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Global correlation among government bond markets and Japanese banks' market risk

Financial System and Bank Examination Department
Yoshiyuki Fukuda, Kei Imakubo, Shinichi Nishioka

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As international ties have been strengthened on the real economic front, global correlation has been higher in the government bond and other financial markets. Under the circumstances, Japanese banks' market risk associated with holdings of Japanese government bonds (JGBs) has been more susceptible to overseas shocks as well as domestic shocks. Once, for example, overseas government bond markets become volatile, JGB volatility is likely to rise through the market correlation and increase the amount of market risk for Japanese banks. In particular, the regional banks that have been increasing investment in medium- to long-term JGBs have been relatively susceptible to the increased volatility arising from overseas shocks. Banks and other market participants are required to assume various possible channels of shocks and to utilize multiple risk measurement methods including stress testing, thereby grasping market risk from various perspectives.

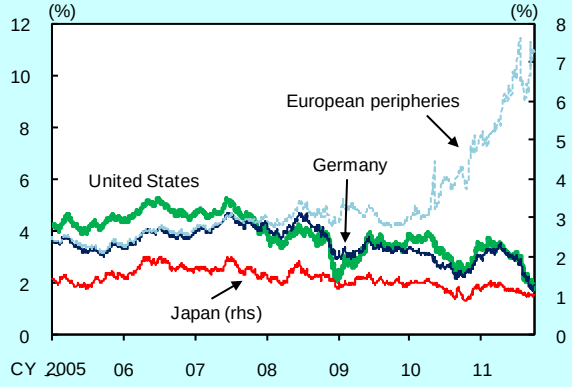
Introduction

Global correlation has been higher among financial markets. Against this background lie the strengthening of international ties on the real economic front and the increase in activities in global financial markets. Since the global financial crisis, high positive correlation has been observed in the real GDP among developed economies. Moreover, there have been cases -- so called the "global risk reduction" -- where risk-averse activities taken by globally active investors across markets had adverse effects and actually amplified fluctuations in those markets.

Global correlation has been higher also among government bond markets (Chart 1). As monetary policy stances of central banks have attracted attention of market participants as one of the common market factors, government bond yields in developed countries have synchronized their developments in these years, and recorded their local peaks and bottoms almost at the same time. Recently, the increased concerns over the sovereign debt problems of Greece and other peripheral European countries and the increased uncertainties about financial and economic conditions have led to a flight of investors to safe assets from risk assets around the globe. Against this background, yields on Japanese, U.S., and German government bonds have declined simultaneously.

Due to the higher global correlation, fluctuations in overseas yields may affect a wide range of domestic and overseas financial assets including government bonds through various channels. For example, there is a possibility that turmoil in overseas markets will increase Japanese banks' market risk associated with holdings of both overseas and domestic securities, which include not only overseas government bonds but also Japanese government bonds (JGBs).

[Chart 1] 10-year government bond yields



Source: Bloomberg.
Note: Figures for European peripheries are simple averages of Greece, Ireland, Italy, Portugal, and Spain.

This paper first measures the degree of global correlation among government bond markets. It then shows how a shock arising from overseas government

bond markets can increase Japanese banks' market risk associated with JGB holdings by conducting stress testing.

Correlation among Government Bond Markets

Spillover and amplification of shocks

Yields on government bonds issued by different countries can be globally correlated to each other through various channels even if there are only weak direct ties on the real economic front. For example, if yields on a certain government bond change, some investors may accordingly adjust their positions in other government bonds.[1] Moreover, investors may reduce at once their whole positions in several countries' government bonds, if some constraints, such as upper limits on the amount invested or the amount of risk borne as well as borrowing restrictions for financing the investment funds, bind their investment activities. Furthermore, there has been a rise in globally active investors who primarily pursue an indexed investment strategy.[2] Those activities have caused yields on government bonds of different countries to be likely to move with each other.

