t is the number of years to maturity from 1 through 20 years, and that of a risk-free government bond with the same maturity, y_t^f. Then the credit spread, $cs_{kt} = y_{kt} - y_t^f$, is the excess bond premium. We calculated month-end credit spreads from June 2000 through September 2015. The starting point of June 2000 was determined by the availability of JSDA data on yields for the corporate bonds issued by Japanese firms listed in Thomson Reuter Eikon. As the number of observations for the yields of corporate bonds with AAA and BB ratings is small, we dropped the credit spreads of corporate bonds with AAA and BB ratings from our data set.

For the June 2000 to September 2015 period, the events that followed the nuclear disaster that occurred at Tokyo Electric Power Co.'s (TEPCO's) Fukushima Daiichi Nuclear Power Plant on March 11, 2011, had a severe impact on TEPCO, which was Japan's largest corporate bond issuer, and the value of the outstanding TEPCO corporate bonds totaled about 5 trillion yen ($ 60.9 billion) when the disaster occurred (The Nikkei, April 21, 2011). Since the JSDA data for each rating class are the arithmetic average, outstanding TEPCO corporate bonds influenced them decisively, in particular the yield for the rating class to which TEPCO belongs. For example, TEPCO's corporate bonds were rated AA+ by R&I when the Great East Japan earthquake occurred on March 11, 2011. At that time, the JSDA's weekly AA-rated yield for 1 year to maturity closed at 0.286 (%). The great uncertainty of their future costs regarding the nuclear disaster led to a series of downgrades of TEPCO's long-term credit rating. R&I lowered TEPCO's corporate bonds rating from AA+ to AA$^-$ on March 25, 2011, and then the weekly AA-rated closing yield for 1 year to maturity was up to 0.518 by the time TEPCO's corporate bonds were downgraded to A on April 7, 2011. Although the weekly A-rated closing yield for 1 year to maturity was 0.436 before TEPCO's credit rating was downgraded to A, the closing yield rose to 0.698 when TEPCO's corporate bonds were downgraded to A. When R&I lowered TEPCO's credit rating from A to BBB on October 7, 2011, the weekly BBB-rated closing yield for 1 year rose to 2.889 from 1.247 in the following week of the downgrade. The yield for the rating class to which TEPCO's corporate bonds belong was affected significantly.

To mitigate this effect, the data on the credit spread after January 2011 were drawn from Thomson Reuters Bond Credit Curve (hereafter TRBCC) where smoothing basis splines are used to derive the curves for Japanese corporate bonds that start August 2010. The sample is also limited to corporate bonds with a fixed coupon schedule and bullet bonds with a remaining term to maturity of more than 1 year, and the credit spread is calculated using comparable-maturity government bonds. Callable bonds are not included in the data drawn from the JSDA and TRBCC.[2] The credit spread from the JSDA tends to be higher in comparison with that of TRBCC across ratings, especially for bonds with a BBB rating. We calculated the differences between these two datasets and adjusted the data after January 2011 by using the average of these differences.[3] The following modified credit spreads are used after January 2011

$$cs_{kt}^{modified} = cs_{kt}^{TRBCC} + cs_{kt}^{JSDA} \times \frac{1}{n} \sum \frac{cs_{kt}^{JSDA} - cs_{kt}^{TRBCC}}{cs_{kt}^{JSDA}}$$

where cs_{kt}^{TRBCC} is the credit spread for the corporate bond y_{kt} drawn from TRBCC, cs_{kt}^{JSDA} is the one drawn from JSDA, and n is the number of time-series observations.

The literature exploring the predictive ability for economic activity practically measure the output growth by GDP growth rates; however, GDP is not available on a monthly frequency. Thus, we refer to the growth rate of the Coincident index (CI), which is an index of Business Conditions published monthly by the Cabinet Office, the government of Japan, as the output growth in this paper.

[Figure 1 around here]

[Figure 2 around here]

Figure 1 plots the monthly CI together with the credit spreads for the AA, A, and BBB rating classes. The shaded vertical bars represent recession periods as defined by the Cabinet Office, the government of Japan. Figure 1 illustrates that the absence of the high-yield bonds market that can be seen in the US makes BBB-rated corporate bond spreads reflect changes in the default risk markedly.[4] In particular, the BBB-rated credit spreads were obviously widening during the

[2]Duffee (1998) pointed out that spreads based on indexes constructed using callable and noncallable bonds are inversely related to Treasury yields, and Gilchrist and Zakrajšek (2012) also imply that the shape of the Treasury term structure and interest rate volatility have economically significant effects on the credit spreads of callable bonds.

[3]Estimation results of same equations using three different data from (i) only JSDA (ii) JSDA and unadjusted TRBCC, and (iii) JSDA and adjusted TRBCC are qualitatively similar with no substantial difference.

[4]There are corporate bonds rated below investment grade in the Japanese secondary market, which were originally issued with ratings in the investment-grade category. As the number of such corporate bonds is not large enough to calculate the credit spread curve, we do not use this information.

period from the late 2008 to late 2011, which coincides with the global financial crisis period after the Lehman Brothers bankruptcy. The CI also markedly lowered after the Lehman Brothers bankruptcy in September 2008. Figure 2 plots the monthly CI together with the government bond yield and the average credit spreads for all rating classes (AA, A, and BBB ratings). As can be seen in the figure, the government bond yield has been in a downward trend since 2008. Due to the aggressive monetary easing by the Bank of Japan, the government bond yield has been very low since the global financial crisis. These plots are simple illustrations using average credit spread information and government bond yield information; thus, we explore their ability to predict the business cycle further in the following sections.

