



## The impact of sovereign risk on bond duration: Evidence from Asian sovereign bond markets

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### ABSTRACT

This paper examines the effect of sovereign risk on bond duration. We compare the sovereign risk-adjusted duration for U.S. dollar-denominated Asian sovereign bonds with their Macaulay duration for both investment grade bonds and speculative grade bonds. We find that the sovereign risk-adjusted duration is significantly shorter than its Macaulay counterpart for all bonds, regardless of their bond rating and their maturity. Further, the “shortening” effect of sovereign risk on duration gets stronger as bond rating deteriorates and in recessionary conditions. Our findings provide strong support for the importance of adjusting for sovereign risk when bond portfolio managers apply the popular duration measure to hedge interest rate risk.

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### 1. Introduction

The duration measure is extensively used by financial institutions and fixed income funds worldwide to hedge interest rate risk in their portfolios. A common practice among practitioners is to match the duration of their liabilities with that of their assets to immunize unfavorable impacts of adverse interest rate movements on their positions. If there are mismatches in durations of assets and liabilities, concerned institutions may suffer significant losses and could even go bankrupt. The failures of some financial institutions, such as Lehman Brothers and AIG, during the global financial crisis of 2007–2008 manifest the grave consequence of duration mismatch. A mismatch in durations may be resulted from financial institutions investing in long-term assets but heavily relying on the financial market to provide liquidity for their short-term liabilities. Significant losses experienced by numerous financial institutions and fixed income funds in the recent global financial crisis underscore the importance of implementing effective immunization strategies with precise duration measures in interest rate risk management.<sup>1</sup>

The widely adopted duration measures by practitioners include Macaulay duration, modified duration, and effective duration.<sup>2</sup> The Macaulay duration reflects the average length of time that would elapse before the value of a bond is compensated by its future known stream of fixed payments. The modified duration measures the price elasticity of a bond to changes in its own bond yield. In a continuous time framework, the modified duration is equivalent to the Macaulay duration. As shown in the earlier studies on duration (Acharya & Carpenter, 2002; Chance, 1990; Cox, Ingersoll, & Ross, 1979; Fisher & Weil, 1971), both of these duration measures are not accurate measures of interest rate risk because the effects of the term structure of interest rates, default risk, and call risk are ignored in the computation. In comparison, the effective duration, which reflects the percentage change in the bond price in response to one percent change in the risk-free rate, is a more appropriate measure for interest rate risk. Often,

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<sup>1</sup> An earlier example is the case of Long-Term Capital Management, which failed in 1998 due to its mismatch in the durations of its assets and liabilities during a time of extreme turbulence in interest rates.

<sup>2</sup> Effective duration is more appropriate for bonds with embedded options as well as for stochastic interest rates (e.g., Duan, Sealey, & Yan, 1999).

researchers compare the effective duration of a risky bond with its Macaulay counterpart in examining the effect of risk factors on bond duration. In this paper, we adopt this approach of using the effective duration to examine the effect of sovereign risk on bond duration.

As global financial markets become increasingly integrated and more capital is invested in sovereign bonds issued by national governments, it is imperative for both institutional and individual investors to understand how sovereign risk affects duration as they manage interest rate risk in their bond portfolios. Sovereign risk is the risk that a nation may default on its sovereign debt because of adverse changes in its country's economic fundamentals, and/or deteriorations in country-specific fiscal and external positions such as increasing current account deficit and declining international cost competitiveness (Beck, 2001; Diaz-Ledeza & Gemmill, 2003; Ferrucci, 2003; Siklos, 2008). To some extent, sovereign risk on sovereign bonds is analogous to default risk on corporate bonds as both types of risk pertain to the ability of the issuer to pay its debt obligations. As the recent global financial crisis has shifted the focus of bond investors from corporate default risk to sovereign risk due to their concerns that the credibility of national governments is constrained by the size of their foreign reserves, it becomes more important to understand how sovereign risk and its changes over time affect bond duration.

The literature documents an unresolved debate on the effect of default risk on duration. In an early study, Chance (1990) employs an options-based model to derive the duration of defaultable zero-coupon bonds. Assuming independence between asset values and interest rates, Chance shows that default risk-adjusted durations are always shorter than Macaulay durations. In contrast, by allowing asset values to be dependent on interest rates, Nawalkha (1996) demonstrates that default risk-adjusted durations can be shorter than, equal to, or longer than Macaulay durations of zero-coupon bonds.

