CREDIT SPREADS, BOND INDEX CHANGES AND BOND DIVERSIFICATION

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ABSTRACT

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This thesis consists of four essays. In the first essay, we reexamine how default, taxes and systematic risk measures influence corporate credit spreads for investment grade corporate bonds for the 1987-1996 time period using a modified version of the methodology used in Elton , Gruber, Agrawal, and Mann (2001). The methodological improvements not only change the estimates for the default and tax components of credit spreads materially but the factors from the Fama and French three-factor model no longer help to explain the remaining variation in credit spreads. In contrast, a good portion of the variation in the remaining (unexplained) spread is explained by measures of aggregate bond liquidity. In the second essay, unlike the literature that deals extensively with the diversification of stock portfolios, we investigate diversification benefits for bond portfolios and the optimal portfolio size to achieve a low marginal benefit from increased portfolio size. Since the classic paper on bond diversification by McEnally and Boardman (1979), the structure of the bond market has changed significantly and many risk metrics have been introduced into the literature. In this essay, we use various risk metrics to assess the diversification benefits and the optimal bond portfolio sizes based on investment opportunity sets differentiated by credit ratings, issuer type and term to maturity. Our results suggest that a portfolio size of 25 to 40 bonds could be optimal since going beyond this size achieves a marginal diversification benefit of less than 1%.

In the third essay, we formulate and test an alternate model for explaining the changes in corporate credit spreads. The model includes some new potential determinants (such as undiversifiable risk) and uses ex ante (forecast) data from Consensus Economics instead of realizations for other determinants previously identified in the literature. Compared to other models previously tested in the literature, our model achieves substantially higher explanatory power while being more parsimonious.

Finally, in the fourth essay, we introduce what appears to be the first investigation of the impact of bond index additions and deletions on the returns of bonds and stocks of the same-firm issuers using various unconditional and conditional return-generating models. The effect of additions and deletions is symmetric for each asset class and robust across various return-generating models. While bond returns are positively (negatively) affected by bond index inclusions (exclusions), stock returns are unaffected by these bond index revisions. These results suggest that, although bond index additions and deletions materially affect bond values when measured at market, equity investors do not perceive any material change in financial risk from such changes.

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Chapter 1

Introduction

In this thesis, we investigate four topics related to bonds. Since the finance literature has focused to a much greater extent on stock markets, several areas of research on bonds remain to be explored. Thus, this thesis not only investigates bond-specific topics, such as credit spread components and the determinants of credit spreads, but also the diversification benefits associated with bond investment and the market effects of bond index revisions for both bonds and stocks of the same-firm issuers.

In the second chapter, we examine the yield associated with the components of bond credit spreads.[1] While investors should be compensated for holding risky corporate bonds instead of risk-free treasury bonds, the magnitudes of the rewards for bearing different types of risks embodied in credit spreads is still debatable. A paper by Elton , Grubber, Agrawal, and Mann (2001) (henceforth EGAM) finds that the components of credit spreads are mainly the default spread, the tax spread, and the Fama and French three-factor model betas. In this chapter, we demonstrate some inaccuracies in the implementation of the methodology used by EGAM (2001). These inaccuracies are reflected in every measurement reported in EGAM (2001) due to their usage of a hypothetical bond with a hypothetical coupon rate to measure the default spread, tax spread, and the unexplained portion of the credit spread. These inaccuracies probably account for the link that EGAM (2001) find between the unexplained portion of the credit spread and the Fama and French three-factor model.

[1] Credit spreads are defined as the difference between the zero-coupon corporate spot rates and the zero-coupon treasury rates.

In this chapter, actual bond data and not a hypothetical bond are used to first derive the term structure of interest rates for corporate bonds, and then to derive the term structure while accounting for default probabilities. The difference between these two types of term structures is attributed to the default spread. Another modification made in this chapter is to estimate the default spread using the transition matrices suggested by the current literature; that is, using default probabilities conditioned on the business industry sector and the state of the business cycle instead of the unconditional default probabilities used by EGAM (2001).

We make two modifications to the measurement of the tax spread. First, the term structure of interest rates of corporate bonds is estimated by accounting for the probabilities of default and the taxed cash flows of the bonds using a similar methodology to the one used to estimate the default spreads. The tax spread investors pay for holding corporate bonds is then the difference between these term structures and the term structures derived for estimating the default spreads, where the bond cash flows were assumed to be untaxed. To estimate the tax spread component of credit spreads, we simply deduct the tax spread paid by Treasury bond investors from the tax spread paid by corporate bond investors,[2] since the tax component of credit spreads is theoretically the excess tax paid by corporate investors over the tax paid by treasury investors. Second, we use an accurate estimate of taxes by applying all the main tax regulations in the US market instead of using gross tax estimates, as in EGAM (2001).[3]

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[2] The tax spread paid by treasury investors is computed in the same way as we compute the tax spread paid by corporate bond investors. Specifically, we first compute the treasury term structure and then we compute the treasury term structure when the cash flows are taxed and the difference between the two types of term structures is the tax spread paid by treasury bond investors.

[3] Premium and discount bounds are taxed differently, as are bonds issued prior to or after September 27, 1985. The taxation of accrued interest and a better estimate of the tax on cash flows in case of default are also embodied in the calculations.

Not unexpectedly, the remaining unexplained spread is no longer explained by the Fama and French three-factor model. Instead, some common liquidity proxies used in the literature explain up to 20% of the unexplained spread. In summary, we are able to explain from 83% (Aa-rated bonds) to 97% (Baa-rated bonds) by decomposing the spread into three components: default, tax, and liquidity.

In the third chapter (second essay), the diversification benefits of bond portfolios and the optimal portfolio size to achieve a certain minimum marginal benefit from further diversification are examined. Since bond diversification benefits were studied by McEnally and Boardman (1979), the bond market has changed significantly. Not only have bonds with more sophisticated features been introduced but the bond market also has grown in terms of quantity and amount issued. More importantly, there are many dimensions of risk that investors consider when making bond investments. Determining the optimal portfolio size by simply examining the reduction in unconditional portfolio volatility ignores other risk dimensions and gives an incomplete assessment of the diversification benefits associated with bond portfolios.

Thus, various dimensions of risk and some recently introduced risk metrics are used in this essay to study the diversification benefits associated with bond portfolios. These metrics are grouped into four categories, which are the dispersion of bond return metrics, the reward-to-risk metrics, the higher-order-moment metrics, and the probability of underperforming target rate of return metrics. To fully diversify the risk of bond portfolios requires a number of bonds that probably exceeds the financial resources of most investors. Therefore, the decision on the optimal portfolio size beyond which increasing portfolio size results in a marginal change in the value of the diversification metric of one percent or less is used to determine the optimal portfolio size for diversification purposes.

Based on the results for the various metrics, a portfolio size of about 20 to 40 bonds generally is sufficient for all investment opportunity sets examined herein to reach a portfolio size beyond which the marginal change in the value of the diversification metric is one percent or less.

In the fourth chapter (third essay), some topics introduced in the first and second chapters are combined and explored further. These include the factors that lead to credit spread changes as well as the effect of diversification on credit spread changes. The motivation for conducting this research is that the models in the literature that are used to explain the changes in credit spreads have poor explanatory power. To illustrate, Collin Dufresne et al. (2001) report a model with a R^2 of 28%, whereas Avramov et al. (2004) report a R^2 of 35% for investment grade bonds. Another motivation for examining this topic is to test the theoretical claim by Amato and Remolona (2003) that diversification is a main driving force for credit spreads. To fully diversify bond portfolio risks, investors need to hold a large number of bonds, which could be beyond the financial capability of most investors. Consequently, Amato and Remolona (2003) claim that credit spreads incorporate a premium for undiversifiable risk.

In order to develop a model that could better explain the changes in credit spreads, we improve upon the measurement of credit spreads themselves. Some papers measure credit spreads as the difference between the yield to maturity of corporate bonds and treasury bonds. We use the more accurate theoretical definition which is the difference between the zero-coupon corporate spot rates and zero-coupon Treasury spot rates.[4] The empirical tests use the expected values of certain variables identified previously in the literature as potential explanatory variables, specifically GDP and the slope of the term structure, instead of their realized values. Since the term structure of interest rates reflects expectations about the future, any change in the term structure should be a result of a change in these expectations. The test also introduces various potential explanatory variables, such as the diversification benefit as proxied by the relative frequency of monthly matrix prices to the total number of monthly corporate quotes (as a liquidity proxy), rating volatility, and the one-year default probabilities of speculative grade bonds. Not only are these variables significant but the adjusted R^2 of the tested model is as high as 60%.