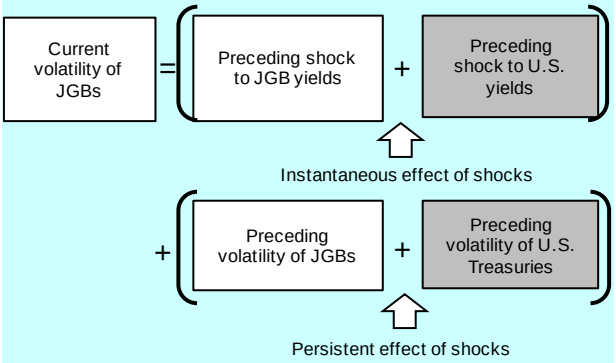
Another cause of the high correlation among government bond yields is investors' overreaction, which has been observed in peripheral European countries.[3] Once markets become volatile, investment activities can be myopic and tend to overreact to news about a downgrading of government bonds. When market confidence in government bonds is eroded, one possible option for individual investors to avoid higher bond-related losses is to withdraw funds invested in government bonds of peripheral countries. If investors start doing so simultaneously in response to news, it may cause bond prices to plunge and therefore they may suffer even larger bond-related losses.

Summary of estimation method

In what follows, the impact of overseas shocks on JGB volatility is measured to confirm the strength of global correlation among government bond markets. For this measurement, a bivariate generalized autoregressive conditional heteroscedasticity (GARCH) model is used with domestic and overseas government bond yields. This model takes into account market characteristics -- the comovement of market volatility and the persistence of high volatility. Because of this persistence, market volatility is likely to remain high once it rises.

Taking a pair of domestic and U.S. yields as an example, the bivariate GARCH model expresses a relationship between those two variables as follows (Chart 2).[4] Current JGB volatility can be decomposed into the following two factors: 1) the factor -- the instantaneous effect of shocks -- that is proportional to the preceding shock occurring in JGB and U.S. Treasury markets; and 2) the factor -- the persistent effect of shocks -- that is proportional to the preceding volatility in those two markets.[5]

[Chart 2] Spillover /amplification of shocks



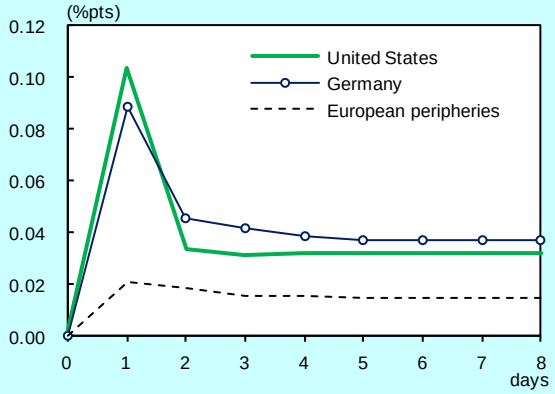
Upward shocks to overseas yields and the corresponding changes in volatility

A relationship between overseas and domestic yields is measured by applying yield data since 2000 (on a weekly difference basis) to the abovementioned model. Specifically, JGB yields with different terms (3- and 6-month, and 1-, 3-, 5-, 7-, 10- and 15-year) are paired with yields on government bonds of the United States, Germany, and peripheral European countries, respectively.[6]

Estimation results show that an upward shock to yields in the United States or Germany would have a considerable influence on JGB yields. Chart 3 indicates historical developments in JGB volatility, which is estimated when assuming an upward shock with a 1 percent probability of occurrence to overseas yields. The degree of assumed shock is equivalent to a rise of 0.4 percentage point of 10-year U.S. Treasury yields, 0.3 percentage point of 10-year German bund yields, and 0.4 percentage point of peripheral European countries, respectively. JGB volatility tends to rise instantaneously in response to the shock in the United States or Germany. Although an influence of the shock diminishes gradually over time, JGB volatility remains higher than that before the shock. On the other hand, an upward shock to yields in peripheral European countries does not have a statistically important effect on JGB yields. This result is robust regardless of estimation periods. It implies

that turmoil in government bonds markets of peripheral European countries, particularly of Greece, would cause less contagion to JGB market.