III Term structure of credit spreads and business cycle

A. In-sample predictive regression analysis

This paper examines whether the term structure of credit spreads is useful for predicting the business cycle in Japan. To this end, we conduct an in-sample predictive regression analysis in this subsection.

Our benchmark model (Model 1) is a predictive regression model regressing the CI growth rate on government bond yield curve information. More specifically, it is given as follows:

$$\Delta^h ci_{t+h} = \alpha + \beta_1 gsr_t + \beta_2 gts_t + \phi \Delta ci_t + \varepsilon_t \tag{1}$$

where ci is the CI, $\Delta^h ci_{t+h} = \frac{100}{h} \ln(ci_{t+h}/ci_t)$, $h = 1, 3, 6$, or 12 is the forecast horizon, gsr is the government short-term rate defined by the 1-year government bond yield, and gts is the term spread of the government yield curve defined by the difference between the 5-year and 1-year government bond yields.

We estimate Model 1 with ordinary least squares (OLS) and calculate the p-value of each coefficient based on the Hodrick (1992) standard errors to correct for the moving average error terms. The estimate of each coefficient and its p-value are summarized in Table 1. The results indicate that the short-term rate is significantly negative, at least the 5% significance level for all horizons. Specifically, the results suggest that if the short-term rate increases 1 basis point, the CI annualized growth rate would decrease 0.16% over the next month and 0.20% over the subsequent 3 months, etc. The results are also economically significant and quite reasonable, given the extremely low short-term rate over the last 15 years in Japan. In contrast, the term spread of government bond yields is significant only for the 1-month horizon. These results are fairly consistent with those of Ang et al. (2006), who document that the short-term rate has more predictive power than any term spread for the U.S. economy. Overall, Table 1 demonstrates the modest predictive power of the government bond yield curve on the Japanese business cycle with R^2 ranging from 0.18 for the 1-month horizon to 0.33 for the 1-year horizon.

[Table 1 around here]

To examine whether the term structure of credit spreads is useful for predicting the business cycle in Japan, we extend the benchmark model (1) to contain the information in the term structure of credit spreads as follows:

$$\Delta^h ci_{t+h} = \alpha + \beta_1 gsr_t + \beta_2 gts_t + \gamma_1 scs_t + \gamma_2 cts_t + \phi \Delta ci_t + \varepsilon_t \quad (2)$$

where scs is the credit spread of 1-year corporate bonds, and cts is the term spread of credit spreads defined by the difference between 5-year and 1-year credit spreads.

We call the extended model (2) that use the credit spreads of AA-, A-, or BBB-rated corporate bonds Models 2 to 4. The estimation results for Models 2 to 4 are reported in Tables 2-4. As can be seen in Table 2, the p-values of γ_1 and γ_2 are greater than 10% for all horizons, meaning that the credit spread curve of the AA ratings has no additional information on the future economic growth compared with the government bond yield curve. As a consequence, the Table 2 results are essentially the same as those of Table 1. The government short-term rate is significantly negative for all horizons, and the government term spread is significant only for short-run horizons with very similar estimates of β_1 and β_2. This is most likely because the corporate bonds of AA ratings in Japan are qualitatively very similar to government bonds with extremely low credit risk. Therefore, including the credit spread curve information in AA-rated corporate bonds cannot improve the forecasting for the business cycle in Japan.

[Table 2 around here]

In contrast, as can be seen in Table 3, the results using the term structure of A-rated credit spreads indicate a noticeable improvement in predictability. Specifically, the 1-year credit spread and the term spread of the credit spreads are significantly positive at the 5% significance level for all horizons with a sizable increase in R^2 ranging from 0.26 for the 1-month horizon to 0.42 for the 1-year horizon. However, there is one concern regarding the estimation results: the positive estimates of γ_1. This implies that the widening credit spread predicts future economic growth, contradicting the theoretical prediction, as well as the empirical evidence reported by, among others, Gilchrist and Zakrajšek (2012). We seek a possible explanation for these positive estimates of γ_1 by introducing the Markov-switching framework to the extended predictive regression model (2) in the following section.

[Table 3 around here]

Similarly, the results based on the BBB credit spreads shown in Table 4 suggest that the term structure of BBB-rated credit spreads also contains useful information for predicting the business cycle in Japan. The 1-year credit spread is significantly positive for all horizons except the 6-month horizon, although the term spread of the BBB-rated credit spread is not significant for any horizon. In addition, the values of R^2 indicate a solid improvement compared with Model 1, in particular at a longer horizon.

[Table 4 around here]

The results thus far clearly demonstrate that the term structure of credit spreads for either A- or BBB-rated corporate bonds can be used to better predict the business cycle in Japan. One remaining interesting question is whether we can further improve the predictability by combining the credit spread curve information in A- and BBB-rated corporate bond spreads. More specifically, it is worth investigating whether we can obtain a better forecast of future economic growth using the 1-year credit spreads of A and BBB ratings, as well as the term spread of A-rated corporate bonds, as the term spread of the BBB rating is not significant. However, including the 1-year credit spreads of A and BBB ratings in the extended model (2) causes the possible multi-collinearity problem with a relatively high correlation of 0.71 between the two variables. Therefore, we estimate the extended model (2) with the 1-year credit spreads of the BBB rating and the term spread of the A-rated credit spread (Model 5) to see whether the combined information from different rating classes can be helpful for improving predictability.

