



# The cross section of international government bond returns



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## ABSTRACT

Volatility risk, credit risk, value effect, and momentum are major return drivers in the fixed-income universe. This study offers a four-factor pricing model for international government bonds. The model thoroughly explains the variation of government bond returns and covers a range of more than 60 cross-sectional return patterns in government bond markets, verifying its usefulness for asset pricing. The research was conducted within a sample of bonds from 25 developed and emerging markets for the years 1992 to 2016.

## 1. Introduction

In recent years, numerous academic studies have been devoted to finding commonalities in cross-sectional return patterns in various asset classes. [Asness et al. \(2013\)](#) documented solid value and momentum premia in equities, stock market indices, bonds, currencies, and commodities. The role of systematic risk across a range of different asset classes was also evaluated by [Frazzini and Pedersen \(2014\)](#). [Kojien et al. \(2015\)](#) demonstrated that the carry strategy—assuming overweighting of high-yielding assets over low-yielding assets—could be successfully implemented in equities, fixed-income, commodities and currencies. Finally, [Keloharju et al. \(2016\)](#) proved that the cross-sectional seasonality is present in individual stocks, equity indices, commodities, and equity anomalies. These studies are underpinned by fundamental questions of financial market integration and its implications for return co-movements relative to global markets.

Nevertheless, one asset class has largely avoided the attention of the academic community: international government bonds. In comparison with the multitude of studies regarding equities or commodities, government bonds are still an unexplored field. The main goal of this paper is to fill, at least partially, this gap in the literature.

This research attempts to apply the models and techniques discussed in the studies of equity markets to the universe of international government bonds, proposing a cross-sectional four-factor pricing model for international government bond markets. The model accounts for four grand return drivers that have been proven important in the international fixed-income universe: volatility, credit risk, value effect, and momentum. The volatility premium, which offers compensation for the market risk of a bond resulting mostly from interest rate shifts, was documented by [Fama \(1984\)](#), [Cochrane and Piazzesi \(2005\)](#), [de Carvalho et al. \(2014\)](#), and [Choi et al. \(2016\)](#). The credit risk premium rewards investors for risking the bankruptcy of the issuer ([Ejsing et al., 2012](#); [Dockner et al., 2013](#)). The value effect is a tendency of assets with high fundamentals-to-price ratios to outperform assets with low fundamentals-to-price ratios. In the fixed-income universe, this is usually proxied by various yield-based measures or long-run reversal. The phenomenon was documented in government bonds by [Asness et al. \(2013\)](#), who found that the “value” bonds outperformed the “growth” bonds by 1.1% annually in the years 1982 to 2011. The effect was also later confirmed in various types of bonds by [Houweling and van Zundert \(2017\)](#), and [Beekhuizen et al. \(2016\)](#). Finally, the momentum effect is one of the most robust and pervasive return

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patterns ever discovered (Asness et al., 2013). It is a tendency for assets that performed well (poorly) in the past to continue to outperform (underperform). This anomaly has been documented in government bonds by Luu and Yu (2012), Duyvesteyn and Martens (2014), and Hambusch et al. (2015). Again, Asness et al. (2013) estimated the momentum factor returns in bonds during the 1982–2011 period to amount to approximately 1%.

This paper aims to contribute in two basic ways. First, it provides new insights into asset pricing and the cross section of returns on international government bonds. Second, it offers a new four-factor pricing model for government bonds that could be used in the future for both academic and practical applications. Thus, the study is related to three strains of academic literature: first, on commonalities in return regularities across multiple asset classes (e.g., Asness et al., 2013; Frazzini and Pedersen, 2014; Keloharju et al., 2016); second, on cross-sectional return patterns in government bond returns (e.g., Luu and Yu, 2012; de Carvalho et al., 2014; Duyvesteyn and Martens, 2014; Houweling and van Zundert, 2017; Hambusch et al., 2015; Beekhuizen et al., 2016); and third, on cross-sectional asset pricing models for bonds (e.g., Grundy and Martin, 2001; Konstantinov, 2016). The earlier research in the first two areas concentrated predominantly on selected individual effects in limited samples. Our contribution is that we conducted the first comprehensive investigation of a broad number of cross-sectional patterns in international government bonds. In the finance literature on cross-sectional asset pricing models for bonds, Grundy and Martin (2001) based their model solely on default and volatility risk, while Konstantinov (2016) built a broad model including bond trend and carry factors, and subsequently applied it to mutual fund portfolio evaluation. In comparison, our approach was to conduct bond market asset pricing tests to validate our model.

