The Joys of Industrial Diversification in the Stock and Eurobond Markets

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Abstract

Although the positive effect of international diversification on portfolio risk is well understood what causes it is still an open issue. Several studies find that the difference in industrial structure across countries explains little of the total risk reduction achievable in international portfolios. In this paper we re-appraise the extend of industry effects in the return volatility of stock portfolios and find them to be substantially larger than it was previously thought. We also find that both geographical and industrial diversification cause a significant reduction in the spread return volatility of bond portfolios while their impact on interest rate risk is much weaker. Maturity, seniority and rating diversification effects are also investigated.

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1. Introduction

Several studies have tried to explain why international diversification is effective in reducing portfolio risk. Lessard (1974) argues that the systematic risk component of stock returns in a country is generally not systematic globally. Hence, to a degree, locally systematic risk can be diversified by distributing portfolio holdings across countries. Lessard points out that the resulting decline in international portfolio risk depends on idiosyncrasies between two distinct sources of return variation namely, country risk factors and industry risk factors. International differences in legal system, monetary and fiscal policy, access to credit and capital markets justify the existence of country specific factors. In addition, industrial structures are non-homogeneous across countries. This too may be responsible for the low covariation of international stock returns. Lessard finds that industry factors explain a small portion of national stock index returns while much stronger is the explanatory power of country factors. So, the latter, he concludes, are the main cause behind the portfolio risk reduction effect of international diversification. Several papers since have looked at the same question producing conflicting evidence. Roll (1992) finds that industrial composition is an important determinant of the low correlation among country stock index returns. On the other hand, using a different approach based on a decomposition of stock returns into country and industry effects Heston and Rowenhorst (1994) and Griffin and Karolyi (1998) show that industry effects are responsible but for a fraction of the risk reduction achievable in internationally diversified portfolios. In this study, building on the model introduced by Heston and Rowenhorst, and by proposing a new way of interpreting the model's estimates, we show that industry effects may have been substantially underestimated in previous research.

We contribute to the existing literature in four ways. First, we present an analysis of the main determinants of the international covariation of stock as well as corporate bond portfolio returns. Although previuos researcher have explored corporate bond diversification (Ibbotson, Carr and Robinson 1982, Grauer and Hakansson 1987, Levy and Lerman 1988 and Eichholtz 1996) none, to our knowledge, has investigated the causes behind diversification in bond portfolios. In this study, we isolate and compare country, industry, maturity, seniority and rating diversification effects in a large sample of eurobonds. Maturity diversification has long been aknowledged as a source of portfolio risk reduction (see Roll 1971), but the impact of the distribution of a bond portfolio across seniority classes and rating categories has not been previously explored.

Second, we extend previous research by studying the influence of *national* industry effects on portfolio risk. Roll (1992), Beckers, Grinold, Rudd and Stefek (1992), Drummen and Zimmermann (1992), Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998) among others, employ country and *global* industry factors to gauge the relative importance of country and industry effects on international portfolios. However, this approach may conceal the diversification benefits that stem from idiosyncrasies among *national* industries within the same broad global industry sector. We argue that there is no compelling reason why, for example, the banking sector in the US should be subject to the same systematic risk factors as the banking sector in France or Germany. La Porta et al (1998) report that the origin and characteristics of the legal systems around the world can be traced back to four distinct legal families in which, for example, lenders' rights are protected with a varying degree. This undoubtedly creates a substantially different legal environment for banks in Anglo-Saxon countries and their German or French counterparts. A counterargument could be that legal differences across countries are captured by country factors but this is only the case if such differences apply across all sectors, for instance, via commercial or bankruptcy law. However, when legal idiosyncrasies are specific to one sector they could only be captured by national industry factors. Another instance in which the heterogeneity of national industries within the same global industry is more noticeable may be given by the energy sector. The energy sector in a country is shaped by several forces among which, the availability of natural energy sources (oil, natural gas, coal), technology (nuclear and solar for example) and government policy may be said to play a major role. Hence, in spite of the forces of globalisation, it is likely for energy sectors across countries to maintain a degree of segmentation, which again points to the relevance of risk factors that are specific to national industries.

If national industry diversification is found to be significant, then the implications for portfolio managers would be important. Closer attention would have to be paid to the industrial composition of portfolios at both global and national level. Interestingly, Isakov and Sonney (2003) report that European professional investors have recently started to base their allocation strategies on industry sectors rather than geographical areas, as was traditionally done. This move is also justified in the light of recent research that shows how global industry diversification alone has become increasingly more prominent and in the last years has even overtaken country diversification effects (see Baca, Garbe and Weiss 2000, Cavaglia, Brightman and Aked 2000 and Isakov and Sonney 2003).

Third, we point out that the diversification measure used in the literature based on the Heston and Rowenhorst (HR) model is not an appropriate indicator of diversification gains. We find the indicator is increasingly biased the wider the volatility dispersion of risk factors in the portfolio. The indicator, can lead to serious error, for example, when assessing diversification across developed countries and emerging markets, which typically exhibit large volatility differences, across assets with large beta differentials (stocks and bonds) or across fixed income securities of different maturity or rating. Fourth, to address this problem we propose a new way to measure diversification effects that we call the asymptotic diversification gain indicator (ADGI). The ADGI is not sensitive to volatility dispersion across factors and hence can be generally applied.

One of our main conclusions is that industry effects are markedly stronger than it was previously thought. In our stock sample, the new specification of the HR model that includes national industry effects and the introduction of the new measure of diversification effects cause industry to country diversification gain ratios to increase by more than 60% with local currency returns and more than 80% with common currency returns. The analysis of portfolio total returns in the bond market reveals that the percentage reduction in portfolio risk obtained from country and industry diversification is smaller than in the stock market, although the relative strength of the two diversification effects is similar in both bond portfolio total returns and equity portfolio returns. In bond portfolio *spread* returns, on the other hand, the percentage reduction in portfolio volatility from country and industry diversification is significantly larger than for total bond returns which indicates that sources of spread risk (default risk, recovery risk, liquidity risk and local systematic market risk, see Elton et al 2001) are more diversifiable than interest rate risk, probably owing to increasing convergence of monetary policy among the developed economies considered in our study. Finally, we find that the largest diversification gains in bond portfolio spread returns is via country diversification, followed, in the order, by industry, maturity and credit rating diversification. Seniority diversification gains are negligible.

The paper is organised as follows. Section 2 presents a description of the data. Section 3 introduces the models employed in our analysis. In Section 4 we discuss how models' estimates should be interpreted. Results are summarised in Section 5. Section 6 concludes the paper.