The other variables used in the literature fail to add more explanatory power to our model. However, when testing the robustness of our model, some of these variables (such as the realized GDP, realized slope and the default spread) are significant although they lead to lower adjusted R^2 values (up to a maximum of 35%). These robustness tests confirm that the variables that are being proxied play a major role in determining the changes in credit spreads. However, the variables in our original model not only result in a higher adjusted R^2 but the resulting model is more parsimonious than the ones tested in the current literature.

In the fifth chapter (fourth essay), the effect of bond index revisions are examined. No reported tests of this effect could be found in the literature whose focus has been

[4] Elton et al. (2001) present an argument for why zero-coupon spots are better for calculating the credit spread. Specifically, using the yield to maturity instead of zero-coupon spots makes the credit spreads dependent on coupons and does not differentiate between the credit spreads of bonds with different durations and convexities.

primarily on stock index revisions. The effect of revisions of the Lehman and Brothers bond index on the returns of the bonds subject to revisions as well as the returns of the same-firm bonds and stocks are examined. If the impact of these revisions on these two asset classes is asymmetric, this could have implications on the use of the debt–to-equity ratio as a measure of financial risk when this ratio is measured using market values.

Various bond return-generation models are used in order to draw a robust conclusion about the effect of bond index revisions. The unconditional bond models include an unconditional single-factor model where a bond index (the Aggregate Lehman Brothers bond index) is used to capture the bond market effect; an unconditional two-factor bond-stock model, where the additional factor, the S&P500 index, could capture equity-like characteristics embedded in some corporate bond issues such as bond convertibility; and an unconditional three-factor model that reflects differences in maturity structure and default risk.[5] The conditional bond models make each factor beta in their unconditional version dependent on the lagged values of the dividend yield on the CRSP stock index, the slope of the term structure, the corporate credit spread, and the risk-free rate.[6] Unconditional and conditional versions of the Fama and French three-factor model are used for stocks.

As expected, announcements of index additions and deletions lead to positive and negative abnormal bond returns, respectively, with a larger magnitude for the impact of the latter. In contrast, bond index revisions have no significant impact on the returns of the stocks of the same firms, which has interesting consequences for the measurements of

[5] The factors are the Lehman Brothers mortgage bond index, a term structure spread which captures the shifts in interest rates, and a default spread that captures shifts in economic conditions.

[6] The three-factor model is conditional only on the dividend yield on the CRSP stock index and the risk-free rate since two of the three factors already capture the term structure and credit spread effects.

the debt-to-equity. This implies that a debt-to-equity ratio is a noisy estimate of financial risk when measured at market.

Chapter 2

A REEXAMINATION OF CREDIT SPREAD COMPONENTS

Credit spreads are of increasing interest in the academic literature and have long been of interest in corporate practice. While credit spreads are often generally perceived as being compensation for credit risk, the time-series behavior of credit spreads is not yet well understood. EGAM (2001) provide estimates of the size of each factor-related component of the credit spread for investment-grade corporate bond portfolios (namely, the default spread, tax spread, and risk premium).

Our analysis finds that EGAM did not address three potentially important issues when making their estimations. In short, EGAM's default spread depends on the one-year transition matrix published by Moody's. Nickell et al. (2001) show that transition matrices depend on the country of domicile, the industry, and the phase in the business cycle. As expected, business-cycle-conditioned, sector-specific transition matrices differ significantly from the one used by EGAM. A second shortcoming is the absence of federal taxes and amortization effects and other important complexities in the tax system on EGAM's tax computations. Wang et al. (2005) show that these factors are important and could change tax measurements significantly. Finally, although EGAM note that liquidity may affect credit spreads and the literature has long alluded to the existence of a liquidity component in credit spreads, estimates of the impact of the liquidity component on credit spreads is absent in the EGAM study.

Given these shortcomings, the primary objective of this chapter is to estimate the default spread in the light of the findings of Nickell et al. (2001), to re-estimate the tax effect by more carefully modeling the intricacies of the actual tax code, and to examine the portion of the spreads attributable to systematic risk and aggregate liquidity.

This chapter makes three important contributions to the literature. The first contribution consists of better estimates of the components of credit spreads than the ones previously reported in the literature, since our estimates are based on the recent findings regarding the estimation of transition matrices and the tax effect. The second contribution is to show that the use of an improved estimation methodology leads to different estimates for the various components of credit spreads, and that the macro-factors effect reported by EGAM no longer plays any role in credit-spread determination. The third contribution is to show that aggregate market liquidity plays an important role in the determination of credit spreads. Thus, the significant relations found between stock returns and aggregate liquidity by Chordia et al. (2001), Amihud (2002), amongst others, also applies to bond credit spreads.

This chapter is organized as follows. The literature on credit-spread decomposition is presented in the next section. The databases and data selection procedures used herein are described in section two. Methods used to compute the credit spreads are detailed in section three. The decomposition of credit spreads into default spreads, tax spreads, and risk premia are reported and analyzed in section four. The findings on the liquidity credit-spread effect are reported and analyzed in section five. Section six concludes the chapter.

2.1. LITERATURE REVIEW

The existing literature on the determinants of credit spreads is limited. EGAM (2001) examine the spreads in the rates between corporate and government bonds by decomposing the credit spread into three components; namely, default risk, taxes and a residual. EGAM find that default risk accounts for only a small portion of credit spreads, which is consistent with most credit-spread studies. Collin-Dufresne et al. (2001) find that factors associated with default risk explain only about 25% of the changes in credit spreads. Huang and Huang (2003) find confirming results using a structural model estimated on the same datasets as EGAM. However, using a continuous time all-sectors transition matrix and a methodology similar to that of EGAM,[7] Dionne et al. (2004) suggest that these studies may have underestimated the portion of corporate spreads explained by default risk since their study's estimates of the proportional contribution of default spreads are as high as 80% of the estimated spreads.

EGAM (2001) also examine how much of the time-series variation in the residual spread can be explained by systematic risk factors. They find that the Fama and French (1993) factors explain substantial variations in credit-spread changes. Collin-Dufresne et al. (2001) report that a dominant but unidentified systematic factor accounts for about 75% of the variation in spreads. They also find that, while aggregate market factors (such as the level and volatility of interest rates, the volatility of the equity market, and the Fama and French (1993) factors) are more important than issuer-specific characteristics in determining credit spread changes, these factors provide limited additional explanatory power over the default risk factors.

Leland and Toft (1996) claim that the Treasury yield influences not only the discount rate but also directly influences the value of the underlying asset. Thus, the value of the firm decreases and the probability of default correspondingly increases as the Treasury yield increases. In turn, this implies a positive relation between credit spreads and the

[7] Dionne et al use a theoretical 10-year, zero-coupon bond instead of the coupon-paying bond used by EGAM.

level of Treasury yields. Duffee (1998) finds a significant, although weaker, negative relationship between changes in credit spreads and Treasury interest rates, which he claims is consistent with the contingent claims approach of Merton (1974) where the firm is valued in an option-theoretic framework. In the Merton model, an increase in the level of the Treasury rate increases the value of the firm. In turn, this should lower the probability of default by moving the price farther away from the exercise price. Morris et al. (2002) show that the relation is positive (and not negative) in the long run. Using a reduced-form model to decompose spreads into taxes, liquidity risk, common factor risks, default event risk, and firm-specific factor risks, Driessen (2002) finds that the default jump risk premium explains a significant portion of corporate bond returns.

To summarize, the literature on credit spreads suggests that factors such as the level of the Treasury interest rate, systematic risk, firm-specific risk, liquidity, and taxation play an important role in determining credit spreads.

2.2. SAMPLE AND DATA

To maintain comparability with the findings of EGAM, our bond data are extracted from the Lehman Brothers Fixed Income Database distributed by Warga (1998). This database contains monthly clean prices and accrued interest on all investment grade corporate and government bonds. In addition, the database contains descriptive data on bonds including coupons, maturities, principals, ratings, and callability. Our sample includes 10 years of monthly data from 1987 through 1996.[8] All bonds with embedded options, such as callable, puttable, convertible, and sinking fund bonds, are eliminated. Similarly, all corporate floating-rate debt and bonds with an odd frequency of coupon

[8] The results for the 1987-1997 period are not materially different from those for the 1987-1996 period.

payment (i.e., other than semi-annual) are eliminated from the sample.[9] Furthermore, all bonds not included in the Lehman Brothers bond indexes are eliminated because, as EGAM report, much less care occurs in preparing the data for these non-index bonds. This leads to the elimination of, for example, all bonds with a maturity of less than one year. A $5 pricing error filter is used also to eliminate bonds where the price data are problematic.