The results summarized in Table 5 demonstrate that actually this is the case. The 1-year credit spread of the BBB rating is significantly positive for all horizons, while the term spread of the A-rated credit spreads is significantly positive for at least the 10% significance level for all horizons except the 1-year horizon. In addition, once we include these two variables, the term spread for government bonds becomes significantly positive for at least the 10% significance level for all horizons except the 1-year horizon. As a consequence, R^2 of Model 5 is the highest among the five models for all horizons, suggesting that the combination of the 1-year credit spreads of the BBB rating and the term spread of the A-rated credit spreads has the best predictability for the business cycle in Japan.

[Table 5 around here]

In sum, our in-sample analysis strongly indicates that the credit spread curve of medium-grade corporate bonds with A or BBB ratings has more useful information than the government bond yield curve for predicting the business cycle in Japan. Additionally, our results demonstrate that combining the information from the different grade credit spread curves can further increase the predictive power for the future economy. However, our results thus far are all based on an in-sample analysis. To evaluate the performance of the predictive regression models such as those of this paper, it is also important to compare the models using an out-of-sample analysis, which we do in the following subsection.

B. Out-of-sample predictive regression analysis

In this subsection, we compare the five models using out-of-sample analysis to confirm our finding of the usefulness of credit spread curve information for predicting the business cycle in Japan even for the out-of-sample.

To compare the models based on the out-of-sample, we conduct an out-of-sample forecast evaluation using a 7-year rolling window as follows.[5] First, we estimate Models 1-5 using data from July 2000 to June 2007 and evaluate the terminal 1-month-ahead forecast error based on the estimation results. The data are then updated by 1 month, and the terminal 1-month-ahead forecast error is re-calculated from the updated sample (specifically, from August 2000 to July 2007). This procedure is repeated until reaching 1 month before the end of the sample period, namely, September 2015. Finally, we calculate the root-mean-squared forecast error (RMSE) using the time series of 1-month-ahead forecast errors. We also calculate the RMSE based on the random walk model as a reference and evaluate the RMSE ratios of all models to the random walk model.

Table 6 reports the results of the RMSE ratios for Models 1-5. If the ratio is smaller than 1, the out-of-sample forecast performance is better than the random walk model, and the smaller the ratio, the better the model. The table indicates similar results to those for the in-sample analysis. First, the government bond yield curve contains useful information for forecasting the business cycle with RMSE ratios less than 1 for all horizons. Second, the RMSE ratios of either Model 3 or 4 are generally smaller than those of the RMSE ratios of Model 1, meaning that the credit spread curve of A- or BBB-rated corporate bonds information has more information on future economic growth than the government bond yield curve. Third, and most importantly, the RMSE ratios of Model 5 are the smallest among the five models for all horizons, suggesting Model 5 has the best out-of-sample forecast performance.

[Table 6 around here]

[5]The results of the out-of-sample forecast evaluation are qualitatively similar even if we use a 6- or 8-year rolling window: Model 1 is never the best model, and Model 5 is the best model for most of the cases.

Overall, our results are clear-cut: Although the government bond yield can be helpful for predicting the business cycle, the credit spread curves of A and BBB ratings are more useful. In addition, combining credit spread curve information from different ratings, namely, the 1-year credit spreads of the BBB rating and the term spread of A-rated credit spreads, can produce the best predictive power for future economic growth. However, our results suggest that a larger credit spread predicts higher economic growth, contradicting the theoretical prediction as well as empirical evidence reported by, among others, Gilchrist and Zakrajšek (2012). We seek a possible explanation for this result by introducing the Markov-switching framework in the predictive regression model (2) in the following section.

IV Markov-switching analysis

The results of the previous section demonstrated the predictive power of the term structure of the credit spreads for the business cycle in Japan. However, our results showed a positive relationship between the 1-year BBB-rated credit spread and future economic growth, which is not straightforward to interpret. One possible explanation could be that there is a regime with this unusual possible relationship that affects the estimation results.

To explore this possibility, we introduce Markov-switching (MS) into the extended predictive regression model (2) as follows:

$$\Delta^h ci_{t+h} = \alpha(s_t) + \beta_1(s_t)gsr_t + \beta_2(s_t)gts_t + \gamma_1(s_t)scs_t + \gamma_2(s_t)cts_t + \phi(s_t)\Delta ci_t + \varepsilon_t. \quad (3)$$

Here s_t is a latent variable that describes a state or regime at time t and takes a value of either 1 or 2. Moreover, we assume that the variance of ε_t depends on the regime, although the mean is regime-invariant of 0.

The model also requires specifying a stochastic process for s_t, which governs the behavior of the state. Following the pioneering work of Hamilton (1989), we assume that s_t follows a two-state Markov chain with transition probability $\mathbf{P}$ of the form

$$\mathbf{P} = \begin{pmatrix} p_{11} & 1-p_{22} \\ 1-p_{11} & p_{22} \end{pmatrix}.$$

The Markov chain is a simple model that describes the dynamics of a discrete random variable, assuming that transition probabilities depend only on the current state, but still realistic to describe economic behavior, since the current economic state is typically the most important factor in determining the next period's economic state.

We estimate the MS predictive regression model (3) via quasi-maximum likelihood (QML) estimation.[6] Figure 3 shows the smoothed probability of the state being regime 1 for each horizon. As can be seen, for horizons of $h = 1, 3$, and 6, the regime has been in regime 1 most of the time except one period from late 2008 to late 2011. This period almost coincides with the global financial crisis period after the Lehman Brothers bankruptcy in September 2008. For the 1-year horizon, the Regime 2 period is longer than for other horizons ranging from the beginning of 2007 to the middle of 2012, but the main period is still the global financial crisis period. Thus, our smoothed probability estimates strongly suggest different relationships between economic growth and the government yield curve and/or the credit spread curves.