2. Data

The data that we use in this work are stock prices for 2,133 companies obtained from DataStream and 2,539 eurobonds, issued by 469 firms listed on the Reuters 3,000 Fixed Income service. The sample period begins in January 1993 and ends in February 1998 for both samples. The distribution of stocks across countries and industry sectors is presented in Table 1. Stock prices are adjusted for dividends and splits. Table 2 shows a breakdown of our bonds by country, industry, maturity, seniority and rating. We consider three maturity intervals: up to two years, from two to five years and above five years. We distinguish between two seniority categories, "senior" and "junior". Under the first heading we include bonds that are classified as guaranteed, collateralised, mortgaged or senior proper. The second heading comprises unsecured and subordinated issues. A definition for the various seniority types can be found in Appendix A. As mentioned in the previous section all the bonds in the sample are investment grade.[2] They were selected on the basis that they were plain vanilla bonds that is (i) they were neither callable nor convertible; (ii) that the coupons were constant with a fixed frequency; (iii) that repayment was at par and that (iv) they did not possess a sinking fund. All the bond prices in the sample are dealer quotes.

The stock and bond samples include firms from eight countries, namely Australia, Canada, France, Germany, Japan, Netherlands, United Kingdom and United States, and six broad industry sectors defined as in the Financial Times Actuaries/Goldman Sachs. The industry groups are (i) finance (ii) energy; (iii) utilities; (iv) consumer goods and services; (v) capital goods; and (vi) basic industries. In the finance industry we also distinguish between "banking" that denotes depository institutions and "finance" proper that includes non-depository institutions (such as insurance companies, investment banks, asset managers and real estate). We do this to allow for the specific industry effects in the banking sector that may arise because of its particular regulatory environment (capital regulation, deposit insurance and lender of last resort provisions).

3. The Model

The statistical approaches we employ to study alternative diversification effects are the return decomposition model of Heston and Rowenhorst (1994) and an extended version we call Extended HR (ExHR). Through these models, we decompose the cross-section of stock and bond returns into country and industry return effects. For bond total and spread returns we also estimate maturity, seniority and rating effects. We define bond spread returns as the difference between total returns and 'local' risk-free returns. If we made the assumption that foreign exchange risk was fully hedged (e.g. via forward contracts), spread returns could be dealt with in local currency. A common alternative is to convert spread returns into a numeraire currency. The converted spread return would then be,

[2] The rating scale adopted throughout the paper is that of the rating agency Standard and Poor's. However, our bonds may be rated by other agencies. We convert non-S&P ratings to S&P ratings through conversion tables supplied by Reuters.

$$R - R_f = (r - r_f) + r_x(r - r_f)$$

where, R is the converted total bond return, R_f is the converted local risk-free return, r and r_f denote the total bond return in local currency and the local risk-free return in local currency respectively, and r_x is the rate of return of the exchange rate.[3] In this paper, we report results obtained from returns in local currency as well as from returns converted into US dollars.

In the original HR model, stock returns are assumed to obey the following data generating process,

$$\phi_{z,t} = a_t + c_{f,t} + i_{g,t} + e_{z,t} \qquad \textbf{(1)}$$

where a_t is the base level of return in period *t*; $c_{f,t}$ and $i_{g,t}$ are the effect of country *f* and industry *g* respectively; and $e_{z,t}$ is a firm-specific disturbance. The above model implies that country and industry effects are linearly separable. Hence, they can be estimated by decomposing returns with a simple cross-sectional dummy regression, with dummies

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[3] An important implication of this definition is that foreign exchange risk becomes immaterial. As Beckers *et al* (1992) note, the term $r_x(r - r_f)$ is very small and can usually be ignored. If this is the case, then it should not make much difference whether spread returns are converted into a numeraire currency or left in their original currency. In fact, if the size of $r_x(r - r_f)$ is negligible then,

$$R - R_f \cong r - r_f$$

We define the local risk-free return associated with bond *i* at time *t* as follows,

$$r_{f,i,t} = \frac{Q_{i,t}}{Q_{i,t-1}} - 1$$

where,

$$Q_{i,t} = \sum_{\tau > t} c_{i,\tau} B_\tau$$

where c_i are the contractual cash flows of bond *i* (coupon and principal) paid after time *t*. B_τ is a discount factor given by the price of a pure discount risk-free bond issued by the country whose currency, bond *i* is denominated into, and maturing at time τ with a redemption value of one. Risk-free bond price quotes for all the countries represented in the sample are extracted from zero government interest rate curves. The zero curves are bootstrapped from benchmark government bonds provided by Datastream.

capturing the various countries and industries effects represented in the sample. The regression will look like,

$$\phi_z = a + c_1 C_{z,1} + \ldots + c_9 C_{z,9} + i_1 I_{z,1} + \ldots + i_8 I_{z,8} + e_z \qquad \textbf{(2)}$$

where upper case letters denote dummies (C and I stand for country and industry respectively) and lower case letters their coefficients. a is the constant term.

As it stands, the model is not identified because of perfect linear dependence among the regressors. As suggested by HR, this is solved by imposing linear constraints such that the weighted sum of the coefficients of each set of dummies is zero,

$$\sum_{f=1}^{9} \alpha_f c_f = 0 \quad \text{and} \quad \sum_{g=1}^{8} \beta_g i_g = 0 \qquad \textbf{(3)}$$

where, α_f and β_g are the market value weights of country f and industry g and $\sum_f \alpha_f = \sum_g \beta_g = 1$. Such restrictions are appealing for two reasons:

(i) They allow for a more immediate interpretation of the meaning of dummies' coefficients. In every group of dummies, each dummy captures deviations of the dependent variable from the dependent variable's cross-sectional unconditional mean, which corresponds to the regression constant. This is useful because the regression constant has an appealing economic meaning as the mean return of the international market. Therefore, country, industry and other dummies' coefficients describe the cross-sectional behaviour of returns in a particular country, industry or of particular bond characteristics as deviations from the average international market return.

(ii) The second interesting implication that follows from the restrictions is that they provide a simple way to model, and hence understand, the effect of diversification on portfolio returns. Through diversification, portfolio returns lose the source of variation stemming from the dimension being diversified (e.g. the country dimension). For example, by virtue of (3), the return of a portfolio that is geographically diversified will not have a country effect. Therefore, portfolio risk can be seen as composed by a core element that cannot be diversified away, i.e. the volatility of the market as a whole, plus additional sources of volatility that arise because of the differing composition of the portfolio relative to the market. The former type of risk is 'globally' systematic whereas the latter types are only 'locally' systematic because they can be eliminated by increasing asset diversity in the portfolio.[(4)]

We extend the HR model in two ways: (a) To broaden its applicability to bond returns and, (b) to measure the impact of national industry diversification. The former extension is simply obtained by adding maturity, seniority and rating effects to the data generating process. This implies that new dummies are included in equation (2). Three maturity dummies separate bonds with maturities up to 2 years, from 2 to 5 years and above 5 years. Similarly, we distinguish between senior and junior bonds as well as AAA, AA, A and BBB rated bonds. The inclusion of these dummies is consistent with Fama and French (1993) who find that bond returns are affected by both maturity and default risk factors.