Also, following EGAM (2001), bonds maturing after 10 years are eliminated. Since Kryzanowski and Xu (1997) show that the yields from both extremes of the one-to-thirty-year term structure do not exhibit clear pairwise cointegration, we find it also more appropriate to eliminate the bonds maturing after 10 years (as in EGAM) since these very long maturities are driven by different factors than those driving the short-term spot rates.

Only the prices based on dealer quotes are extracted. All matrix-based prices are eliminated from the sample since matrix prices might not reflect fully the economic influences in the bond markets. Since we are unable to identify the frequency of payments and the nature of coupons (fixed or variable) from the Warga (1998) database, we rely on the descriptive statistics from *The Fixed Income Securities Database* (*FISD*) to identify various bond characteristics. *FISD* contains all insurance company daily buys and sells of US corporate bonds for the 1995-1999 period, and reports more extensive bond details than those provided by Warga (1998).

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[9] While EGAM eliminate government flower bonds and inflation-indexed government bonds, these bonds could not be identified even when using the FISD database. Since no flower bonds are issued after March 3, 1971 and since no flower bonds have maturities after 1998, we eliminate the few treasury bonds that were issued prior to 1971 and were due to mature before 1998. Regarding inflation-indexed government bonds, we eliminate the variable rate bonds from our sample. We assume that these inflation-indexed bonds are included in the elimination process although there is no information about which bonds are inflation-indexed bonds.

Since the number of buy and sell prices in the FISD are limited, the term structures of the credit spreads could be extracted for only a few bond categories (such as the Aa-rated industrial bonds) from the FISD database. Consequently, the FISD prices could not be used to derive the components of the credit spreads.

Our study is focused on the industrial sector since our methodology, as is explained later, requires an estimation of the after-default and after-tax term structures as well as the before-default and before-tax term structures. By focusing on this sector, computation time is decreased significantly. It is our belief that computational time constraints induced EGAM to take a short cut, which is shown later as leading to a number of estimation drawbacks.

The final sample consists of 59,463 bond prices from which 47,000 bond prices are corporate and 12,463 are Treasury. Of this total, 14,754 are for Aa-rated bonds, 18,031 bond prices are for A-rated bonds and 14,215 are for Baa-rated bonds.

2.3. SPREAD MEASURES

Most previous work has considered credit spreads as being the conventional difference between the yields to maturity on corporate and Treasury bonds with similar maturities. Due to the effect of the coupon level on yields-to-maturity and measures of risk, EGAM note that credit spreads should be considered as the difference between the yields to maturity on a zero-coupon corporate bond (corporate spot rate) and the yields to maturity on a zero-coupon government bond of the same maturity (government spot rate). Extracting the yields to maturity from coupon-paying bonds results in a term structure being extracted from bonds with different durations and convexities.

The Nelson-Siegel (1987) procedure, which is briefly described in Appendix A and is used by many central banks, is used herein to estimate the zero-coupon spot rates. In addition to its advantage in approximating zero coupon bonds from coupon-carrying bonds, this procedure is chosen because it has enough flexibility to reflect the patterns of the observed market data, is relatively robust against disturbances from individual observations, and is applicable with a small number of observations.

The Nelson and Siegel approach uses the following equation:

$$r(t) = \beta_0 + \beta_1 \left[\frac{1 - \exp(-t/\tau_1)}{t/\tau_1} \right] + \beta_2 \left[\frac{1 - \exp(-t/\tau_1)}{t/\tau_1} - \exp(-t/\tau_1) \right] \tag{2.1}$$

where r is the estimated spot rate with maturity t. The four parameters, β_0, β_1, β_2, and τ_1, need to be estimated in order to estimate the spot rates.

The corporate spot rate curve is estimated for each of the three bond-rating categories of Aa, A and Baa for the industrial sector for each month of the sample period.[10] The estimated spot rates with maturities from 1 to 10 years are obtained by minimizing the sum of squared pricing errors using a four-step estimation procedure. In the first step, the TOMLAB (OQNLP solver) software, which starts with different sets of initial values and returns the global minima, is used.[11] The reason is that, since the optimization toolbox in Matlab provides spot rate estimates that are very sensitive to the selected vector of starting parameters (β_0, β_1, β_2, and τ_1), there is a high probability that the solution converges to a local and not global minimum. The second step is to determine the discount factors corresponding to the coupon and face value payment dates using these

[10] Technically, the corporate instantaneous forward rate curve is derived first, which gives an estimate of the four parameters β_0, β_1, β_2, and τ_1. After that the corporate spot rate curve is estimated.

[11] The TOMLAB Optimization Environment is a powerful optimization platform for solving applied optimization problems in Matlab. The solution is independent of the starting values. The starting values are calculated from a scatter search algorithm. TOMLAB provides a multi-start algorithm designed to find global optima.

starting parameters. The third step is to calculate the theoretical dirty prices of the bonds by discounting the bond cash flows to time *0* (the quote dates). Numerical optimization procedures are used to re-estimate the set of parameters that minimizes the sum of squared pricing errors between the observed dirty prices and the theoretical ones. The fourth and last step is to use the estimated set of parameters (β_0, β_1, β_2, and τ_1) to determine the spot rate function by plugging these estimated parameters into equation (2.1) and assigning maturities ranging from 1 to 10 years. The estimated spot rates are the annual continuously compounded zero-coupon spot rates.

The resulting spot rate estimates, which are summarized in panel A of table 2.1, are consistent with the theory. All the empirical bond-spread curve estimates are positive and increasing as the rating class deteriorates. This strongly suggests that ratings are indeed linked to credit quality. Furthermore, the credit spreads are upward-sloping exhibiting higher credit spreads with lower ratings, and higher credit spreads with longer maturities.

Based on the root mean squared errors (RMSEs) that are reported in panel B of table 2.1, our estimates produce acceptable average RMSEs that range from \$ 0.362 per \$100 for Treasuries to \$1.570 per \$100 for Baa bonds. Our average RMSEs are slightly higher than those reported by EGAM but this could be attributed to the apparent elimination of fewer outliers from our sample (947 industrial bond prices herein whereas 2,710 industrial and financial bond prices in EGAM).

2.4. SPREAD DECOMPOSITION

2.4.1 Default Spread Estimates Based on the Unmodified EGAM Approach

Although the expected loss on corporate bonds due to default is an obvious component of credit spreads, most of the previous studies find that the default premium accounts for a surprisingly small fraction of credit spreads. The findings reported in this section support these previous findings.

The EGAM methodology is used to estimate the proportional representation of the default spread. Under risk neutrality with the tax effect ignored, the difference between the corporate and forward rates is given by:

$$e^{-(f_{tt+1}^{C}-f_{tt+1}^{G})} = (1 - P_{t+1}) + \frac{aP_{t+1}}{V_{t+1T} + C} \tag{2.2}$$

where f_{tt+1}^{C} and f_{tt+1}^{G} are the forward rates as of time *0* from *t* to *t+1* for corporate and government bonds, respectively; P_{t+1} is the conditional probability of default between *t* and *t+1* given no bankruptcy at *t*; *a* is the recovery rate; V_{t+1T} is the value of a *T*-period bond at *t+1* given no bankruptcy in earlier periods; and *C* is the coupon rate.

To calculate the risk-neutral spread in forward rates, the marginal default probability, the recovery rate, and the coupon rate need to be estimated. To calculate the conditional probability of default, the one-year transition matrix from Moody's (see table 2.2) is used to calculate the default probabilities of year 1 by simply taking the default probabilities indicated in the last column and ascribing them to bonds with corresponding credit ratings. For example, a Baa-rated bond is assigned a 0.103% probability of default within one year using this approach. A similar approach is used for longer-term unconditional default probabilities. For example, the matrix is multiplied by itself (*n-1*) times to obtain the *n*-year unconditional default probabilities, where the desired default probabilities are given in the default (last) column of that matrix. Similarly, the conditional default probabilities for year *t+1* are computed as the difference between the unconditional default probabilities for years $t+1$ and t, all divided by the probability of not defaulting in year t.[12]

The Altman and Kishore (1998) estimates of recovery rates by rating class that are reported in panel C of table 2.2 are used herein. These estimates are based on actual recovery rates observed in practice based on an examination of 696 defaulted bond issues over the period 1975-1995. As in EGAM, the coupon rate that makes the value of a 10-year bond approximately equal to the par value of the bond in all periods is used to estimate the default spread.

