Risk and Return in International Corporate Bond Markets*

Geert Bekaert† and Roberto A. De Santis‡

March 2019

Abstract

We investigate risk and return in the major corporate bond markets of the developed world. We find that average returns increase with maturity and ratings class (where ratings go from high to low) and that this pattern is fit well by a global CAPM model, where the market consists out of equity, sovereign and corporate bonds. Nonetheless, we strongly reject "asset class integration", finding a model which separates the market portfolio into its three components to fit much more of the corporate bond return variation. The corporate bond factor receives much higher exposure than suggested by its relative market capitalization. We also strongly reject "international market integration"; local factors contribute substantially more to the variation of corporate bond returns than do global factors, and a "local" three-factor model explains more than 80% of the return variation for 59 of 63 portfolios examined. The factor exposures show intuitive patterns; for example, the corporate bond factor betas increase steeply as ratings worsen. Our results are robust to the use of hedged versus unhedged returns and also show up in a panel regression at the CUSIP level.

Keywords: Corporate bond markets, CAPM, international market integration, asset class integration, bond ratings, risk, return

JEL classification: G10, G11, G15.

This is a preprint version of the article. The final version may be found at https://doi.org/10.1016/j.intfin.2021.101338

*The views expressed in this paper are those of the author and do not necessarily reflect those of the European Central Bank or the Eurosystem.

†Geert Bekaert, Columbia Business School, 3022 Broadway, Uris 411, New York, NY 10027. E-mail: gb241@columbia.edu.

‡Roberto A. De Santis, European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt am Main, Germany. Email: roberto.de_santis@ecb.europa.eu; tel.: +49 69 1344 6611.

I Introduction

While the corporate bond market in the US is well-established, many countries have witnessed significant growth in these markets over the last two decades. Corporate bonds are an important asset class but surprisingly little is known about their return and risk characteristics. Fama and French (1993), in their seminal paper on common risk factors also examine US corporate bond returns, explaining rating differentiated bonds with essentially a government and corporate market return factor. The betas with respect to the government bond return factor are all around one (except for speculative bonds which show lower government bond betas) and the betas on the corporate bond market factor increase as ratings worsen but only vary between 0.94 for the highest rated bonds and 1.01 for speculative bonds.[1] They also examine exposures to an equity market factor showing small increases in equity betas for lower rated bonds, but the beta spread is small (varying between 0.19 and 0.30). When equity and bond factors are put together, the higher corporate bond factor beta for speculative bonds disappears and is soaked up by equity exposure. Nevertheless, Fama and French (1993) conclude that the two bond factors can explain the cross-section of corporate (and sovereign) bond returns.

In this article, we investigate risk and return in the major corporate bond markets of the developed world; the US, UK, Euro area, Japan, Canada and Australia, using data extending back to 1998. Our analysis updates, extends and internationalizes the evidence in Fama and French (1993). We examine how a series of simple factor models explain the returns of corporate bonds stratified across rating categories, maturity and other bond characteristics. Importantly, we use securities level data. Our first set of results uses portfolios stratified across the above-mentioned characteristics, but we also use the full panel in determining how various bond characteristic affect risk and return.

Our starting point is that of a fully integrated world, integrated across countries and across asset classes. In such a world, corporate bonds should be priced according to a World CAPM where the market portfolio includes corporate bonds. For the developed markets in our sample, there is an extensive literature testing market integration in equity markets

[1] We could not determine how many corporate bonds are represented in each rating category used in this article. The t-statistics on the coefficients for the bond factors do seem unusually high, exceeding 30 for the most part.

(see Harvey, 1991; Hardouvelis, Malliaropoulos, and Priestley, 2006) but more recent work suggests that even for developed markets local factors are necessary to explain variation in returns (see e.g. Bekaert, Hodrick and Zhang, 2009; Hou, Karolyi and Kho, 2011). There is less research on government bond markets, but it also suggests that developed government bond markets are only partially integrated (see e.g. Barr and Priestley, 2004; Chaieb, Errunza, and Gibson, 2014). We are not aware of research on the international integration of corporate bond markets. Because corporate bonds are a relatively young asset class, it is conceivable that they are less internationally integrated than are equities and government bonds. The degree of integration may also depend on bond characteristics, such as credit rating, as certain institutional investors may have restrictions on the types of bonds they can invest in. For similar reasons, corporate bonds or sub-segments of the asset class are good candidates for segmented pricing. Segmented pricing has a long tradition in the government bond literature though the "preferred habitat hypothesis" and modern versions of it (e.g. the bond clientele hypothesis in Guibaud, Nosbusch and Vayanos, 2013). Therefore, we consider factor models incorporating corporate bonds in the market portfolio, complementing equity securities and Treasury bonds, but also consider models excluding them. We also consider models where we use aggregate equity, Treasury and corporate bond market portfolios as separate factors. This framework allows us to formulate formal tests of both "asset class integration" and "international market integration".

Our main findings are as follows. First, average returns roughly increase with residual maturity and ratings class (where ratings go from high to low). However, the sample period (January 1998-August 2018) available to us is short and marred by large realizations of risk (such as the Great Recession), which makes it unlikely that historical average returns are entirely representative for expected returns or permit powerful tests. This makes the use of factor models to differentiate expected returns across different types of corporate bonds even more important.

Second, we do find a strong link between average returns and volatility: more volatile bond portfolios have higher returns, producing a return slope of about 30 basis points per volatility point (annualized). Our second major result shows that systematic risk largely explains the link between volatility and returns. More highly volatile bond portfolios have higher betas with respect to a world market factor and the pattern is near monotone across rating and maturity ranked bonds.

Third, while a global CAPM model fits a non-negligible part of the variation in corporate bond returns, we strongly reject "asset class integration". If we separate the market portfolio into its three components, the corporate bond factor receives much higher exposure than suggested by its relative market capitalization.

Fourth, we also very strongly reject international market integration, and this is true for all six considered economic areas: local factors contribute substantially more to the variation of corporate bond returns than do global factors. The increase in fit by adding global factors is mostly so minimal that a local three factor model featuring the local equity market return, the local sovereign bond return and the local corporate bond return suffices to explain in excess of 80% of the return variation for 59 of 63 portfolios examined.

Fifth, the factor exposures ("betas") show intuitive patterns. In the preferred "local" three-factor model, for ratings ranked portfolios, sovereign bond betas decrease as ratings deteriorate and become strongly negative for the lowest rating; the equity betas increase but only from the speculative bond categories onwards. The corporate bond factor betas increase steeply as ratings worsen, with betas mostly lower than 0.8 for AAA bonds, but higher than 2.0 for C rated bonds. These beta increases are much stronger than those recorded by Fama and French (1993) for the old US data. We observe fewer clear patterns for maturity ranked portfolios, where the clearest pattern is one of increasing sovereign bond betas with residual maturity. Yet, overall, the factor model manages to extinguish the return-volatility slope in the data and renders most alphas statistically insignificant.

Finally, we examine whether our factor models explain all common variation in corporate bond returns, by examining the correlation structure of the model residuals. Surprisingly, we still find a strong correlation pattern that suggests the presence of a "spread factor".

These results are robust to the use of hedged versus unhedged returns, to the use of double sorted portfolio returns by ratings and residual maturity, and also show up in a panel regression at the CUSIP level.[2] They also hold up in two sub samples of our data.

[2]CUSIP is an acronym that refers to Committee Uniform Security Identification Procedures, which consists of nine-digit alphanumeric numbers that are used to identify securities. The first six characters are known as the base, or CUSIP-6, and uniquely identify the bond issuer. The seventh and eighth digit identify the exact bond maturity and the ninth digit is an automatically generated "check digit."

Our research comes at an opportune time, as several large asset managers have just (in 2018) started to offer investment vehicles with exposure to international corporate credit, including Vanguard and AQR. Extant research on risk and return in international bond markets is hard to find outside practitioner's brochures. There are a few related articles studying the cross-section of corporate bond returns, focusing on US data. Jostova et al. (2013) study momentum in corporate bonds; while Israel, Palhares and Richardson (2018) and Bai, Bali and Wen (2019) attempt to explain the cross-section of corporate bond returns using various bond characteristics. The practitioner's paper by Israel, Palhares and Richardson (2018) focuses on intricate measures of carry, quality, momentum and value. Instead Bai, Bali and Wen (2019) focus on downside risk, credit quality (ratings), bond liquidity and bond betas (relative to the corporate bond market) to explain the cross-section of bond returns creating risk factors associated with them. Given our results, an international extension of their work would necessitate country by country analysis.

The remainder of the paper is organized as follows. Section II sets out our empirical modeling framework. In Section III, we discuss the data and provide summary statistics, documenting the size and the growth of the corporate bond markets, and establishing basic facts regarding the returns and risks in corporate bonds, relative to equity and sovereign bond markets. Section IV contains the main results regarding asset class and international integration tests and provides results using international and "local" factor models for the various bond markets. In Section V, we consider the correlation structure in the factor model residuals. Section VI conducts a series of robustness checks, performing our tests on currency hedged returns and on portfolios sorted by duration or double sorted, reporting the results of a panel regression and of sub-sample analysis. The concluding remarks also outline two follow-up projects suggested by our analysis.

II Empirical Model and Hypotheses

II.A Returns, Benchmarks and Factors

Our analysis uses price and yield data on individual corporate bonds. In accordance with Bai, Bali and Wen (2019) and the methodology adopted by ICE BofAML to calculate total returns, monthly returns for bond i in currency j are constructed as follows

$$R_{i,t}^{j} = \frac{\left(P_{i,t}^{j} + AI_{i,t}^{j} + Coupon_{i,t}^{j}\right)}{\left(P_{i,t-1}^{j} + AI_{i,t-1}^{j}\right)} - 1 \tag{1}$$

where $R_{i,t}^{j}$ is bond i's return at time t (the last Friday of the month), $P_{i,t}^{j}$ is its price (per unit of face value), $AI_{i,t}^{j}$ is its accrued interest, and $Coupon_{i,t}^{j}$ is any coupon paid between $t-1$ and t.

We take the perspective of a dollar-based investor. This requires converting $R_{i,t}^{j}$ using exchange rates and subtracting the one-month US T-bill, instead of the local Treasury bill rate. Therefore, the US dollar-based excess return, $r_{i,t}$, is:

$$r_{i,t} = \left(1 + R_{i,t}^{j}\right) \frac{S_{t}^{j}}{S_{t-1}^{j}} - \left(1 + i_{rf,t-1}\right), \tag{2}$$

where S_{t}^{j} is the spot exchange rate of asset currency j in terms of the US dollar (based on the last Friday of the month) and $i_{rf,t-1}$ is the 1-month US Treasury rate in the previous period. We omit the j superscript from dollar denominated returns. We revisit local excess returns in the robustness section, both to verify robustness to the currency perspective and to examine a proxy to hedged returns. Returns hedged one-for-one with forward contracts yield excess returns that are approximately equal to local excess returns, when covered interest parity holds. Exchange rate changes are more volatile than bond returns, making currency hedging popular in fixed income markets.

Most of our analysis uses portfolios of individual bonds. Each month t, bonds are sorted into portfolios based on ratings or residual maturity. Within each portfolio, portfolio returns are a weighted average of individual bond returns with weights based on prior-month relative market capitalization. Therefore, the US dollar-based excess returns of corporate bond portfolio p at time t, $r_{p,t}$, is defined as follows

$$r_{p,t} = \sum_{i} w_{cb,i,t-1} r_{i,t}, \text{ if } i \in p, \tag{3}$$

where $w_{cb,i,t} = P_{i,t}^{j} F_{i,t} / \sum_{i} P_{i,t}^{j} F_{i,t}$ and $F_{i,t}$ is the outstanding face value of corporate bond i at time t.

We investigate bond markets in the US, the Euro area, Japan, the UK, Canada and Australia, which represent the bulk of the global corporate bond market. Some of our models use as a pricing factor global factors (upper script G), some use local factors (upper script L). For corporate bond returns, global and local factors are indicated and computed as follows: $r^G_{cb,t} = \sum_{i \in G} w_{cb,i,t-1} r_{i,t}$, $\sum_{i \in G} w_{cb,i,t} = 1$, and $r^L_{cb,t} = \sum_{i \in L} w_{cb,i,t-1} r_{i,t}$, $\sum_{i \in L} w_{cb,i,t} = 1$.

We also use global and local equity and sovereign bond index returns, which we indicate by subscripts eq and sb, respectively, and collect their market capitalizations over time (see Section III for more detail). Let $w^N_{k,t-1}$ indicate the relative weight of asset class k (cb, eq or sb) at time $t-1$ for global or local portfolios N (G, or L). Then, we can define the excess return for the aggregate market as:

$$r^N_t = w^N_{cb,t-1} r^N_{cb,t} + w^N_{sb,t-1} r^N_{sb,t} + w^N_{eq,t-1} r^N_{eq,t}, \qquad w^N_{cb,t} + w^N_{sb,t} + w^N_{eq,t} = 1.$$

Because corporate bonds are a relatively young asset class, and are mostly ignored in CAPM studies, we also consider specifications where the world market portfolio omits the corporate bond class. Nevertheless, from a theoretical perspective, corporate bonds surely belong in the market portfolio, whereas arguments (such as Ricardian equivalence) could be used against (fully) incorporating sovereign bonds.

To create test portfolios, we use two standard dimensions of risk in corporate bonds, rating class and residual maturity. The portfolios stratified according to credit ratings have seven buckets ranging from AAA to C, those stratified according to residual maturity have 5 buckets, namely 1 to 3-year bonds, 3 to 5-year bonds, 5 to 7-year bonds, 7 to 10-year bonds, and bonds with a residual maturity longer than 10 years. Credit ratings are a good proxy for default risk with AAA being the least risky category and C the riskiest category; whereas higher residual maturity bonds face more interest rate risk. Interest rate risk is potentially better captured by duration, but the link between duration and maturity is tight, and we want to avoid using a measure that depends on the level of interest rates. Nonetheless, the robustness section considers duration ranked bonds.

II.B Global Models and Asset Class Integration

The first model we test is simply the global CAPM, using a straightforward time series regression:

$$r_{p,t} = \alpha_p + \beta_p r_t^G + \varepsilon_{p,t}, \tag{4}$$

where $\varepsilon_{p,t}$ represents the residuals. We use heteroskedasticity and autocorrelation consistent (HAC) Newey-West standard errors with two lags.

For the world market factor to be efficient with respect to our corporate bond portfolios, the alphas should be jointly zero. We are also interested in how the factor exposures, β_p, vary with the risk dimensions (ratings and residual maturity) and how much return variation the model fits (which can be measured using the adjusted R^2).

It is unlikely that a global CAPM model adequately prices all the differential corporate bond risks. A plausible alternative hypothesis is that the corporate bond factor, $r_{cb,t}^G$, has better ability to price differential corporate bond risks. This would effectively suggest that there is market segmentation across these asset classes in pricing corporate bond risks. It is straightforward to test this hypothesis using the following model:

$$\begin{aligned} r_{p,t} = {} & \alpha_p + \delta_{cb,p} r_{cb,t}^G + \delta_{sb,p} r_{sb,t}^G + \delta_{eq,p} r_{eq,t}^G + \\ & \beta_{cb,p} w_{cb,t-1}^G r_{cb,t}^G + \beta_{sb,p} w_{sb,t-1}^G r_{sb,t}^G + \beta_{eq,p} w_{eq,t-1}^G r_{eq,t}^G + \varepsilon_{p,t}, \end{aligned} \tag{5}$$

where $w_{cb,t}^G$, $w_{sb,t}^G$ and $w_{eb,t}^G$ denote respectively the global market shares of corporate bonds, sovereign bonds and stocks, $w_{cb,t}^G + w_{sb,t}^G + w_{eb,t}^G = 1$. Under the null of the global CAPM, the following restrictions should hold, which constitutes a test of *asset class integration*:

$$\begin{aligned} H_o: \quad & \beta_{cb,p} = \beta_{sb,p} = \beta_{eq,p} = \beta_p, \\ & \delta_{cb,p} = \delta_{sb,p} = \delta_{eq,p} = 0. \end{aligned}$$

The test statistic follows a $\chi^2(5)$ distribution.

A simple alternative "asset-segmented" model may describe the data better, simply allowing the coefficients on the three factors to be different and not linked to market capitalization:

$$r_{p,t} = \alpha_p + \beta_{cb,p} r_{cb,t}^G + \beta_{sb,p} r_{sb,t}^G + \beta_{eq,p} r_{eq,t}^G + \varepsilon_{p,t}. \tag{6}$$

For this model, we can similarly perform the tests for zero alphas (pricing) and verify fit through the adjusted R^2.

II.C International Market Integration

If markets are segmented, the global CAPM model is mis-specified and the use of local factors is desirable. Therefore, we repeat the factor models (4)-(6), using the local market portfolios.

To test the null of *international market integration*, we include both global and local factors:

$$r_{p,t} = \alpha_p + \beta_p r_t^G + \gamma_p r_t^L + \varepsilon_{p,t}, \tag{7}$$

or

$$r_{p,t} = \alpha_p + \beta_{cb,p} r_{cb,t}^G + \beta_{sb,p} r_{sb,t}^G + \beta_{eq,p} r_{eq,t}^G + \gamma_{cb,p} r_{cb,t}^L + \gamma_{sb,p} r_{sb,t}^L + \gamma_{eq,p} r_{eq,t}^L + \varepsilon_{p,t}. \tag{8}$$

The null of international market integration implies $\gamma_p = 0$ in model (7) or $\gamma_{cb} = \gamma_{sb} = \gamma_{eq} = 0$ in model (8), yielding a $\chi^2(1)$ or $\chi^2(3)$ statistic, respectively. We also test the joint hypothesis: $\beta_{cb} = \beta_{sb} = \beta_{eq} = 0$. This hypothesis tests the null of market segmentation, where international factors do not have explanatory power for corporate bonds returns. If both global and local factors matter, the corresponding bond market can be viewed as partially integrated.

II.D Comovements

Factor models must also fit the comovements of corporate bonds of differential risks. To test the ability of the models to do so, we test whether the associated residuals, $\varepsilon_{p,t}$ in the various models, show zero-comovement. Therefore, we test the following restrictions through a GMM test (for one pair):

$$\begin{bmatrix} \varepsilon_{p_l,t}^2 - \sigma_{p_l}^2 & = 0 \\ \varepsilon_{p_m,t}^2 - \sigma_{p_m}^2 & = 0 \\ \varepsilon_{p_l,t}\varepsilon_{p_m,t} - c_{p_l p_m}\sigma_{p_l}\sigma_{pm} & = 0 \end{bmatrix} \tag{9}$$

where $\varepsilon_{p_l,t}$ and $\varepsilon_{p_m,t}$ represent different residuals for a particular factor model, p_l and p_m ($l \neq m$) denote the two portfolios with a different risk profile, $\sigma^2_{p_l}$ and $\sigma^2_{p_m}$ provide the residual variances and $c_{p_l p_m}$ measures the bilateral correlations across two portfolios.

The null hypothesis is then H_0: $c_{p_l p_m} = 0$. This exercise is carried out for credit rating portfolios as well as for residual maturity portfolios. The test above only tests the zero restriction for one correlation pair, but the factor model comovement test requires testing the hypothesis that all residual correlations are jointly zero. For the ratings-based portfolios, when all ratings classes are available, this involves 21 restrictions (and thus results in a $\chi^2(21)$ test statistic); for the residual maturity bonds, there are 10 zero restrictions (and thus results in a $\chi^2(10)$ test statistic). The null hypothesis is equivalent to the factor model matching the correlation structure of corporate bond portfolio excess returns.