[Figure 3 around here]

The estimation results for the Markov-switching models (3) shown in Table 7 indicate the different effect of government bonds and corporate credit spread on the business cycle during the recent financial crisis, in particular the relation between the BBB-rated corporate bond spread and the business cycle. As shown in the results, the short-term government bond yield has a significantly negative effect on the business cycle for both regimes and all horizons except the 1-month horizon of regime 2. Similarly, the term spread of the A-rated corporate bond spread has a significantly positive effect on future economic growth for both regimes and all horizons. In contrast, the term spread of government bonds is significantly positive only for the longer horizons of regime 2. More importantly, the BBB-rated corporate bond spread contains significant explanatory power for the future business cycle only during the recent financial crisis period (regime 2), suggesting that the positive relationship between the 1-year BBB-rated credit spread and future economic growth exists only in the global financial crisis period between 2008 and 2010.

[Table 7 around here]

In the recent 2008-2010 financial crisis that led to the global recession, the Japanese economy was hit by intensive flight-to-quality behavior by international investors with the rapid appreciation of the Japanese yen. As a consequence, although Japanese banks had little exposure to the U.S. subprime crisis compared to banks in the United States and Europe, the Japanese economy experienced a sharp decline in stock prices due to the sizable capital outflow and appreciation in the yen that deteriorated the performance of export companies. Furthermore, although Japanese

[6] QML estimators are consistent under the ergodic stationarity, which is the most likely case for this paper. However, calculating robust standard errors of the QML estimators for the Markov-switching regression model and developing asymptotic normality are still underdeveloped, to the best of our knowledge. Therefore, we calculate the standard errors using the ML formula and assume the asymptotic normality to calculate the p values.

banks did not experience a direct financial impact of the financial crisis and no major Japanese bank collapsed, sagging global demand and the decline in stock prices made Japanese banks curb loans as the financial crisis was progressing.

As a product of the credit crunch caused by the global financial crisis, the Japanese corporate bond market experienced defaults in 2008 for the first time in 7 years, which were then followed by a series of defaults over the next few years, including the first default in the REITs sector. The Bank of Japan launched a scheme to purchase corporate bonds to improve the cash position in March 2009, but the target at that time was only corporate bonds with a maturity of up to 1 year and a credit rating above A. As a result, the decrease in new issues of A-rated corporate bonds and the Bank of Japan's purchase of corporate bonds increased the demand for A-rated corporate bonds.

The positive sign of the BBB-rated corporate bond spread in regime 2 reflects this turmoil in the Japanese corporate bond market where the credit spreads jumped during the financial crisis period, especially for BBB-rated corporate bonds. As Japanese banks did not suffer a direct financial impact from the financial crisis, the lagged impact of the sluggish economy on the relation between the BBB-rated corporate bond spread and the business cycle is a special case only during the financial crisis period (regime 2).

In sum, our Markov-switching analysis demonstrates that two distinct regimes exist: one for the usual period (regime 1) and another for the global financial crisis regime (regime 2). Our results indicate that our finding of a positive relationship between the 1-year BBB-rated credit spread and future economic growth is a peculiar phenomenon observed only in regime 2. In contrast, there seems to be no significant relation between the two variables in regime 1. Our results also suggest that the 1-year government bond yield and the term spread of the A-rated credit spread have useful information for predicting the business cycle in Japan regardless of the economic state. These findings provide important new evidence for the predictive ability of the credit spread curve in previous studies such as Ang et al. (2006), who document that the government short-term rate has more predictive power than any term spreads of government bond yields for the U.S. economy, and Gilchrist and Zakrajšek (2012), who demonstrate that their constructed credit spread index has significant predictive power for future economic activity.

Although many previous studies found a link between the term spread and the business cycle using yield data from the US and from EU countries, our results do not find a significant predictive relation between them but find one between the term spread of the A-rated credit spread and the business cycle in Japan. One possible interpretation of our results is that the aggressive monetary easing in Japan loses the predictive power of the term spread over the short-term rate because the long-term interest rate movement is limited under the control of the monetary authorities. In this scenario, the information content of the medium-graded credit spread curve could be more important for predicting the future economy.

V Conclusion

This paper examines the predictive power of credit spreads for the business cycle in Japan for the period from June 2000 to September 2015 focusing on the term structure of the credit spread by taking the rating information into account. The estimation results shown in this paper are clear-cut that the credit spread curve information for A- and BBB-rated corporate bonds are more useful for predicting the business cycle in Japan although the government bond yield can be helpful. In spite of the extremely low short-term rate over the last 15 years in Japan, government bond yield curve information is still useful for predicting the business cycle. The credit spreads for issuers with low default risk, here AA-rated credit spreads, appear to have little additional information content for predicting the business cycle, which is most likely because they are qualitatively similar to government bonds.

By introducing the Markov-switching framework to the extended predictive regression model, the results show that two distinct regimes exist: one for the usual period and another for the global financial crisis regime. It helps to explain the relation between the BBB-rated credit spread and the business cycle in conflict with the theoretical prediction. Because the Japanese financial sector was not directly damaged severely by the global financial crisis, with little exposure to the U.S. subprime crisis, no major Japanese bank collapsed. Japanese financial institutions could afford to acquire U.S. investment banks even right after the collapse of Lehman Brothers, for example, Nomura's acquisition of Lehman Brothers' Asian business and European business and Mitsubishi UFJ's 21 percent ownership of Morgan Stanley. However, intensive flight-to-quality behavior by international investors with the rapid appreciation of the yen hit the Japanese economy, and then the lagged impact of the sluggish economy appeared to widen the BBB-rated credit spread after the Lehman Brothers collapse, which causes the relation with BBB-rated credit spreads and the business cycle to be incompatible with the theoretical prediction as in the theory of the financial accelerator. Markov-switching analysis allows us to isolate this different relation and to show the 1-year government bond yield and the term spread of A-rated credit spread information are useful for predicting the business cycle regardless of the economic state.