The forward rates are obtained assuming risk neutrality and zero taxes using equation 2.2 along with the conditional default probabilities from table 2.3, recovery rate estimates from table 2.2 and coupon rates estimated as explained earlier. Forward rates are then used to compute the spot rate spreads.[13] As reported previously in the literature, the default spreads using the EGAM methodology for our sample that are reported in table 2.4 account for only a small percentage of credit spreads. For example, the default spreads for bonds maturing after 10 years are only 0.014%, 0.05% and 0.35% for Aa-, A- and Baa-rated bonds, respectively. This small increase in the default spread for Baa- versus Aa-rated bonds is attributed mainly to a higher default probability and a lower recovery rate. For instance, the default probability and the recovery rate are 0.146 % and

[12] Bayes' theorem is used to obtain the conditional probability of default (that is, the probability of default between time t and time $t+1$), which is given by $[s(t+1) - s(t)]/s(t)$ where s or the probability of surviving the previous period is calculated as 1- probability of default. The probability of default is obtained from the transition matrix. Specifically, the probability of default, assuming probabilities are independent of each other, after n years is calculated by multiplying the matrix by itself n times and extracting the relevant numbers from the default column that correspond to the investment grade rating of the bond.

[13] The relationship between the n period forward rate at time t, $r^f_{t,n}$, and the spot rates is $Exp[r^f_{t,n}] = (Exp[(t+n)r_{t+n}] / Exp[tr_t])^{1/n}$.

59.59%, respectively, for an Aa-rated bond, compared to 1.264% and 49.42%, respectively, for a Baa-rated bond.

2.4.2 Default Spread Estimates Based on an Improved Estimation Methodology

In this section, we outline how the EGAM methodology used in the previous section to estimate default probabilities can be improved. This includes the use of sector-specific, conditional default probabilities that are dependent on the phase of the business cycle, and the computation of the default spreads based on the after-default corporate spot rates instead of a theoretical 10-year, par value bond.

2.4.2.1 Transition Matrix for the Industrial Sector

In this section, we deal with our first concern with the EGAM methodology; that is, with the use of a theoretical par value bond with an estimated coupon rate that does not disturb the par value property. We argue that estimating the default spread as the difference between the spot rate curves computed in section 2.3 and the after-default term structures computed from the data should be more accurate since this spread is based on the actual data and not on a theoretical bond.

Our initial sample for building these transition matrices consists of all ratings in Moody's Default Risk Service (DRS) database for the industrial, US-based, senior and unsecured corporate bonds from the 1970-1998 period.[14] As is the common approach in the literature (Carty, 1997; Nickell et al., 2000; among others), withdrawn ratings are removed from the sample. The final sample consists of 23,645 yearly bond ratings for

[14] This database not only contains detailed information about bonds rated by Moody's that defaulted but it also contains the historical ratings for all bonds rated by Moody's along with other descriptors such as industry and country of domicile of the borrower. This sample period was chosen because the database has complete data for this period. On the other hand, most of the studies in the literature including the rating agency estimates are based on only senior unsecured bonds. For details about Moody's approach, refer to Carty (1997).

2,144 obligors.[15] To estimate the transition matrix probabilities, the cohort approach is used after combining the C, Ca and Caa ratings due to the paucity of observations in the C and Ca categories and given that our main concern is to study the spread of investment grade bonds.[16]

Our industrial-sector transition results without reflecting business cycle effects (panel B of table 2.2) are quite different from the all-sectors estimates (panel A of table 2.2) reported by Carty and Fons (1994) and used in the EGAM study. Our transition results show higher default probabilities for certain categories (Baa and BB) and lower probabilities for other categories (B and Caa). Except for the Aa category, our results exhibit a greater tendency to remain in their initial rating category over the next year.

To assess the impact of using the industrial versus all-sectors transition matrix, we compare the evolution of these conditional default probabilities over the 10-year period for the Aa-, A-, and Baa-rated bonds. Based on table 2.3, conditional default probabilities for the industrial sector are significantly lower than those for the all-sectors. Consequently, we would expect to obtain lower default spreads for the industrial sector than those reported by EGAM. As expected, the probabilities reported in table 2.4 are substantially lower using our methodology instead of the unaltered methodology of EGAM. For example, the default spreads using the industrial versus all-sector transition matrix for bonds maturing after 10 years in our sample are lower by 44%, 47% and 37% for Aa-, A- and Baa-rated bonds, respectively. Similarly, the default spreads using the

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[15] The 7,632 ratings obtained from the ratings master file are allocated to yearly ratings. For example, if a rating is from 1/1/1994 until 12/31/1996, then this rating is used for the years from 1/1/1994 until 12/31/1994, 1/1/1995 until 12/31/1995, and 1/1/1996 until 12/31/1996.

[16] The empirical transition matrix has probabilities $P_{ij} = N_{ij} / M_i$ where N_{ij} is the number of times that the credit rating went from i to j in one year, and M_i is the number of times the credit rating started at i.

industrial transition matrix and our sample are lower than those reported by EGAM by 71%, 66% and 37% for the Aa-, A- and Baa-rated bonds, respectively.

2.4.2.2 The Business Cycle Effect

In this section, we deal with our second concern with the EGAM methodology; that is, with the use of default probabilities derived from Moody's one-year transition matrix since this matrix does not capture the relationship of rating transitions with the phase of the business cycle, as found by Nickell et al. (2000). Thus, we build our own one-year transition matrices to capture the business cycle effect.

The first step in this adjustment procedure is to use the data published by the Bureau of Economic Analysis (BEA) on real GDP growth to identify the thresholds that differentiate between trough, normal and peak phases of business cycles. Over the 1970-1998 period, these rates can be differentiated into three groupings; namely, years with negative and weak growth rates (growth rates less than 2.5%); years with "normal" growth of 2.5 % to 4.18%; and years with growth rates higher than 4.5%. Based on these cut-off values, there are 7 trough years, 14 normal years and 8 peak years in our 29-year sample.

The transition matrices corresponding to these three business cycle phases are reported in Table 2.5. Not surprisingly, the probabilities of default are highest and lowest during the trough and peak phases of the business cycle, respectively. Based on the t-test results reported in table 2.6, the probabilities are statistically different between the trough and peak phases of the business cycle. Not only are all transition matrices different statistically but also these differences are most prominent for a comparison of the matrices for the normal and peak phases of the business cycle.

These business-cycle-conditioned transition matrices are now used to determine *n*-year probabilities. The first step in doing so is to determine the relative frequency, π_{ij}, of going from state *i* (trough, normal or peak) to state *j* (trough, normal or peak) during the following year using historical data. For example, for the seven years when the initial phase was a trough, the following year was a peak year twice, a normal year three times and unchanged two times. Thus, $\pi_{\text{Trough, Trough}} = 2/7$, $\pi_{\text{Trough, Normal}} = 3/7$, and $\pi_{\text{Trough, Peak}} = 2/7$.[17] The next step is to calculate the unconditional default probabilities. The initial probability for any bond quote is drawn from that year's corresponding business cycle phase transition matrix. The relative frequencies and the transition matrices for the three business cycle phases are used to determine the expected unconditional default probabilities for the following years. To illustrate, take an Aa-rated bond quote for 1991 (a trough phase of the business cycle). If this bond has annual coupon payments and matures after 5 years, the one to five year default probabilities need to be determined. The one-year default is derived directly from the one-year trough transition matrix. The two-year unconditional default probabilities is determined by taking the first row from the default probabilities column in the two-year transition matrix starting from a trough phase:

$$M_{2\text{ years}} = M_{\text{Trough}} \text{x} \left[\pi_{\text{Trough,Traugh}} M_{\text{Trough}} + \pi_{\text{Trough,Normal}} \text{x} M_{\text{Normal}} + \pi_{\text{Trough,Peak}} \text{x} M_{\text{Peak}}\right] \quad (2.3)$$

In (2.3), *M* is the ratings transition matrix, and π is the relative frequency as defined previously. A similar procedure is used to derive the three- to five-year unconditional default probabilities. For instance, the five-year default probability is derived from