III Data and Summary Statistics

III.A Data Sources and Coverage

Data are compiled using the individual bond data of Bank of America Merrill Lynch (BofAML), a leading fixed income index provider, which is part of Intercontinental Exchange (NYSE: ICE), an operator of global exchanges and clearing houses which includes the New York Stock Exchange (NYSE). Blackrock, JP Morgan and PIMCO have all launched exchange-traded funds designed to capture exposure to the corporate bond sector tracking the ICE BofAML indices and the Wall Street Journal publishes their performance daily.

The data cover investment grade and high yield corporate debt publicly issued in the major markets. Qualifying securities must satisfy the following requirements to be included: (i) a minimum size, (2) a rating issued by Moody's, S&P or Fitch, (3) a fixed coupon schedule and (4) a minimum 18 month maturity at issuance. Qualifying currencies and their respective minimum size requirements (in local currency terms) are: Australian dollar (AUD) 100 million; Canadian dollar (CAD) 100 million; Euro (EUR) 250 million;[3] Japanese Yen (JPY) 20 billion; British pound (GBP) 100 million; and US dollar (USD) 250 million.

[3] Pre-euro bonds, issued in ECU (European Currency Unit), Deutsch mark, the Dutch guilder, the French franc, Italian lira and Spanish pesetas, are also included.

Eurodollar bonds (bonds not issued in the domestic market but offshore in several markets) also qualify for inclusion in the data set.

We collect data at the monthly frequency, specifically the last Friday of the month. This avoids potential statistical biases resulting from the rebalancing of constituents on the last calendar day of the month.[4] We retain bonds with a residual maturity above 11 months that are available for at least two consecutive months and are issued by companies whose "country of risk" is based in Australia, Canada, the euro area, Japan, the UK, or the US and are issued in one of the six economies' respective currencies.[5] This also includes bonds issued in pre-euro currencies, because these bonds remained in the market until 2002. Bond prices are based on quotes, not transaction prices.

To the best of our knowledge, our sample represents the largest cross-section and longest times-series of bonds issued worldwide used in an empirical study. It includes 2.4 million bond-month return observations from February 1998 to August 2018. The number of bonds in the sample increases over time: 7187 bonds in January 1998 to 13887 in August 2018, with the largest number of bonds issued in USD (5237/8629), EUR and pre-EUR currencies (628/2772) followed by GBP (278/799), JPY (626/430), CAD (330/916) and AUD (88/341). The only country recording a contraction in the corporate bond market is Japan with the number of bonds starting a steady decline in September 2008 after having reached 1096 bond issues. One curious phenomenon is that there are no speculative bonds issued in Japan during our sample period. Some Japanese companies do issue speculative bonds, but they do so in the international bond markets.

Table 1 contains information about the relative sizes of the various markets. The columns split up the various bonds in our data set by currency denomination, including USD, EUR, JPY, GPB, CAD and AUD. The rows show the country of risk of the bond issuer, split up across our six economies, and the rest of the world ("Other").

[4] The BofAML constituents are rebalanced on the last calendar day of the month, based on information available up to and including the third business day before the last business day of the month. Bond issues that meet the qualifying criteria are included in the BofAML constituents for the following month. Issues that no longer meet the criteria during the course of the month remain in the Merrill Lynch data set until the next month-end rebalancing, at which point they are removed.

[5] The country of risk is based on the physical location of the issuer's operating headquarters with the following exceptions: (i) holding company issuers are assigned a country of risk based on the location of the majority of operating assets. If no single country represents a majority of operating assets, or if this cannot be determined, the country of risk is the issuer's operating headquarters; (ii) bank branch issues are assigned the country of risk of the parent entity.

The first column shows that over the sample period there are on average 4 trillion USD denominated corporate bonds outstanding; EUR issuances come second at USD 1.5 trillion. About 72% of the USD corporate bonds are issued by corporations with their main activity in the US, and 88% by companies in our six economic areas. This implies that a large fraction of the USD bonds are international bonds, issued by non-US companies. However, some of the USD bonds issued by foreign companies, may be issued within the US (Yankee bonds) targeting US investors; whereas US companies may issue USD bonds not in the local bond market but the international Eurobond market. Therefore, it is not clear which fraction of the total bonds outstanding in dollars is actually owned by American investors. While 88% of all USD bonds is issued in our six economies, this fraction is much larger for all other currencies; it is even 99.7% for CAD-denominated bonds. This difference is due to bond issuance of firms in emerging markets, which typically issue USD-denominated bonds not covered in this paper. The domestic shares vary between 50.6% for the AUD bonds and 88.6% for the JPY bonds. In terms of size, the JPY and GPB markets represent about 25% of the EUR market (USD 350 to 400 billion on average). The CAD market is about USD 200 billion, and the AUD market about USD 50 billion.

We also split up these statistics over two sub-periods; the first period represents broadly the first half of the sample, starting in January 1998 and ending in July 2007, just before the Great Recession. The second period is from August 2007 until August 2018 and thus, includes the Great Recession, which started with the interbank credit crisis in August 2007 that forced central banks to inject an enormous amount of overnight liquidity in the banking system to ensure that money markets continued to function.

First, despite the financial crisis, the corporate bond market experienced substantial growth in all areas except in JPY issues, where the market actually shrank. In fact, for the five other currencies issuance more than doubled. Second, the domestic shares are smaller in the second half of our sample than before everywhere, with the decrease only marginal for EUR and CAD bonds, but more considerable elsewhere. Third, our sample, focusing on the six economies, has become slightly less comprehensive over time for USD and EUR bonds. Given substantial growth in the corporate bond markets worldwide (including in emerging markets), the additional international corporate bonds are mostly issues in the two main international currencies.

The coverage of our sample is also extensive in a relative sense. The market share of the six economies for our corporate bond sample is 89.6% of the entire BofAML database over the period 1998-2007 before the global financial crisis, and 95.1% thereafter. Because BofAML uses several screens (see above) before including a bond issuance, the question arises what percentage of all bonds our data set represents. Bloomberg is likely the most comprehensive source for bond quotes. We created a table like Table 1 with outstanding face value for December 2018 using Blomberg data and contrast it with the BofAML data in the Online Appendix. For the six currencies, the BofAML data set represents 62% of the face value of all bonds available on Bloomberg. If we exclude bonds with a floating coupon and bonds with a callability below 1-year, which are not part of the BofAML data set, the latter would represent 86% of the face value of all bonds available on Bloomberg.

Our bond data set can be organized in six areas according to two principles, the "area of risk" or the "currency of issuance." Because of the importance of international bonds, these two principles do deliver different relative market sizes, with, for example, the USD and EUR market capitalizations larger than the bonds issued by US and Euro area companies (see the last column in Table 1 for the size from the area perspective). Conversely, the bond markets in Australia and the UK are relatively larger from the "risk area" perspective, because companies in these countries issue a relatively large number of international bonds; in fact, they issue more bonds internationally than domestically. We use the currency perspective to avoid currency translations to affect returns within one area. Apart from USD denominated bonds, which dominate multinational Eurobond issuances, it is well-known that companies cater their bond issuances to local clienteles, e.g. US companies may issue AUD bonds in the Australian bond market. Burger, Warnock, and Warnock (2018) and Maggiori, Neiman and Schreger (2018) document "currency" home bias in corporate bond holdings, suggesting that a currency perspective may get us closer to investor holdings. In the robustness section, we use our panel analysis at the CUSIP level to examine whether our results differ for domestic and international bonds.

Using the currency issuance perspective for corporate bonds, we now compare the relative size of the three asset classes, equities, sovereign bonds and corporate bonds. In Figure 1, we graph the market capitalizations of the various corporate bond markets and super impose the market capitalizations of the corresponding equity and sovereign bond markets covering the six economies. The corporate bond market capitalization uses market values converted in USD. The stock market capitalization at market value is provided by Thomson DataStream,[6] the sovereign bond market capitalization is the universe based on book value provided by the BIS. The top graph aggregates the six economic areas; and the other graphs plot the market capitalization evolution over time for the six individual markets. The graphs on the left show actual dollar amounts, the ones on the right-hand side show the fractions of market capitalization across all three asset classes. Overall, equity is the dominant asset class representing over 60% of total market capitalization early in the sample. The Great Recession made sovereign bonds the dominant asset class for a few years, but it now represents about 40% of the total market capitalization; equities represent 50% and the corporate bond asset class 10%. The latter's share has risen from 6% to 10% over the sample period. There are rather important but perhaps not surprising differences across countries. The equity market is most dominant in the US, and the corporate bond market also represents a larger fraction of the total market capitalization there (having increased from about 8% in 1998 to 13% in 2013). In the euro area, sovereign bonds dominate, representing 50% of the total market capitalization; equities represent 40% and the corporate bond market accounts for a bit more than 10% of the total market capitalization. Japan is unusual. The sovereign bond market represents mostly more than 60% of the total; the equity market only 35 to 40%. However, the corporate bond market has shrunk to 0.8% by the end of the sample period. In the UK, Canada and Australia, the equity market is also dominant with shares before the Great Recession ranging between 70%-80% in the UK and Australia and close to 60% in Canada. The relative size of the corporate bond market mimics global developments in the UK and Canada, while it is rather small in Australia. As for the sovereign bond market capitalization, it has increased steadily in absolute and relative terms in the UK and Australia since the bankruptcy of Lehman in September 2008, while its fraction relative to the total market capitalization has fluctuated between 35% and 40% in Canada.

[6] Thomson DataStream indices are calculated on a representative list of stocks for each market. The sample for each economy covers a minimum of 80% of total market capitalisation.

III.B Return and Risk

To characterize risk and return in international corporate bond markets, we stratify bonds in portfolios according to credit ratings (7 buckets) and according to residual maturity (5 buckets). Credit ratings are a good proxy for default risk; whereas higher maturity bonds face more interest rate risk. Specifically, the seven portfolios based on credit ratings pull together excess returns of bonds with AAA, AA (AA1, AA2, AA3), A (A1, A2, A3), BBB (BBB1, BBB2, BBB3), BB (BB1, BB2, BB3), B (B1, B2, B3) and jointly the categories C (CCC1, CCC2, CCC3, CC, C) and D, which we refer to as "C" hereafter.[7] Ratings AAA through BBB are investment grade. We use the average credit rating reviews associated with the bond, as carried out by Moody's, S&P and Fitch, the three largest credit rating agencies. The composite ratings are calculated by assigning a numeric equivalent to the ratings in each agency's scale, and averaging those numbers. The average is then rounded to the nearest integer and finally converted back to an equivalent composite letter rating using the scale in the Online Appendix.[8] The five portfolios based on residual maturity include excess returns of bonds with residual maturity ranging between 1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, and above 10 years. Weights are market capitalization based.

In Tables 2a, 2b, and 2c we report summary statistics for the global, USD and EUR portfolios, the latter two being the largest corporate bond markets, with the remainder relegated to the Online Appendix. The last line in each panel reports the relative market capitalization of the bond "bucket".

In the aggregate, about 85% of the bonds in the sample are investment grade mainly concentrated among the A and BBB categories. These bonds are broadly equally split across residual maturity. In relative terms, the USD denominated bonds have the largest

[7] The number of D-rated bonds is marginal.

[8] If only two of the designated agencies rate a bond, the composite rating is based on an average of the two. Likewise, if only one of the designated agencies rates a bond, the composite rating is based on that one rating. The composite ratings are updated once a month as part of the rebalancing process. Composite rating changes take effect on the last calendar day of the month based on information available up to and including the rebalancing lock-out date (the third business day prior to the last business day of the month). Rating upgrades or downgrades occurring after that day will not be considered in the current month rebalancing and will get incorporated at the following month's rebalancing. For example, assuming there are no global holidays in between, if August 31 fell on a Friday the rebalancing lock-out date would occur on August 28. Therefore, a bond that was downgraded to below investment grade on August 28 would transition from the investment grade index to the high yield index at the August 31 rebalancing. Conversely, if the bond was downgraded on August 29, it would remain in the investment grade index for the month of September and transition to high yield at the September 30 rebalancing.

share of high yield bonds, amounting to about 20%; for EUR bonds this proportion is less than 10%. In terms of residual maturity, EUR-denominated bonds (55%), JPY-denominated bonds (70%) and Australian-denominated bonds (84%) have the largest share of bonds with residual maturity below 5 years. In contrast, GBP-denominated bonds (44%) have the largest share of bonds with residual maturity above 10 years. USD denominated bonds are rather evenly split over the different maturity buckets.

In Table 2a, we report some simple properties of the different bond portfolios, where the bond portfolios are aggregated across our six economic areas and thus represent a good proxy to the world corporate bond market. Average returns generally increase both as the rating worsens and residual maturity increases, but the pattern is not 100% monotonic. The same is true for the standard deviation of portfolios, with AAA bonds have an unusually large return standard deviation, higher than AA, A and BBB bonds; while 7-to-10 year maturity bonds have a slightly smaller standard deviation than the 5-to-7 year bonds.

We also report the correlations with the three global risk factors: the global corporate bond portfolio, the global sovereign bond portfolio and the global equity portfolio. When we correlate the various bond portfolios with the corporate bond risk factor, we exclude the portfolio segment considered from the market portfolio computation, to avoid spurious correlation. This is necessary because bonds in the various risk spectrums represent such different market capitalizations.

For the correlation with the global corporate bond portfolio, we find a reverse V-shaped pattern, with correlations increasing at first, then decreasing. The pattern is the natural outcome of increasing factor exposures with respect to this portfolio, which we document in Section IV, and portfolio standard deviations increasing with risk, with the latter effect eventually dominating. The patterns for the correlation with sovereign bonds show a very high positive correlation for A-rated bonds, which then decreases quickly to become even negative for the C-category, while we find a V-shaped pattern in the residual maturity space in the 0.55-0.65 range. In terms of the correlation with the global equity portfolio, we find the opposite patterns: correlations monotonically increase as the credit rating worsens, up and till the B-category; correlations show an inverse V-shaped pattern in the residual maturity space. These simple statistics already show substantial differences between the return properties and especially the risk exposures of the various bond portfolios.

Investigating the sub-samples, the return patterns are quite similar to those observed for the full sample, with the exception that the returns are generally higher in the second subperiod, and speculative bonds performed very poorly in the first sample period. In the aftermath of the dot com boom, default rates in the US quadrupled between 1998 and 2002, leading to very poor performance of speculative bonds. These findings certainly confirm that using average historical returns to measure risk premiums in this market may be problematic. Correlation patterns changed substantially over the two sub sample periods. Correlations with the corporate bond risk factor increased for the credit rating portfolios. Correlations with the equity risk factor increased considerably for all portfolios. Correlations with the sovereign bond risk factor declined for the investment grade portfolios as well as for all portfolios based on residual maturity.

In Tables 2b and 2c, we report the results for the USD- and the EUR-bonds, including the correlation with local risk factors. Again when we correlate the various bond portfolios with either the USD- or EUR-corporate bond risk factor, we exclude the portfolio segment considered from the market portfolio computation. In the Online Appendix, we provide similar tables for the excess returns in all other currencies. The return patterns largely confirm what we report for the global market, with returns mostly increasing with risk. The correlations with the local risk factors are overall substantially higher than with the global factors. The correlations also changed over time. The correlation with both the global and local corporate bond market mostly increased in the last half of the sample, but only for the ratings portfolios. The correlations with the local sovereign bond market decreased for all USD-denominated portfolios, while they remained high in the EUR-denominated portfolios. The correlation with both the global and local equity market factors experienced a dramatic increase in the second half of the sample, tripling for all bond portfolios.

Table 3 tests where the riskiest bonds received higher returns than the safest bonds during our sample period, for the World and our six economic area portfolios. We compare the riskiest available high yield credit category with AAA, and the longest residual maturity bonds with the 1-3-year bond category. Over the full sample, the differences are always positive, and statistically significant at the 10% level or better in about half the cases. Except for GBP-bonds, this always involves maturity risk receiving significantly higher returns. Similar results hold for the last part of the sample, but with less statistical significance. In the first part of the sample, statistical significance is entirely elusive and some of the return differences are negative.

In Table 4, we report means and standard deviations for all the factor portfolios that we use in the paper, starting with the global portfolios and then all the local portfolios, converted into dollar excess returns. Sovereign bond and equity excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index and the Thomson DataStream equity total price index, respectively, for the above six economies. In order to compile the global factors, we use the capitalization based on book value for the sovereign bond market and the market value for the equity market. For the global portfolio, we also consider a market portfolio that does not include corporate bonds. The equity factor returns are most volatile, ranging from 15.72% for the US, to 21.54% for Australia. Sovereign bond portfolios do not universally feature less volatile returns than the corporate bond portfolios because corporate bonds have overall lower duration than do sovereign bonds. The average duration of corporate bonds for the world portofolio in the sample amounts to 5.4 years. Over the three sample periods, equity returns almost always display average returns higher than sovereign bond returns (the exception is Europe for the August 2007 – August 2018 period), but with such volatile returns streams the sample is too short for risk to be reflected in average returns in a statistically significant manner. The period was also characterized by a declining interest rate cycle, increasing the realized returns on long term sovereign bonds. Corporate bond return averages do not always exceed sovereign bond return averages; in particular, corporate bonds often underperformed the other asset classes substantially in the first part of our sample.

A common theme emerging in studying these historical return and risk characteristics is that average returns are likely to provide little power in differentiating different models over our sample period. To come up with a more powerful test, we exploit the cross-portfolio relationship between risk (rating; residual maturity) and the volatility of the portfolios. Figure 2 shows all our corporate bond portfolios in average return (in dollars) versus standard deviation space. The nearly linear, upward sloping relationship for all currencies is immediately apparent. We report the constant and slope coefficients of regressing average returns on standard deviations, country by country, and overall, using all the portfolios (75 in total). For the latter specification, we use a simple pooled specification and one with country fixed effects. The slope coefficients are highly statistically significant for all regressions, varying between 0.135 for EUR-bonds and 1.44 for JPY-bonds. The pooled coefficient is 0.260 (0.338 with fixed effects). **Volatility should not be priced, but we find a significant price of volatility risk.** A successful risk model should fit the strong pattern of average returns increasing in the volatility of the underlying portfolios and we use this stylized fact as one of the tests of the various risk models.

Figure 3 shows a few examples of time series graphs for bond portfolio returns, $r_{p,t}$, that we study in this paper. We show results for the global portfolios, the Euro portfolios, and the British pound portfolios. The Figures for the other currencies can be found in the Online Appendix. The utter randomness of the various return streams is immediately apparent, with large variation in returns across time and across various portfolios. Yet, we can also detect some contemporaneous correlation between the various portfolios, even across countries, and the next section formalizes the search for a factor structure in these random returns.

IV Main Empirical Results

The main goal of this section is to determine which factor model best fits risk and return in international corporate bond markets. We start out showing the performance of a standard global CAPM model. Subsequently, we test the null of asset class integration, and show the performance of three factor models. Finally, we test the null of international market integration and analyze the performance of local factor models.

IV.A The Global CAPM

Table 5 shows the performance of two global CAPM models for the global corporate bond market. In Panel A, we use a model that includes only equities and Treasuries in the market portfolio; panel B also includes the corporate bond market. Not surprisingly, because the corporate bond market is a relatively small part of world market capitalization, the performance of the two models is similar, with betas slightly higher for the second model. Focusing on this model, the important finding is the near monotonic increase of portfolios betas with decreased ratings, or higher residual maturity. Typical bond risks are clearly partially priced in beta exposure. The beta increases from 0.426 for AAA bonds, to 0.952 for C bonds (and 0.701 for B bonds). Short term bonds (1-to-3 years) have likewise betas of 0.402, whereas long-term bonds (longer than 10 years) have betas of 0.560. The betas are all statistically significantly different from zero and the adjusted R^2's follow a hump-shaped part, being in the 0.300 to 0.512 range. This pattern is remarkable because the relative market capitalization represented by some "buckets" is quite small (see Table 2), yet, the bonds behave consistent with their "risk".