The latter extension is implemented by replacing global industry effects with national industry effects in the data generating process. $a+i$ in the HR model represents a global industry factor diversified across countries. One way to measure benefits of cross-industry diversification is to see how much, on average, the volatility of $a+i$ falls when industry effects are diversified away, which results in the industry effect i to disappear due to constraints (3). With the introduction of national industries we shall be able to measure the diversification benefits that come from cross-industry as well as same-industry diversification. Again the gain can be measured by the drop in volatility from

[(4)] The difference between idiosyncratic risk and 'locally' systematic risk is that the former can be decreased by simply increasing the number of assets in the portfolio regardless of their characteristics (ie country of issue, industry, maturity), while the latter can only be diminished through diversification by asset characteristic.

$a+i$ to a where i this time represents a national industry effect.[5] We will show that part of the volatility reduction of geographical diversification is due to national industry effects. Hence, portfolio managers should be as discriminating in selecting national industries as they are in selecting countries when devising their investment policy. The right choice of sectors will allow them to maximise the benefits of country diversification.

The introduction of national industry effects leads to an interesting statistical problem, which relates to how perfect collinearity should be dealt with in regression (2). The group of national industry dummies for one country are perfectly collinear with the dummy for that country. This implies that we need as many restrictions on industry dummy coefficients as there are countries. These are implemented by adjusting the coefficients of the industry dummies associated with any given country so that they can be interpreted as deviations from the country's return effect rather than the global market return as one would normally do. The procedure to achieve this is summarised in Appendix B.

We estimate regression (2) for each month in the sample period using weighted least squares. Bonds and stocks are value weighted. The value of a bond at a particular date is its amount outstanding in US dollars at that date, while the value of a stock is the market capitalization of its issuer in US dollars.

3.1. Global and national industry effects

How would the introduction in (2) of both global and national industry dummies influence our estimations? Do global and national industry dummies capture different effects? To answer these questions we have considered a simple example reported in Table 3. The example shows that the volatility of national industry effects when estimated alone is distributed between the national and global industry effects when they are jointly estimated, without any addition or diminution. Essentially, global industry effects capture the common variation of national industries within a particular global

[5] Measures of diversification gains will be formally discussed in Section 4.

sector, but do not add explanatory power. Therefore, it is not necessary to estimate global industry effects when national industries are used. The extended HR model presented in this paper encompasses the standard HR model. In the Table, we show three examples in which global industries, when estimated in combination with national industries absorb no, some or the whole volatility (Panel A, B and C respectively) of stand-alone national industry effects.

4. Interpretation of models' output

One of the main indicators of country and industry diversification used in the literature based on the HR model[6] is the average variance of the estimated dummy coefficients $\hat{c}$ and $\hat{i}$ in (2), that is, the portion of return that can be attributed to country and industry effects respectively. We call this the return effect variance indicator (REVI).

In this section, we show that the REVI can lead to overestimation of diversification effects when the "pure"[7] factors, $\hat{a}+\hat{c}$ and $\hat{a}+\hat{i}$ have non homogenous volatility. Let us illustrate the problem with an example. Consider two groups of assets with return X_i for $i=1,...,n_X$ and Y_i for $i=1,...,n_Y$. Each group is influenced by a different return effect (e.g. a country effect). Then, we could use the HR model and the REVI to measure the diversification gain one achieves by combining the two groups of assets in a portfolio. First, we will need to estimate the following regression:

$$r_i = a + f_X F_{i,X} + f_Y F_{i,Y} + e_i \qquad \textbf{(4)}$$

where $r_i = X_i$ for $i=1,...,n_X$ and $r_i = Y_i$ for $i = n_X+1,...,N$, $N = n_X + n_Y$, $F_{i,X}$ and $F_{i,Y}$ are dummies that takes a value of 1 when r_i is a return from the first or second group

[6] Heston and Rouwehorst (1994,1995), Griffin and Karolyi (1998), Baca, Garbe and Weiss (2000), Cavaglia, Brightman and Aked (2000) and Isakov and Sonney (2003) among others.
[7] HR name these indices "pure" because they represent the return within a particular country or industry without any industry or country effects respectively.

of assets respectively, and a value of zero otherwise. With equal weighting and the usual constraints, the ordinary least square estimates[8] of a, f_X and f_Y will be,

$$\hat{a} = \frac{1}{N}\sum_{i=1}^{N} r_i = \frac{n_X}{N} X + \frac{n_Y}{N} Y$$

$$\hat{f}_X = \frac{1}{n_X}\sum_{i=1}^{n_X} X_i - \hat{a} = \frac{n_Y}{N}(X - Y)$$

$$\hat{f}_Y = \frac{1}{n_Y}\sum_{i=1}^{n_Y} Y_i - \hat{a} = \frac{n_X}{N}(Y - X)$$

where $X = \frac{1}{n_X}\sum_{i=1}^{n_X} X_i$ and $Y = \frac{1}{n_Y}\sum_{i=1}^{n_Y} Y_i$. It follows that the variance of the two return effects $\hat{f}_X$ and $\hat{f}_Y$ is given by,

$$V\left(\hat{f}_S\right) = k_S\left(\sigma_X^2 + \sigma_Y^2 - 2\sigma_X^2\sigma_Y^2\rho\right) \geq k_S\left(\sigma_X - \sigma_Y\right)^2 \qquad \textbf{(5)}$$

where $k = \left(\frac{N - n_S}{N}\right)^2$, σ_X is the volatility of factor X and σ_Y is the volatility of factor Y, ρ is the correlation between factor X and Y and $s = X, Y$. The REVI will then be

$$REVI = \frac{n_X}{N} V\left(\hat{f}_X\right) + \frac{n_Y}{N} V\left(\hat{f}_Y\right) \qquad \textbf{(6)}$$

With factor correlation equal to 1, one would expect a correct measure of diversification to be zero, as there are no diversification gains from combining in the same portfolio the two groups of assets. However, as it can be easily seen from (5) and (6) this is only the case if the two factors have identical variance, $\sigma_X^2 = \sigma_Y^2$. As the difference in variance

[8] Here, to keep the analysis simple, we use equal weights and ordinary least squares unlike in the rest of the paper. Using value weights and weighted least squares would only complicate the notation without adding insight.

increases, again with $\rho = 1$, so does the REVI. This follows because the lower bound of $V(\hat{f}_S)$, that is the right hand side of the inequality in (5), grows as $|\sigma_X - \sigma_Y|$ increases. Therefore, the REVI increasingly over-estimates diversification gains the larger the dispersion of factor variance. Thus, we need to devise another indicator of diversification effects.