Consistent with previous studies that document the short-term rate dominates the slope of the yield curve to forecast output growth, our estimation results propose that combining useful information in credit spreads for different rating classes contributes to predicting the business cycle. In particular, the credit spread curve information in corporate bonds can improve the predictability compared with the model that uses only government bond yield curve information. Although numerous previous studies have found a predictive relation between the term spread and the business cycle using yield data from the US and EU countries, our results indicate that the term spread of the Japanese government bonds yield curve does not have significant predictive power. It can be interpreted that the aggressive monetary easing in Japan loses the predictive power of the term spread over the short-term rate because the long-term interest rate movement is limited under the control of the monetary authorities. On the other hand, the credit spread curve contains more information for future economic growth. Our results imply that if the government bond yield curve is getting flatter due to aggressive monetary easing, the information content of medium-graded credit spread curve could be more useful for predicting the business cycle.

References

Ang, A. and M. Piazzesi (2003). A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables. *Journal of Monetary Economics 50*(4), 745—787.

Ang, A., M. Piazzesi, and M. Wei (2006). What does the yield curve tell us about GDP growth? *Journal of Econometrics 131*, 359–403.

Bernanke, B. and M. Gertler (1989). Agency costs, net worth, and business fluctuations. *American Economic Review 79*(1), 14–31.

Bernanke, B. S. and A. S. Blinder (1992). The federal funds rate and the channels of monetary transmission. *American Economic Review 82*(4), 901–921.

Bernanke, B. S., M. Gertler, and S. Gilchrist (1996). The financial accelerator and the flight to quality. *Review of Economics and Statistics 78*(1), 1–15.

Bernanke, B. S., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework. In J. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*, Volume 1, Chapter 21, pp. 1341–1393. Amsterdam: Elsevier Science, North-Holland.

Diebold, F. X., C. Li, and V. Z. Yue (2008). Global yield curve dynamics and interactions: A dynamic Nelson-Siegel approach. *Journal of Econometrics 146*, 351–363.

Dotsey, M. (1998). The predictive content of the interest rate term spread for future economic growth. *Federal Reserve Bank of Richmond Economic Quarterly 84*(3), 31–51.

Duffee, G. R. (1998). The relation between treasury yields and corporate bond yield spreads. *Journal of Finance 53*(6), 2225–2241.

Faust, J., S. Gilchrist, J. H. Wright, and E. Zakrajšek (2013). Credit spreads as predictors of real-time economic activity: A Bayesian model-averaging approach. *Review of Economics and Statistics 95*(5), 1501—1519.

Fisher, I. (1933). The debt-deflation theory of Great Depressions. *Econometrica 1*(4), 337–357.

Gertler, M. and C. S. Lown (1999). The information in the high-yield bond spread for the business cycle: Evidence and some implications. *Oxford Review of Economic Policy 15*(3), 132—150.

Gilchrist, S., V. Yankov, and E. Zakrajšek (2009). Credit market shocks and economic fluctuations: Evidence from corporate bond and stock markets. *Journal of Monetary Economics 56*(4), 471—493.

Gilchrist, S. and E. Zakrajšek (2012). Credit spreads and business cycle fluctuations. *American Economic Review 102*(4), 1692—1720.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica 57*(2), 357–384.

Hamilton, J. D. and D. H. Kim (2002). A reexamination of the predictability of economic activity using the yield spread. *Journal of Money, Credit, and Banking 34*(2), 340–360.

Harvey, C. R. (1989). Forecasts of economic growth from the bond and stock market. *Financial Analysts Journal 45*, 38—45.

Hodrick, R. J. (1992). Dividend yields and expected stock returns: Alternative procedures for inference and measurement. *Review of Financial Studies 5*(3), 357—386.

Kobayashi, T. (2015). Term structure of credit spreads and the macroeconomy in Japan: A global factor approach. *Procedia Economics and Finance 30*, 417–429.

Miao, J. and P. Wang (2010). Credit risk and business cycles. Working Papers Series WP2010-033, Boston University.

Mody, A. and M. P. Taylor (2004). Financial predictors of real activity and the financial accelerator. *Economics Letters 82*, 167—172.

Mueller, P. (2009). Credit spreads and real activity. EFA 2008 Athens Meetings Paper.

Philippon, T. (2009). The bond market's q. *Quarterly Journal of Economics 124*(3), 1011–1056.

Shiller, R. J. (2015). *Irrational Exuberance* (3 ed.). Princeton, NJ: Princeton University Press.

Stock, J. H. and M. W. Watson (1989). New indexes of coincident and leading economic indicators. In O. J. Blanchard and S. Fischer (Eds.), *NBER Macroeconomics Annual*, Volume 4, pp. 351–409. Cambridge: The MIT Press.

Stock, J. H. and M. W. Watson (2003). Forecasting output and inflation: The role of asset prices. *Journal of Economic Literature 41*(3), 788—829.