Importantly, none of the alphas are statistically significant and there is no clear pattern across bond with different ratings and residual maturity. The simple CAPM model already provides a reasonable differentiation of returns with different risk profiles. Of course, as we discussed before, this test may lack power.

It is conceivable that the global CAPM works substantially less well for the country specific portfolios, but that is not the case. Figure 4 shows the various beta patterns for the ratings portfolios (Panel A) and for the residual maturity portfolios (Panel B). All betas are statistically significantly different from zero. The pattern of monotonically increasing betas repeats itself for USD, EUR, GPB and CAD bond portfolios. The patterns mostly display some convexity indeed by the switch from investment trade to speculative bonds for ratings ranked portfolios. Similar, but weaker patterns are observed for the residual maturity portfolios in Panel B. For JPY and AUD portfolios, we only have a limited number of ratings portfolios, but in both countries, the betas are rather flat with respect to increases in default risk or maturity. The highest betas are generally observed for the EUR and AUD bonds; the lowest ones for global, USD, and JPY bonds.

The alphas for the various country portfolios are also mostly statistically insignificantly different from zero, with the only exception being five portfolios in the US, comprising investment grade and short maturity bonds.

IV.B Asset Class Integration

While average returns cannot reject the CAPM model, the adjusted R^2's generated by the model (shown in the last row of Table 6) are not impressive, ranging in the 0.20 to 0.50 range. The performance is especially poor for Japanese bonds (R^2's lower than 10%) and US AAA bonds (an R^2 of only 6%). From further analysis, it appears that AAA bonds in the US are positively exposed to global sovereign bonds and global corporate bonds (with moderate betas), but negatively exposed to global equity. This makes them potential "safe" assets (Baele et al., 2019, show that US bonds with low default risk feature positive returns in periods characterized by flights-to-safety).

The global CAPM imposes strong assumptions of integration across the different asset classes. To test asset class integration, we regress our portfolios on the three factors comprising the world market factor (equities, Treasuries, corporate bonds), and the product of their time-varying market capitalization weights with the factors as described in equation (5). The asset market integration hypothesis imposes five restrictions (three zero and two equality restrictions), so the test statistic asymptotically follows a $\chi^2(5)$-distribution. Performing this test for all six currencies and the global portfolio, we find that asset market integration under the global CAPM is universally rejected. We do not even tabulate the results as the Wald test values are invariably above 40 (in one case, the world portfolio with 5-to-7 years residual maturity, as high as 4966), and the p-values are zero. The parameter values are not informative, often containing both positive and offsetting negative coefficients for the same factor. We delegate these results to the Online Appendix.

Table 6 reports the adjusted R^2's also for the global and six currency specific portfolios, of four different models: the six-factor model featuring the global equity, Treasury and corporate bond markets, and their interactions with lagged market cap weights; the three-factor model eliminating the interaction factors; the two-factor model featuring only the global equity and Treasury market, and finally, the Global CAPM model as a reference point. We show these R^2's for two portfolios only, the AAA and B portfolios. The table delivers two key results. First, the adjusted R^2's only change marginally going from the six-factor model to the three-factor model. Second, the R^2's change quite substantially from the two- to the three-factor model. Thus, it is the corporate bond factor that substantially increases the R^2's. The performance of the global CAPM relative to two- and three-factor models with the separate factors differs greatly across countries. Except for JPY portfolios and CAD B portfolios, their adjusted R^2's are relatively close to that of the two-factor model. Across different markets, the global three factors generate relatively high R^2's, typically exceeding 35%, including for JPY portfolios.

The patterns of the beta exposures of the global portfolios make economic sense. Specifically, Table 7 shows these exposures for the three-factor model in Panel A and the two-factor model in Panel B, for all the bond portfolios under consideration. In the two-factor model, the sovereign bond exposure decreases from 0.727 for an AAA portfolio to -0.158 for a C portfolio (it is 0.005 for B-portfolios). Equity exposures, in contrast, increase from 0.117 for a AAA portfolio, to 0.622 for a C-portfolio. There is weaker monotonicity for the maturity ranked bonds, and, here the exposure with respect to Treasury bonds also increases with residual maturity, because the duration of the corporate bonds starts to approximate the duration of the sovereign bond portfolio as the maturity is increased.

For the three-factor model, logically the betas for both the sovereign bond and equity factors decrease in magnitude. For the ratings portfolios, the strong monotonicity pattern has somewhat disappeared, but it is still the case that bonds with an A rating have positive Treasury exposure and B-rated bonds a negative Treasury exposure, with the differences in betas economically quite large. Likewise, the equity exposure of investment grade bonds is now economically very close to zero (less than 0.10 in absolute magnitude), but the equity exposure of speculative bonds increases from 0.059 for BB rated bonds to 0.164 for C rated bonds. These latter exposures are statistically significantly different from zero. The exposure relative to the corporate bond market increases from 0.716 for AAA bonds to 2.357 for C bonds. For maturity ranked bonds, there is now a near monotonically increasing pattern in the exposure of the bond portfolios to the corporate bond market factor, increasing from 0.656 for short maturity bonds to 1.324 for the long-term bonds, and a decreasing pattern in the exposure vis-à-vis the equity market factor, decreasing from 0.034 for short maturity bonds to -0.066 for the long-term bonds. There are unclear maturity patterns for sovereign betas.

These patterns are mostly repeated for the currency specific portfolios. We show the coefficients in Figure 5. Panel A graphs the exposures for the three-factor model and Panel B for the two-factor model. We only show the ratings portfolios. The betas with respect to the global corporate bond market are very large for EUR and GBP corporate bonds, roughly ranging between 1.0 and 3.4. The corporate bond betas for the other currencies also largely increase as ratings deteriorate, and, while lower than for the EUR and GBP bonds, they also tend to exceed one for speculative bonds. The exception is the JPY bond market, where this exposure is negative, but the exposure with respect to the global sovereign market is quite large (around 1.2). This is mainly a currency effect as the betas of all three factors estimated for currency-hedged JPY portfolio excess returns are generally not statistically significant (see Section 6.1). As a counterpart to the corporate bond betas increasing in default risk, sovereign betas monotonically decrease with default risk, except in Japan. These betas are mostly positive for very highly rated bonds, but negative for more lowly rated bonds. The equity beta patterns are less monotonic, but tend to be low and even negative for highly rated bonds and higher (and positive) for speculative bonds. When the corporate bond factor is omitted, the equity betas show a more distinct monotonically increasing pattern, capturing higher systematic risk as default risk increases.

We conclude that corporate bonds worldwide have intuitive exposures with respect to global Treasuries and equities, but that a corporate bond factor is necessary to increase the explained variation substantially. Japan is special in that its corporate bonds load negatively on the global corporate bond market factor, and strongly positively on global Treasuries; which is due to a currency effect.

We do not specifically report on the alphas. Some alphas are statistically significant relative to the three factor model, but sometimes they are negative, suggesting that the model over-corrects for risk.

IV.C International Market Integration

So far, we have only considered global factors. The vast literature on international market integration in equities suggests that local or at least regional factors may be necessary to build adequate international factor models (Bekaert, Hodrick and Zhang, 2009; Hou, Karolyi and Kho, 2011). While this is undoubtedly true when emerging markets are considered, some have suggested that the developed world (especially Northern America and Europe) should be considered as an integrated market (Bekaert, et al., 2011). Given that corporate bonds are a "younger" asset class, and we reject asset class integration under the null of the global CAPM model, the global corporate bond market may well be segmented. International market integration tests are joint tests of the null of market integration and a risk model. We consider two models. First, we revisit the global CAPM model, but add the local market factor, involving all three asset classes according to their respective market capitalizations within the country. Second, we use the three-factor model that generated such high R^2's in the previous sub-section, now complemented with the corresponding three local factors.

Table 8 reports some summary statistics for the global model in Panel A and the global and local factor model in Panel B for the six economies, with the full results relegated to the Online Appendix. We show the adjusted R^2's and the betas for the AAA and B portfolios, except for JPY and AUD portfolios for which we show the betas associated with the AA and BBB categories. First, adding the local market factor substantially increases the adjusted R^2's for all economies. On average, the R^2's increase by about 20-40 percentage points for the AAA/AA portfolios and by 15 percentage points for the B/BBB portfolios. The only exceptions are the JPY and the USD portfolios. The JPY portfolios record an even more considerable increase in R^2's by about 70 percentage points, while the R^2's for the USD market, which constitutes the most significant portion of the global market, remain broadly invariant. For this market, the coefficients on the global market factor are highly statistically significant for all ratings and maturity portfolios (see the Online Appendix), whereas the coefficients on the local market portfolio are predominantly negative.[9] On the contrary, for all other currencies, the beta exposures show a distinct pattern, with the global and local risk factor getting predominantly negative and positive weights, respectively. However, the exposures to the local factor do not monotonically increase as ratings deteriorate or maturity increases for all currencies. This is to be expected as the two factors are highly correlated and the local factor exposures interact with the mostly negative exposures to the global factor.

[9] The very low R^2's for the US AAA portfolio is perhaps surprising, but the R^2's steadily increase as ratings deteriorate. It also noteworthy that the AAA category represents a very small part of the total market capitalization of USD bonds, representing only 2.74% of total market capitalization (see Table 3b).

We do not further test this model, as it is dominated by the model separating the different asset classes in the market portfolio. The full version of this model contains six factors (the global and local equity markets; the global and local Treasury bond market, and the global and local corporate bond market). Table 9 summarizes the main results for each currency. The first line reports the p-value of a test of the joint significance of the global factors in the six-factor model (the null of segmentation); the second line reports the p-value from a Wald test on the joint significance of the three local factors, constituting the test of the null of international market integration (i.e. $\gamma_{cb} = \gamma_{sb} = \gamma_{eq} = 0$ in model (8)). The other three lines report adjusted R^2's for three different models; the first one repeats the adjusted R^2's of the global model, using the three global factors; the second R^2's is for a three-factor model that only uses the local factors and the final R^2's is that for the six-factor model.

Focusing first on the international market integration test, the second p-value in each panel, the result is quite stark: we reject the null of international market integration at the 1% level for every single portfolio in every single country. In fact, the p-values are zero to the third digit in all cases. For the EUR- and the AUD-denominated portfolios, we also reject the null that the coefficients on the global factors are jointly zero at the 5% level for the majority of the portfolios, although the p-values are mostly not as low as for the integration test. For the other countries, rejections occur less than half the time; for Japan for only 2 out of the 8 cases.

While this appears to suggest that both local and global factors are necessary to explain corporate bond returns, the R^2's results indicate strongly that a local factor model may suffice. First, the R^2's invariably increase substantially when the local factors are added. Second, the adjusted R^2's barely decrease when the global factors are removed from the six-factor model and sometimes actually increase. Moreover, the adjusted R^2's for the local model are generally high, especially for investment grade bonds, and for most maturity ranked portfolios, exceeding 90% in the majority of the cases and 80% for 59 of 63 portfolios examined. For AUD and JPY-denominated bonds, the global factors do not meaningfully improve the fit of the local factors. For JPY bonds, the local model generates adjusted R^2's of over 94%; for AUD bonds, the lowest R^2 is 92%. For the other currencies, the R^2's are lower for the speculative bonds, typically decreasing from around 80%-93% for BB rated bonds to a range of 52% to 82% for C bonds.

In Figure 6, we show the betas of the local factors for the various portfolios in the various currencies. We show the ratings portfolio betas on the left and the residual maturity portfolios on the right. There are three boxes, one for the sovereign betas, one for the equity betas, one for the corporate bond market betas. For the ratings portfolios, the dominant pattern is one where the sovereign betas decrease with worse ratings, and mostly go from positive to negative when the bond category becomes non-investment grade. The pattern for the equity betas is increasing for the high yield categories, but the betas are rather flat and close to zero for investment grade categories. For the corporate bond market factor, the pattern is one of larger and increasing betas. For example, for the USD-bonds, the betas range from 0.354 for AAA rated bonds to 2.382 (1.491) for C-rated (B-rated) bonds. Note that these patterns are very similar to the patterns we saw for the global model in Figure 5, so they reflect fundamental properties of the three asset classes. However, there is less dispersion in betas across countries. The patterns emerging for residual maturity ranked bonds are much less uniform. For the corporate bond factor, betas increase with maturity in the USD-, GBP- and CAD-denominated bonds, but decrease in EUR-, AUD- and JPY-denominated bonds. For the sovereign bond factor, the dominant pattern is one of rising betas with increasing residual maturity for the corporate bond factor at least for the USD-, JPY- and AUD-denominated bonds. For EUR-denominated bonds, only the longest maturity bonds have a high and significant beta with respect to the sovereign bond factor. The equity betas are now overall quite close to zero, and the maturity pattern is often flat.

IV.D The Pricing of Volatility Risk

So far, we have not discussed how well the factor models fit the average returns on the various portfolios. Such a test simply involves testing whether the alphas in the regression are statistically significantly different from zero. Overall, we find few statistically significant alphas, and often the alphas are even negative, suggesting the factor model and its associated realized risk premiums more than compensate for the realized returns on the various portfolios. The more complicated models do not necessarily perform better than the simpler models in that regard. For example, for the local three-factor model we record 17 statistically significant alphas out of a total of 63 portfolios. Of these significant alphas, 9 are negative and most are economically quite small, a few basis points per month.

A more powerful way to investigate return patterns is to verify whether the factor model can replicate the return-volatility pattern present in the data. Table 10 tests this for three different models: the global three-factor model; the local three-factor model and the six-factor model with both local and global factors. We repeat the volatility tests but applied to the alphas instead of the returns. If the systematic risk exposures of the factor model capture the return-volatility pattern, we should not see significant volatility slopes here. We see quite similar patterns across the three models. First, there is an intercept that is often statistically significant but negative. For the currencies with significantly negative intercepts, we often find a statistically significant volatility slope, but the slope is quite small, varying from 1.3 basis points for EUR bonds to 5.5 basis points for GBP bonds in the case of the three-factor model. Focusing on the six-factor model, the slope is positive and statistically significant for 5 of the 8 portfolios but at most 4.9 basis points. In every such case, the intercept is statistically significantly negative. Economically, the return differences predicted for portfolios of different volatilities, are very small. As Figure 2 shows, the volatility spreads across portfolios in a given currency can easily be 10%. Before applying a risk model, the pooled model records a volatility slope of around 0.3, suggesting a return spread of 3% associate with a volatility spread of 10%. Once factor risks are removed, there is still, on average, a positive return spread (an alpha spread if you will) associated with volatility in 5 out of 8 cases, but it has dwindled to between 1 and at most 5 basis points. Therefore, the factor models capture the risk-return relationship present in the data.

V Explaining Comovements

The various factor models typically generate relatively high adjusted R^2's suggesting that these models likely fit comovements across corporate bonds of various risks rather well. Explaining covariances is important in asset management and here we address the question whether these models fully explain the correlation structure of corporate bond portfolios.

We compute the correlations of the residuals and their standard errors using system

(9) and the Generalized Method of Moments (Hansen, 1992) to investigate this issue. We also compute a Wald test for these correlations being jointly zero across either the ratings portfolios or the residual maturity portfolios for the factor models we previously estimated. For the ratings portfolios, the test statistic is a $\chi^2(21)$ when all ratings portfolios are available; for the residual maturity portfolios it is a $\chi^2(10)$.

We do not tabulate the results, as the Wald test statistics are invariably very high. For the global factor models, the statistics mostly exceed 100,000. When local factors are included, the test statistic values fall considerably, but still lead to rejections at any possible significance level.

Table 11 reveals the origin of these results. The table shows residual correlations for four representative factor models, the global CAPM (with all three asset classes); the global three factor model; the six-factor model with local and global factors and the local three factor model. Showing all the correlations requires space, so we focus on a limited set that suffices to make the main points. Full results are available in the Online Appendix. In particular, the rows are reporting the correlations between the AAA bond portfolio, as a representative investment grade bonds portfolio, with the lowest possible investment grade category bond, BBB and with B rated bonds (we do not use the C-category as it is not available for all currencies). We also show the correlation between BBB rated bond residuals and B residuals, and between BB and B rated bond residuals (correlation within speculative bond categories). For residual maturity ranked bonds, we show the correlation between short term bond residuals (1-to-3 versus 3-to-5 years of remaining maturity); between long term bonds (7-to-10 years remaining maturity, and more than 10 years) and the correlation between the short and long- term bonds (1-to-3 year bonds versus more than 10 year residual maturity bonds).

Investigating the first two columns, the residual correlations are mostly extremely high, often exceeding 0.9. Despite the fact that these factor models often generate reasonably high adjusted R^2's, they do seem to leave a very strong factor structure in the residuals. The reason is, obviously, that they only feature global factors, and that a local corporate bond factor is necessary to substantially lower residual correlations.[10] The next two columns,

[10] There are some exceptions to the high correlations, notably the correlation of the AAA and B portfolios for the USD bonds (and then by extension for global portfolios, which are dominated by USD bonds).

featuring local factors and, importantly, the local corporate bond factor, show this very clearly. Correlations decrease substantially in most cases. However, they remain relatively high in absolute magnitude. Moreover, for rating ranked bonds, the correlations tend to be positive within the investment grade category (although not always for BBB bonds) or speculative bond categories, but negative across these two categories. A similar pattern is apparent for the residual maturity rated bonds for short maturity and long maturity bonds. In sum, while our factor models explain risk and return reasonably well, they fail at fully matching the correlation structure in corporate bonds, where there appears to be excessive correlations between bonds in similar rating categories or of similar maturities. The latter is reminiscent of the preferred habitat theory for Treasury bonds, where different clienteles drive different pricing for bonds of different maturities (see e.g. Vayanos, and Vila, 2009).

Clearly, this is suggestive that a two-factor structure with a "Level" (first principal component) and "spread" factor (second principal component) would constitute a good factor model. This is analogous to the two-factor model in Lustig, Roussanov and Verdelhan (2011) for interest rate sorted currencies. Of course, such a model would perfectly span two of our test portfolios and is therefore not a good candidate to explain residual correlations. However, it may be a parsimonious option as a factor model.

In Table 12, we show the adjusted R^2's for the local three-factor model, and for two "spread" models. Both spread models use the overall corporate bond factor and they use a spread portfolio, either the return on the portfolio of B-rated bonds minus the return on AAA bonds, or the return on the portfolio of more than 10 years maturity, minus the return on the portfolio of short-term bonds (1-to-3 years). Overall, it is clear that the spread models can approximate the R^2's of the three-factor model or do even (mostly slightly) better. In general, the ratings spread model does a relatively good job for the ratings portfolio, and the maturity spreads model does a good job for the maturity ranked bonds; but the ratings spread model does a relatively better job with the maturity ranked bonds, than does the maturity spread model with the ratings ranked bonds.

