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Asymmetry in government bond returns ☆

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ABSTRACT

Is there asymmetry in the distribution of government bond returns in developed countries? Can asymmetries be predicted using financial and macroeconomic variables? To answer the first question, we provide evidence for asymmetry in government bond returns in particular for short maturities. This finding has important implications for modeling and forecasting government bond returns. For example, widely used models for yield curve analysis such as the affine term structure model assume symmetrically distributed innovations. To answer the second question, we find that liquidity in government bond markets predicts the coefficient of skewness with a positive sign, meaning that the probability of a large and negative excess return is more likely in a less liquid market. In addition, a positive realized return is associated with a negative coefficient of skewness, or a small probability of a large and negative return in the future.

1. Introduction

In the latter half of 2010, we observed significant fluctuations in government bond yields of many developed countries. The yields gradually decreased but went up abruptly towards the end of the year. For example, the yield on a 10 year US government bond remained stable from January until April at approximately 4.0%. From the end of April to the beginning of November, the yield gradually decreased to around 2.8%. In the mid of December, the yield quickly recovered to around 3.8%. While the decrease by about 120 basis points took place over a period of six months, the increase by about 100 basis points occurred in only one month and a half. This observation suggests that ups and downs in government bond yields are asymmetric.

In this paper, we study asymmetries in government bond excess returns for five developed countries – Canada, Germany, Japan, UK and the US – using different approaches based on both statistical tests and econometric models.[2]

First, we measure unconditional asymmetry in government bond returns using both the coefficient of skewness and the Bowley coefficient, a measure that is robust to extreme observations. Second, we investigate if there is conditional asymmetry in government bond excess returns by applying the test of Bai and Ng (2001) to our data set. Third, we analyze how quarterly asymmetry comoves across countries and how it is related to macroeconomic and financial variables.

We find that excess returns to government bonds are negatively skewed when asymmetry is measured by the coefficient of skewness, or that there is a small probability of a large and negative excess return. In contrast, the Bowley coefficient is positive for most countries and maturities, implying that much of the asymmetries measured by the coefficient of skewness can be attributed to extreme observations.

Turning to the test results, we provide evidence for conditional asymmetry in excess returns to government bonds. For bonds with a maturity of 2 years, conditional asymmetry is statistically significant in all countries but there is less evidence for asymmetry in long term bonds for the US and the UK. Conditional asymmetry has important implications for the modeling and forecasting of

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[2] Throughout the paper, the words asymmetry and skewness are used interchangeably.

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government bond returns. In response to the rejection of the expectation hypothesis in the data, the affine term structure model (Vasicek, 1977; Piazzesi, 2010) has become a workhorse in the analysis of the yield curve.[3] Affine term structure models, however, usually assume normally, and thus symmetrically distributed innovations to bond returns to make the computation of the term premium easier. This is at odds with our findings. Concerning forecasting, the presence of asymmetries calls for new models that allow for the possibility that positive and negative forecast errors are not equally likely. Additionally, asymmetry in government bond returns implies that mean and variance are not sufficient to characterize the risk in government bond returns, and has thus important implications for optimal portfolio allocation (Chunhachinda et al., 1997). Jondeau and Rockinger (2006) document that there is an advantage of using higher moments in portfolio allocation.

Investigating the properties of quarterly asymmetry, we find that the cross-country correlation of asymmetry is increasing in the maturity of the bond. This finding implies that for longer maturities, common factors play a larger role in explaining asymmetries, while idiosyncratic factors are more important at short maturities. When asymmetry is measured robustly, cross-country correlations are smaller than when asymmetry is measured by the coefficient of skewness. Therefore, there is tail correlation in government bond excess returns. When predicting the coefficient of skewness using macroeconomic and financial variables, we find that liquidity in government bond markets predicts the coefficient of skewness with a positive sign, meaning that the probability of a large and negative excess return is more likely in a less liquid market. In addition, a positive realized return is associated with a negative coefficient of skewness, or a small probability of a large and negative return in the future. Negative skewness conditional on a positive realized excess return has been documented previously by Brunnermeier et al. (2009) in the context of carry trades.

Asymmetries in equity returns have been documented in many previous studies (Peiro, 2002; Premaratne and Bera, 2005; Bekaert et al., 1998; Bai and Ng, 2001; Grigoletto and Lisi, 2009). These studies have analyzed data from different countries and time periods. However, while most of these studies have tested for unconditional asymmetry, our paper investigates conditional asymmetry instead. Conditional asymmetry has more significant implications for government bond markets when compared to unconditional asymmetry. As mentioned above, affine term structure models assume that the innovations are symmetrically distributed. Testing for conditional asymmetry in government bond returns is one contribution of our paper to the literature.