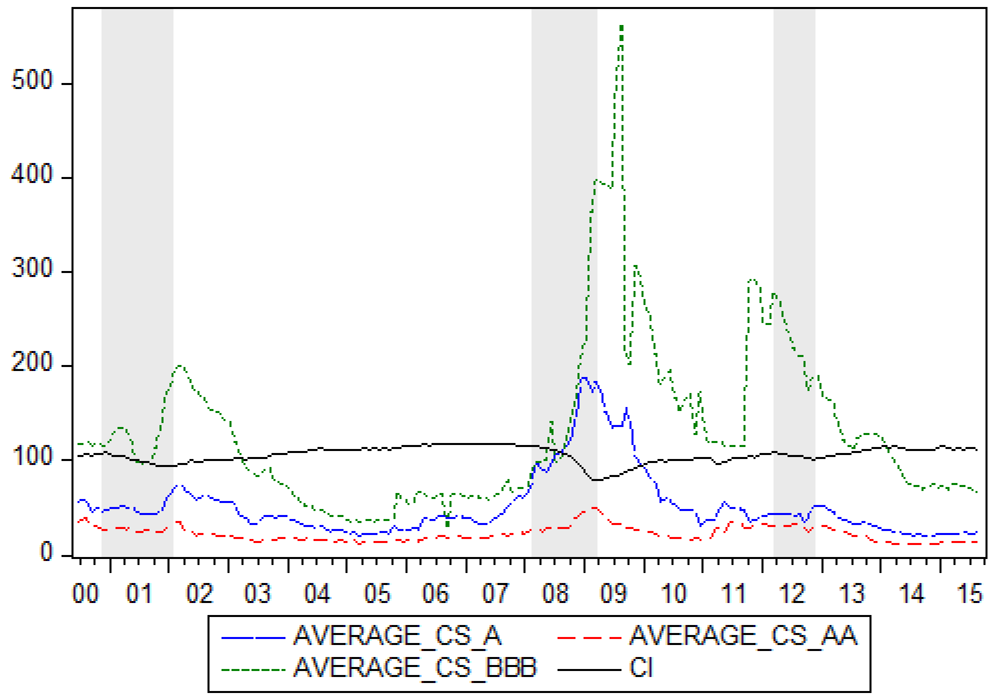

Figure 1: Credit spreads for each rating class and coincident index (CI)

Notes: Sample period: 2000:6-2015:9. The figure plots monthly Coincident index (CI) together with the credit spreads for AA, A, and BBB ratings. The shaded vertical bars represent recession periods as defined by the Cabinet Office, the government of Japan.

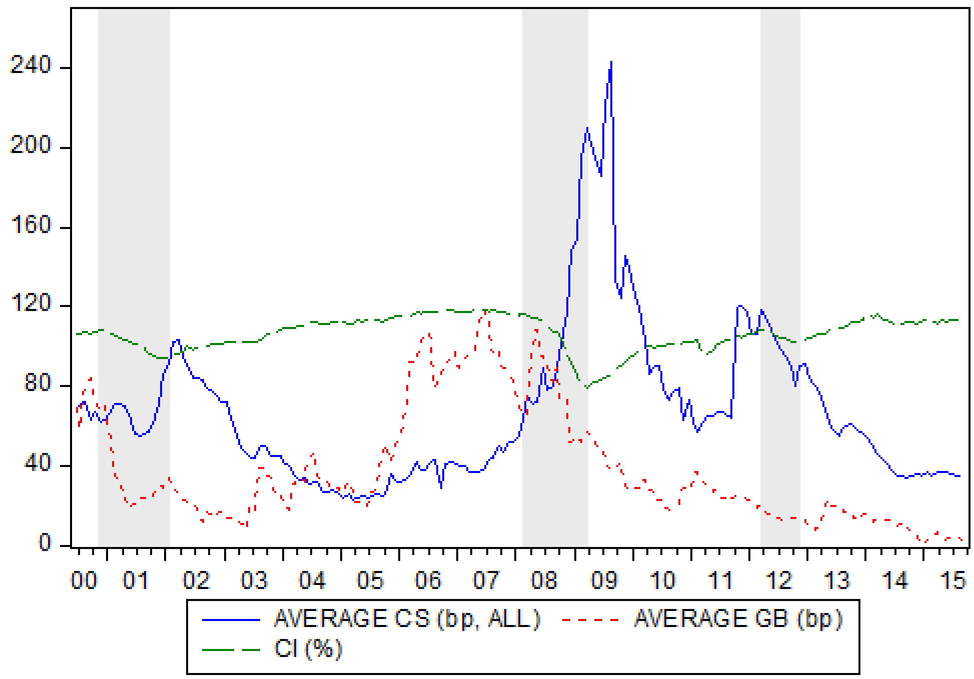

Figure 2: Average credit spreads, government bond yield, and coincident index (CI)
Notes: Sample period: 2000:6-2015:9. The figure plots monthly Coincident index (CI) together with the government bond yield and the average credit spreads for all rating classes (AA, A, and BBB ratings). The shaded vertical bars represent recession periods as defined by the Cabinet Office, the government of Japan.