For the ratings portfolios, the ratings spread model either generates a higher adjusted R^2 than the local three-factor model, or one that is very close (less than 0.01 difference). The

This likely arises from the near safe asset properties of USD bonds (see also Section V). We see a similar phenomenon for hedged EUR and CAD AAA bonds.

maturity spread model does worse than the local factor model for the USD- and EUR-bonds, but the fit is relatively better for the GBP- and CAD-bonds. For AUD- and JPY-bonds there are too few bond categories to see a clear distinction in R^2's and all models do well. For the maturity portfolios, the roles are largely reversed. The maturity spread model mostly does as well or slightly better than the three-factor model. The ratings model typically generates slightly lower or very similar R^2's to the three-factor model.

In all, it is hard to differentiate these models on R^2's, and so the three-factor model remains a good candidate for a successful factor model for corporate bonds. We plan to investigate more formally the cross-section pricing performance of these models with respect to larger cross-sections of bonds in future work.

VI Robustness

VI.A Local Currency/Hedged Returns

All the analysis so far uses dollar returns and is thus relevant for a US investor. One defining feature of fixed income investments is that currency changes are often more volatile than the underlying bond returns, making foreign bond investments contain a large currency component. In this sub-section, we consider local bond excess returns. That is, for example, for the EUR-bonds, we use the return measured in euros and subtract a risk free euro rate, measured by the 1-month overnight indexed swap (OIS) rate.[11] Similarly, for all other bonds issued in the other currencies considered in this paper, we employ local returns and subtract the respective 1-month Treasury yield.

[11] According to the ECB (2014), the OIS rate has a very low perceived credit risk and, over the crisis period, was much less sensitive to flight-to-liquidity flows relative to the euro area AAA yield curve and German Bund yields. The euro over-night index average (EONIA) swap index or OIS rate is a fixed-floating rate interest rate swap where the floating rate is indexed to the EONIA rate at which banks provide loans to each other, with duration of one day. Banks may qualify for the EONIA Swap Index Panel if they meet the following criteria: 1) they are active players in the euro derivative markets, either in the euro area or worldwide, and they have the ability to transact large volumes in EONIA swaps, even under turbulent market conditions; 2) they have a high credit rating, and exhibit high standards of ethical behaviour and enjoy an excellent reputation; 3) they disclose all relevant information requested by the Steering Committee. At present, 25 prime banks constitute the EONIA Swap Index Panel. These selected banks are obliged to quote the EONIA swap index for the complete range of maturities in a timely manner, every business day and with an accuracy of three decimal places. The independent Steering Committee, which consists of 10 members, closely monitors all market developments and ensures, by reviewing panel banks' contributions on a regular basis, strict compliance with the Code of Conduct. It has the right to request information and remove or appoint panel banks.

One interpretation of our results here is that they reflect the pricing of the various local bond markets. However, our preferred interpretation is that these local excess returns are a good approximation for hedged bond returns for a US investor. Hedged fixed income benchmarks typically use rolling one-month forward contracts at the beginning of the investment period to hedge currency risk with a unit hedge ratio. Let F_t^j be the one month forward rate. If this is the case, the hedged foreign exchange gross return, $\widetilde{R}_{i,t}$, is:

$$\widetilde{R}_{i,t} \approx R_{i,t+1} + \frac{F_t^j - S_{t+1}^j}{S_t^j} = R_{i,t+1}^j + f_t^j.$$

where $f_t^j = F_t^j / S_t^j - 1$. The forward premium is determined by covered interest rate parity: $f_t^j \approx i_{rf,t-1} - i_{rf,t-1}^j$, where $i_{rf,t}$ and $i_{rf,t}^j$ are the risk free rates of the USD base currency and asset currency j at time t, respectively. Therefore, the fully hedged portfolio excess return on a foreign asset denominated in currency j is approximately equal to

$$\widetilde{R}_{i,t} - i_{rf,t-1} \approx R_{i,t+1}^j - i_{rf,t-1}^j.$$

Given this interpretation, we also use "hedged" benchmarks as factors, both for the local and global factors and including the equity and sovereign bond factors.

It would take up too much space to tabulate all the results, so here we discuss the robustness of our key results and relegate the actual tables to the Online Appendix. First, the near monotonic pattern of returns increasing in bond risk (by rating or residual maturity) persists. The one glaring exception is Japan, where BBB bonds have had the lowest returns and AA bonds the highest. There are also small deviations from strict monotonicity for the other currencies; in particular B, bonds had lower returns than BB bonds everywhere, which was also true for unhedged returns. These results imply that the strong return-volatility relationship persists also for hedged returns. The volatility slope is slightly smaller for all currencies, and substantially so for the AUD, but the pooled slope is even slightly higher, at 0.294, than for unhedged returns.

Second, we investigate the beta patterns for the global CAPM model, which are increasing with bond risk for unhedged returns. For JPY-bonds, we find, just as was true for unhedged returns, no relation between bond risk and CAPM betas. The monotonicity patterns across the other bonds largely persist, but the betas are lower than for hedged returns.[12] This is not surprising, as for unhedged returns, the betas are affected by an exchange rate variability term, which affects the test and factor portfolios simultaneously.

Similar to the pattern shown for the unhedged returns, the betas increase (nearly) monotonically in maturity (with indeed slightly lower betas), whereas for ratings ranked portfolios the betas are higher for speculative than for investment grade bonds, with few exceptions. Because the betas are now lower, there are a few cases where they are not significantly different from zero.

Third, we continue to strongly reject asset class integration with the Wald tests all rejecting at the 1% level.

Fourth, we also reject international market integration very strongly, at the 1% level, for all hedged portfolios, except for GBP C bonds. The local three factor model continues to generate very high R^2's with 52 out of 63 portfolios generating adjusted R^2's higher than 0.78. The portfolios with lower R^2's generally tend to be those including speculative bonds. The evidence against the null of market segmentation is rather weak, with rejections (at the 5% level) occurring for less than half the portfolios.

Fifth, the monotonic pattern of the beta with respect to the corporate bond market factor increasing as ratings deteriorate and maturity increases is also preserved, with very few exceptions. The beta drops for the longest maturity EUR- and AUD-bonds for example, and the monotonicity pattern is somewhat weak for the GBP ratings ranked bonds.

Finally, the factor models fail to fully capture the correlations across bond portfolios, with the residuals showing the same patterns we unearthed for unhedged bonds.

VI.B Duration versus Residual Maturity

Duration and residual maturity are naturally highly correlated and move similarly over time. We repeat all our results with duration ranked portfolios, instead of residual maturity ranked portfolios, finding the results unchanged. All these results are in the Online Appendix.

[12] There are some exceptions, for example for GBP C bonds, which are related to very large covariances between hedged bond returns and exchange rate changes.

VI.C Double Sorting on Ratings and Residual Maturity

Because high yield bonds tend to have slightly lower maturity on average than more highly rated bonds, our residual maturity sorts may partially reflect rating risks offsetting maturity risks. In the Online Appendix, we report results on double sorted portfolios, looking at the whole universe of bonds. In order to have sufficient bonds to construct portfolios, we use four ratings categories only, AA and AAA together, A bonds, BBB bonds and all the speculative bonds combined. The AAA and AA bonds represent on average 16.2% of the market capitalization (see also Table 2a); the A and BBB bond categories are the largest categories, representing respectively 36.5% and 31.4% of the total market capitalization on average, and speculative bonds together represent 15.9%. Given that we construct five residual maturity categories, we investigate 20 portfolios. We estimate the global model using the global sovereign bond market, the global equity market and the global corporate bond market as factors. The beta exposures show the same intuitive patterns discussed before. The sovereign betas decrease as ratings worsen, being strongly negative for speculative bonds, no matter the residual maturity. They increase with residual maturity for the highest investment grade category but decrease with residual maturity for the BBB and speculative bonds, decreasing to -0.911 for speculative bonds with a residual maturity of longer than 10 years. The equity beta patterns are less monotonic, but the betas are generally positive for high yield bonds and change from positive to negative with maturity for investment grade bonds. Finally, the betas on the corporate bond factor increase monotonically as ratings worsen or residual maturity increases. They increase from 0.485 for the AAA/AA low residual maturity bonds to 1.948 for the speculative bond portfolio with residual maturity longer than 10 years.

VI.D Sub-Sample Analysis

We have derived all our results for two sub-samples, February 1998 to July 2007 and August 2007 to August 2018. Again, we relegate detailed results to the Online Appendix. Our main results remain intact over the two sub-samples. Here we highlight some properties that are slightly different across the two halves of the sample.

The monotonic beta pattern delivered by the global CAPM is present in both sub-samples; the betas are higher in the second sub-sample however for all currencies except for JPY-bonds, where the betas become insignificantly different from zero in the second sub-sample. In the global bivariate factor model, the Treasury bond exposures are larger in the first sub-sample, but equity exposures are larger in the second sub sample. This pattern is true for all currency specific portfolios except for JPY-bonds, where the equity betas are insignificantly different from zero in the second period. For the global three-factor model, the beta exposures for the Treasury and equity bond factors are robustly monotonic across the two sub-samples, with the spread in exposures substantially wider, especially for Treasuries, in the first sample period. Similarly, there is more dispersion in the corporate bond exposures in the second sample period. The monotonicity patterns are largely robust across all currency specific portfolios, with the usual proviso that the JPY bond market is special. In terms of maturity ranked bonds, the Treasury exposures become mostly insignificant in the second subsample, whereas they displayed a positive/negative pattern in the first sample period (short term bonds being positively, long term bonds negatively exposed). For the six-factor model: the adjusted R^2's are generally higher in the second sample (although not always). For the local three-factor model, the R^2's are also mostly higher in the second sub-sample (JPY and AUD excepted). For these two currencies, the relative performance of the global model and the local model in terms of adjusted R^2's is the same across the two sub-samples. For some of the other countries, there is sometimes a bit more difference between the two models in the second sub-sample, but it is not a strong, prevalent phenomenon. Overall, some key results remain invariant.

VI.E Panel Model

The data set records the bond data at the CUSIP level. Therefore, we can also conduct the analysis using individual bonds, rather than aggregate the bonds into portfolios. In the panel regressions, we use "ratings" and "residual maturity" as individual bond characteristics. Ratings are coded as 1 for AAA, 2 for AA1, until 22 for D-rated bonds following the scale in the Online Appendix. Residual maturity is coded as remaining maturity in years. Given our previous results, we focus on the local three-factor model. The results for other models are provided in the Online Appendix. The full specification is defined as follows

$$r_{i,t} = \alpha_{i,t} + \beta_{i,t} r^L_{cb,t} + \gamma_{i,t} r^L_{sb,t} + \delta_{i,t} r^L_{eq,t} + \varepsilon_{i,t},$$

$$\begin{aligned} \alpha_{i,t} &= \alpha_0 + \alpha_1 X_{i,t-1} + \alpha_2 Z_{i,t-1}, \\ \beta_{i,t} &= \beta_0 + \beta_1 X_{i,t-1} + \beta_2 Z_{t-1}, \\ \gamma_{i,t} &= \gamma_0 + \gamma_1 X_{i,t-1} + \gamma_2 Z_{t-1}, \\ \delta_{i,t} &= \delta_0 + \delta_1 X_{i,t-1} + \delta_2 Z_{t-1}. \end{aligned}$$

where $X_{i,t}$ includes ratings and residual maturity and $Z_{i,t}$ contains bond characteristics, such as secured and junior/subordinated versus senior bonds. On average, senior unsecured debt represents 85.4% of the total market capitalization, and senior secured debt and junior debt, 7.4% and 7.2%, respectively. Both the alphas and betas are interacted with the ratings and maturity characteristics, but we also introduce a dummy for secured bonds and one for junior unsecured debt. The coefficient patterns are therefore to be interpreted as applying for unsecured senior debt.

The ratings effects nicely replicate the portfolio results (see Table 13). The betas with respect to the corporate bond factor as a function of ratings show a positive coefficient for all currencies, which is highly statistically significant. Betas increase from 9.3 (GBP) to 19.6 (JPY) basis points per rating point. A coefficient of 0.10 implies that the difference in corporate bond beta between a C- and AAA-bond equals 2. Similarly, the betas with respect to the sovereign bond factor show a negative coefficient with respect to ratings for all currencies, which is highly statistically significant. The ratings interaction coefficient for the betas with respect to the equity factor is positive and significant for the USD-, EUR- and CAD-bonds, not statistically significant for GBP- and AUD-bonds, and negative for JPY-bonds. All in all, we conclude that the patterns we observed for the portfolios are robust in the panel analysis.

The interaction coefficient with respect to the residual maturity for the betas with respect to the corporate bond factor are positive and hence consistent with our previous results for the USD-, the GBP- and the AUD-bonds, while they are statistically insignificant for the EUR-bonds and even negative for JBP- and CAD-bonds. The betas with respect to the equity factor always show an economically small dependence on maturity and are negative in four of the six cases. Conversely, the betas with respect to sovereign bonds increase with residual maturity in a statistically significant manner for all currencies, rising between 1.9 (GBP) and 8.8 (JPY) basis points per year of maturity.

With the panel, we can estimate the effect of other bond characteristics on risk exposures. Secured and junior bonds do show slightly different alphas from unsecured debt, but the pattern is different across currencies. In terms of risk exposures, it appears that secured debt has higher sovereign bond exposures, but lower corporate bond exposures, and the latter is true for four out of six currencies. Economically, these results are expected. The equity exposure is significantly lower for secured bonds only for the two main currencies, USD- and JPY-bonds. Junior bonds have lower sovereign bond exposures (five out of six cases), but higher corporate bond exposures (four out of six cases, and one is insignificant). Junior bonds have also higher equity exposure (four out of six cases), but these effects are mostly small and statistically insignificant.

We also examine whether international bonds are priced differently by introducing dummies for international bonds. The results are reported in the Online Appendix. There are no material differences in the key patterns for pure domestic and international dummies for the USD-bonds, with the dummy coefficients either statistically insignificant, or economically small. Hence, domestic investors likely view bonds issued in the same currency as similar, no matter what the "areas of risk" of the issuer, consistent with the currency home bias results reported in Burger, Warnock and Warnock (2018), and Maggiori, Neiman and Schreger (2018).

Finally, to capture potential non-linearities characterizing ratings effects, we also consider a model which introduces a quadratic term. The ratings effects available in the online Appendix nicely replicate the portfolio results. The betas with respect to the corporate bond factor as a function of ratings shows different patterns with the dominant one, applicable to the JPY-, EUR-, CAD- and AUD-bonds, being one of a positive linear coefficient and a negative quadratic one, with all coefficients highly statistically significant. However, given that ratings are coded from 1 to 22 and the quadratic term is relatively small, the betas duly increase as ratings deteriorate. For USD-bonds, both coefficients are positive and thus, the betas indeed increase as ratings worse. For GBP-bonds the linear term is high and positive and the quadratic term is statistically insignificant, rendering the beta pattern rather identical to what we saw for the portfolios, with betas increasing from less than 0.5 to over 2.0. We conclude that the patterns we observed for the portfolios are robust in the panel analysis.

VII Conclusions

In this article, we provide a comprehensive investigation of risk and return in the major corporate bond markets of the developed world using the CUSIP level data base of Bank of America Merrill Lynch (BofAML), for the period 1998-2018. We first investigate 75 portfolios ranked on credit ratings (from AAA to C) and residual maturity in six economic areas (US, euro area, UK, Canada, Japan and Australia), and the world. We find that average returns and volatility increase with maturity and ratings class (where ratings go from high to low), generating a strong "return- volatility slope" in the data. We examine how simple factor models fit this pattern, and more generally variation in corporate bond returns. Our starting point is the global CAPM model, where the market consists out of equity, sovereign and corporate bonds. Perhaps surprisingly, this simple model generates intuitive factor exposures that increase with bond risk, rendering most alphas statistically insignificant.

We show that the model is strongly rejected along two dimensions. First, we reject "asset class integration," showing that a model which separates the market portfolio into its three components fits a (much) larger fraction of corporate bond return variation. The corporate bond factor receives substantially higher betas than suggested by its relative market capitalization, and the betas with respect to this factor increase nearly monotonically with bond risk. For ratings ranked portfolios, the betas with respect to the equity factor increase as ratings worsen; whereas sovereign betas decrease. Second, we strongly reject international market integration; local factors contribute substantially more to the variation of corporate bond returns than do global factors, and a "local" three-factor model explains more than 80% of the return variation for 59 of 63 portfolios examined. Here too, the factor exposures show intuitive patterns; for example, the corporate bond factor betas increase steeply as ratings worsen. The spread in betas that we find is much larger than what was shown in the seminal Fama and French (1993) paper for a US sample of corporate bonds. Also, the model explains between a low of about 50% of the return variation for some speculative bond portfolios, to typically over 90% of the variation of investment grade and maturity ranked bond portfolios. Our results are robust to the use of hedged versus unhedged returns and are confirmed using a panel regression at the CUSIP level. The intuitive beta exposures are preserved when we double sort on residual maturity and ratings.

Our results strongly suggest that to compute relative expected runs on various corporate bond portfolios, a simple factor model with a local Treasury bond, local equity and local corporate bond factor may be a very adequate starting point.

An analysis of the return residuals after applying our factor model does reveal an interesting pattern: there appears to be excess correlation between investment grade bond residual on the one hand, and speculative bond residuals, on the other hand; in contrast, the residuals of these two types of bonds are negatively correlated. A similar phenomenon applies to short versus long maturity bonds. This suggests that a model with simply the corporate bond factor and a spread factor may fit the data very well. However, such a model does not perform noticeably better than our local three-factor model in terms of adjusted R^2's. We plan to further investigate the formal pricing of factor models for the cross-section of corporate bonds in future work. Jostova et al (2013) and Bai et al (2019) have already shown strong cross-sectional pricing effects for US corporate bonds, that deserve future exploration with our international data sets. Frazzini and Pedersen (2013) claim that the flattish security market line, observed for stocks, also exists in corporate bonds; whereas Kang, et al. (2018) demonstrate the presence of a volatility puzzle in corporate bonds (low volatility/credit risk bonds outperform high volatility/high credit risk bonds within a particular ratings category). We have also not addressed liquidity issues in corporate bonds, which has been the topic of a large literature (see Bongaerts, de Jongh and Driessen, 2017).

The rejection of assert class and international market integration also suggests that corporate bonds are in fact an adequate diversification vehicle for institutional and retail portfolios. Apart from practitioner's articles singing the praises of corporate bonds (e.g. Schlanger, Walker and Roberts, 2018, on investment grade bonds), there is scant academic work on this issue. Liu (2016), by using investment grade bonds obtained from the Merrill Lynch constituencies from January 2000 to December 2010, which cover 41% of our data set on the same decade and 20% of our data set over the entire sample period, shows that international corporate bonds offer diversification benefits to US investors.

In addition, our results raise the intriguing possibility of segmented pricing: between different asset classes, and within the corporate bond asset class, between speculative versus non-speculative bonds. The latter phenomenon may be simply due to an equilibrium where certain institutional investors must hold investment grade bonds. Because returns are noisy, it may be better to investigate such relations using comovements and/or data on holdings. We defer further analysis of these topics to future research.

References

[1] Baele, Lieven, Geert Bekaert, Koen Inghelbrecht and Min Wei, 2019. "Flights to safety", *Review of Financial Studies*, forthcoming.

[2] Bai, Jennie, Turan G. Bali and Quan Wen, 2019. "Common risk factors in the cross-section of corporate bond returns", *Journal of Financial Economics*, 131, 619-642.

[3] Barr, David B. and Richard Priestley, 2004. "Expected returns, risk and the integration of international bond markets", *Journal of International Money and Finance*, 23, 71-97.

[4] Bekaert, Geert, Campbell R. Harvey, Christian T. Lundblad and Stephan Siegel, 2011. "What segments equity markets?", *Review of Financial Studies*, 24, 3841-3890.