By creating a portfolio with assets that are perfectly correlated but with different volatility, one obtains a portfolio volatility which is simply the average volatility of the assets in the portfolio. Diversification gains, on the other hand, are generated only if the volatility of the portfolio is *below* the average volatility of the assets. This simple observation leads us naturally to an intuitive measure of diversification effects. We define the new measure as the difference between the no-diversification scenario and the scenario when a risk dimension is fully diversified. The no-diversification scenario represents a situation in which the investor concentrates her holdings in one risk factor (e.g. one country). The diversification scenario, on the other hand, represents an investment strategy in which portfolio holdings are spread across all the factors (e.g. across all countries) of the specific risk dimension being diversified. In the models discussed in this study, return effects are defined as deviations from the mean return and they cancel out when diversified. So, the diversification case is exemplified by the volatility of the market return, that is the volatility over time of the constant in regression (2). The no-diversification case is given by the weighted average volatility of the risk factors under analysis (that is the volatility of a portfolio diversified across those factors, and no other factor influence, under the assumption that they are perfectly correlated). We define a "diversification gain indicator" based on the above considerations as

$$DGI = \frac{\left[\sum_j SD\left(\hat{a} + \hat{f}_j\right) w_j\right]^2 - V(\hat{a})}{V(\hat{a})} \qquad \textbf{(7)}$$

where *SD* and *V* denote the standard deviation and variance operators and w_i is the time average weight for factor *i*. Standard deviation and variance are calculated from the time series of $\hat{a}$ and $\hat{f}_j$ obtained by estimating cross-section (4) at different times over the sample period. It is easy to see that this measure, unlike the REVI, is zero in the case of perfect correlation between $\hat{a}+\hat{f}_1$ and $\hat{a}+\hat{f}_2$, and increasing as the correlation between the two indices decreases, which is what we would expect from a suitable indicator of portfolio diversification. For instance, in our example with two groups of assets, the DGI would be

$$DGI = \frac{2\sigma_X \sigma_Y \dfrac{n_X n_Y}{N^2}(1-\rho)}{V(\hat{a})}$$

The desirable properties of this indicator can be easily summarised. If $\rho = 1$, the DGI equals zero regardless of the difference between σ_X and σ_Y. If $\rho < 1$ and $|\sigma_X - \sigma_Y|$ increases but factor covariance remains constant, that is σ_X / σ_Y does not change, then the numerator of the DGI remains unaltered. The denominator, $V(\hat{a})$, will grow because the minimum volatility achievable with total diversification has gone up. So the final effect would be a decline in DGI. The above conditions apply to the REVI, on the other hand, would make it go up, which is misleading as the difference in variance between the no-diversification and the diversification scenarios has remained the same. To conclude, the DGI appears to be a superior diversification indicator in the general case when risk factors in the portfolio have heterogeneous volatility.

4.1 Asymptotic DGI

The DGI as defined in (7) is based on the assumption that the number of assets used to estimate each return effect f_S is sufficiently large as to eliminate from the estimate the impact of idiosyncratic risk. Factors that are poorly populated will have an inflated volatility which in turn will inflate the DGI. This is a particularly serious problem in our analysis because we want to determine if, by allowing for national industry effects, the impact of industry diversification grows. But national industries are the factors with the lowest number of assets, which will result in spuriously high DGI estimates on national industry factors. As a consequence, the DGI of different groups of risk factors could not be meaningfully compared.

To address this problem, we estimate the asymptotic DGI (ADGI) in which instead of factor volatility we employ the factors' average covariance (square rooted) as a proxy for the factors' asymptotic volatility. Similarly, we replace the variance of the average market return in (7), $V(\hat{a})$, with the average market covariance. The procedure to estimate average factor covariances with value weighted returns is described in Appendix C. The key points are as follows. First, we assume the DGP in (1) or its extension when dealing with bond returns. Then, to derive the average covariance of, say, country *f*, we compute the average covariance of the "pure" return of country *f* assets, that is the return of assets in country *f* without any other effect,

$$\phi_{z,t} - i_{g,t} = a_t + c_{f,t} + e_{z,t}$$

We do the same for every factor. On the other hand, the average covariance of the market will simply be the average covariance across the full returns ϕ_z. Hence, the asymptotic DGI will be,

$$ADGI = \frac{\left[\sum_j ASD\left(\hat{a} + \hat{f}_j\right)w_j\right]^2 - AV(\hat{a})}{AV(\hat{a})} \qquad \textbf{(8)}$$

where ASD and AV stand for asymptotic standard deviation and asymptotic variance respectively.

5. Results

Results have been derived with local currency returns as well as with returns converted in US dollars. The advantage of the former approach is that local currency returns are more insulated against foreign exchange risk.[9] This has important implications when studying bond portfolio returns. As foreign exchange risk tends to inflate the importance of country diversification, that effect alone may be responsible for changes in the relative size of country as opposed to industry diversification in bond portfolios. Equity returns, on the other hand, are much larger than bond returns and we find that the marginal effect of currency risk on them is small and unlikely to influence the ranking of alternative diversification effects. We also derive results after converting returns in US dollar for ease of comparison of our findings with previous studies, which often use common currency returns, and to show the effect of geographical and industrial diversification when currency risk is left unhedged.

Table 4 and 5 report descriptive statistics of our stock and bond samples with value weighted local currency monthly returns.[10] The HR model applied to stocks leads to an average country factor volatility and correlation of 3.907% and 0.475 respectively. The average volatility of global industry factors is lower at 3.456% while the correlation is substantially higher at 0.649. When industry and country factors are diversified they will yield the same portfolio volatility equal to the volatility of the global market return $\hat{a}$. Therefore, according to the HR model, from this preliminary analysis, one could tentatively conclude that country diversification is more effective in reducing portfolio risk because it brings about a larger drop in portfolio volatility (which can be inferred from the larger value of country factor volatility). However, when using the extended HR model we reach the opposite conclusion. Average national industry factor volatility is

[9] As Dumas and Solnik (1995) point out local currency returns are not fully free from currency effects as they still include a currency premium.

[10] Descriptive statistics tables with dollar denominated returns have not been included for brevity and can be obtained from the author on request. Dollar stock returns statistics are qualitatively similar to those in Table 4. Dollar denominated bond factor total returns are much more volatile than the local currency ones due to currency risk (which is more noticeable than in stock factors for the smaller magnitude of bond returns). Also, the average correlation of bond total returns of country factors denominated in US dollars is noticeably lower compared with the average local currency country factor return correlation.

higher and its correlation lower than those of country factors. But, as pointed out in Section 4.1, national industry factors are internally much less diversified than all the other factors. This implies that their volatility is affected to a greater extent by idiosyncratic risk. So, a firm conclusion about the relative efficacy of country and industry diversification in the stock market can not be reached from this Table. The problem of idiosyncratic risk in factors is directly addressed in Tables 6 to 8 through the calculation of asymptotic diversification gain indicators.