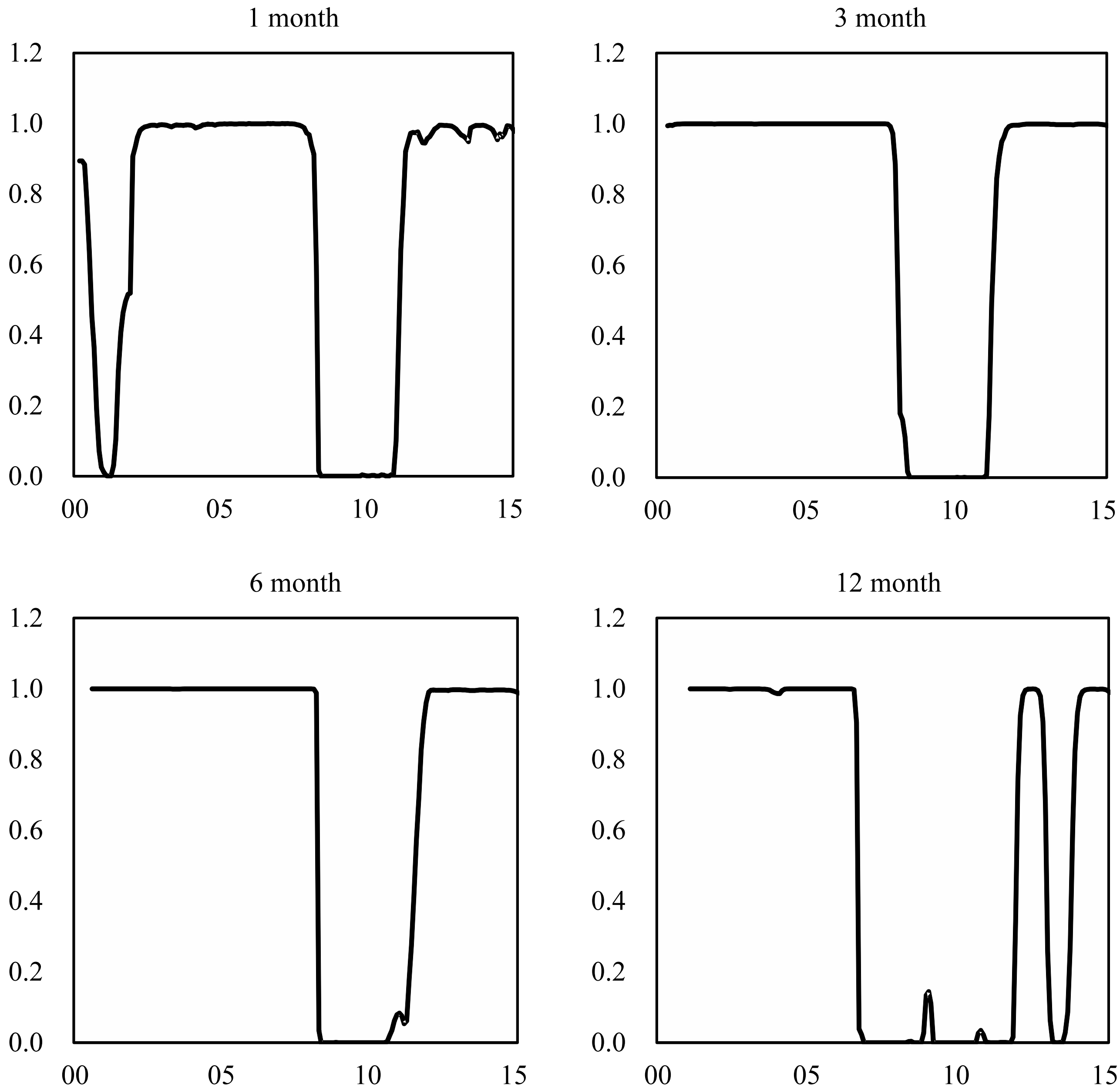

Figure 3: Smoothed probability of Regime 1

Notes: The figures plot the smoothed probability of being in Regime 1 for each horizon (1, 3, 6, and 12 month).

Table 1: Forecasts of output growth from the government bond yield curve

Horizon		α	β_1	β_2	ϕ	Adj. R^2
1	Est.	0.040	-0.013	0.006	0.369	0.184
	P-val.	0.639	0.000	0.001	0.032	
3	Est.	0.105	-0.017	0.006	0.308	0.278
	P-val.	0.512	0.038	0.124	0.005	
6	Est.	0.206	-0.021	0.005	0.173	0.276
	P-val.	0.214	0.071	0.246	0.000	
12	Est.	0.353	-0.022	0.003	-0.004	0.333
	P-val.	0.030	0.005	0.492	0.906	

$Notes$: The table reports the estimated coefficients, p-value, and adjusted R^2 for the equation (1). Horizon refers to the forecast horizon h, and the p-value of each coefficient is calculated using Hodrick (1992) standard errors.

Table 2: Forecasts of output growth from the government bond yield curve and AA-rated credit spread curve

Horizon		α	β_1	β_2	γ_1	γ_2	ϕ	Adj. R^2
1	Est.	0.094	-0.013	0.005	-0.008	0.018	0.353	0.179
	P-val.	0.757	0.000	0.014	0.710	0.145	0.020	
3	Est.	-0.113	-0.017	0.007	0.009	0.008	0.317	0.273
	P-val.	0.714	0.031	0.083	0.637	0.699	0.003	
6	Est.	-0.240	-0.022	0.007	0.019	0.012	0.195	0.287
	P-val.	0.561	0.075	0.189	0.415	0.629	0.002	
12	Est.	-0.192	-0.023	0.005	0.021	0.016	0.019	0.364
	P-val.	0.686	0.008	0.366	0.387	0.278	0.617	

$Notes$: The table reports the estimated coefficients, p-value, and adjusted R^2 for the equation (2) using the AA-rated credit spread information as credit spread related variables: sct_t and cts_t. Horizon refers to the forecast horizon h, and the p-value of each coefficient is calculated using Hodrick (1992) standard errors.