[5] Bekaert, Geert, Robert J. Hodrick and Xiaoyan Zhang, 2018. "International stock return comovements", *Journal of Finance*, 64, 2591-2626.

[6] Bongaerts, Dion, Frank de Jong and Joost Driessen, 2011. "Derivative pricing with liquidity risk: Theory and evidence from the credit default swap market", *Journal of Finance*, 66, 203-240.

[7] Bongaerts, Dion, Frank de Jong and Joost Driessen, 2017. "An asset pricing approach to liquidity effects in corporate bond markets", *Review of Financial Studies*, 30, 1229-1269.

[8] Burger, John D., Francis E. Warnock and Veronica C. Warnock, 2018. "Benchmarking portfolio flows", *IMF Economic Review*, 66, 527-563.

[9] Chaieb, Ines, Vihang R. Errunza and Rajna Gibson, 2014. "Integration of sovereign bonds markets: Time variation and maturity effects", University of Geneva working paper.

[10] ECB (2014). "Euro area risk-free interest rates: Measurement issues, recent developments and relevance to monetary policy", *European Central Bank Economic Bullin*, July 2014, 63-71.

[11] Fama, Eugene F. and Kenneth R. French, 1993. "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics*, 33, 3-56.

[12] Frazzini, Andrea and Lasse Heje Pedersen, 2013. "Betting against beta", *Journal of Financial Economics*, 111, 1-25.

[13] Guibaud, Stephane, Yves Nosbusch and Dimitri Vayanos, 2013. "Bond market clienteles, the yield curve, and the optimal maturity structure of government debt", *Review of Financial Studies*, 26, 1914-1961.

[14] Hansen, Lars P., 1982. "Large sample properties of Generalized Method of Moments estimators", *Econometrica*, 50: 1029-1054.

[15] Hardouvelis, Gikas, Dimitrios Malliaropoulos and Richard Priestley, 2006. "EMU and European stock market integration", *Journal of Business*, 79, 365-392.

[16] Harvey, Cambell .R., 1991. "The world price of covariance risk", *Journal of Finance*, 46, 111-157.

[17] Hou, Kewei., G. Andrew Karolyi and Bong-Chan Kho, 2011. "What factors drive global stock returns?", *Review of Financial Studies*, 24, 2527-2574.

[18] Israel, Ronen, Diogo Palhares and Scott Richardson, 2018. "Common factors in corporate bond returns", *Journal of Investment Management*, 2, 17-46.

[19] Jostova, Gergana, Stanislava Nikolova, Alexander Philipov and Christof W. Stahel, 2013. "Momentum in corporate bond returns", *Review of Financial Studies*, 26, 1649–1693.

[20] Kang, Johnny, Tom Parker, Scott Radell and Ralph Smith, 2018. "Reach for safety", *Journal of Fixed Income*, 27, 6-21.

[21] Liu, Edith X., 2016. "Portfolio diversification and international corporate bonds", *Journal of Financial and Quantitative Analysis*, 51, 959-983.

[22] Lustig, Hanno, Nikolai Roussanov and Adrien Verdelhan, 2011. "Common risk factors in currency returns", *Review of Financial Studies*, 24, 3731–3777.

[23] Maggiori, Matteo, Brent Neiman and Jesse Schreger, 2018, "International currencies and capital allocation", *NBER Working paper*, n. 24673.

[24] Schlanger, Todd, David J. Walker and Daren R. Roberts, 2018. "Going global with bonds: The benefits of a more global", *Vanguard*, April 2018.

Table 1. Corporate Bond Market: Country and Currency breakdown

(Average, market share and US dollar billions)

	USD	EUR	JPY	GBP	CAD	AUD	SIX Economies
				Jan. 1998 - Aug. 2018			
Australia	56.9	29.5	4.2	8.9	1.3	26.6	127.3
Canada	115.7	5.8	0.6	1.9	167.6	0.4	292.0
Euro area	253.9	977.3	10.0	90.1	5.6	9.5	1346.4
Japan	47.5	12.1	313.8	3.9	1.8	2.4	381.5
UK	157.4	140.2	3.7	196.9	2.2	2.4	502.8
US	2920.9	182.1	18.1	59.7	20.3	8.4	3209.5
Other	485.9	159.4	4.0	26.1	0.7	2.8	678.8
Six economy	3552.2	1347.1	350.3	361.4	198.8	49.7	5859.5
Total	4038.1	1506.5	354.3	387.5	199.4	52.5	6538.4
				Market share relative to the total			
Domestic share	0.723	0.649	0.886	0.508	0.840	0.506	0.896
Six economy share	0.880	0.894	0.989	0.933	0.997	0.946	0.896
				Jan. 1998 - Jul. 2007			
Australia	14.7	7.0	0.5	3.2	0.4	17.0	42.9
Canada	58.9	2.9	0.3	2.0	76.3	0.1	140.5
Euro area	115.2	474.0	6.7	50.0	5.2	5.2	656.4
Japan	17.5	8.0	381.6	1.8	0.9	2.4	412.2
UK	62.7	78.0	1.8	137.7	0.5	0.9	281.7
US	1750.6	100.8	16.6	32.5	4.9	3.6	1908.9
Other	100.8	56.0	3.2	13.8	0.8	1.1	175.8
Six economies	2019.5	670.7	407.5	227.2	88.2	29.4	3442.5
Total	2120.3	726.7	410.8	241.0	89.0	30.5	3618.3
				Market share relative to the total			
Domestic share	0.826	0.652	0.929	0.571	0.857	0.559	0.951
Six economy share	0.952	0.923	0.992	0.943	0.991	0.965	0.951
				Aug. 2007 - Aug. 2018			
Australia	93.3	48.8	6.4	13.8	2.2	34.8	199.3
Canada	164.8	8.4	0.7	1.7	233.5	0.5	409.6
Euro area	373.8	1412.5	12.9	124.8	5.9	13.2	1943.1
Japan	73.5	15.7	255.1	1.9	2.2	2.4	350.8
UK	239.2	194.0	4.8	248.1	3.6	3.3	693.1
US	3932.9	252.4	19.1	83.2	33.7	12.6	4333.9
Other	818.9	248.7	4.6	36.8	0.5	4.3	1113.8
Six economy	4877.5	1931.8	299.0	473.5	281.1	66.8	7929.7
Total	5696.4	2180.5	303.6	510.3	281.6	71.2	9043.5
				Market share relative to the total			
Domestic share	0.690	0.648	0.840	0.486	0.829	0.489	0.877
Six economy share	0.856	0.886	0.985	0.928	0.998	0.939	0.877

Sources: Bloomberg, ICE BofA Merril Lynch and authours' calculations.

Notes: This table shows the average market value of corporate bonds held by investors world-wide in the six main currencies (i.e. US dollar - USD, euro - EUR, Japanese JPY - JPY, British pounds - GBP, Canadian dollar - CAD, Australian dollar - AUD) and the relative market share held by domestic and foreign investors between 1998 and 2018. Corporate bonds held in Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU are grouped in the euro currency.

Table 2a. Summary Statistics: Corporate Bond Portfolios in all Currencies

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
						February 1998 - August 2018						
Mean (%)	2.641	2.623	2.469	3.583	4.530	3.225	4.827	1.969	2.945	3.707	3.360	4.502
Standard deviation (%)	6.646	5.982	6.246	6.205	7.853	9.561	15.240	5.180	5.659	6.737	6.695	8.285
Correlation global CB	0.602	0.645	0.731	0.770	0.691	0.626	0.562	0.555	0.597	0.608	0.601	0.522
Correlation global SB	0.806	0.845	0.706	0.589	0.142	0.023	-0.058	0.639	0.665	0.556	0.618	0.623
Correlation global EQ	0.299	0.381	0.441	0.493	0.661	0.702	0.643	0.511	0.513	0.577	0.529	0.382
Market weight (%)	3.9	15.6	36.0	29.4	7.2	5.9	2.1	22.3	22.6	16.2	19.8	19.1
						February 1998 - July 2007						
Mean (%)	2.704	2.603	2.441	2.608	2.110	1.000	0.590	1.978	2.480	2.905	2.242	3.328
Standard deviation (%)	6.545	5.871	4.898	4.859	5.866	8.040	12.666	4.390	4.856	4.949	5.321	6.398
Correlation global CB	0.451	0.480	0.560	0.613	0.474	0.393	0.316	0.507	0.574	0.593	0.574	0.510
Correlation global SB	0.892	0.957	0.924	0.776	0.141	-0.007	-0.112	0.863	0.913	0.833	0.798	0.722
Correlation global EQ	-0.002	0.107	0.067	0.159	0.433	0.556	0.433	0.177	0.150	0.195	0.213	0.134
Market weight (%)	8.4	19.9	34.7	24.2	5.2	5.9	1.8	22.5	22.2	15.3	21.3	18.7
						August 2007 - August 2018						
Mean (%)	2.587	2.640	2.494	4.419	6.605	5.132	8.458	1.961	3.344	4.395	4.318	5.508
Standard deviation (%)	6.755	6.098	7.223	7.170	9.203	10.694	17.120	5.790	6.283	7.971	7.690	9.628
Correlation global CB	0.703	0.755	0.811	0.845	0.794	0.748	0.689	0.577	0.609	0.617	0.615	0.528
Correlation global SB	0.733	0.750	0.600	0.496	0.146	0.040	-0.029	0.500	0.506	0.429	0.525	0.588
Correlation global EQ	0.518	0.580	0.636	0.668	0.784	0.789	0.765	0.702	0.724	0.766	0.698	0.510
Market weight (%)	2.2	14.0	36.5	31.4	7.9	5.8	2.2	22.2	22.7	16.6	19.2	19.2

Notes: This table shows the annualised mean and standard deviation of corporate portfolio bond excess returns, grouped by rating class and residual maturity, their correlation with market factor excess returns and their market weight. Portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. (*) refers to corporate bond excess returns computed excluding the bonds of the same portfolio segment. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill.

Table 2b. Summary Statistics: Corporate Bond Portfolios in US Dollars

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
						February 1998 - August 2018						
Mean (%)	2.373	2.670	2.879	3.502	4.307	3.106	4.831	2.219	3.097	3.635	3.208	4.673
Standard deviation (%)	4.146	4.080	5.238	5.559	7.056	8.978	14.892	2.659	3.778	5.745	5.887	8.439
Correlation global CB (*)	0.343	0.517	0.564	0.657	0.621	0.580	0.544	0.476	0.526	0.504	0.507	0.437
Correlation global SB	0.732	0.669	0.580	0.480	0.085	-0.022	-0.074	0.266	0.397	0.295	0.457	0.552
Correlation global EQ	-0.050	0.100	0.191	0.325	0.593	0.670	0.631	0.332	0.392	0.527	0.453	0.282
Correlation local CB (*)	0.446	0.592	0.656	0.717	0.596	0.529	0.457	0.550	0.597	0.588	0.597	0.517
Correlation local SB	0.858	0.733	0.611	0.459	-0.076	-0.227	-0.301	0.158	0.296	0.149	0.395	0.573
Correlation local EQ	-0.108	0.029	0.113	0.254	0.538	0.620	0.575	0.258	0.309	0.451	0.373	0.210
Market weight (%)	2.7	10.8	33.9	32.0	9.0	8.4	3.2	18.8	20.5	16.1	21.9	22.7
						February 1998 - July 2007						
Mean (%)	1.814	1.849	1.964	1.645	1.650	0.799	0.617	1.519	1.988	1.935	1.461	2.626
Standard deviation (%)	3.326	3.537	4.157	4.697	5.732	7.874	12.565	1.623	2.868	4.040	4.791	6.767
Correlation global CB (*)	0.376	0.422	0.450	0.520	0.431	0.354	0.295	0.467	0.496	0.437	0.424	0.392
Correlation global SB	0.728	0.679	0.661	0.550	0.086	-0.059	-0.137	0.543	0.609	0.459	0.486	0.514
Correlation global EQ	-0.228	-0.193	-0.130	0.070	0.406	0.536	0.419	-0.131	-0.023	0.208	0.204	0.095
Correlation local CB (*)	0.468	0.523	0.584	0.655	0.501	0.385	0.295	0.552	0.602	0.592	0.597	0.571
Correlation local SB	0.948	0.928	0.890	0.716	0.072	-0.150	-0.226	0.669	0.753	0.524	0.610	0.700
Correlation local EQ	-0.236	-0.197	-0.143	0.054	0.367	0.498	0.368	-0.151	-0.056	0.171	0.166	0.083
Market weight (%)	5.8	12.8	32.5	28.8	7.9	9.3	2.9	18.8	20.1	15.8	23.6	21.8
						August 2007 - August 2018						
Mean (%)	2.852	3.374	3.665	5.094	6.585	5.084	8.444	2.819	4.048	5.092	4.706	6.427
Standard deviation (%)	4.746	4.497	6.020	6.185	7.982	9.821	16.606	3.295	4.404	6.867	6.673	9.642
Correlation global CB (*)	0.330	0.566	0.620	0.731	0.719	0.708	0.675	0.485	0.540	0.534	0.546	0.458
Correlation global SB	0.757	0.672	0.548	0.441	0.081	0.000	-0.038	0.166	0.288	0.222	0.450	0.592
Correlation global EQ	0.043	0.272	0.358	0.473	0.701	0.754	0.755	0.518	0.600	0.683	0.591	0.382
Correlation local CB (*)	0.435	0.627	0.688	0.748	0.638	0.600	0.532	0.554	0.595	0.586	0.599	0.499
Correlation local SB	0.818	0.617	0.469	0.307	-0.167	-0.282	-0.354	-0.032	0.069	-0.021	0.276	0.508
Correlation local EQ	-0.036	0.177	0.264	0.383	0.652	0.709	0.715	0.445	0.518	0.610	0.505	0.287
Market weight (%)	1.6	10.1	34.4	33.1	9.3	8.1	3.3	18.8	20.7	16.2	21.3	23.1

Notes: This table shows the annualised mean and standard deviation of corporate portfolio bond excess returns, grouped by rating class and residual maturity, their correlation with market factor excess returns and their market weight. Portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. (*) refers to corporate bond excess returns computed excluding the bonds of the same portfolio segment. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in USD. Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies: USD, EUR, JPY, GBP, CAD, AUD. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the US; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the US; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in USD. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill.

Table 2c. Summary Statistics: Corporate Bond Portfolios in Euro

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
February 1998 - August 2018												
Mean (%)	3.204	3.066	2.960	3.615	6.003	4.746	5.058	2.449	3.473	4.204	4.353	5.385
Standard deviation (%)	10.306	10.606	11.190	11.609	15.630	18.204	26.590	10.579	11.014	11.774	12.350	12.219
Correlation global CB (*)	0.563	0.604	0.653	0.686	0.722	0.705	0.593	0.488	0.519	0.547	0.562	0.566
Correlation global SB	0.719	0.685	0.637	0.589	0.350	0.272	0.089	0.595	0.614	0.614	0.624	0.703
Correlation global EQ	0.331	0.378	0.437	0.490	0.666	0.686	0.633	0.415	0.437	0.470	0.481	0.406
Correlation local CB (*)	0.803	0.830	0.855	0.871	0.816	0.800	0.629	0.635	0.649	0.653	0.649	0.628
Correlation local SB	0.957	0.944	0.911	0.877	0.638	0.572	0.337	0.886	0.898	0.892	0.894	0.931
Correlation local EQ	0.489	0.534	0.587	0.634	0.766	0.776	0.665	0.577	0.594	0.617	0.621	0.540
Market weight (%)	6.2	18.4	37.8	28.1	6.1	2.6	0.7	27.6	27.5	20.1	18.8	6.0
February 1998 - July 2007												
Mean (%)	3.977	4.181	4.200	3.660	4.991	2.958	0.650	3.435	4.023	4.581	4.713	5.769
Standard deviation (%)	10.409	10.444	10.407	10.190	13.663	15.493	24.738	9.780	10.226	10.590	10.962	11.594
Correlation global CB (*)	0.421	0.459	0.480	0.532	0.538	0.500	0.422	0.467	0.488	0.499	0.509	0.536
Correlation global SB	0.806	0.810	0.802	0.773	0.430	0.367	0.161	0.749	0.788	0.805	0.808	0.825
Correlation global EQ	0.036	0.042	0.060	0.132	0.426	0.469	0.482	0.073	0.072	0.076	0.089	0.060
Correlation local CB (*)	0.757	0.762	0.774	0.795	0.656	0.694	0.475	0.646	0.657	0.659	0.656	0.646
Correlation local SB	0.980	0.982	0.978	0.952	0.583	0.574	0.308	0.941	0.967	0.977	0.982	0.985
Correlation local EQ	0.223	0.230	0.252	0.317	0.571	0.609	0.546	0.268	0.263	0.265	0.274	0.238
Market weight (%)	16.1	26.1	33.7	19.3	2.2	2.1	0.5	24.7	26.4	19.7	23.6	5.5
August 2007 - August 2018												
Mean (%)	2.542	2.110	1.897	3.577	6.757	6.278	8.836	1.604	3.002	3.881	4.044	5.055
Standard deviation (%)	10.253	10.775	11.850	12.738	16.994	20.290	28.129	11.250	11.684	12.741	13.468	12.773
Correlation global CB (*)	0.667	0.701	0.753	0.765	0.810	0.807	0.697	0.505	0.543	0.575	0.593	0.591
Correlation global SB	0.642	0.580	0.515	0.467	0.304	0.212	0.030	0.483	0.483	0.479	0.499	0.608
Correlation global EQ	0.557	0.624	0.687	0.705	0.791	0.813	0.734	0.638	0.677	0.717	0.721	0.643
Correlation local CB (*)	0.841	0.880	0.906	0.916	0.906	0.865	0.731	0.629	0.645	0.649	0.645	0.617
Correlation local SB	0.937	0.914	0.868	0.841	0.689	0.588	0.366	0.852	0.852	0.841	0.844	0.894
Correlation local EQ	0.679	0.738	0.787	0.808	0.858	0.865	0.742	0.760	0.791	0.816	0.813	0.728
Market weight (%)	3.1	16.1	39.1	30.9	7.4	2.8	0.7	28.5	27.8	20.2	17.3	6.2

Notes: This table shows the annualised mean and standard deviation of corporate portfolio bond excess returns, grouped by rating class and residual maturity, their correlation with market factor excess returns and their market weight. Portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. (*) refers to corporate bond excess returns computed excluding the bonds of the same portfolio segment. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in EUR. Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies: USD, EUR, JPY, GBP, CAD, AUD. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the euro area; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the euro area; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in EUR. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill.