[Chart 3] JGB volatility in response to upward shocks to overseas yields



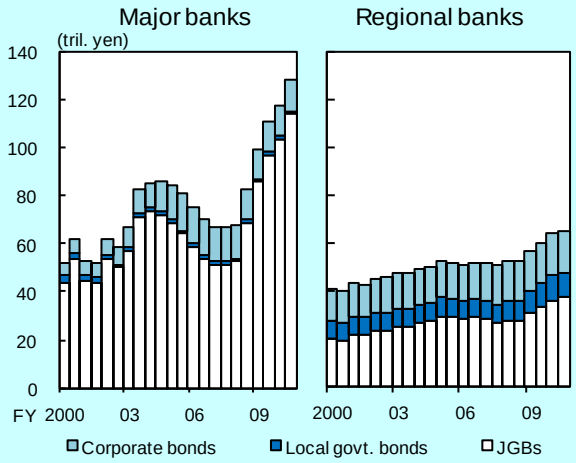
Note: The increase in volatility of 10-year JGB yields in response to an upward shock with a 1 percent probability of occurrence to overseas yields.

Market risk associated with JGB holdings

Banks' investment in JGBs

Since fiscal 2008, both the major banks and the regional banks have been increasing JGB holdings (Chart 4). Against this background lie the sluggish growth in bank loans and the stable inflow of deposits. As of the end of fiscal 2010, the percentage of JGB holdings in the banking accounts among banks' total assets has reached 22 percent at the major banks and 12 percent at the regional banks. It suggests that their asset portfolios have become more susceptible to changes in JGB market.

[Chart 4] Bondholdings by propduct

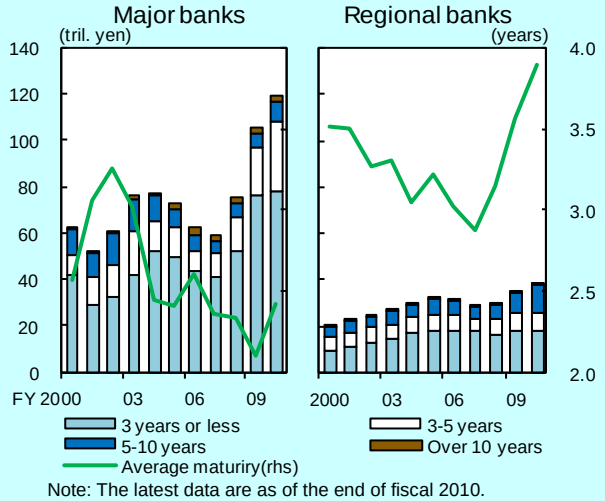


Note: The latest data are as of the end of fiscal 2010.

The major banks and the regional banks have provided a contrast in terms of the maturity of JGB investment (Chart 5). The major banks, who are relatively cautious about taking interest rate risk, have increased investment in short- to medium-term JGBs.

The average maturity of their JGB holdings has declined from over 3 years in the early 2000s to around 2.5 years. On the contrary, the regional banks have increased investment in medium- to long-term JGBs with a maturity of over 5 years. The average maturity has extended to nearly 4 years since it shortened to around 3 years toward fiscal 2007.

[Chart 5] JGB holdings by maturity

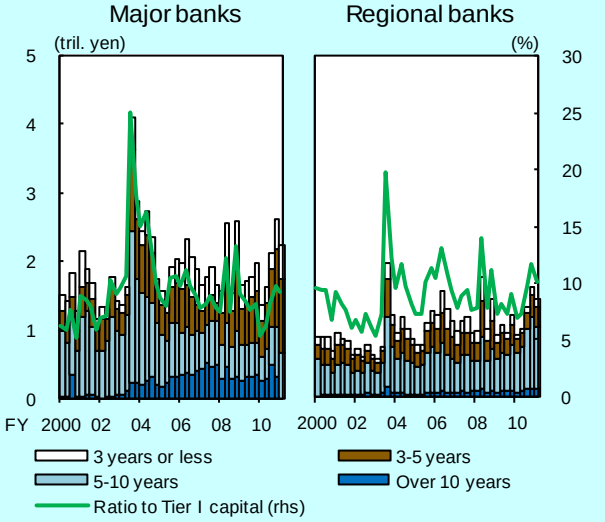


Note: The latest data are as of the end of fiscal 2010.

Amid the prolonged low yield environment, a number of the regional banks have been striving to keep the level of yields on their JGB holdings from declining. According to their preference, they have increased investment in long-term JGBs.