[17] The remaining probabilities are: $\pi_{21} = 4/14$, $\pi_{22} = 8/14$, $\pi_{23} = 2/14$, $\pi_{31} = 1/8$, $\pi_{32} = 3/8$ and $\pi_{33} = 4/8$.

raising the appropriate value from the 2-year matrix obtained from equation (2.3) to the 4th power. These unconditional default probabilities then are used to derive the conditional ones when needed as is illustrated in footnote 12.[18]

2.4.2.3 The After-default Spot Curves[19]

In this section and unlike EGAM, we derive the after-default term structure of corporate spot rates from the actual prices of bonds using an approach similar to that used in section 2.3. Since we now account for the possibility that the bond could default before maturity, the spot rates obtained are lower than those reported in table 2.1 in section 2.3, where the difference is the default spread. The formula used to derive the after-default spot curves is:

$$\tilde{P}_t = \left\{ C(\sum_{m=1}^{M} d_{t,m} + d_{t,M} \right\} \prod_{m=1}^{M} (1-\lambda_m) + \sum_{m=1}^{M} \left\{ \left[C\sum_{i=1}^{m-1} d_{t,i} + \delta d_{t,m} \right] \lambda_m \prod_{i=1}^{m-1} (1-\lambda_i) \right\} \qquad (2.4)$$

In (2.4), $\tilde{P}_t$ is the dirty price, C is the coupon, d is the discount factor, λ is the conditional probability of default, and δ is the recovery rate. Equation (2.1), which was used to derive the spot rates without accounting for default and tax effects, is easily obtained by assuming that $\lambda=0$ in (2.4). Based on the default spread findings reported in table 2.7,[20] the default spreads over short- [long-] term periods are higher [lower] than those reported

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[18] Similar to the argument in footnote 12, the conditional default for any time interval Δt can be computed using Bayes' theorem as $[s(t)-s(t+\Delta t)]/\Delta t \times s(t)$ where $s(t)$ is the survival function.

[19] Further support is found for our earlier finding that using a theoretical 10-year bond and the unaltered EGAM methodology to decompose the credit spread can result in erroneous spread (i.e., negative) measurements. These tests of robustness used the Nelson and Siegel (and Svensson) approaches and the unaltered EGAM methodology on our sample prior to the elimination of 10+-year bonds. Based on unreported results, some of the estimated default spreads for the Aa- and A-rated bonds were negative. The Nelson-Siegel-Svensson (NSS) yield curve is based on six parameters instead of four as in the Nelson-Siegel (NS) model, and it allows for two humps instead of one in estimating yield curves. The results are mixed in terms of the superiority of the NSS over the NS approach. Dionne et al (2004) also find negative default spread estimates for short maturities and highly related bonds when using a zero-coupon, ten-year theoretical bond to decompose the spread instead of a coupon-paying bond.

[20] When incorporating the default spread to derive the after-default spot rates, the number of outliers and the root mean square errors do not change materially.

by EGAM. To illustrate, our 2-year default spread for Aa-rated bonds are more than double those reported by EGAM, while our 10-year default spread is one-third of that reported by EGAM for the same period. Furthermore, our results support the literature findings that the size of the default spread is small. For example, for the 10-year period, our default spread estimates do not exceed 0.014%, 0.05% and 0.351% for the Aa-, A-, and Baa-rated bonds, respectively.

2.4.3 Tax Spread Estimates

The expectation is that the after-tax yield on corporate bonds is higher than that of state-tax-free Treasury bonds all else held equal to compensate for the higher effective tax rate on the former in the US. To maintain comparability, an effective tax rate of 4% on Treasuries as in EGAM is used to calculate the magnitude of the tax spread.[21] In the next section, the shortcomings of this measurement are addressed.

The following equation is used to compute the tax spread (for greater details, please see Appendix C):

$$e^{-(f^{C}_{tt+1}-f^{G}_{tt+1})} = (1-P_{t+1}) + \frac{aP_{t+1}}{V_{t+1T}+C} + \frac{C(1-P_{t+1})-(1-a)P_{t+1}}{V_{t+1T}+C}(t_s)(1-t_g) \qquad (2.5)$$

Given the low effective tax rate, we expect and find in table 2.8 that the tax spread represents a small proportion of the credit spread (from around 0.4% to 8.4% for Aa- to Baa-rated bonds, respectively). These values are a little higher but consistent with EGAM.

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[21] The effective tax rate is the state tax rate multiplied by one minus the federal tax rate, or $t_s(1-t_g)$ in equation (3).

2.4.4 A Reexamination of the Tax Spread Estimates

The EGAM approach ignores many complexities of the tax system such as the different tax treatment of discount and premium bonds, and uses only a gross, exogenously determined uniform tax rate of 4%. Instead, we incorporate more of the complexities of the actual tax system into our computations. Our approach is grounded mainly in the work of Green and Odegaard (1997) and Liu et al (2005). Appendix E provides the derivation of the after-tax term structure when the effect of personal and federal tax rates, the amortization of taxes, accrued interest taxes, issue dates, and the difference between premium and discount bond tax treatment are considered.[22] By assuming that the taxes on income and capital gains are unknown in our optimization model, we can determine implied tax rates from the sample prices so that the tax rates are no longer constant by assumption as in EGAM. Our approach is consistent with the findings of Green (1993), Ang, Peterson and Peterson (1985), Skelton (1983), and Kryzanowski, Xu and Zhang (1995) that the implied marginal tax rates based on the spread between tax-free and taxable yields decrease with maturity.

Six parameters are estimated in our optimization model. These include the four parameters of the Nelson and Siegel approach, which are needed to derive the spot rates, the marginal income tax rate, and the capital gains tax rate. Based on table 2.7, our tax-spread estimates are generally lower than those reported by EGAM for short-term maturities and higher for the long-term maturities.[23] Interestingly, our tax rate estimates

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[22] After accounting for default and taxes, the number of outliers removed from the computation process becomes lower (804 bond prices) and the accuracy of our results is higher. The RMSEs for the Aa-, A-, and Baa-rated bonds become 1.1, 1.3, and 2.2, respectively.

[23] The tax spread component of the credit spread is the excess taxes on corporate bonds over the taxes on treasuries. Consequently, the tax spread is calculated as the difference between the after default interest rates (derived by assuming that the taxes in equation (E1) are equal to zero) and the after default and after

materially exceed those reported by EGAM. We find that investors pay on average a tax of 5.43% on income and 5.44 % on capital gains for Aa rated bonds whereas they pay on average a tax of 6.34% on income and 6.43% on capital gains for A-rated bonds and pay about 8.94% on income and 9.33% on capital gains for Ba-rated bonds.

2.4.5 Risk Premium Estimates

Since systematic risk affects credit migration, which in turn could lead to a downgrading of the credit rating and higher uncertainty about recovery rates, systematic risk is expected to represent a significant portion of a credit spread. Many studies find a link between systematic risk and the credit spread. For example, Ericsson and Renault (2000) and Baraton and Cuillere (2001) show that the valuation of credit risk requires that one account for macroeconomic factors. Duffee (1998) finds that the correlation between credit spreads and the stock market is higher for high yield bonds than for low yield bonds. EGAM find that a large portion of the variation in credit spreads of corporate bonds is systematic in that the risk factors identified by Fama and French (1993) are priced.