Table 3. Summary Statistics: Difference in the Riskiest and Safest Corporate Bond Portfolios

	Global	Global	USD	USD	EUR	EUR	GBP	GBP	CAD	CAD	JPY	AUD
	C - AAA	>10 - 1-to-3	C - AAA	>10 - 1-to-3	C - AAA	>10 - 1-to-3	C - AAA	>10 - 1-to-3	B - AAA	>10 - 1-to-3	>10 - 1-to-3	7-to-10 - 1-to-3
							February 1998 - August 2018					
Diff. in means	2.289	2.581*	2.459	2.454*	1.853	2.936**	10.815*	1.925	1.780	3.157**	-0.326	1.664
s.e.	(4.232)	(1.459)	(4.566)	(1.458)	(6.568)	(1.281)	(6.218)	(1.516)	(3.218)	(1.35)	(0.632)	(1.239)
							February 1998 - July 2007					
Diff. in means	-1.868	1.342	-1.197	1.107	-3.327	2.334	10.003	0.973	2.493	2.175	-0.532	0.852
s.e.	(5.357)	(1.656)	(5.461)	(1.646)	(9.684)	(1.528)	(8.081)	(1.427)	(4.869)	(1.523)	(0.576)	(1.099)
							August 2007 - August 2018					
Diff. in means	5.853	3.643	5.592	3.608	6.294	3.451*	11.443	2.741	1.168	3.999*	0.036	2.361
s.e.	(6.308)	(2.294)	(7.035)	(2.311)	(8.88)	(1.981)	(9.075)	(2.523)	(4.313)	(2.126)	(1.407)	(2.092)

Notes: This table shows the difference in annualised average excess returns of highest and lowest risk portfolios. Portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. There are no enough bonds issued in Canadian dollars with "C" ratings, therefore the highest risk portfolio is substituted by B. There are no bonds issued in Japanese JPY and Australian dollars with high yield ratings. Therefore, the difference in mean sorted by ratings is not computed for these two currencies. "Global" includes securities issued in one of these currencies: USD, EUR, JPY, GBP, CAD, AUD, Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Heteroskedastic and autocorrelation consistent (HAC) standard errors (2 Newey-West lags) are given in parentheses. *,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively.

Table 4. Summary Statistics: Global and Local Factors' Excess Returns

		February 1998 - August 2018		February 1998 - July 2007		August 2007 - August 2018	
		Mean (%)	Standard deviation (%)	Mean (%)	Standard deviation (%)	Mean (%)	Standard deviation (%)
Global	All	4.178	8.816	3.789	8.877	4.512	8.796
Global	Sov. & Eq.	4.298	9.226	3.909	9.402	4.631	9.107
Global	Sovereign	3.325	7.296	2.418	7.487	4.102	7.148
Global	Equity	5.997	15.796	5.478	14.671	6.442	16.753
Global	Corporate	3.144	6.023	2.488	4.752	3.706	6.944
USD	Sovereign	2.962	7.126	1.517	6.685	4.201	7.490
USD	Equity	6.794	15.722	4.031	15.715	9.163	15.756
USD	Corporate	3.325	5.054	1.852	3.937	4.589	5.835
EUR	Sovereign	4.646	10.976	4.780	11.605	4.532	10.452
EUR	Equity	6.553	20.580	9.556	17.955	3.979	22.631
EUR	Corporate	3.493	11.213	4.164	10.355	2.917	11.936
JPY	Sovereign	2.162	11.398	0.456	11.849	3.624	11.023
JPY	Equity	3.730	17.692	3.722	20.070	3.736	15.444
JPY	Corporate	0.713	10.628	-0.445	11.209	1.705	10.138
GBP	Sovereign	3.410	9.304	4.675	9.059	2.326	9.532
GBP	Equity	4.240	17.168	5.627	13.925	3.052	19.571
GBP	Corporate	3.385	11.025	4.971	8.402	2.025	12.874
CAD	Sovereign	4.511	9.424	6.402	9.145	2.890	9.666
CAD	Equity	8.280	19.890	12.854	18.796	4.358	20.785
CAD	Corporate	4.264	9.600	5.812	8.122	2.937	10.721
AUD	Sovereign	5.544	13.045	5.479	12.475	5.599	13.562
AUD	Equity	9.346	21.540	13.132	18.015	6.100	24.185
AUD	Corporate	4.858	12.397	4.906	10.920	4.816	13.577

Notes: This table shows the annualised mean and standard deviation of global and local factors. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.

Table 5. Global CAPM: Global Portfolios

Global	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
	Panel A: CAPM with two securities											
Intercept	0.082	0.073	0.053	0.145	0.186	0.033	0.083	0.031	0.098	0.129	0.103	0.193
s.e.	(0.119)	(0.098)	(0.111)	(0.11)	(0.146)	(0.169)	(0.298)	(0.085)	(0.094)	(0.120)	(0.114)	(0.145)
Glo CAPM	0.387***	0.407***	0.427***	0.428***	0.535***	0.659***	0.892***	0.370***	0.411***	0.504***	0.494***	0.510***
s.e.	(0.066)	(0.05)	(0.078)	(0.079)	(0.097)	(0.114)	(0.161)	(0.050)	(0.054)	(0.082)	(0.078)	(0.105)
Adjusted R^2	0.285	0.391	0.395	0.403	0.393	0.402	0.289	0.433	0.446	0.474	0.462	0.319
	Panel B: CAPM with three securities											
Intercept	0.072	0.064	0.043	0.135	0.178	0.025	0.071	0.024	0.090	0.118	0.092	0.180
s.e.	(0.116)	(0.095)	(0.106)	(0.106)	(0.142)	(0.166)	(0.292)	(0.082)	(0.090)	(0.114)	(0.109)	(0.141)
Glo CAPM	0.426***	0.444***	0.468***	0.469***	0.574***	0.701***	0.952***	0.402***	0.447***	0.548***	0.539***	0.560***
s.e.	(0.066)	(0.049)	(0.079)	(0.080)	(0.101)	(0.118)	(0.169)	(0.05)	(0.054)	(0.084)	(0.079)	(0.108)
Adjusted R^2	0.316	0.426	0.435	0.441	0.413	0.416	0.300	0.466	0.483	0.512	0.501	0.352

Notes: This table shows the OLS coefficients of CAPM regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns formed by two securities (sovereign bonds and stocks) in Panel A and three securities (corporate bonds, sovereign bonds and stocks) in Panel B. The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Heteroskedastic and autocorrelation consistent (HAC) standard errors (2 Newey-West lags) are given in parentheses.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

Table 6. Adjusted R^2: Global Factor Models

	Global	Global	USD	USD	EUR	EUR	JPY	JPY	GBP	GBP	CAD	CAD	AUD	AUD
	AAA	B	AAA	B	AAA	B	AA	BBB	AAA	B	AAA	B	AA	BBB
Six factors	0.855	0.758	0.628	0.698	0.711	0.752	0.525	0.481	0.520	0.650	0.573	0.352	0.623	0.634
Three factors	0.852	0.750	0.598	0.685	0.703	0.749	0.521	0.474	0.520	0.643	0.572	0.347	0.625	0.637
Two factors	0.724	0.489	0.537	0.447	0.610	0.531	0.491	0.449	0.356	0.379	0.499	0.325	0.567	0.559
Glo CAPM	0.316	0.416	0.058	0.361	0.306	0.516	0.066	0.070	0.214	0.342	0.459	0.256	0.521	0.517

Notes: This table shows the adjusted R^2 of multi-factor OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns of (i) six factors comprising aggregate corporate bonds, sovereign bonds and stocks as well as their interaction with lagged market capitalization weights; (ii) three factors comprising aggregate corporate bonds, sovereign bonds and stocks; (iii) two factors comprising aggregate sovereign bonds and stocks; and (iii) CAPM with corporate bonds, sovereign bonds and stocks. The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.

Table 7. Global Factor Models for the Global Portfolios

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
	Panel A: Three-factor model											
Intercept	-0.052	-0.049**	-0.059**	0.050*	0.154**	0.030	0.096	-0.051	0.003	0.030	-0.001	0.064
s.e.	(0.048)	(0.024)	(0.027)	(0.026)	(0.077)	(0.090)	(0.172)	(0.044)	(0.031)	(0.019)	(0.026)	(0.074)
Glo Sovereign	0.344***	0.369***	0.054	-0.120***	-0.603***	-0.782***	-1.418***	0.093***	0.057*	-0.145***	-0.055***	-0.011
s.e.	(0.044)	(0.026)	(0.033)	(0.034)	(0.096)	(0.118)	(0.163)	(0.034)	(0.031)	(0.021)	(0.021)	(0.065)
Glo Equity	-0.023	0.021**	-0.030***	-0.034***	0.059*	0.139***	0.164***	0.034***	0.014*	0.006	-0.004	-0.066***
s.e.	(0.014)	(0.009)	(0.009)	(0.012)	(0.032)	(0.034)	(0.060)	(0.011)	(0.008)	(0.007)	(0.007)	(0.019)
Glo Corporate	0.716***	0.591***	1.012***	1.141***	1.378***	1.472***	2.357***	0.656***	0.840***	1.206***	1.139***	1.324***
s.e.	(0.055)	(0.042)	(0.054)	(0.040)	(0.111)	(0.143)	(0.211)	(0.041)	(0.041)	(0.023)	(0.031)	(0.082)
Adjusted R^2	0.852	0.949	0.965	0.946	0.789	0.750	0.678	0.826	0.929	0.977	0.961	0.800
	Panel B: Two-factor model											
Intercept	-0.040	-0.039	-0.042	0.069	0.177	0.055	0.135	-0.040	0.017	0.051	0.018	0.086
s.e.	(0.076)	(0.050)	(0.090)	(0.099)	(0.137)	(0.152)	(0.256)	(0.069)	(0.074)	(0.103)	(0.097)	(0.130)
Glo Sovereign	0.727***	0.685***	0.595***	0.490***	0.134*	0.005	-0.158	0.444***	0.506***	0.500***	0.554***	0.697***
s.e.	(0.036)	(0.022)	(0.034)	(0.044)	(0.071)	(0.081)	(0.140)	(0.027)	(0.031)	(0.039)	(0.041)	(0.070)
Glo Equity	0.117***	0.136***	0.167***	0.188***	0.327***	0.425***	0.622***	0.162***	0.177***	0.240***	0.217***	0.192***
s.e.	(0.030)	(0.021)	(0.039)	(0.042)	(0.053)	(0.063)	(0.095)	(0.026)	(0.029)	(0.045)	(0.041)	(0.053)
Adjusted R^2	0.724	0.841	0.674	0.571	0.448	0.489	0.414	0.649	0.685	0.623	0.641	0.518

Notes: This table shows the OLS coefficients and adjusted R^2 of multi-factor regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns of (i) three factors comprising aggregate corporate bonds, sovereign bonds and stocks (Panel A); and (ii) two factors comprising aggregate sovereign bonds and stocks (Panel B). The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Heteroskedastic and autocorrelation consistent (HAC) standard errors (2 Newey-West lags) are given in parentheses.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

Table 8. Global and Local CAPM Performance

	USD	USD	EUR	EUR	JPY	JPY	GBP	GBP	CAD	CAD	AUD	AUD
	AAA	B	AAA	B	AA	BBB	AAA	B	AAA	B	AA	BBB
	Panel A: Global CAPM											
Glo CAPM	0.117**	0.614***	0.649***	1.485***	0.322**	0.324**	0.519***	1.132***	0.692***	0.949***	1.013***	1.035***
s.e.	(0.047)	(0.111)	(0.094)	(0.195)	(0.129)	(0.128)	(0.098)	(0.184)	(0.083)	(0.105)	(0.083)	(0.091)
Adjusted R^2	0.058	0.361	0.306	0.516	0.066	0.070	0.214	0.342	0.459	0.256	0.521	0.517
	Panel B: Global and local CAPM											
Glo CAPM	0.265***	0.444**	-0.615***	0.042	-0.415***	-0.396***	-0.304**	-0.492**	-0.089	-0.093	-0.053	-0.030
s.e.	(0.091)	(0.177)	(0.152)	(0.177)	(0.064)	(0.064)	(0.133)	(0.201)	(0.096)	(0.211)	(0.085)	(0.096)
Loc CAPM	-0.162**	0.186	1.043***	1.191***	1.053***	1.028***	0.654***	1.292***	0.622***	0.830***	0.612***	0.612***
s.e.	(0.078)	(0.173)	(0.100)	(0.138)	(0.058)	(0.052)	(0.088)	(0.140)	(0.051)	(0.124)	(0.037)	(0.041)
Adjusted R^2	0.073	0.364	0.717	0.687	0.763	0.760	0.402	0.588	0.777	0.423	0.779	0.763

Notes: This table shows the OLS coefficients and adjusted R^2 of CAPM regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA; high yield: B, except for the Japanese JPY and Australian dollar for which AA and BBB ratings are used) and the regressors are global excess returns of (i) Global CAPM (Panel A); and (ii) Global and Local CAPM (Panel B), obtained from corporate bonds, sovereign bonds and stocks. The portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Heteroskedastic and autocorrelation consistent (HAC) standard errors (2 Newey-West lags) are given in parentheses.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

Table 9. Testing International Market Integration

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
USD												
Chi-Sq. Glo Fac	0.288	0.439	0.750	0.077	0.129	0.013	0.343	0.029	0.010	0.068	0.040	0.128
Chi-Sq. Loc Fac	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac	0.598	0.659	0.669	0.704	0.644	0.685	0.656	0.668	0.771	0.804	0.745	0.624
Adj. R^2 - 3 LOC Fac	0.862	0.899	0.910	0.938	0.826	0.869	0.818	0.840	0.922	0.947	0.983	0.909
Adj. R^2 - 6 Fac	0.875	0.911	0.917	0.944	0.805	0.831	0.745	0.803	0.907	0.945	0.977	0.908
EUR												
Chi-Sq. Glo Fac	0.000	0.000	0.167	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chi-Sq. Loc Fac	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac	0.703	0.714	0.748	0.75	0.746	0.749	0.589	0.635	0.707	0.768	0.801	0.792
Adj. R^2 - 3 LOC Fac	0.970	0.993	0.994	0.990	0.932	0.887	0.733	0.969	0.995	0.994	0.970	0.911
Adj. R^2 - 6 Fac	0.982	0.996	0.996	0.988	0.837	0.836	0.608	0.984	0.997	0.996	0.987	0.957
JPY												
Chi-Sq. Glo Fac		0.426	0.252	0.791				0.005	0.592	0.088	0.045	0.523
Chi-Sq. Loc Fac		0.000	0.000	0.000				0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac		0.521	0.473	0.474				0.459	0.477	0.503	0.551	0.555
Adj. R^2 - 3 LOC Fac		0.999	0.993	0.982				0.996	0.999	0.995	0.992	0.942
Adj. R^2 - 6 Fac		0.998	0.996	0.989				0.996	0.999	0.996	0.993	0.958
GBP												
Chi-Sq. Glo Fac	0.130	0.000	0.566	0.002	0.202	0.000	0.287	0.001	0.083	0.586	0.000	0.252
Chi-Sq. Loc Fac	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac	0.520	0.562	0.622	0.646	0.622	0.643	0.375	0.47	0.554	0.641	0.679	0.591
Adj. R^2 - 3 LOC Fac	0.884	0.976	0.988	0.979	0.854	0.721	0.526	0.857	0.918	0.957	0.986	0.950
Adj. R^2 - 6 Fac	0.916	0.982	0.989	0.980	0.808	0.718	0.421	0.862	0.919	0.954	0.982	0.947
CAD												
Chi-Sq. Glo Fac	0.598	0.000	0.132	0.043	0.536	0.213		0.000	0.011	0.185	0.005	0.003
Chi-Sq. Loc Fac	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac	0.572	0.533	0.585	0.584	0.488	0.347		0.504	0.548	0.584	0.590	0.577
Adj. R^2 - 3 LOC Fac	0.974	0.986	0.994	0.992	0.801	0.536		0.956	0.982	0.994	0.979	0.915
Adj. R^2 - 6 Fac	0.971	0.988	0.995	0.989	0.794	0.505		0.956	0.983	0.993	0.981	0.929
AUD												
Chi-Sq. Glo Fac		0.000	0.016	0.014				0.000	0.022	0.000	0.045	0.109
Chi-Sq. Loc Fac		0.000	0.000	0.000				0.000	0.000	0.000	0.000	0.000
Adj. R^2 - 3 GLO Fac		0.625	0.649	0.637				0.613	0.639	0.665	0.660	0.676
Adj. R^2 - 3 LOC Fac		0.998	0.993	0.990				0.996	0.998	0.985	0.912	0.897
Adj. R^2 - 6 Fac		0.999	0.996	0.992				0.997	0.998	0.989	0.947	0.921

Notes: This table shows the adjusted R^2 of multi-factor OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns of (i) six factors (6 Fac)), three global and three local factors, comprising aggregate corporate bonds, sovereign bonds and stocks; (ii) three global factors (3 GLO Fac) comprising aggregate corporate bonds, sovereign bonds and stocks; and (iii) three local factors (3 LOC Fac) comprising aggregate corporate bonds, sovereign bonds and stocks. The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. "Chi-Sq. Glo Fac" and "Chi-Sq. Loc Fac" are the Chi-Square's P-value of the Wald test testing the joint significance of all global factors and all local factors, respectively. Sample period: February 1998 – August 2018.

Table 10. Fitting the Volatility Patterns

	Global	USD	EUR	JPY	GBP	CAD	AUD	FE	POOL
			Panel A: Alphas from the global three-factor model						
Intercept	-0.086**	0.112***	-0.069**	-1.091***	-0.564***	-0.206**	-0.266	-0.171***	0.001
s.e.	(0.034)	(0.014)	(0.031)	(0.101)	(0.086)	(0.08)	(0.547)	(0.017)	(0.058)
Slope	0.014***	0.000	-0.006**	0.083***	0.045***	0.025**	0.018	0.015***	-0.002
s.e.	(0.004)	(0.002)	(0.002)	(0.009)	(0.007)	(0.008)	(0.043)	(0.002)	(0.006)
Adjusted R^2	0.250	-0.100	0.147	0.891	0.854	0.524	-0.123	0.593	-0.012
Portfolios	12	12	12	8	12	11	8	75	75
			Panel B: Alphas from the local three-factor model						
Intercept		0.057**	-0.138***	-0.187***	-0.609***	-0.185*	0.014	-0.224***	-0.156***
s.e.		(0.025)	(0.036)	(0.032)	(0.073)	(0.099)	(0.747)	(0.030)	(0.054)
Slope		-0.009**	0.013***	0.018***	0.055***	0.020*	0.000	0.023***	0.017***
s.e.		(0.004)	(0.003)	(0.003)	(0.006)	(0.010)	(0.059)	(0.003)	(0.005)
Adjusted R^2		0.226	0.529	0.599	0.911	0.301	-0.167	0.384	0.323
Portfolios		12	12	8	12	11	8	63	63
			Panel C: Alphas from the (three local and three global) six-factor model						
Intercept		0.054	0.053*	-0.177***	-0.537***	-0.226**	0.221	-0.139***	-0.093**
s.e.		(0.030)	(0.024)	(0.035)	(0.087)	(0.085)	(0.736)	(0.027)	(0.037)
Slope		-0.008	-0.005**	0.017***	0.049***	0.024**	-0.016	0.015***	0.010***
s.e.		(0.005)	(0.002)	(0.003)	(0.007)	(0.009)	(0.058)	(0.003)	(0.004)
Adjusted R^2		0.177	0.129	0.518	0.852	0.462	-0.144	0.188	0.132
Portfolios		12	12	8	12	11	8	63	63

Note: This table shows the intercept and the slope coefficient of the alpha regressisons against the standard deviation of each portfolio. Alphas are obtained from the global three-factor model in Panel A, the local three-factor model in Panel B and the (three local and three global) six-factor model in Panel C. The panel FE model controls for time-invariant unobserved heterogeneity at currency level. Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Heteroskedastic consistent (HC) White standard errors are given in parentheses.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