In Table 5, we report the mean, volatility and correlation of bond total return and spread return for the various factors estimated with the HR and ExHR models. The models yield comparable results for all but industry factors. Also, factor correlations are generally lower for spread returns than for total returns. Interestingly, this implies that interest rate risk is less diversifiable than spread risk. As expected, the ExHR model produces national industry factors that are more volatile (and less correlated) than the global industry factors obtained from the HR model. Both models lead to plausible maturity factors for total and spread returns, with increasing factor mean and volatility as maturity increases. Results for seniority factors, on the other hand, are more surprising. Both the total and spread returns of the senior bond factor have slightly higher mean than the junior bond factor, although we expect the risk premium of senior bonds to be lower. This curious finding is consistent with Fridson and Garman (1997) who show that senior bonds have higher risk premiums than subordinated bonds within the same rating category. The explanation for this result lays in the fact that rating agencies tend to give senior issues a higher rating than junior issues from the same issuer. So, within a particular rating, say A, one can find senior bonds with a probability of default higher than a typical A-rated security because issued by companies with lower rating (i.e. BBB), and junior bonds with lower probability of default because issued by A-rated companies. As a result, the expected loss at default defined as the product between default probability and expected recovery rate may be higher for senior than for junior bonds, thus justifying the higher return of senior bonds.

Another interesting "anomaly" is the total return volatility of rating factors. BBB-rated bonds exhibit a lower volatility than all the more highly rated issues. The total return volatility of a rating factor depends on the volatility of interest rates, the volatility of spreads and the correlation between spreads and interest rates. Our finding can be explained by the negative correlation between corporate bond yield spreads and Treasury yields, discussed in Duffee (1998), which may be stronger for lowly rated issues. This interpretation of the results is confirmed by the volatility of spread returns – also reported in the Table - which, as common sense suggests, is increasing as the rating worsens.

In Tables 6, 7 and 8 we report the two measures of diversification gains discussed in previous sections, the REVI and the ADGI, for equity and bond portfolio returns. One of the main findings, is that industry effects appear to be more important than the standard HR model would allow one to infer. A comparison between the REVI and the ADGI shows that the new measure reveals significantly larger industry diversification effects. This increase, relative to country diversification, is by a factor of 1.61 (1.83) from 0.41 (0.30) to 0.66 (0.54).

With the introduction of national industry effects, local currency (US dollar) diversification gains, as measured by the ADGI, relative to country diversification, rise by a factor of 1.88 (1.92) from an industry over country ADGI ratio of 0.35 (0.28) to one of 0.66 (0.54) in the stock portfolio (Table 6). In the bond market, the increase in the ratio is by a factor of 5.71 (2.99) from 0.10 (0.12) to 0.57 (0.35) for total returns (Table 7). For spread returns (Table 8) the increase is smaller and equal to 1.34 (1.32) from 0.36 (0.35) to 0.48 (0.46).

The more striking difference between the REVI and the ADGI occurs when we look at maturity diversification effects in Table 7. When local currency returns are used with the ExHR (HR) model the REVI shows that maturity diversification is 2.10 (2.17) times more effective in reducing portfolio risk than country diversification. The ADGI based maturity to country ratio is 0.15 (0.15), which leads to the opposite and correct conclusion. As pointed out in Section 4, the difference is due to the wide variation in the volatility of maturity factors which inflates the REVI. A discrepancy of such magnitude is not observed for other groups of factors (industry, seniority and rating factors for example), because the volatility of factors in non-maturity groups is normally much less erratic. When bond total returns are denominated in US dollar, the ratios are overall more aligned and the odd spike in the REVI based maturity/country ratios disappears, as country effects become more prominent because of currency risk.

The ranking in diversification effect on bond portfolio total return (in local currency) that emerges by looking at the ExHR model in Table 7, places in the first position country diversification, followed by industry diversification which is 43% less powerful, and by maturity diversification, 85% weaker. Seniority and rating diversification do not have any significant impact on portfolio risk as measured by the ADGI. The slightly negative ADGI for rating factors is due to the fact that estimated rating return effects are very small (with an estimated variance of one half a basis point, see column 3 in Table 7). Therefore, if rating effects are negligible the average covariance among bonds within a particular rating is not distinguishable from the average covariance across the whole portfolio. The asymptotic ADGI which compares the two covariances should then be zero or marginally deviate from zero in excess or defect, as the results indicate.

Results for bond spreads in Table 8 are not dissimilar from those for total returns. Again the ranking of diversification effects as measured by the ADGI sees country diversification first followed by industry diversification which is 52% less powerful with local currency spreads (54% with US dollar spreads) and by maturity factors, 71% (71%) weaker. Rating diversification brings about a diversification gain which is 16% (16%) of that of country diversification while the relative strength of seniority diversification is negligible. The ADGI of national industry factors reported in the Table have been computed by assuming the average covariance in each national industry to be positive or zero, which is a condition that must hold asymptotically, that is when the number of securities is large.[11] Indeed, while this assumption is not needed for all other factors as

[11] The minimum average correlation of a portfolio tends to zero from below as the number of assets increases. Formally, given a portfolio of n equally weighted assets, with constant asset variance and

they normally include a sufficiently high number of securities, some national industries are poorly populated which, together with the modest size of the average spread return, may cause their average covariance to become negative and result in the computation of the ADGI being not feasible.

6. Conclusion

Several papers have looked at the relative importance of country and industry diversification in international portfolios of stocks. Here we critically appraise previous contributions and point out that industry effects on portfolio diversification have been underestimated. We correct for the estimation bias and conclude that overall industry diversification may have a much stronger impact on portfolio risk than previously believed. In addition, we find that the results from existing models in the literature need to be interpreted with caution, especially when a popular indicator is used to measure diversification effects. We show that when risk factors in the portfolio have heterogeneous volatility such indicator will spuriously inflate causing an over-estimation of diversification gains. We suggest a new indicator that addresses this problem. Finally, we extend previous studies' analysis of country and industry diversification in stock portfolios, by looking at the determinants of diversification in corporate bond portfolios which, to the best of our knowledge, is the first attempt in this direction. From our bond sample we detect smaller diversification benefits from geographical and industrial diversification than in the stock market, after controlling for maturity, seniority and rating influences.

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constant correlation ρ, for portfolio volatility to be positive the following condition must be satisfied, $\rho > -(n-1)^{-1}$.

Appendix A

The following seniority types are listed roughly in decreasing order or repayment priority.

Senior liquidation status types:

1. Collateralised: Collateralised debt is secured by specifically allocated assets including financial instruments, property, equipment, held in trust.

2. Guaranteed: Guaranteed debt is accompanied by a pledged guarantee of (re)payment of interest and/or principal by a non-sovereign government issuer and/or other entity or entities.

3. Mortgage: The issuer has provided an unspecified lien to the bondholders on his properties to satisfy any unpaid obligation.