Based on the size of the default and tax spreads, a considerable proportion of the credit spreads remains unexplained (specifically, the unexplained portion ranges from an average of 14.7 % for the Baa bonds to 48.9% for the Aa bonds). To test the relationship between the Fama and French (FF) systematic factors and the unexplained portion of the spread for the 120 term structures estimated earlier on a monthly basis for the ten-year period, the following relationship between spreads and the three FF factors is examined:

$$R^C_{t,t+1} - R^G_{t,t+1} = -m[(r^C_{t+1,m} - r^G_{t+1,m}) - (r^C_{t,m} - r^G_{t,m})] = -m\Delta S_{t,m} \qquad (2.6)$$

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tax interest rates (from equation (E1)) plus the difference between the interest rates on treasuries and their after tax interest rates (derived by assuming that the default rates are equal to zero in equation (E1)).

where $R^C_{t,t+1}$ and $R^G_{t,t+1}$ are the monthly returns on corporate and government constant maturity bonds maturing m periods later, respectively; m is the term-to-maturity of the bonds; r^C and r^G are the spot rates on corporate and government bonds, respectively; and $\Delta S_{t,m}$ is the monthly change in the credit spreads. Although Equation (2.6) relates spreads to returns, equation (2.6) needs to be extended to deal with what corresponds to only the unexplained portion of the total spread (i.e., after removing the portion explained by default and taxes). Doing such, equation (2.6) becomes:

$$R^{uc}_{t,t+1} - R^G_{t,t+1} = -m[(r^{uc}_{t+1,m} - r^G_{t+1,m}) - (r^{uc}_{t,m} - r^G_{t,m})] = -m\Delta S^{uc}_{t,m} \tag{2.7}$$

where $\Delta S^{uc}_{t,m}$ and $R^{uc}_{t,t+1}$ are the unexplained portion of credit spread changes and returns, respectively; and all the other terms are as previously defined.[24]

Equation (2.7) is used to compute the unexplained excess returns based on the unexplained credit spreads.[25] Similar to EGAM, we apply the Fama and French (1992) three-factor model to (2.7) to yield:

$$R^{uc}_t - R^G_t = \alpha + \beta_M R_{Mt} + \beta_{SMB} SMB_t + \beta_{HML} HML_t + e_t \text{ , t=1,2,..119} \tag{2.8}$$

where $R^{uc}_t - R^G_t$ is the excess unexplained monthly return, which is calculated from the monthly changes in the unexplained portion of spreads;[26] R_M is the excess market return; *SMB* is the return on a portfolio of small stocks minus the return on a portfolio of large stocks; and *HML* is the return on a portfolio of stocks with high book to market values minus the return on a portfolio of stocks with low book to market values.

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[24] Equations (2.6) and (2.7) are derived more fully in Appendix D.

[25] For example, if the change in the monthly unexplained spread is 0.1%, then the excess unexplained monthly return for the 2-year credit spread is – 2 x 0.1% = -0.2%. This is done for each month for the two to ten year unexplained credit spreads.

[26] The unexplained portion of the spread is simply the credit spread minus the default spread minus the tax spread.

Based on the empirical results presented in table 2.9, we find that the explanatory power of this model across most maturities is insignificant, with the exception of the market factor across all maturities for the Baa bonds. These results support the findings of Collin-Dufresne et al (2001) who find that the FF factors are not significant and do not increase the overall explanatory power of their estimated model. This contradicts the findings of EGAM who report an adjusted R^2 as high as 31% for the three-factor FF model. At least two possible explanations exist for the differences between our results and those of EGAM. The first is grounded in our rectification of some of the shortcomings in the EGAM methodology used to determine the spreads. The second possible explanation is that the macroeconomic factors may be determinants of the unexplained spread in EGAM because they capture the conditional nature of default probabilities where the conditioning variable is the phase of the business cycle.

2.5. THE ROLE OF ILLIQUIDITY

2.5.1 Measures of Illiquidity

Numerous measures of bond (il)liquidity are proposed in the literature. The liquidity measures range from direct measures based on quote and/or transaction data (such as the quoted or effective bid-ask spreads, quote or trade depth, quote or trade frequencies, trading volume and number of missing prices) to indirect measures based on bond-specific characteristics (such as issued amount, age, yield volatility, number of contributors, and yield dispersion). Since our data set does not contain bid and ask prices or volume traded, quote- and trade-based direct measures of liquidity are not used herein. Therefore, we use one direct and three indirect proxies to measure aggregate market liquidity.

Since all the liquidity proxies proposed in the literature are bond-specific, we used the average approach adopted for equities by Chordia et al. (2001) for equity markets to obtain our aggregate proxies.[27] We consider whether or not the aggregate liquidity indexes should include the eliminated bonds (callable, puttable, more than 10 year maturity, zero coupon and variable rate bonds), and whether the indexes should be differentiated by rating or industrial sector category. Intuitively, it seems most appropriate to form indexes based on the market from which each credit-spread curve is estimated (i.e., by rating and only including bonds in our final sample). However, since the factors that affect liquidity could be macro factors such as the business cycle, we would expect (and find that) the proxy that better captures such macro factors is the one with the largest bond market coverage.

Thus, we form the liquidity proxies based on three broad categorizations of the initial data in order to ensure that our liquidity findings are robust. The categories are: all traded bonds including treasuries and non-investment grade bonds (Cat1); the full corporate bond market (Cat2), or Cat1 minus treasuries; and industrial-sector bonds only (Cat3). For each of these three categories, three additional categories are formed but with the deletion of callable and puttable bonds and bonds with maturities exceeding ten years to use only the bonds in our final sample (Cat1a, Cat2a, Cat3a). Finally, six subsamples of bonds are formed for Aa-, A- and Baa-rated bonds from the two corporate bond categories (Cat2 and Cat2a) and the two industrial bond categories (Cat3 and Cat3a).[28] This yields 18 measures of liquidity for each type of aggregate liquidity proxy.

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[27] Total value proxies are used for tests of robustness.

[28] For example, another three categories, Cat2aAA, Cat2aA and Cat2aBaa that represent the Aa-, A-, and Baa-rated corporate bonds, respectively, are formed from Cat2a.

The direct proxy of aggregate liquidity for a month is the relative frequency of monthly matrix prices to the total number of monthly corporate quotes during that month as captured in the Warga (1998) database. Any lack of liquidity in the corporate bond market should be reflected in the need for greater matrix pricing. Thus, this measure of thin trading should be inversely related with bond liquidity.

The first indirect proxy of aggregate market liquidity is the average dollar issued amount of bonds that were traded during the month. The dollar amount of the bond at the issue date is reported in the Warga and FISD databases. Since most investment banks rely on this measure to form their bond indices,[29] proponents of this measure argue that larger issues should trade more often than smaller issues since they are broadly disseminated among investors. Furthermore, Sarig and Warga (1989) and Amihud and Mendelson (1991) argue that bonds with smaller issued amounts tend to be absorbed in buy-and-hold portfolios more easily. Consequently, small issue bonds are not expected to generate much secondary market activity. Thus, both arguments lead to the expectation that a bond is more liquid with a larger issue size.

The second indirect proxy of aggregate market liquidity is the total age of bonds that traded during the month. This is obtained by finding the sum in years of the differences between the trading dates and the issue dates for all the bonds that traded during that month. The age of a bond is commonly used in the literature as an issuer-specific proxy of liquidity. The expected relationship between liquidity and age is that a bond becomes less liquid with increasing age because a higher portion of its outstanding position is held in the portfolios of buy-and-hold investors. Sarig and Warga (1989) observe that longer maturity bonds are more illiquid than shorter maturity bonds.

[29] For example, Lehman Brothers use this criterion for their Euro-Aggregate Corporate Bond index.

The third and final proxy of aggregate market liquidity is the mean of all the yield volatilities of bonds that traded during the month using yields starting 2 years earlier.[30] Since the inventory-cost component of bid-ask spreads is higher for greater yield volatility all else held constant, we expect illiquidity to increase with increasing yield volatility.[31]

2.5.2 Explanatory Power of Illiquidity

The following multiple regression is conducted first to determine if the portions of the credit spreads unexplained by default and taxes are related to the monthly aggregate (il)liquidity proxies for the 1987-1996 period:

$$S_{t,m}^{uc} = \beta_0 + \beta_1 Amount_{t,m} + \beta_2 Age_{t,m} + \beta_3 Matrix_{t,m} + \beta_4 Volatility_{t,m} + \varepsilon_{t,m}^{uc}, \qquad (2.9)$$

where $S_{t,m}^{uc}$ is the portion of the credit spread unexplained by default and taxes for a term-to-maturity of m, which is measured either as the total credit spread minus the estimated default spread minus the estimated tax spread for a term-to-maturity of m, or alternatively, as the difference between the after-default and after-tax corporate and treasury term structures for a term-to-maturity of m;

Amount is the average dollar issued amount of bonds in billions that traded during the month t;

Age is the average age in thousands of years of bonds traded during the month t;

Matrix is the relative frequency of monthly matrix prices to the total number of monthly corporate quotes during month t;

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[30] To illustrate, take the month of January 1987. The mean of all the volatilities of each bond that traded during this month is calculated using historical yields from 1985.

[31] Hong and Warga (2000), Alexander et al. (2000), among others, use yield volatility as a proxy for uncertainty.

Volatility is the average yield volatility in hundreds of bonds quoted during month t; and

$\varepsilon_{t,m}^{uc}$ is the error term with the usually assumed properties.