In examining the U.S. corporate bond indices over the period of 1980–1988, Fons (1990) finds that their empirical durations are always shorter than their Macaulay durations, while the difference between these two duration measures widens as bond ratings decline. However, his findings may be tainted by the inclusion of callable bonds in the corporate bond indices (Duffee, 1998). Duffee finds that the yield spreads of both callable and non-callable corporate bonds fall when Treasury yields rise, implying that both call risk and default risk reduce duration. Thus, the shortening effect of default risk on duration may be confounded with the shortening effect of call risk. Acharya and Carpenter (2002) confirm Duffee's findings by examining the effects of default risk and call risk on duration using an options-based valuation model for coupon-bearing callable, defaultable bonds. Based on numerical simulations, which assume either zero or negative correlation between interest rate and firm value, they show that default risk or call risk alone reduces bond duration.

Jacoby (2003) derives a default risk-adjusted duration while considering both the risk aversion of investors and a delay period in recovery in the default process. He finds that the risk-adjusted duration is longer than the Macaulay duration if a flat term structure is assumed, due to the delay in recovery. As with Chance (1990), he assumes that default probabilities are independent of interest rates. Applying a reduced-form model<sup>3</sup> to examine the interactive effect of default risk and interest rate risk on the durations of defaultable zero-coupon bonds, Xie, Liu, and Wu (2005) find that durations for defaultable straight bonds can be longer or shorter than those of their non-defaultable counterparts, depending upon the relation between default intensity and interest rates. Kraft and Munk (2007) come up with a similar conclusion that the relation between the default intensity and the default-free interest rate is crucial for the duration of corporate bond. If the default intensity is increasing (decreasing) in the risk-free short rate, the duration of a corporate zero-coupon defaultable bond is greater (less) than that of an equivalent risk-free bond. Recently, Xie, Liu, Wu, and Anderson (2009) empirically estimate the effects of default risk and call risk on duration of bonds rated AA to BB, and find that default risk generally reduces bond duration except for short- and medium-term AA rated bonds.

As different theoretical bond pricing models predict opposite effects of default risk on bond duration, the impact of default risk on the duration of risky bonds is an empirical issue that warrants further research effort. While sovereign risk is analogous to default risk in nature, there is a dearth of literature on the effect of sovereign risk on duration. In examining the determinants of sovereign bond yield spread changes, Westphalen (2001) finds that monthly sovereign bond yield spread changes are negatively related to monthly changes in the level and slope of the yield curve. His finding parallels that of Duffee (1998) on changes in yield spreads of U.S. corporate bonds, implying that sovereign risk could also shorten bond duration. However, Westphalia's study does not address the magnitude of the effect of sovereign risk on duration.

In this paper, we examine the direction and magnitude of the impact of sovereign risk on the duration of U.S. dollar-denominated sovereign bonds in order to provide an improved interest rate risk measure to international bond portfolio managers. Emerging Asian countries, led by China, become increasingly important as the growth engine of the global economy (Prasad, 2009), and the rising Asian bond markets play a key role in the growth of global financial market (Asian Development Bank, 2009). Our study thus focuses on how sovereign risk affects the duration of Asian sovereign bonds, which provides insight to an increasing number of international bond investors.

To isolate the possible confounding effect of call risk and interactive effect of foreign exchange risk with interest rate risk on the duration measure, we only include non-callable Asian sovereign bonds denominated in U.S. dollars in our sample. In addition, we follow Xie et al. (2009) to convert the measure of sovereign risk effect on duration into examining the relation between changes in sovereign yield spreads (i.e., yields of Asian sovereign bonds minus yields of matching U.S. Treasuries with the same coupon and maturity) and changes in the matching U.S. Treasury yields. The matching procedures provide us with a precise control for the coupon and maturity effects in our investigation of the impact of sovereign risk on duration. In our further analysis, we investigate the potential roles of bond characteristics and business cycle in the sovereign risk effect on duration.

<sup>3</sup> The reduced-form bond valuation model is an alternative to the options-based (structural) bond valuation model. It treats default as a surprising event governed by a pure jump process where the default intensity process depends on some exogenously specified state variables. Instead, the structural approach models default by a stopping time, where default is triggered when the firm value falls below a specified threshold.

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