4. Secured: Secured means that additional security is provided for payment of interest and principal.

5. Senior proper: Denotes an unsecured issue ranked higher than 'unsecured' issues.

Junior liquidation status types:

1. Unsecured: Unsecured means that no provision is made for additional security enhancement. An 'unsecured' security type is ranked higher than any subordinated security types.

2. Subordinated: Denotes issues ranked below 'unsecured' issues.

Source: Reuters 3000 Fixed Income Services.

Appendix B

The procedure to estimate the extended HR model involves imposing restrictions to regression coefficients in a sequential way. The general regression we want to estimate at time t is (the subscript t is not included in expressions below to simplify notation):

$$\phi = a + \sum_{\lambda=1}^{N} c_\lambda C_\lambda + \sum_{\lambda=1}^{N} \sum_{\gamma=1}^{M_\lambda} i_{\lambda,\gamma} I_{\lambda,\gamma} + e$$

where $I_{\lambda,\gamma}$ and $i_{\lambda,\gamma}$ are respectively the dummy and its coefficient for industry γ in country λ. The estimation procedure consists of the following three steps.

Step 1. Since $\sum_{\lambda=1}^{N} C_\lambda$ is equal to the constant vector and $\sum_{\gamma=1}^{M_\lambda} I_{\lambda,\gamma} = C_\lambda$, to avoid multicollinearity we need to eliminate one country and one industry sector in each country. The eliminated coefficients will be reintroduced after estimation as described in Step 2 and 3. Then, the regression becomes,

$$\phi = a + \sum_{\lambda=1}^{N-1} c_\lambda C_\lambda + \sum_{\lambda=1}^{N} \sum_{\gamma=1}^{M_\lambda -1} i_{\lambda,\gamma} I_{\lambda,\gamma} + e$$

Step 2. We now impose restrictions on the remaining national industry coefficients that will allow us to reintroduce the lost coefficients. To do so, we add a constant k_λ to all the estimated coefficients of the industries in country λ, for any λ, such that $\sum_{\gamma=1}^{M_\lambda} \left(\hat{i}_{\lambda,\gamma} + k_\lambda\right) v_{\lambda,\gamma} = 0$, where $v_{\lambda,\gamma} = w_{\lambda,\gamma} w_\lambda^{-1}$ with $w_{\lambda,\gamma}$ denoting the relative weight of industry γ in country λ over the cross-sectional sample $\left(\sum_{\lambda=1}^{N} \sum_{\gamma=1}^{M_\lambda} w_{\lambda,\gamma} = 1 \right)$, and w_λ indicating the relative weight of country λ over the cross-sectional sample $\left(\sum_{\lambda=1}^{N} w_\lambda = 1 \right)$.

Note that $\hat{i}_{\lambda,M_\lambda}$ is equal to zero for all λ due to restrictions in the previous step. It follows that $k_\lambda = -\sum_{\gamma=1}^{M_\lambda} \hat{i}_{\lambda,\gamma} v_{\lambda,\gamma}$ for λ=1,…,N. Next, country and industry coefficients are re-defined as

$\hat{i}^*_{\lambda,\gamma} = \hat{i}_{\lambda,\gamma} + k_\lambda$	For λ=1,…,N and γ= 1,…,M_λ-1
$\hat{i}^*_{\lambda,M_\lambda} = k_{M_\lambda}$	For λ=1,…,N
$\hat{c}^*_\lambda = \hat{c}_\lambda - k_\lambda$	For λ=1,…,N-1
$\hat{c}^*_\lambda = -k_\lambda$	For λ=N

Note that, at this stage, the restrictions on national industries do not affect the regression constant.

Step 3. We now implement restrictions in country coefficients. Similarly to the previous step, the objective is to ensure that $\sum_{\lambda=1}^{N} \left(\hat{c}^*_\lambda + k\right) w_\lambda = 0$ which implies $k = -\sum_{\lambda=1}^{N} \hat{c}^*_\lambda w_\lambda$. Then, country coefficients and the regression constant are redefined as,

$$\hat{c}^{**}_\lambda = \hat{c}^*_\lambda + k \qquad \text{For } \lambda=1,\ldots,N$$

$$\hat{a}^* = \hat{a} - k$$

The new coefficients $\hat{a}^*$, $\hat{c}^{**}_\lambda$ and $\hat{i}^*_{\lambda,\gamma}$ will guarantee that the following relations hold,

i. $\sum_{\lambda=1}^{N} \hat{c}^{**}_\lambda w_\lambda = 0$

ii. $\sum_{\gamma=1}^{M_\lambda} \hat{i}^*_{\lambda,\gamma} v_{\lambda,\gamma} = 0$ for λ:1,…,N.

In addition, if we use weighted least squares to estimate the regression above then,

iii. $\hat{a}^*$ is the unconditional weighted average return at time t.

iv. $\hat{a}^* + \hat{c}^{**}_{\lambda}$ is the unconditional weighted average return of country λ at time t.

v. $\hat{a}^* + \hat{c}^{**}_{\lambda} + \hat{i}^*_{\lambda,\gamma}$ is the unconditional weighted average return of industry γ in country λ at time t.

The procedure does not depend on the presence of other variables (dummies or otherwise) in the regression so it can be easily extended to the model employed for the analysis of bond returns.

Appendix C

We estimate index asymptotic variances as follows. Let R_t and μ be the return of an index and its mean, R_{it} the return of asset i included in the index, w_{it} the weight of asset i at time t and T the number of return observations. If a security's return is not available at any given time its weight for that date is set to zero. Then, the variance of the index can be decomposed as

$$\frac{1}{T-1}\sum_{t=1}^{T}\left(R_t-\mu\right)^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left(\sum_{i=1}^{N} R_{it}w_{it}-\mu\right)^2 =$$

$$\frac{1}{T-1}\sum_{t=1}^{T}\left(\sum_{i=1}^{N}\left(R_{it}w_{it}-\mu_i w_{it}\right)+\sum_{i=1}^{N}\mu_i w_{it}-\mu\right)^2 =$$

$$\frac{1}{T-1}\sum_{t=1}^{T}\left(\sum_{i=1}^{N}\left(R_{it}-\mu_i\right)w_{it}+\left(\mu_t-\mu\right)\right)^2 =$$

$$\frac{1}{T-1}\sum_{t=1}^{T}\left(\begin{array}{l}\sum_{i=1}^{N}\left(R_{it}-\mu_i\right)^2 w_{it}^2+\sum_{i\neq j}^{N}\left(R_{it}-\mu_i\right)\left(R_{jt}-\mu_j\right)w_{it}w_{jt}+\\ 2\sum_{i=1}^{N}\left(R_{it}-\mu_i\right)\left(\mu_t-\mu\right)w_{it}+\left(\mu_t-\mu\right)^2\end{array}\right)$$