A comparison of the regression results for all aggregation categories shows that liquidity plays a major role in explaining the unexplained portion of credit spreads. A representative set of results is presented in table 2.10. These results are for regressions of the unexplained credit spreads for the Aa-, A- and Baa-rated bonds against the average liquidity proxies for Amount, Volatility and Age for their corresponding rating-specific aggregate corporate industrial bond indexes based on the initial sample of bonds (Cat3). Using the average value for Age allows for an indirect capture of the size of the market as reflected by the number of bonds trading in each applicable rating category in each month.

All reported regressions are strongly significant based on the F-test. All liquidity proxies are significant in most of the reported regressions and all categories. Therefore, aggregate liquidity is a major determinant of credit spreads, and plays sometimes even a more important role than default for the Aa rating category in the determination of the credit spread as is illustrated in table 2.11.

2.6. CONCLUDING REMARKS

In this chapter, we reexamined the work of EGAM on the components of credit spreads for industrial investment grade bonds. We recomputed the default spread based on industrial-sector default probabilities conditional on the phases in the business cycle. We reexamined the tax spread by allowing for variable tax rates and by accounting for the intricacies of actual bond taxation and not just from the use of a gross estimate of the tax rate. Moreover, we derived the default and tax spreads by computing the after-default and after-tax spot rates instead of using a theoretical ten-year par value bond as in EGAM.

We obtained different estimates for the default and tax spreads where the latter proved to be more important in determining the credit spreads. However, unlike EGAM, we found that the three factors in the Fama and French model do not play any significant role in explaining the remaining (unexplained) portion of credit spreads. However, we found that a portion of the unexplained spreads could be explained by market (il)liquidity using such proxies as issue amount, issue age and frequency of matrix pricing.

Chapter 3

DIVERSIFICATION BENEFITS FOR BOND PORTFOLIOS

The seminal work on modern portfolio theory by Markowitz (1952) illustrates the benefits of forming portfolios with less than perfectly positively correlated assets. The subsequent literature has focused on the benefits and drawbacks of using this approach for primarily equity portfolios. The studies on bond portfolios remain limited and outdated, probably because early studies find that the diversification benefits from holding bond portfolios of increasing size are minor due to the undeveloped state of bond markets. Since the bond opportunity set has expanded substantially in terms of credit quality, industry, country and bond maturity, opportunities to benefit from risk diversification in bond portfolios has increased.

The study by McEnally and Boardman (1979) examines the benefits of diversifying volatility risk and investigates how many bonds are necessary to obtain a target level of diversification benefits for investment opportunity sets differentiated by bond ratings. McEnally and Boardman (1979) conclude that eight to sixteen bonds significantly reduce volatility risk in bond portfolios. They also find that diversified portfolios of high yield bonds have lower systematic risk than portfolios of investment grade bonds, which could be attributed to an industry effect since most low risk bonds are in the utility sector whereas the high risk bonds are industrial bonds.

However, the implications of the results of McEnally and Boardman may not be applicable to more recent periods for a number of reasons. First, they examine a randomly chosen sample of 515 corporate *straight* bonds for the period 1972-76. Second, as McEnally and Boardman (1979) note, this time period is characterized by extreme instability in the corporate bond market in terms of interest rate volatility and default premia. As a result, Moody's re-rated approximately one fourth of the bonds in their sample during the studied period. Third, the only metrics used to assess diversification benefits in their study is unconditional variance. More recent tests of the benefits of equity diversification use a much broader set of metrics that reflect higher-order moments, alternate definitions of risk, and reward-to-risk measures.

Thus, the primary purpose of this chapter is to re-examine the diversification benefits associated with different-sized portfolios of bonds using various metrics. These metrics investigate the diversification benefits in terms of dispersion of returns, reward to risk, downside risk, and the probability of outperforming a target rate of return. In addition, the investment opportunity sets are categorized by industry and credit ratings. Also, the impact on the minimum portfolio sizes of an investor's preference for long- versus short-term investments is assessed by dividing the investment opportunity sets into sets of bonds maturing in more and in less than ten years, respectively.

This chapter makes four contributions to the literature. The first contribution deals with the benefits of diversification of bond portfolios for investment opportunity sets that are differentiated not only by credit ratings but also by industry sectors, domesticity and/or maturities. The second contribution is the investigation of bonds that are different in characteristics than the straight bonds previously investigated in the literature. Our study investigates a more developed market where bonds with additional characteristics such as callability, puttability, convertibility, and the like are included. The third contribution is an examination of the diversification benefits using various metrics, including some that were only recently introduced into the literature on stock diversification benefits. Finally, we show that there is no minimum portfolio size. The choice of the minimum portfolio size depends on the objectives of investors in terms of risk, return and bond maturity, and on issuer and bond characteristics, such as industry and rating, respectively.

The remainder of the chapter is organized as follows. A brief literature review is presented in the next section. In section two, the sample, data and investment opportunity sets are discussed. In section three, we report our results for the various performance metrics and discuss the minimum portfolio size beyond which most of the marginal diversification benefits are exhausted. In section four, we conduct a sensitivity analysis to determine if our results change materially for a straight bond sample or different sample years. Section five concludes the chapter.

3.1. LITERATURE REVIEW

While the theory shows that diversification minimizes the firm-specific component of total portfolio risk, researchers reach different conclusions concerning the minimum portfolio size (henceforth, PS) needed to achieve a "well-diversified" portfolio. As noted earlier, most of this research concerns equities. Evans and Archer (1968) regress a portfolio's standard deviation on the inverse of portfolio size and find that portfolios with eight to ten securities are "well diversified". They find that a PS of 10 has a standard deviation almost identical to that of the market. Latane and Young (1969) examine the reduction in standard deviation as the number of stocks in the portfolio increases. Their results confirm those of Evans and Archer (1968); namely, that 85 percent of the possible gains from diversification are achieved, on average, with an eight-stock portfolio. Elton and Gruber (1977) argue that the risk of a portfolio is not just the variability of the return of that portfolio around its mean return. They propose that risk is the probability of that portfolio's mean return being different from the market return. According to this "total risk" measure, a PS of eight stocks captures eighty percent of the benefits from diversification.

Many studies (e.g., Jennings, 1971) report an optimal PS of 15. Kryzanowski, Rahman and Sim (1985) identify a minimum PS of 15 and 30 for the U.S. and Canadian equity markets, respectively. In contrast, Statman (1987) claims that a well-diversified portfolio needs at least 30 randomly selected shares, and that 51% of the portfolio's risk is reduced with ten firms. Fama (1965) notes that a PS of at least 100 is needed to nearly consume all the potential benefits from diversification. Wagner and Lau (1971) find that a larger number of low quality stocks leads to better portfolio performance (as measured by the Sortino ratio) than a smaller number of high quality stocks.

More recent studies find that the number of stocks needed to obtain a "well diversified" portfolio has increased to 50 (Malkiel and Xu, 2006) or as high as 300 (Statman, 2004) due to increases in idiosyncratic volatility and an increase in the correlations between stocks. Bennett and Sias (2005) argue that the increased volatility is due to a change in the size and structure of industries.

Some empirical studies investigate the relationship between diversification benefits and market trend. Silvapulle and Granger (2001) examine diversification benefits given large negative movements in stock returns. They find that the average conditional correlation is much higher when the market is bearish, which diminishes diversification benefits. Sancetta and Satchell (2003) argue that this non-constant correlation with the market is increasingly important during extreme conditions. Demier and Lien (2004) find higher return dispersions at the firm level when market returns are largely negative. Van Nieuwerburgh and Veldkamp (2005) address the observation that investors tend to hold fewer assets than suggested by the literature on diversification benefits. They find that investors tend to concentrate their portfolios because they have informational advantages.

Numerous authors (e.g., Solnik et al., 1996; Chollerton et al., 1986; Jorion, 1987 & 1989; Kaplanis and Schaefer, 1991; Thomas, 1989) document improved return-risk combinations with international diversification. However, the benefits of international diversification are lower recently, as numerous authors report higher correlations between national and international stocks (e.g., Goetzman, Li and Rouwenhorst, 2001). Cappiello et al. (2003) and Hunter and Simon (2004, 2005) examine whether these weakened international diversification benefits for equities also apply to bonds. They find that the average correlation in the international bond market has increased over time but not to the same extent as observed in the equity market. Hunter and Simon (2004) find that U.S. investors who hold a well-diversified portfolio of domestic fixed-income and equity investments can obtain incremental diversification benefits from investing in international government bonds if currency risk is hedged. Economic uncertainty and unobservable regime shifting could increase the benefits from investing in bonds and equities. During times of increased stock uncertainty, the return co-movement between stocks and bonds becomes less positively correlated, and the price of U.S. Treasury bonds tends to increase relative to stocks. (This is a notion known as the flight-to-equity.)