Their value at risk (VaR) -- the amount of market risk associated with JGB holdings -- is slightly increasing partly because JGB volatility has slightly risen (Chart 6).[7] Nevertheless, the level of VaR remains low relative to their Tier I capital, especially for the major banks, as they increased capital substantially toward fiscal 2010.

[Chart 6] VaR associated with JGB holdings



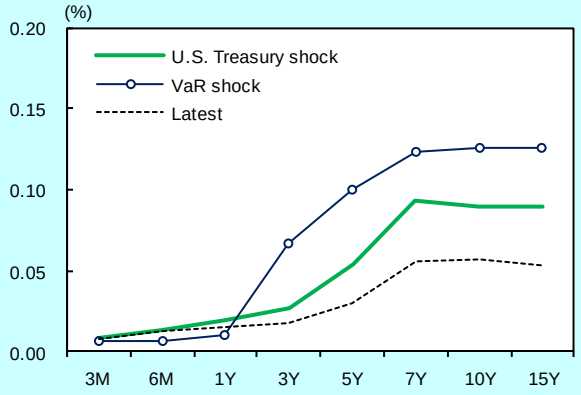
Note: VaR with a 99 percent confidence level and 1-year holding. Volatility estimated in the GARCH model is used for calculation of the VaR.The latest figures are as of January-March 2011.

Upward shocks to overseas yields and the corresponding changes in VaR

A possible increase in banks' market risk is measured assuming the abovementioned upward shock to overseas yields (see Box for a possible increase in banks' market risk associated with stockholdings, which is caused by a downward shock to overseas stock prices).

A stress scenario assumes an upward shock with a 1 percent probability of occurrence to the U.S. yields. The size of assumed shock is equivalent to an increase of 0.4 percentage point in the U.S. 10-year yields. 1-month average of JGB volatility for the period following the shock shows a steep volatility curve, implying that the longer the maturity, the higher JGB volatility (Chart 7). Short-term JGB volatility with a maturity of less than one year barely changes even for the same shock. This is attributable to the fact that short-term JGB yields are more susceptible to domestic factors -- such as a monetary policy anchor. Short-term JGB yields are therefore relatively unaffected by upward shocks to the U.S. yields.

[Chart 7] Volatility curves



Note: Figures for the "VaR Shock" and "latest" are as of July-September 2003 and January-March 2011, respectively. Figures for "U.S. Treasury shock" are the sum of those for the "latest" and the increase in volatility due to the shock.

Chart 8 shows the estimated ratio of VaR associated with JGB holdings to Tier I capital under the stress scenario. The left-hand side of Chart 8 indicates the VaR by maturity while the right-hand side of that indicates the overall VaR. The estimation is based on the maturity structure shown in Chart 5. For the major banks, the overall amount of risk relative to Tier I capital under the stress would be at a level of 13 percent, which is slightly above the latest actual level of 9 percent (the left-hand side of Chart 8). The estimated ratio of risk is about half the level of 25 percent observed when the VaR shock hit in 2003.[8]

In 2003 when profitability of short-term JGB investment declined under the quantitative monetary easing policy, the major banks concentrated on medium- to long-term JGB investment and extended the average maturity of their JGB holdings (Chart 5). Against this background, the amount of risk in a zone of 5-10 years, at the time of the VaR shock, significantly increased due to the sharp rise in volatility. Since then, their JGB portfolios have shifted toward those concentrating on short- to medium-term JGBs although the amount of their JGB holdings has increased 1.6 times since 2003. As a result, the amount of risk in a zone of 5-10 years has been restrained to one third or less of the level at the time of the VaR shock. Their JGB portfolios have changed the maturity structure to be less susceptible to an upward shock to the U.S. yields.