Note that,

a) $\sum_{i=1}^{N} \frac{1}{T-1} \sum_{t=1}^{T} (R_{it} - \mu_i)^2 w_{it}^2$ is similar to the weighted sum of the variances of the assets in the index with the difference that the weights here are time dependent. In fact, the unusual term $(\mu_t - \mu)^2$ is caused by the variability of asset weights over time.

b) $\sum_{i \neq j}^{N} \frac{1}{T-1} \sum_{t=1}^{T} (R_{it} - \mu_i)(R_{jt} - \mu_j) w_{it} w_{jt}$ is approximately equal to the weighted sum of all covariances. The asymptotic covariance is defined as $\sum_{i \neq j}^{N} \frac{1}{T-1} \sum_{t=1}^{T} (R_{it} - \mu_i)(R_{jt} - \mu_j) w_{it}^* w_{jt}^*$ where $w_{it}^* = \frac{w_{it}}{\sum_{i \neq j}^{N} w_{it} w_{jt}}$.

c) $2 \sum_{i=1}^{N} \frac{1}{T-1} \sum_{t=1}^{T} (R_{it} - \mu_i)(\mu_t - \mu) w_{it}$ is approximately equal to the weighted sum of covariances between asset returns and the cross-sectional mean.

d) $\frac{1}{T-1} \sum_{t=1}^{T} (\mu_t - \mu)^2$ is the variance of the cross-sectional mean.

As the number of assets increases a) and c) tend to zero while b) tends to the asymptotic covariance. d) is negligible for all index variance decompositions reported in the paper. Therefore, the asymptotic variance of an index is typically well approximated by the index's asymptotic covariance.

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Table 1
Stock sample: Country-Industry composition

Monthly average number of companies. Sample period: 1/93 - 2/98

	Fi	Bk	En	Ut	CG	KG	Ba	Total
Australia	2.5	8.7	5.0	-	20.0	-	18.3	54.5
Canada	8.2	9.0	22.1	13.4	34.3	8.4	47.6	143.0
France	8.0	4.6	5.6	4.0	55.8	15.6	13.1	106.8
Germany	17.3	14.0	2.0	8.4	41.1	21.8	24.0	128.6
Japan	28.6	71.0	8.0	23.0	208.5	158.4	134.7	632.3
Netherlands	5.9	2.0	2.0	-	25.1	12.1	8.7	55.8
UK	22.0	4.7	10.3	14.3	99.7	33.7	42.1	226.7
US	59.0	61.8	41.5	79.4	192.3	73.1	64.8	572.0
Total	151.6	175.8	96.5	142.5	676.8	323.2	353.3	1919.7

Monthly average market value %

	Fi	Bk	En	Ut	CG	KG	Ba	Total
Australia	0.03	0.50	0.12	-	0.39	-	0.62	1.66
Canada	0.14	0.54	0.42	0.56	0.39	0.13	0.82	2.99
France	0.05	0.04	0.04	0.06	0.25	0.05	0.09	0.58
Germany	0.58	0.42	0.00	0.42	0.48	0.33	0.49	2.72
Japan	1.87	3.76	0.39	4.90	9.30	6.26	5.46	31.94
Netherlands	0.20	0.13	0.51	-	0.45	0.11	0.08	1.48
UK	0.61	0.96	1.68	1.60	4.88	0.67	1.48	11.87
US	3.75	2.81	3.76	7.70	20.63	4.67	3.43	46.76
Total	7.23	9.16	6.92	15.23	36.77	12.21	12.47	100.00

Fi = Finance, Bk = Banking, En = Energy, Ut = Utilities, CG = Consumer Goods, KG = Capital Goods, Ba = Basic Indsustries

Table 2
Bond sample: Country-Industry composition

Panel A

Monthly average number of companies. Sample period: 1/93 - 2/98

	Fi	Bk	En	Ut	CG	KG	Ba	Total
Australia	3.7	11.8	-	-	-	-	-	15.5
Canada	5.1	6.8	-	-	-	-	-	11.9
France	6.9	10.3	2.5	2.0	-	2.6	-	24.3
Germany	-	12.9	-	-	2.2	-	-	15.1
Japan	-	-	-	11.5	8.6	-	-	20.1
Netherlands	16.2	8.5	-	-	3.1	-	-	27.7
UK	15.6	19.8	3.9	9.0	18.6	-	2.5	69.3
US	39.1	15.2	8.9	13.6	43.0	8.2	7.3	135.2
Total	86.6	85.3	15.2	36.1	75.4	10.8	9.8	319.3

Monthly average market value %

	Fi	Bk	En	Ut	CG	KG	Ba	Total
Australia	0.15	1.85	-	-	-	-	-	2.01
Canada	0.25	0.74	-	-	-	-	-	0.99
France	4.26	9.71	0.57	2.37	-	0.63	-	17.55
Germany	-	5.42	-	-	0.46	-	-	5.88
Japan	-	-	-	6.80	4.79	-	-	11.59
Netherlands	6.10	4.62	-	-	0.95	-	-	11.67
UK	2.61	7.39	0.86	3.04	2.65	-	0.49	17.05
US	8.50	2.15	1.73	1.74	12.77	5.85	0.53	33.27
Total	21.88	31.89	3.15	13.95	21.61	6.49	1.02	100.00

Panel B

Monthly average market value %

Maturity		***Seniority***		***Rating***	
<2 yrs	24.81	**Senior**	32.12	**BBB**	2.97
2-5 yrs	46.55	**Junior**	67.88	**A**	25.76
>5 yrs	28.64			**AA**	34.33
				AAA	36.95

Fi = Finance, Bk = Banking, En = Energy, Ut = Utilities, CG = Consumer Goods, KG = Capital Goods, Ba = Basic Indsustries

Table 3

Combining Global and National Industry Effects

This graph shows that by introducing global industry effects one only reduces the cross-sectional volatility of national industry indices with no improvement in the explanation of return volatility (note that the sum of global and national industry effects is always equal to national industry effects when estimated alone). We explore three possible cases: global industry indices absorb no (Panel A), some (Panel B) and all (Panel C) of national industry index volatility.

	With global industry effects included				Without global industry effects			
	Country 1 Industry 1	Country 1 Industry 2	Country 2 Industry 1	Country 2 Industry 2	Country 1 Industry 1	Country 1 Industry 2	Country 2 Industry 1	Country 2 Industry 2
Panel A								
Average national industry return	1	2	3	2	1	2	3	2
Market average	2	2	2	2	2	2	2	2
Country effects	-0.5	-0.5	0.5	0.5	-0.5	-0.5	0.5	0.5
Global industry effects	0	0	0	0				
National industry effects	-0.5	0.5	0.5	-0.5	-0.5	0.5	0.5	-0.5
Global industry variance	0.00				-			
National industry variance	0.33				0.33			
Total industry effect variance	0.33				0.33			
Panel B								
Average national industry return	1	2	2	4	1	2	2	4
Market average	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Country effects	-0.75	-0.75	0.75	0.75	-0.75	-0.75	0.75	0.75
Global industry effects	-0.75	0.75	-0.75	0.75				
National industry effects	0.25	-0.25	-0.25	0.25	-0.5	0.5	-1	1
Global industry variance	0.75				-			
National industry variance	0.08				0.83			
Total industry effect variance	0.83				0.83			
Panel C								
Average national industry return	1	2	3	4	1	2	3	4
Market average	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Country effects	-1	-1	1	1	-1	-1	1	1
Global industry effects	-0.5	0.5	-0.5	0.5				
National industry effects	0	0	0	0	-0.5	0.5	-0.5	0.5
Global industry variance	0.33				-			
National industry variance	0.00				0.33			
Total industry effect variance	0.33				0.33			

Table 4
Stock factors: Descriptive Statistics

Returns are monthly and in local currency. Factors are derived by adding the market return and the relevant pure return effect (country or industry).