Table 11. Residual Correlations

	Global CAPM	Global three factors	Global and local six factors	Local three factors
Global				
Correlation AAA / AA	0.879***	0.239***		
Correlation AAA / BBB	0.675***	-0.380***		
Correlation AAA / B	-0.058	-0.352***		
Correlation BBB / B	0.433***	0.154		
Correlation BB / B	0.858***	0.686***		
Correlation 1to3 / 3to5	0.948***	0.882***		
Correlation 1to3 / >10	0.401***	-0.859***		
Correlation 7to10 / >10	0.867***	0.487***		
USD				
Correlation AAA / AA	0.921***	0.887***	0.626***	0.613***
Correlation AAA / BBB	0.672***	0.606***	-0.287*	-0.297**
Correlation AAA / B	-0.120	-0.005	-0.489***	-0.454***
Correlation BBB / B	0.475***	0.416***	-0.058	-0.063
Correlation BB / B	0.866***	0.764***	0.578***	0.600***
Correlation 1to3 / 3to5	0.932***	0.829***	0.731***	0.725***
Correlation 1to3 / >10	0.582***	0.201**	-0.681***	-0.682***
Correlation 7to10 / >10	0.874***	0.778***	-0.302***	-0.264***
EUR				
Correlation AAA / AA	0.986***	0.974***	0.397***	0.501***
Correlation AAA / BBB	0.932***	0.927***	-0.273***	-0.339***
Correlation AAA / B	0.514***	0.547***	-0.012	-0.157*
Correlation BBB / B	0.684***	0.591***	0.149	0.231**
Correlation BB / B	0.781***	0.579***	0.333***	0.408***
Correlation 1to3 / 3to5	0.989***	0.985***	0.634***	0.763***
Correlation 1to3 / >10	0.847***	0.697***	-0.792***	-0.865***
Correlation 7to10 / >10	0.962***	0.921***	0.758***	0.845***
JPY				
Correlation AA / A	0.991***	0.985***	-0.416***	-0.400***
Correlation AA / BBB	0.987***	0.978***	-0.351***	-0.348***
Correlation 1to3 / 3to5	0.997***	0.995***	0.440***	0.432***
Correlation 1to3 / >10	0.909***	0.835***	-0.582***	-0.597***
Correlation 7to10 / >10	0.974***	0.946***	0.370***	0.385***
GBP				
Correlation AAA / AA	0.949***	0.932***	0.528***	0.532***
Correlation AAA / BBB	0.866***	0.861***	-0.192	-0.236*
Correlation AAA / B	0.433***	0.372***	-0.064	-0.116
Correlation BBB / B	0.654***	0.462***	0.230	0.346**
Correlation BB / B	0.723***	0.511***	0.345***	0.359***
Correlation 1to3 / 3to5	0.981***	0.975***	0.910***	0.911***
Correlation 1to3 / >10	0.762***	0.628***	-0.900***	-0.887***
Correlation 7to10 / >10	0.922***	0.873***	-0.377***	-0.335***
CAD				
Correlation AAA / AA	0.966***	0.964***	0.365***	0.323**
Correlation AAA / BBB	0.943***	0.936***	-0.275***	-0.261**
Correlation AAA / B	0.350***	0.408***	-0.199***	-0.205***
Correlation BBB / B	0.435***	0.467***	-0.039	-0.030
Correlation BB / B	0.526***	0.509***	0.238***	0.244***
Correlation 1to3 / 3to5	0.980***	0.979***	0.767***	0.782***
Correlation 1to3 / >10	0.767***	0.735***	-0.883***	-0.894***
Correlation 7to10 / >10	0.937***	0.921***	0.426***	0.465***
AUD				
Correlation AA / A	0.990***	0.989***	-0.412***	-0.503***
Correlation AA / BBB	0.985***	0.982***	-0.613***	-0.647***
Correlation 1to3 / 3to5	0.984***	0.984***	-0.715***	-0.725***
Correlation 1to3 / >10	0.733***	0.719***	-0.359***	-0.456***
Correlation 7to10 / >10	0.837***	0.762***	0.304**	0.384**

Note: This table shows the correlation coefficients between the residuals of OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns of (i) global CAPM with all securities, (ii) three global factors comprising aggregate corporate bonds, sovereign bonds and stocks; (iii) six factors (three global and three local factors) comprising aggregate corporate bonds, sovereign bonds and stocks; and (iii) three local factors comprising aggregate corporate bonds, sovereign bonds and stocks. The correlations are estimated using GMM methods under sequential weighting matrix and coefficient iteration. *,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

Table 12. Adjusted R^2: Factor Models versus Spread Models

	AAA	AA	A	BBB	BB	B	C	1-to-3	3-to-5	5-to-7	7-to-10	> 10
USD												
Local three factors	0.872	0.910	0.918	0.943	0.798	0.819	0.745	0.803	0.904	0.944	0.976	0.907
Spread B-AAA	0.913	0.956	0.959	0.941	0.883	0.981	0.842	0.746	0.893	0.963	0.976	0.911
Spread Maturity	0.641	0.798	0.863	0.942	0.692	0.597	0.521	0.930	0.971	0.948	0.973	0.993
EUR												
Local three factors	0.980	0.995	0.996	0.987	0.818	0.809	0.558	0.972	0.996	0.994	0.976	0.937
Spread B-AAA	0.973	0.992	0.995	0.988	0.844	0.991	0.771	0.971	0.995	0.995	0.977	0.916
Spread Maturity	0.949	0.982	0.995	0.984	0.708	0.637	0.329	0.995	0.998	0.995	0.992	0.996
JPY												
Local three factors		0.998	0.996	0.989				0.996	0.999	0.996	0.993	0.957
Spread BBB-AA		0.996	0.992	0.992				0.987	0.997	0.994	0.974	0.901
Spread Maturity		0.997	0.995	0.988				0.998	0.999	0.996	0.992	0.998
GBP												
Local three factors	0.915	0.981	0.989	0.977	0.805	0.661	0.409	0.852	0.916	0.954	0.981	0.947
Spread B-AAA	0.905	0.978	0.991	0.980	0.829	0.968	0.496	0.856	0.922	0.954	0.981	0.954
Spread Maturity	0.864	0.969	0.994	0.976	0.760	0.571	0.369	0.991	0.990	0.970	0.975	0.995
CAD												
Local three factors	0.971	0.987	0.995	0.988	0.793	0.497		0.951	0.982	0.993	0.980	0.923
Spread B-AAA	0.969	0.987	0.995	0.988	0.795	0.991		0.943	0.981	0.993	0.980	0.913
Spread Maturity	0.964	0.995	0.997	0.989	0.777	0.393		0.996	0.996	0.993	0.986	0.998
AUD												
Local three factors		0.998	0.995	0.992				0.997	0.998	0.987	0.941	0.915
Spread BBB-AA		0.999	0.996	0.999				0.995	0.997	0.980	0.924	0.838
Spread Maturity		0.999	0.996	0.992				0.999	0.998	0.994	0.999	0.894

Notes: This table shows the adjusted R^2 of the the local three factor model, comprising aggregate corporate bonds, sovereign bonds and stocks, and the local corporate bond market plus a spread factor. The spread factor is computed as a differecen between excess returns in B and AAA rating categories (except for JPY and AUD for which the spread in BBB and AA rating categories is used) and between >10 and 1< to <3 residual maturity ("Spread Maturity") categories. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.

Table 13. Multi-Local Factor Regressions and Bond Risk Characteristics: Panel Regression

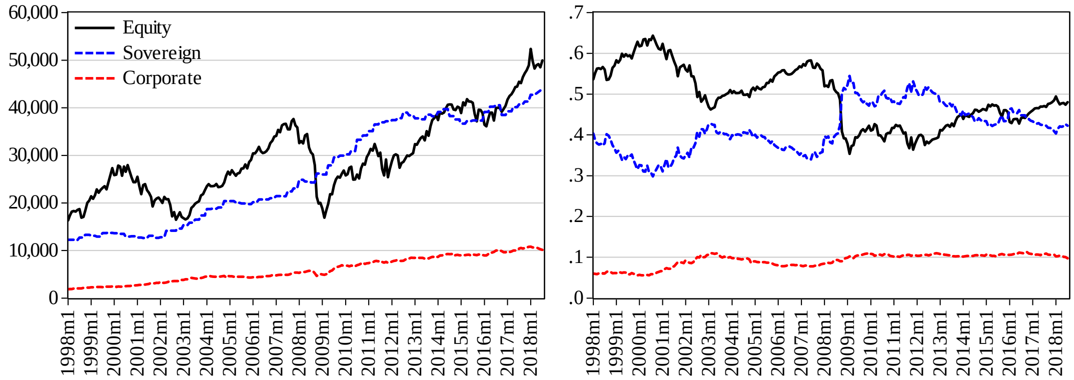
VARIABLES	USD	EUR	JPY	GBP	CAD	AUD
			Intercept and bond characteristics			
Constant	0.044***	0.086***	0.051***	-0.522***	0.172***	0.327***
	(0.013)	(0.025)	(0.015)	(0.151)	(0.026)	(0.027)
Rating	0.004**	-0.001	-0.007***	0.070***	-0.022***	-0.034***
	(0.002)	(0.004)	(0.002)	(0.017)	(0.004)	(0.004)
Maturity	-0.003***	-0.009***	0.001	0.011**	0.004***	-0.030***
	(0.001)	(0.003)	(0.002)	(0.005)	(0.001)	(0.005)
Secured	0.048***	0.169***	0.030***	-0.104*	-0.000	0.049
	(0.012)	(0.039)	(0.009)	(0.053)	(0.016)	(0.034)
Junior Unsecured	0.189**	0.296***	0.126***	0.254***	-0.055***	0.079
	(0.085)	(0.051)	(0.020)	(0.097)	(0.019)	(0.105)
			Slope and bond characteristics			
Local Sov. * Rating	-0.049***	-0.058***	-0.073***	-0.018**	-0.033***	-0.039***
	(0.001)	(0.004)	(0.001)	(0.008)	(0.002)	(0.002)
Local Eq. * Rating	0.002***	0.006***	-0.001***	0.003	0.001*	-0.000
	(0.000)	(0.001)	(0.000)	(0.003)	(0.001)	(0.001)
Local Corp. * Rating	0.104***	0.126***	0.196***	0.093***	0.139***	0.144***
	(0.002)	(0.004)	(0.002)	(0.010)	(0.003)	(0.003)
Local Sov. * Maturity	0.025***	0.069***	0.088***	0.019***	0.025***	0.066***
	(0.000)	(0.003)	(0.002)	(0.003)	(0.001)	(0.004)
Local Eq. * Maturity	-0.001***	-0.002***	0.001***	-0.003***	-0.002***	0.003
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.002)
Local Corp. * Maturity	0.022***	0.004	-0.049***	0.017***	-0.003**	0.047***
	(0.001)	(0.003)	(0.003)	(0.003)	(0.001)	(0.005)
Local Sov. * Secured	0.122***	0.017	0.040**	0.066	0.059***	0.052
	(0.015)	(0.058)	(0.019)	(0.057)	(0.023)	(0.037)
Local Eq. * Secured	-0.024***	0.011	-0.020***	0.042**	0.005	-0.017
	(0.006)	(0.013)	(0.003)	(0.020)	(0.006)	(0.015)
Local Corp. * Secured	-0.184***	-0.154**	0.175***	-0.157**	0.031	-0.116**
	(0.023)	(0.065)	(0.023)	(0.068)	(0.028)	(0.051)
Local Sov. * Junior	-0.147***	-1.068***	0.042	-1.174***	-0.265***	-0.204***
	(0.043)	(0.085)	(0.038)	(0.117)	(0.028)	(0.078)
Local Eq. * Junior	-0.053***	0.109***	0.003	-0.035	0.010	0.046
	(0.018)	(0.021)	(0.006)	(0.045)	(0.006)	(0.030)
Local Corp. * Junior	-0.125	1.211***	-0.024	1.431***	0.450***	0.092
	(0.187)	(0.104)	(0.045)	(0.152)	(0.032)	(0.100)
Number of observations	1,493,469	385,295	200,927	158,098	169,586	53,873
R-squared	0.0685	0.478	0.844	0.228	0.640	0.797

Notes: This table shows the coefficients of multi factor Panel regressions where the dependent variables are corporate bond-specific excess returns at CUSIP level and the regressors are local sovereign (SOV.), equity (Eq.) and corporate bond (Corp.) excess returns interacted with the following bond characteristics: ratings, residual maturity, unsecured senior bonds and junior bonds. Unsecured senior bonds and the interaction between the local factors and the unsecured senior bonds are omitted due to collinearity. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Robust standard errors are given in parenthesis.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

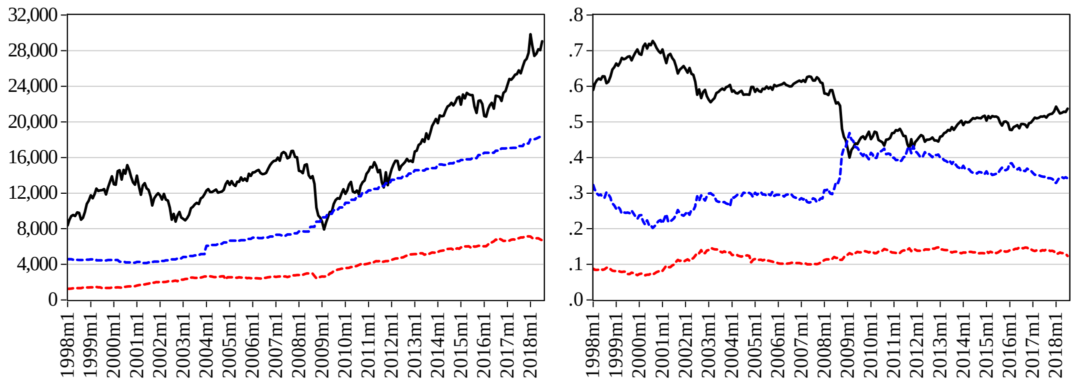
Figure 1. Market Size and Shares

Market Size (USD billion)	Market Share

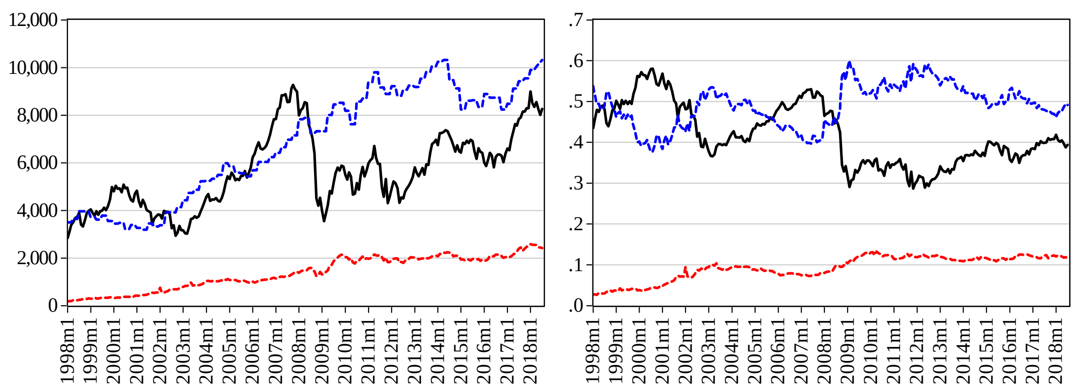
United States, Euro Area, Japan, United Kingdom, Canada and Australia



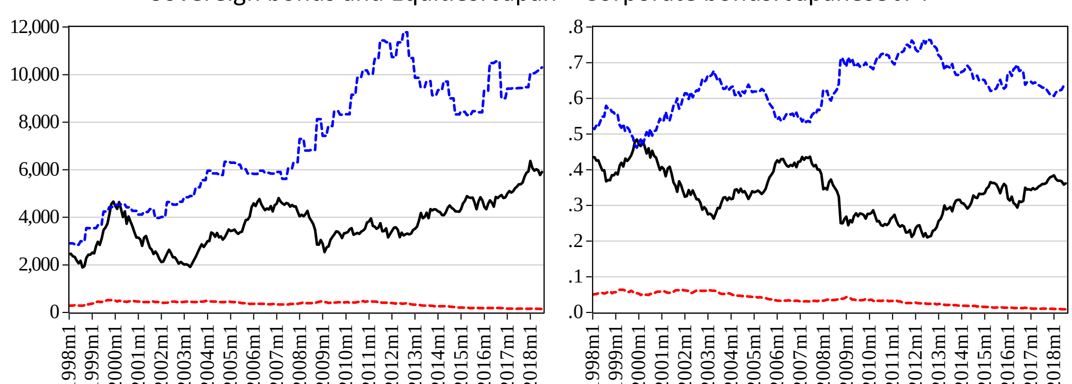
Sovereign bonds and Equities: US – Corporate bonds: US dollars



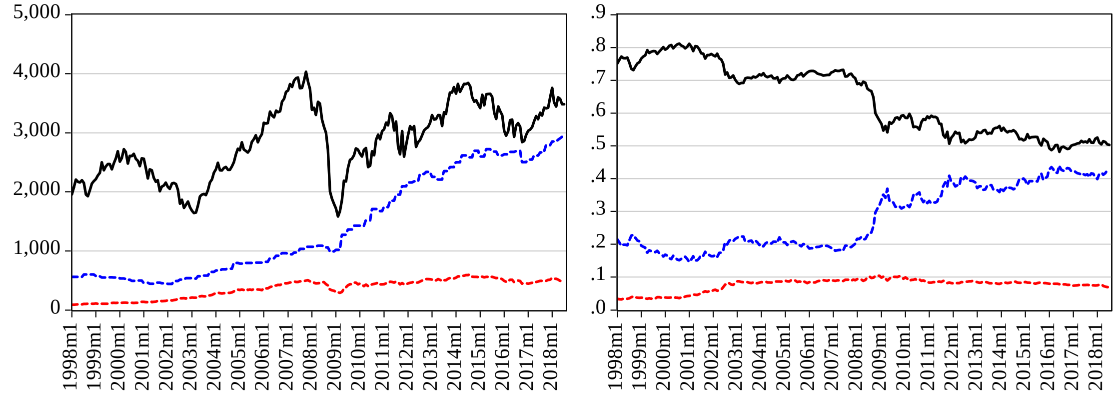
Sovereign bonds and Equities: Euro area – Corporate bonds: euro and pre-euro currencies



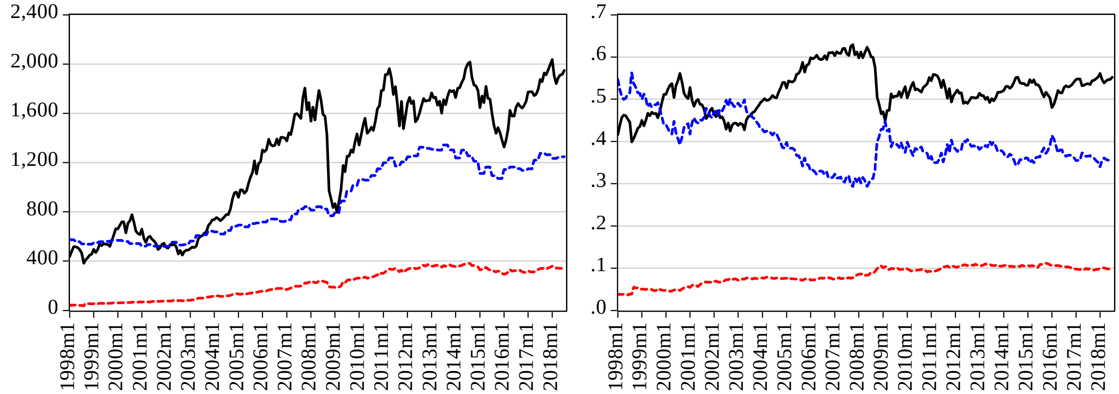
Sovereign bonds and Equities: Japan – Corporate bonds: Japanese JPY