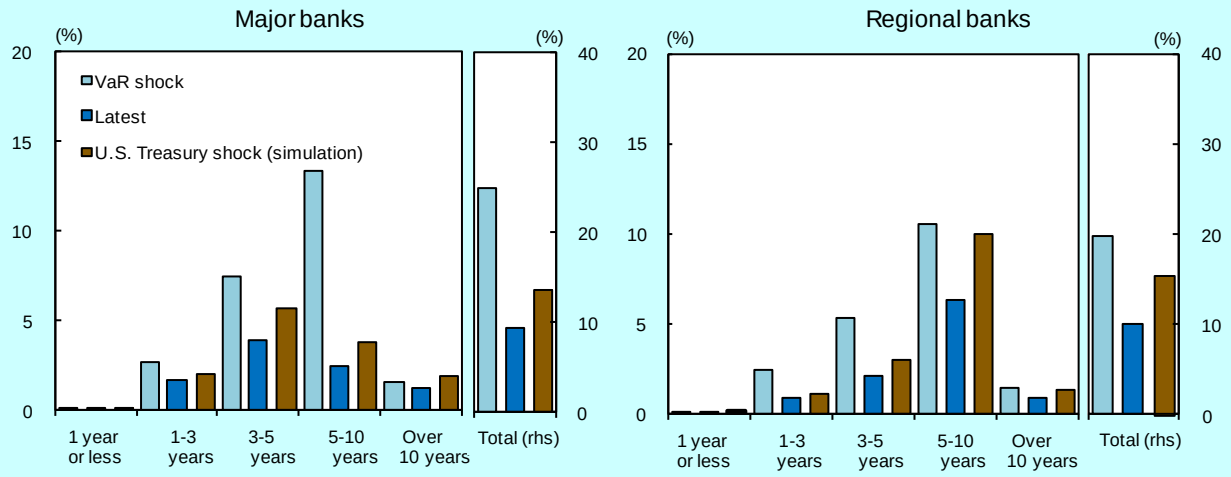
In contrast, the ratio of risk borne by the regional banks under the stress scenario would be at a level of 16 percent, which is close to the level of 19 percent at the time of the VaR shock. In particular, the amount of risk in a medium- to long-term zone is almost the same as that at that time. As the regional banks have stepped up JGB investment in that zone, they have become relatively susceptible to an upward shock to the U.S. yields.

The number of the regional banks that have adopted the VaR measurement to their management of interest rate risk has increased since 2003. It implies that the number of banks that would sell JGBs to reduce their VaR in response to an increase in JGB volatility may also exceed the number of banks that did so in 2003. In such a case, there is a possibility that JGB volatility will be amplified to the level higher than that estimated in this paper.

Concluding remarks

The amount of JGBs held by banks has continued to increase. It is essential for banks to properly manage interest rate risk. Amid the higher global correlation among financial markets, market risk associated with JGB holdings can be affected by various factors. Banks and other market participants are required to assume various possible channels of shocks and to utilize multiple risk measurement methods including stress testing, thereby grasping market risk from various perspectives.

[Chart 8] VaR associated with JGB holdings relative to Tier I capital



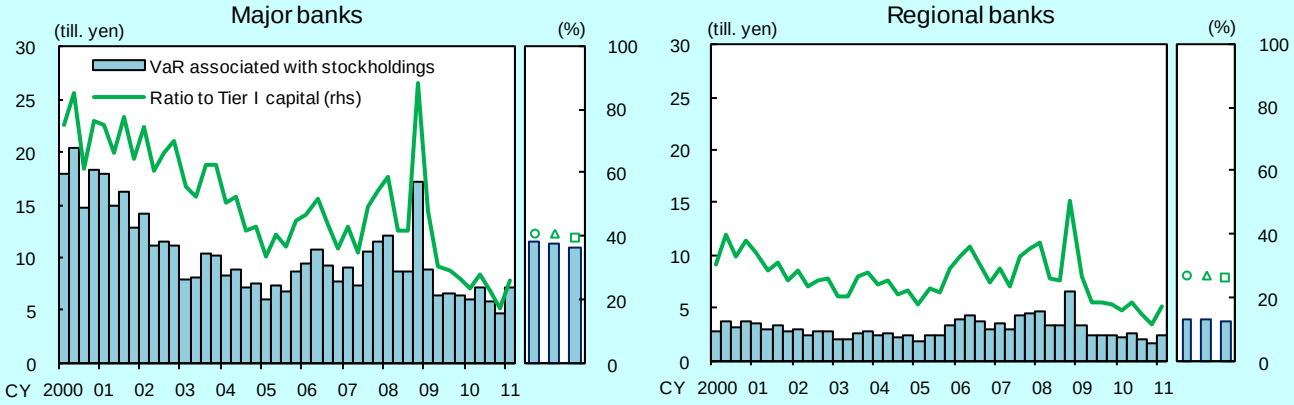
Note: VaR with a 99 percent confidence level and 1-year holding. Figures for the "VaR shock" and "latest" are as of July-September 2003 and January-March 2011,respectively. For volatility used for calculation, refer to the note of Chart 7.