	Factor Return		
Average across countries:	**Mean %**	**Vol. %**	**Corr.**
HR model	1.933	3.907	0.475
ExHR model	1.882	3.893	0.479
Average across industries:			
HR model	1.745	3.456	0.649
ExHR model	1.781	4.277	0.439

Table 5
Bond factors: Descriptive Statistics

Returns are monthly and in local currency. Factors are derived by adding the market return and the relevant return effect (country, industry, maturity, seniority or rating).

	Factor Total Return			Factor Spread Return		
Average across countries:	**Mean %**	**Vol. %**	**Corr.**	**Mean %**	**Vol. %**	**Corr.**
HR model	0.694	0.853	0.855	0.056	0.185	0.374
ExHR model	0.695	0.852	0.854	0.054	0.180	0.397
Average across industries:						
HR model	0.665	0.764	0.955	0.057	0.147	0.582
ExHR model	0.664	0.802	0.897	0.057	0.203	0.401
Maturity - HR model						
<2 years	0.517	0.285		0.044	0.061	
2-5 years	0.637	0.713		0.055	0.112	
>5 years	0.829	1.348		0.056	0.218	
Average	0.661	0.782	0.911	0.052	0.130	0.598
Maturity - ExHR model						
<2 years	0.516	0.284		0.043	0.062	
2-5 years	0.637	0.711		0.054	0.112	
>5 years	0.830	1.352		0.057	0.218	
Average	0.661	0.782	0.910	0.052	0.131	0.588
Seniority - HR model						
Senior	0.675	0.776		0.060	0.120	
Junior	0.662	0.778		0.051	0.121	
Average	0.669	0.777	0.988	0.055	0.121	0.903
Seniority - ExHR model						
Senior	0.673	0.776		0.059	0.122	
Junior	0.663	0.777		0.051	0.120	
Average	0.668	0.777	0.989	0.055	0.121	0.925
Rating - HR model						
BBB	0.739	0.762		0.119	0.267	
A	0.691	0.778		0.080	0.130	
AA	0.661	0.772		0.045	0.122	
AAA	0.648	0.790		0.037	0.130	
Average	0.685	0.776	0.960	0.070	0.162	0.648
Rating - ExHR model						
BBB	0.734	0.754		0.117	0.228	
A	0.691	0.785		0.080	0.131	
AA	0.662	0.771		0.046	0.114	
AAA	0.646	0.787		0.036	0.131	
Average	0.683	0.774	0.968	0.070	0.151	0.705

Table 6

Equity Return Diversification

This table summarises the impact of different types of diversification on equity returns. Diversification is measured with the return effect variance indicator REVI and with the asymptotic diversification gain indicator (ADGI).

	HR Model		ExHR Model	
	REVI %	**ADGI %**	**REVI %**	**ADGI %**
		Local Currency		
Country	7.60	94.58	7.69	96.95
Industry	3.14	33.51	7.03	64.42
		Ratios		
Industry/Country	0.41	0.35	0.91	0.66
		US Dollar		
Country	10.71	96.85	10.83	99.60
Industry	3.16	27.24	7.08	53.86
		Ratios		
Industry/Country	0.30	0.28	0.65	0.54

Table 7
Bond Total Return Diversification

This table summarises the impact of different types of diversification on bond total returns. Diversification is measured with the return effect variance indicator (REVI) and the asymptotic diversification gain indicator (ADGI).

	HR model		ExHR Model	
	REVI %	**ADGI %**	**REVI %**	**ADGI %**
		Local Currency		
Country	0.087	19.21	0.084	18.80
Industry	0.012	1.93	0.028	10.76
Maturity	0.183	2.95	0.184	2.78
Seniority	0.003	0.18	0.003	0.13
Rating	0.005	-0.11	0.005	-0.17
		Ratios		
Industry/Country	0.14	0.10	0.34	0.57
Maturity/Country	2.10	0.15	2.17	0.15
Seniority/Country	0.04	0.01	0.03	0.01
Rating/Country	0.06	-0.01	0.06	-0.01
		US Dollar		
Country	0.589	34.97	0.585	35.05
Industry	0.054	4.03	0.115	12.10
Maturity	0.195	2.79	0.193	2.81
Seniority	0.024	1.28	0.023	1.19
Rating	0.019	1.30	0.020	1.34
		Ratios		
Industry/Country	0.09	0.12	0.20	0.35
Maturity/Country	0.33	0.08	0.33	0.08
Seniority/Country	0.04	0.04	0.04	0.03
Rating/Country	0.03	0.04	0.03	0.04

Table 8

Bond Spread Diversification

This table summarises the impact of different types of diversification on bond spread returns. Diversification is measured by the return effect variance indicator (REVI) and the asymptotic diversification gain indicator (ADGI).

	HR model		ExHR Model	
	REVI %	**ADGI %**	**REVI %**	**ADGI %**
		Local Currency		
Country	0.013	85.40	0.011	72.81
Industry*	0.005	30.52	0.016	34.78
Maturity	0.007	20.80	0.007	21.40
Seniority	0.001	2.99	0.000	2.13
Rating	0.004	14.93	0.003	11.75
		Ratios		
Industry/Country	0.43	0.36	1.42	0.48
Maturity/Country	0.55	0.24	0.61	0.29
Seniority/Country	0.05	0.04	0.04	0.03
Rating/Country	0.30	0.17	0.25	0.16
		US Dollar		
Country	0.013	85.52	0.011	72.98
Industry*	0.005	30.12	0.016	33.90
Maturity	0.007	20.64	0.007	21.27
Seniority	0.001	2.97	0.000	2.12
Rating	0.004	14.91	0.003	11.87
		Ratios		
Industry/Country	0.43	0.35	1.41	0.46
Maturity/Country	0.55	0.24	0.61	0.29
Seniority/Country	0.05	0.03	0.04	0.03
Rating/Country	0.30	0.17	0.25	0.16

*The asymptotic DGI for industry effects with the ExHR model has been computed by assuming average covariance in each national industry to be greater than or equal to zero.