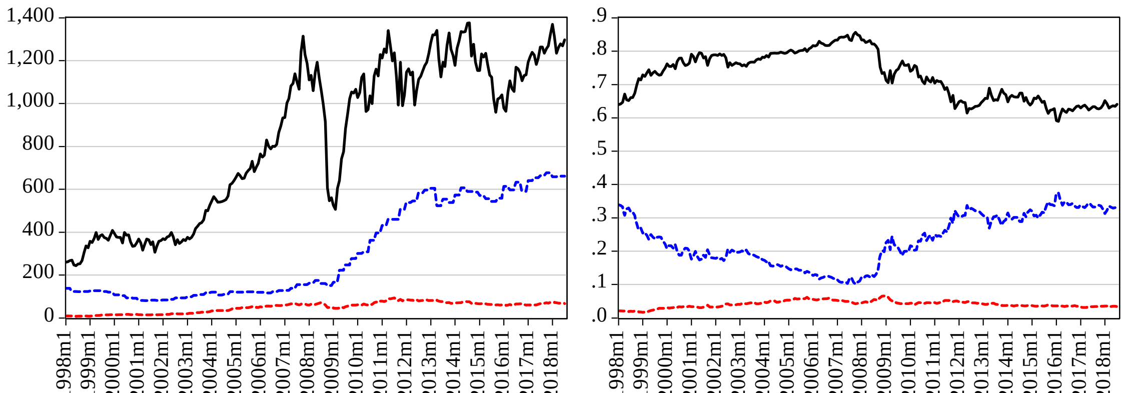
Sovereign bonds and Equities: United Kingdom – Corporate bonds: British pounds



Sovereign bonds and Equities: Canada – Corporate bonds: Canadian dollars



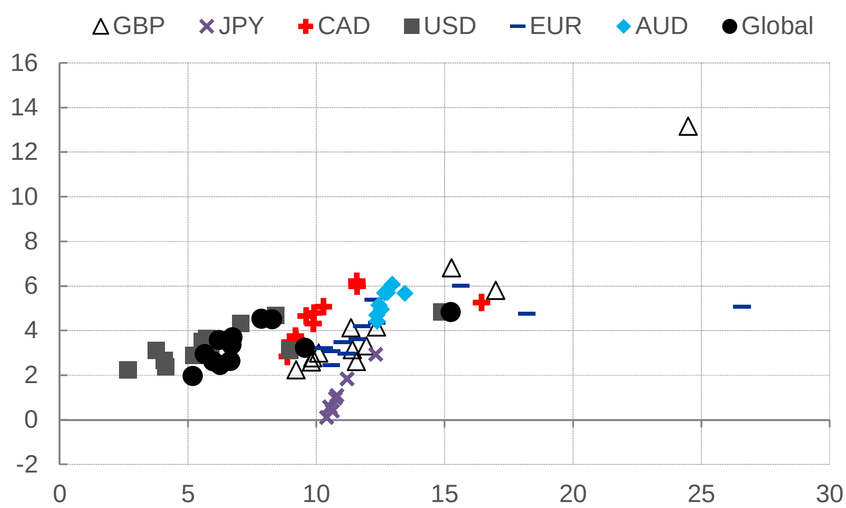
Sovereign bonds and Equities: Australia – Corporate bonds: Australian dollars



Source: BIS, Thomson DataStream, BofAML and authors' calculations.

Notes: This figure show the market size on the left panel and the respective market shares on the right panel. The market value of corporate bonds is constructed multiplying the corporate bond price by the face value of the bond, and the aggregation covers all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). The market value of stocks is the total dollar value of all outstanding shares in Thomson DataStream stock market index. The book value of sovereign bonds is the total dollar value of sovereign debt. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. Sample period: January 1998 – August 2018.

Figure 2. Excess Returns and Volatility among all Currency Portfolios



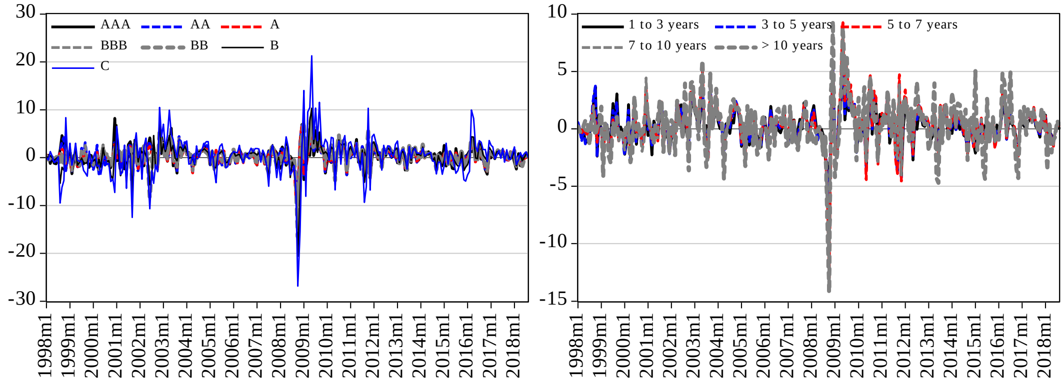
	GLOBAL	USD	EUR	JPY	GBP	CAD	AUD	FE	POOL
Intercept	1.635***	2.058***	2.216***	-14.643***	-4.42***	1.429	-9.469	0.237	1.058**
s.e.	(0.377)	(0.246)	(0.635)	(1.03)	(0.349)	(1.348)	(5.329)	(0.431)	(0.483)
Slope	0.230***	0.207***	0.135***	1.441***	0.691***	0.297**	1.163**	0.338***	0.260***
s.e.	(0.039)	(0.040)	(0.039)	(0.093)	(0.028)	(0.125)	(0.420)	(0.039)	(0.043)
Adjusted R^2	0.426	0.588	0.276	0.938	0.942	0.296	0.448	0.674	0.325
Portfolios	12	12	12	8	12	11	8	75	75

Notes: This figure shows the average percent annualised excess returns of rating portfolios (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) and residual maturity portfolios (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) for each currency (USD, EUR, JPY, GBP, CAD, AUD) on the y-axis and their respective percent annualised standard deviations on the x-axis. "Intercept" and "Slope" are the regression coefficients of the excess returns vis-à-vis the standard deviations. The last two columns show the panel results with country fixed effects (FE) as well as the pooled estimation (POOL). The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Corporate bond excess returns, converted in US dollars, are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. The risk free rate is the one-month US Treasury bill. Heteroskedastic consistent (HC) White standard errors are given in parentheses.*,**, and*** indicate the significance at the 10%, 5% and 1% levels, respectively. Sample period: February 1998 – August 2018.

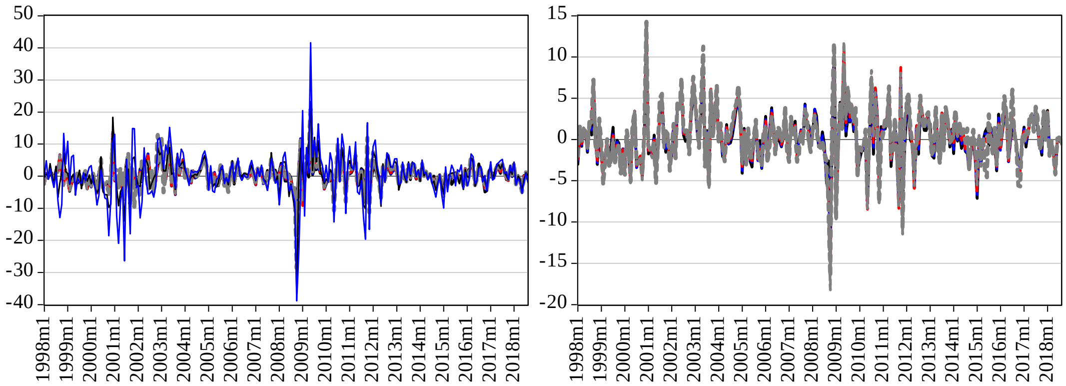
Figure 3. Currency Corporate Portfolio Excess Returns

Credit ratings	Residual maturity

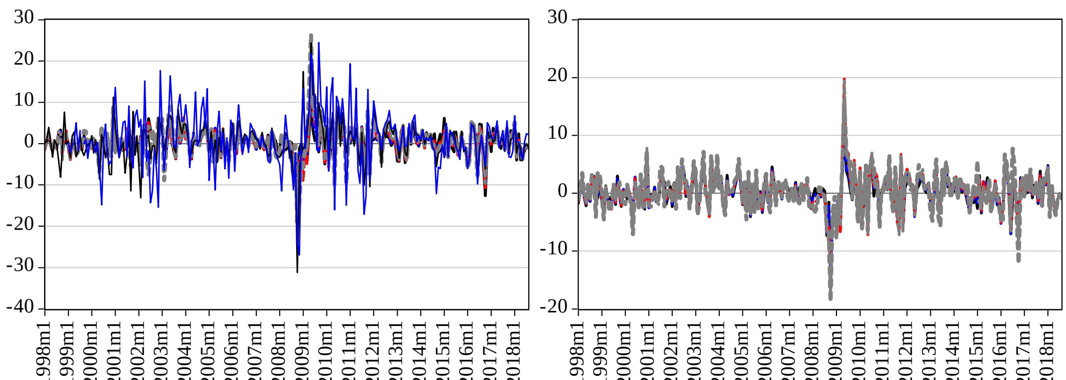
Global



Euro



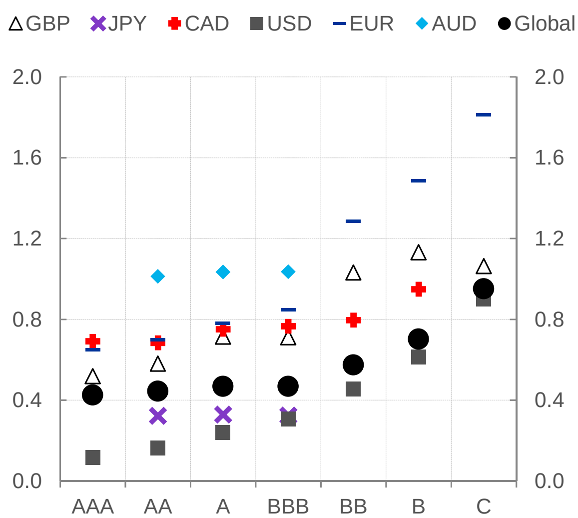
British pounds



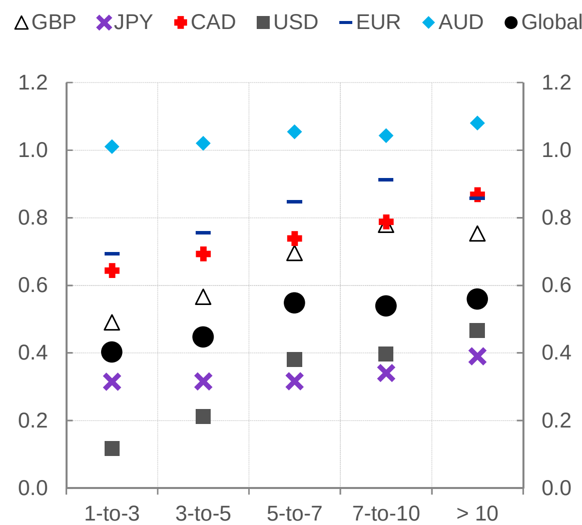
Notes: This figure show the percent annualised excess returns of rating portfolios (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) and residual maturity portfolios (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) for the global as well as the EUR- and the GBP-denominated portfolios. Portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Sample period: January 1998 – August 2018.

Figure 4. Global CAPM Betas

Panel A: Rating porfolios



Panel B: Residual maturity portfolios

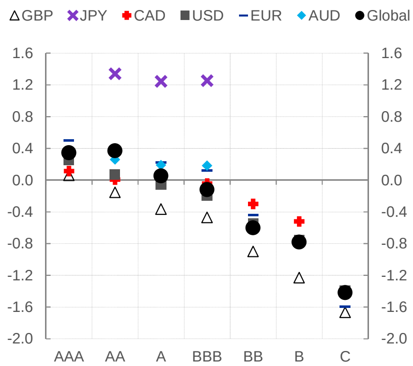


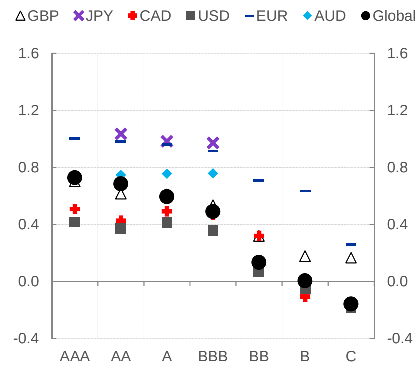
Notes: This figure shows the beta coefficients of OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns with three securities (corporate bonds, sovereign bonds and stocks) for each currency (USD, EUR, JPY, GBP, CAD, AUD). The twelve portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings and residual maturity. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.

Figure 5. Multi Factor Sovereign, Equity and Corporate Bond Betas

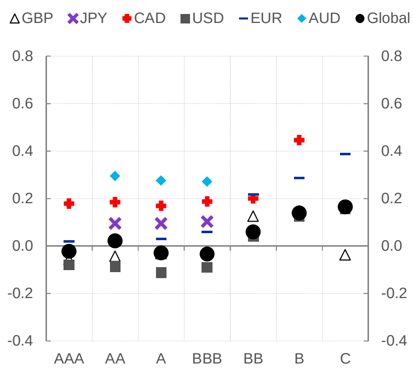
Panel A: Three-factor model | *Panel B: Two-factor model*

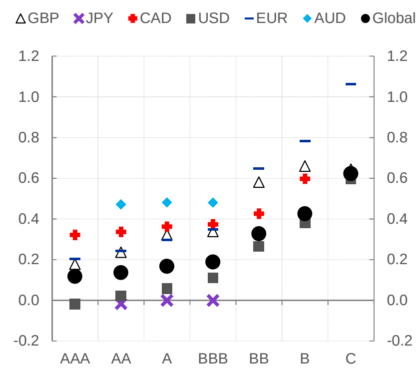
Sovereign betas



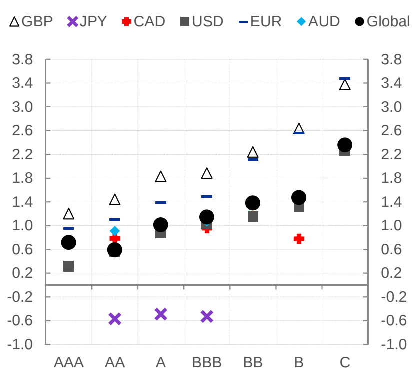


Equity betas





Corporate beta

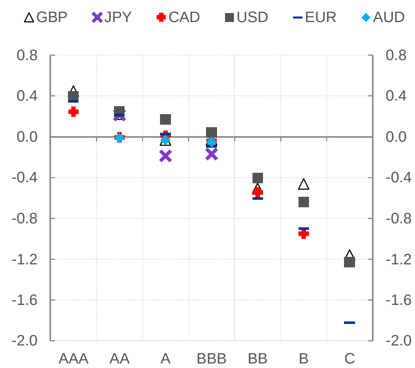


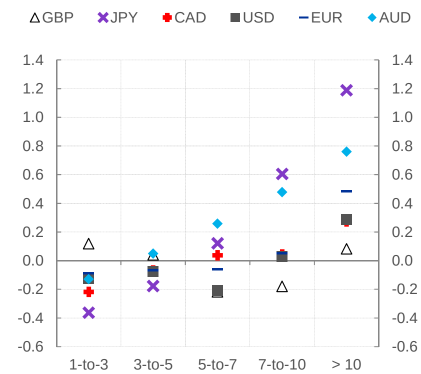
Notes: This figure shows the beta coefficients of multi-factor OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) and the regressors are global excess returns of (i) three factors comprising aggregate corporate bonds, sovereign bonds and stocks; and (ii) two factors comprising aggregate sovereign bonds and stocks. The portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Global factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the above six economies; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the above six economies; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the six currencies. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.

Figure 6. Beta Exposure for the Local Three-Factor Model

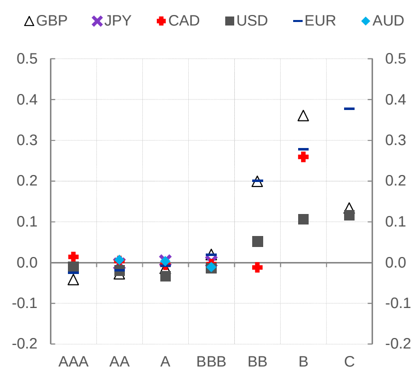
Rating portfolios | *Residual maturity portfolios*

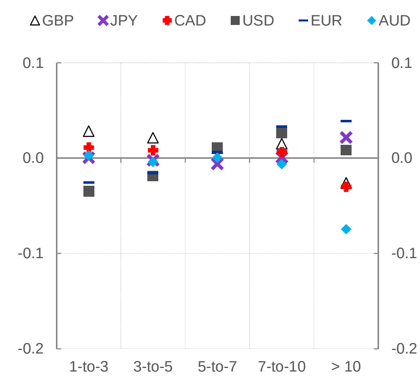
Sovereign betas



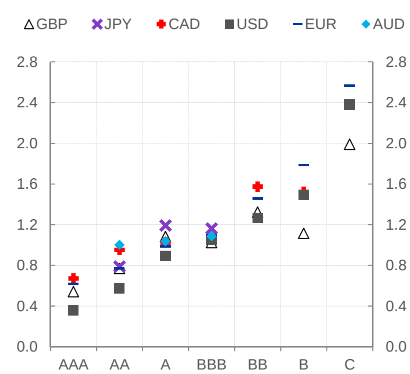


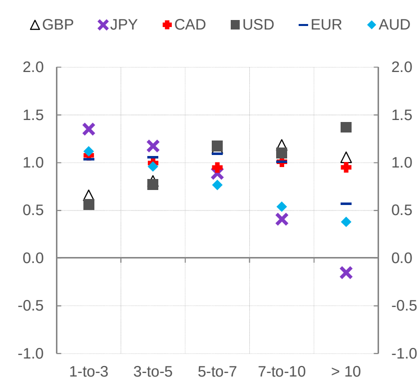
Equity betas





Corporate beta





Notes: This figure shows the beta coefficients of multi-factor OLS regressions where the dependent variables are corporate bond excess returns computed on portfolios based on rating classes (investment grade: AAA, AA, A, BBB; high yield: BB, B, C) or residual maturity (1-to-3 years, 3-to-5 years, 5-to-7 years, 7-to-10 years, > 10 years) and the regressors are global excess returns of local three factors comprising local aggregate corporate bonds, sovereign bonds and stocks. The portfolios are formed every month from January 1998 to August 2018 by sorting corporate bonds based on their credit ratings. Corporate bond excess returns are constructed using all bonds issued in US, euro area, Japan, UK, Canada and Australia in the six currencies (USD, EUR, JPY, GBP, CAD, AUD). Local factors: (i) book-value-weighted sovereign bond excess returns are constructed using the 7-10 year Thomson DataStream benchmark bond total price index in the country's local currency; (ii) market-value-weighted equity excess returns are constructed using the Thomson DataStream equity total price index in the country's local currency; (iii) market-value-weighted corporate bond excess returns are constructed using all corporate bonds issued in the above six economies in the local currency. The EUR includes also the pre-euro currencies: Deutsche Mark, French Frank, Italian Lira, Spanish Peseta, Dutch Guilders and ECU. Currencies are converted in US dollars. The risk free rate is the one-month US Treasury bill. Sample period: February 1998 – August 2018.