Box: Japanese banks' market risk associated with stockholdings

As with JGBs, there are various channels through which an overseas shock would amplify the amount of banks' market risk associated with holdings of Japanese stocks due to market correlation. In Japan, many banks have regarded a reduction in market risk associated with stockholdings as an important management challenge. They have been making efforts in this regard but have not yet achieved their goal. Both the major banks and the regional banks would be susceptible to changes in stock markets.

In this Box, changes in the amount of banks' market risk associated with holdings of Japanese stocks are estimated by assuming turmoil in overseas stock markets and using the same method as described above. Specifically, a stress scenario assumes that a downward shock with a 1 percent probability of occurrence to overseas stock prices. The degree of assumed shock is equivalent to a 9 percent decline in the U.S. S&P 500, a 9 percent decline in the Bloomberg European 500, and a 11 percent decline in the MSCI Emerging. Estimation results suggest that, when overseas stock prices decline, VaR associated with stockholdings would increase for both the major banks and the regional banks due to a rise in stock volatility (Box Chart). Under each scenario, the amount of risk relative to Tier I capital would increase to the level slightly below half of the level at the time of the Lehman shock. The increase in risk borne by the major banks, whose stockholdings are relatively large, would exceed that by the regional banks.

[Box Chart] VaR associated with holdings of Japanese stocks



Note: VaR with a 99 percent confidence level and 1-year holding. Figures for the "latest" are as of January-March 2011. Figures on the right-hand side of the charts are the estimated ratios of VaR to Tier I capital under the assumption of downward shocks to U.S. stocks (circle), European stocks (triangle), and stocks of emerging economies (square).

[1] For more details, see Kyle, A. S., and W. Xiong, "Contagion as a wealth effect," Journal of Finance, Vol. 56 (4), August 2001.

[2] For more details, see Calvo, A. G., and E. G. Mendoza, "Rational contagion and the globalization of securities markets," Journal of International Economics, Vol. 51 (1), June 2000.

[3] For more details, see Grisse, C., "Higher order beliefs and the comovement of asset prices," Federal Reserve Bank of New York Working Paper, March 2009.

[4] There are several variations of the multivariate GARCH model depending on the specification of time-varying variances. This paper adopts the Baba-Engle-Kraft-Kroner (BEKK) specification. The BEKK model ensures the positive definiteness of volatility, and is superior in describing dynamics of interdependence among variables. For more details, see Engle, R. F., and K. F. Kroner, "Multivariate simultaneous generalized Arch," Econometric Theory, Vol. 11, No. 1, March 1995.

[5] Due to the persistence of volatility shocks, a rise/decline in volatility tends to be followed by high/low volatility. Such a phenomenon is referred to as "volatility clustering."

[6] In this exercise, changes in the first principal component of overseas yield curves are defined as yield changes. The first principal component corresponds to the level factor of the Nelson-Siegel model and has high correlation with a level of long-term yields. It is observed that the level factors have high correlation among developed economies. For more details, see Diebold, F. X., C. Li, and V. Z. Yue, "Global yield curve dynamics and interactions: A dynamic Nelson-Siegel approach," Journal of Econometrics, Vol. 146 (2), October 2008.

[7] Assessment of risk could vary depending on measurement methods. For example, interest rate risk associated with bondholdings has evidently been increasing when measured by 100 basis point value, the risk measure under the assumption that yields rise simultaneously by 1 percentage point for all maturities.

[8] In the summer of 2003, some banks that managed their interest rate risk with the VaR came to judge that their VaR exceeded the preset risk limit due to increased volatility, and simultaneously started selling JGBs. As a result, 10-year JGB yields rose sharply to 1.6 percent from 0.4 percent. The turmoil in JGB market is referred to as the VaR shock.

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