Skewness in equity returns has also been assessed by using models that represent it. This approach was followed by Harvey and Siddique (1999) and Ghysels et al. (2011), for example. While Harvey and Siddique (1999) propose a time series model for the coefficient of skewness, Ghysels et al. (2011) develop a quantile approach that is robust to outliers. These studies provide evidence for time-varying asymmetries in equity returns for both developed and emerging countries.

In contrast to equity returns, the literature on asymmetries in government bond returns is scarce. This is surprising since there are situations where economic behavior gives rise to asymmetric dynamics in government bond returns. Afonso et al. (2011) document that there is an asymmetry between the information contained in negative and positive events. In particular they find that the reaction of government bond spreads to downgrades in the sovereign credit rating is more pronounced when compared to upgrades. Gande and Parsley (2005) report that spillovers from rating announcements in different countries are asymmetric, too. In a paper that is similar to our work, Vähämaa (2005) relates option-implied skewness in German bond futures to monetary policy actions. He finds that there is positive skewness when the monetary policy stance is tight meaning that investors believe that a sharp increase in yields is more likely than a sharp decline. In contrast to Vähämaa (2005), our study covers a broader set of countries and relates time-varying skewness to macroeconomic and financial variables, rather than to policy announcements.

The remainder of this paper is organized as follows. Section 2 describes the data on excess returns to government bonds. Section 3 reports the empirical results from testing for conditional asymmetry in government bond excess returns and it discusses the properties of quarterly asymmetry. Section 4 concludes.

2. Government bond excess returns

In this section, we explain how we calculate government bond excess returns and describe their characteristics of these returns.

2.1. Data

For benchmark bond yields that can easily be obtained through various media, the remaining duration is decreasing every day. In addition, the return from the coupon of a benchmark bond is unknown and it varies across different benchmark bonds. Therefore, the returns to government bonds cannot be calculated from benchmark bond yields. Instead, we need to use zero coupon yields with constant maturity in order to compute a bond return that has a coupon with constant maturity. Zero coupon yields for Canada, Germany, Japan, UK and the US for the period from 1997 to 2011 are publicly available at the web site of each Central Bank.[4] The reported maturity on these web sites is, however, quarterly or longer. Hence, in order to calculate daily returns, which is the targeted frequency in our analysis, we apply the Svensson (1994) model

$$y^{(n)} = \beta_0 + \beta_1 \frac{\tau_1 - \tau_1 \exp\left(-\frac{n}{\tau_1}\right)}{n} + \beta_2 \left[\frac{\tau_1 - \tau_1 \exp\left(-\frac{n}{\tau_1}\right)}{n} - \exp\left(-\frac{n}{\tau_1}\right)\right] + \beta_3 \left[\frac{\tau_2}{n} - \exp\left(-\frac{n}{\tau_2}\right)\left(1 + \frac{\tau_2}{n}\right)\right] \tag{1}$$

to our data, where n is the maturity and $y^{(n)}$ is the yield at maturity n. The time dependency of the parameters β_i and τ_i is suppressed. Given the data on zero coupon yields, the unknown parameters of the model are estimated by non-linear least squares with exception of Germany and the US.[5] For these countries, the parameter estimates are reported on the web site of the Central Bank. Using the model in Eq. (1) with estimated parameters, we can compute zero coupon yields as well as bond prices at any maturity n.

[3] Recall that the expectations hypothesis predicts that the yield on a long-term bond is the average of expected short rates. Differently put, excess bond returns or term premia are constant or nil under the expectations hypothesis. The expectation hypothesis is, however, found inconsistent with the data (e.g. Campbell and Shiller, 1995; Fama and Bliss, 1987; Backus et al., 2001; Cochrane and Piazzesi, 2005).

[4] For Canada, http://www.bankofcanada.ca/rates/interest-rates/bond-yield- curves/. For Germany, http://www.bundesbank.de/Navigation/EN/Statistics/Time_series _databases /Macro_economic_time_series/its_list_node.html?listId=www_sl40 _it03c. For Japan, http://www.imes.boj.or.jp/research/papers/japanese/12-J-03.txt. For the UK, http://www.bankofengland.co. uk/statistics/Pages/yieldcurve/default.aspx. For the US, http://www.federalreserve.gov/pubs/feds/2006

[5] We use yields in as many maturities as possible when estimating parameters.