Table 3: Forecasts of output growth from the government bond yield curve and A-rated credit spread curve

Horizon		α	β_1	β_2	γ_1	γ_2	ϕ	Adj. R^2
1	Est.	-0.910	-0.012	0.004	0.013	0.044	0.317	0.257
	P-val.	0.004	0.000	0.044	0.010	0.001	0.018	
3	Est.	-0.958	-0.017	0.004	0.015	0.044	0.271	0.393
	P-val.	0.052	0.011	0.170	0.017	0.035	0.005	
6	Est.	-0.758	-0.022	0.005	0.014	0.034	0.159	0.382
	P-val.	0.060	0.060	0.222	0.038	0.013	0.023	
12	Est.	-0.235	-0.024	0.004	0.010	0.013	0.014	0.420
	P-val.	0.278	0.008	0.358	0.029	0.000	0.565	

$Notes$: The table reports the estimated coefficients, p-value, and adjusted R^2 for the equation (2) using the A-rated credit spread information as credit spread related variables: sct_t and cts_t. Horizon refers to the forecast horizon h, and the p-value of each coefficient is calculated using Hodrick (1992) standard errors.

Table 4: Forecasts of output growth from the government bond yield curve and BBB-rated credit spread curve

Horizon		α	β_1	β_2	γ_1	γ_2	ϕ	Adj. R^2
1	Est.	-0.509	-0.013	0.009	0.003	0.002	0.346	0.198
	P-val.	0.019	0.001	0.000	0.011	0.103	0.056	
3	Est.	-0.392	-0.017	0.009	0.003	0.001	0.293	0.321
	P-val.	0.163	0.044	0.028	0.039	0.481	0.014	
6	Est.	-0.100	-0.021	0.007	0.002	-0.001	0.173	0.364
	P-val.	0.709	0.075	0.163	0.115	0.653	0.001	
12	Est.	-0.079	-0.022	0.006	0.002	0.000	-0.011	0.466
	P-val.	0.825	0.005	0.291	0.070	0.872	0.746	

$Notes$: The table reports the estimated coefficients, p-value, and adjusted R^2 for the equation (2) using the BBB-rated credit spread information as credit spread related variables: sct_t and cts_t. Horizon refers to the forecast horizon h, and the p-value of each coefficient is calculated using Hodrick (1992) standard errors.

Table 5: Forecasts of output growth from the government bond yield curve, BBB-rated 1 year credit spread, and term spread of A-rated credit spreads

Horizon		α	β_1	β_2	γ_1	γ_2	ϕ	Adj. R^2
1	Est.	-0.910	-0.008	0.006	0.004	0.036	0.261	0.303
	P-val.	0.002	0.001	0.006	0.000	0.009	0.038	
3	Est.	-0.835	-0.012	0.007	0.004	0.031	0.213	0.455
	P-val.	0.047	0.012	0.045	0.001	0.063	0.011	
6	Est.	-0.627	-0.017	0.007	0.004	0.022	0.103	0.457
	P-val.	0.033	0.058	0.085	0.000	0.070	0.196	
12	Est.	-0.139	-0.021	0.006	0.003	0.004	-0.023	0.473
	P-val.	0.528	0.006	0.204	0.000	0.414	0.256	

$Notes$: The table reports the estimated coefficients, p-value, and adjusted R^2 for the equation (2) using the BBB-rated 1 year credit spread as sct_t and the term spread of A-rated credit spreads as cts_t. Horizon refers to the forecast horizon h, and the p-value of each coefficient is calculated using Hodrick (1992) standard errors.

Table 6: Out-of-sample forecast evaluation

Horizon	Model 1	Model 2	Model 3	Model 4	Model 5
1	0.947	0.990	0.929	1.007	0.905
3	0.890	0.930	0.858	0.933	0.804
6	0.877	0.902	0.880	0.885	0.808
12	0.838	0.867	0.868	0.820	0.796

$Notes$: The table reports RMSE ratios to the random walk model. Horizon refers to the forecast horizon h. Out-of-sample forecast evaluation is conducted using 7-year rolling window from 2000:06 to 2007:06.

Table 7: Markov-switching models

Horizon			p	α	β_1	β_2	γ_1	γ_2	ϕ	LLH
1	Regime 1	Est.	0.984	-0.757	-0.010	0.007	0.001	0.051	-0.350	-278.80
		P-val.	0.000	0.004	0.008	0.115	0.567	0.000	0.000	
	Regime 2	Est.	0.950	0.094	-0.021	-0.016	0.005	0.029	0.513	
		P-val.	0.000	0.930	0.482	0.514	0.001	0.048	0.000	
3	Regime 1	Est.	0.994	-0.427	-0.006	0.002	0.000	0.034	0.072	-194.67
		P-val.	0.000	0.025	0.013	0.375	0.999	0.000	0.144	
	Regime 2	Est.	0.969	-0.359	-0.064	0.044	0.003	0.033	0.134	
		P-val.	0.000	0.642	0.000	0.132	0.007	0.001	0.149	
6	Regime 1	Est.	0.993	-0.255	-0.008	0.000	-0.001	0.035	0.045	-140.14
		P-val.	0.000	0.112	0.000	0.965	0.196	0.000	0.294	
	Regime 2	Est.	0.969	-0.452	-0.087	0.062	0.003	0.018	-0.081	
		P-val.	0.000	0.287	0.000	0.000	0.000	0.001	0.158	
12	Regime 1	Est.	0.980	0.095	-0.030	0.001	0.000	0.013	0.004	-93.488
		P-val.	0.000	0.462	0.000	0.353	0.738	0.017	0.881	
	Regime 2	Est.	0.965	0.051	-0.038	0.023	0.002	0.007	-0.086	
		P-val.	0.000	0.819	0.000	0.000	0.000	0.080	0.054	

$Notes$: The table reports the estimated coefficients for the equation (3) using the BBB-rated 1 year credit spread as sct_t and the term spread of A-rated credit spreads as cts_t, where LLH is the log-likelihood ratio, and the p is the transition probability of being in regime i ($i = 1, 2$). Regime 1 refers to the usual period, and regime 2 refers to the global financial crisis period.