The model offered in this study includes four asset pricing factors: volatile minus stable (VMS), risky minus safe (RMS), high minus low (HML), and up minus down (UMD), which are long-short portfolios accounting for volatility, credit risk, value, and momentum premia, respectively. The factor portfolios were tailored precisely for the international government bond markets. The VMS factor was based on the bond ranking on modified duration, while RMS relied on measures of budget deficit and indebtedness. The HML factor was formed on metrics related to term spread, while UMD was derived from six-month changes in yields. The model was evaluated with the use of cross-sectional and time-series tests within three types of portfolio sets: one-way sorted portfolios, two-way sorted portfolios, and more than 60 zero-investment portfolios formed on various alternative definitions of volatility, credit risk, value, and momentum. The investigation was conducted within a sample of government bonds from 25 developed and emerging markets for the years 1992 to 2016.

The crucial findings of the paper can be summarized as follows. We documented solid and robust volatility, value, and momentum premia in international government bond returns. The credit risk premium was observed, but it was less robust and the evidence was less convincing in comparison with the three risk premia mentioned above. The factor pricing model for corporate bonds incorporating these effects coped well with the cross section of international government bond returns. It properly explained the returns on the portfolios from both single sorts and double sorts. It also covered a broad range of more than 60 return patterns in government bond markets, leaving no abnormal returns unexplained.

The remainder of the paper is structured as follows. Section 2 provides a description of data and methods employed in the study, while Section 3 presents and discusses the results. Finally, Section 4 concludes the paper.

## 2. Data and methods

For this study, we formed four individual factors and evaluated their performance over various types of tested portfolios. In this

section, we discuss our data sources and sample preparation, followed by a discussion of the cross-sectional tests employed. Next, we outline the factor pricing models that we examined and the sets of portfolios tested. Finally, we describe our evaluation methods and testing procedures.

### 2.1. Data sources and sample preparation

This study was based on Bloomberg/EFFAS Total Return Bond Indices for 25 countries for the period January 1992–June 2016. The sample encompassed all 25 countries and the entire period covered by Bloomberg/EFFAS. The indices were calculated separately for five different maturity buckets: 1–3 years, 3–5 years, 5–7 years, 7–10 years, and over 10 years—investigating 125 international government bond buckets in total. This made the sample markedly broader than earlier studies of return regularities in international government bonds, including Asness et al. (2013), who examined 10 countries; Frazzini and Pedersen (2014), covering nine countries; and Beekhuizen et al. (2016), including 10 countries. Furthermore, our sample included a unique default event: Greece. All prices, along with other additional characteristics such as durations and market values, were sourced from Bloomberg.

The computations were based on monthly returns. To use a consistent currency approach across multiple markets, and at the same time to disentangle the currency and bond returns, we used returns hedged against the U.S. dollar.<sup>1</sup> The returns were calculated in local currencies and adjusted for hedging costs based on the one-month forward points quoted by Bloomberg. Table 1 provides an overview of our research sample.

### 2.2. Cross-sectional tests and bond factors

We began our investigation with simple monthly regressions in the style of Fama-MacBeth (1973):

$$R_{i,t} = \beta_{0,t} + \sum_{j=1}^J \beta_{j,t} K_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where  $R_{i,t}$  is the return on the portfolio  $i$  in a month  $t$ ,  $\beta_{0,t}$  and  $\beta_{j,t}$  are regression parameters, and  $K_{i,t}$  are return predictive variables. In this case, we used four distinct return predictors. The variables represented the four major sources of risk premia in government bond markets: volatility risk, credit risk, value effect, and momentum. While many of these premia are also encountered in other asset classes, the definitions of the underlying variables in this study were chosen to particularly suit international government bond markets.<sup>2</sup>

#### 2.2.1. Volatility

The volatility risk was proxied with the modified duration of the bond portfolio, and included in the modelling as the variable *Duration*. The modified duration is a formula that expresses the measurable change in the value of a bond in response to a change in market-wide interest rates. It is calculated based on the first derivative of the bond price with respect to its yield to maturity (Fabozzi, 2012). Due to its simplicity, modified duration is probably the most popular measure of potential price risk in the investment and fund management community. It is also frequently employed in studies of investment strategies for bonds such as those conducted by de Carvalho et al. (2014), Houweling and van Zundert (2017), or Israel et al. (2016).

<sup>1</sup> For robustness, we also examined unhedged returns and found no qualitative differences in results.

<sup>2</sup> All variables were normalized on a monthly basis (de-measured and the standard deviation was set to unity).

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