3.2. SAMPLES AND DATA

Our bond sample is extracted from the Lehman Brothers Fixed Income Database (Warga, 1998), which consists of 39,132 bonds and 1,289,010 monthly bond prices from January 1985 until December 1997. This database contains monthly quoted and matrix prices, and descriptive bond information, such as industry, rating, duration, convexity, monthly total dollar returns, coupons, maturities, and embedded option features. Since monthly dollars returns are reported in the database, we calculate the monthly rate of return at time t+1 using the formula:

$$r_{t+1} = \frac{C_{t+1} + P_{t+1} + A_{t+1} - P_t - A_t}{P_t + A_t} \tag{3.1}$$

where P_t and P_{t+1} are the clean (bid) prices at time t and t+1, respectively; A_t and A_{t+1} are the accrued interest at time t and t+1, respectively; and C_{t+1} is the coupon payment at time t+1. We obtain the monthly rate of return by dividing the total dollar return (numerator) by the beginning of the period dirty price.

Our initial sample includes all bonds with quoted bid prices. This initial sample is divided into many investment opportunity sets depending on the deemed preferences of our hypothetical investor. When differentiating by issuer type, there are 27,497 unique bonds and 939,267 bond prices. When differentiating by credit ratings, there are 30,758 unique bonds with 927,295 bond prices. [32]

[32] For the breakdown of the sample sizes, please refer to the appendix F.

3.3. DIVERSIFICATION BENEFITS MEASURED USING VARIOUS METRICS

In this section of the chapter, various metrics are used to measure the benefits of portfolio diversification and to identify the minimum PS needed to diversify a specific percentage of nonsystematic risk or to capture a specific percentage of the reward from bearing risk using naïve diversification. This is implemented by selecting bonds randomly without replacement using a Monte Carlo approach in order to create 5000 portfolios for each IO set j and each portfolio size s. We test for a PS ranging from 2 to 100 and "All", where the latter includes N-1 bonds and N is the number of bonds in the IO set *j*.[33]

Since the form of the distribution changes as the IO set, metric and portfolio size change, the value of the dispersion metrics used in the determination of the minimum PS will also change. Therefore, we examine various metrics for different PS and different IO sets to determine how the optimal portfolio size changes when the return distribution is time varying. In Appendix G, we show that various metrics (such as skewness, kurtosis and tail shape) change across time and across IO sets, which suggests that a number of metrics should be used in determining the optimal portfolio size.

The most common method used to estimate the overall benefits of diversification as PS increases is to estimate the ratio in percentage terms of the potential benefits that are achieved, on average, for the specific PS versus the potential benefits achievable from holding all the assets in the IO set. The most common method for estimating the marginal

[33] When the number of bonds for a specific month is less than 101, the PS of "all" represented by a portfolio of N-1 bonds is lower in size than a PS of 100. Consequently, we eliminate months from our metric calculations where the number of bonds available for selection is less than 101. This results in the elimination of 4 months for the foreign (short maturities) IO set, 1 month for financial (long maturities) IO set, 1 month for foreign (long maturities) IO set, and 32 months for speculative grade (long maturities) IO set.

benefits of diversification as the PS increases is to estimate the speed at which the value of the diversification metric changes (e.g., Campbell et al., 2001). However, since the average correlation among security returns limits the power of diversification to reduce risk, a PS level should be reached at which an increase in PS produces only a small change in the metric measuring the marginal benefits of diversification. Due to the costs associated with further diversification, rational investors will be adverse to increasing the PS when the diversification benefits from incrementing the PS to the next larger PS are "small", which is taken herein to be a marginal change in the value of the diversification metric of one percent or less. However, this small marginal benefit or SMB-determined criterion for the determination of a "minimum" PS may leave a substantial proportion of the overall potential benefits from further diversification unrealized, as is show below.

3.3.1 Correlations of Bond Returns

The first metric used in this section is the correlation of bond returns. The correlation metric enables us to identify which IO sets have low or negative correlations, on average, and consequently may produce the highest diversification benefits. For each month for each IO set j (un)differentiated by issuer type, rating category and maturity, the cross-sectional mean of the correlations between every unique pair of bonds contained therein is calculated using only the bonds with at least 27 returns over the 36-month moving window ending during that month.

Summary statistics for various time-series distributions of the cross-sectional mean correlations for the (un)differentiated IO sets are reported in table 3.1. The industrial and financial sectors have the lowest means and medians for the time-series of cross–sectional mean correlations over the studied period. For a fixed PS, portfolios composed of bonds issued by industrial or financial firms can be expected to eliminate idiosyncratic risk faster than portfolios consisting of bonds issued by firms of the other issuer types. As is the case for short- versus long-term maturity bonds (i.e., less than versus greater than 10 years), speculative grade bonds have a lower mean for the time-series of cross-sectional mean correlations over the studied period compared to the other rating categories. All else held equal, this implies that investors may achieve diversification benefits faster, on average, for any PS by holding bonds with shorter maturities or lower quality ratings.

Summary statistics for this metric for various pairs of the differentiated IO sets are reported in table 3.2. The potentially superior diversification properties of speculative grade bonds persist. The maximum and minimum time-series correlations for speculative grade bonds are 0.19 and 0.03 for A- and Aaa–rated bonds, respectively. Furthermore, the time-series correlations between speculative grade bonds with maturities less than 10 years and the other IO sets even becomes negative. Similarly, the categories of utilities and foreign bonds show relatively low levels of time-series average correlations with the other differentiated IO sets. For instance, the categories of utilities and foreign bonds are negatively correlated with the treasury/agency category for bonds with maturities longer than 10 years.

3.3.2 Dispersion of Bond Return Metrics

The first metric examined in this sub-section of the chapter is the excess standard or mean derived deviation for a randomly selected portfolio, which is defined as the difference between the time-series standard deviations of the random portfolio and the whole IO set to which that portfolio belongs. This metric, which is calculated for 5000 randomly selected portfolios for each (un)differentiated IO set, is given by:

$$MDD_{j,s} = \bar{\sigma}_{j,s} - \sigma_J \,, \tag{3.2}$$

where $\bar{\sigma}_{j,s}$ is the mean of the standard deviations for the 5000 randomly selected portfolios with a portfolio size or PS of s for (un)differentiated IO set j, and σ_J is the average standard deviation of all the bonds in (un)differentiated IO set j.

As expected, the MDD decreases with increasing PS (see table 3.3). The minimum PS that satisfies the SMB criterion ranges from 35 to 45 for IO sets differentiated by issuer type. The overall diversification benefits at this minimum PS are substantial with reductions in the MDD ranging from 75% to 96%. For issuer-type-differentiated IO sets for bond maturities less than 10 years, we observe not only a lower SMB-determined PS with a range of 30-35 but also similar reductions in MDD of 75-95% (except for the 62% reduction in MDD for the foreign IO set). A comparison of the MDD for a specific PS for shorter versus longer maturities clearly shows that the former is never smaller with a wide range of PS of 35-55 but with similar overall reductions in MDD of 72-97%. This is due most probably to the higher sensitivity of long-term bonds to changes in economic factors.

The IO sets differentiated by rating category have a wider range for SMB-determined PS than the issuer-type-differentiated IO sets. For the rating category IO sets, the SMB-determined PS range from 35 to 50 with an overall reduction in MDD ranging between 72 and 93%. When differentiated by maturities, the short maturities IO sets also show in general lower SMB-determined PS (40-55) than the longer maturities (35-60), except for the Baa and Speculative IO sets where the shorter maturities have a higher SMB-determined PS. The overall reductions in MDD are considerable for both long and short maturities (80-96%), except for the Aa short maturity IO set that exhibits a slightly lower reduction in MDD of 65%.

The second metric examined in this sub-section is the average cross-sectional standard deviation (de Silva et al., 2000; Ankrim and Ding, 2002), which sometimes is referred to as the mean realized dispersion (MRD). When cross-sectional variations in returns are high, a fund manager is operating in a high risk environment where the probabilities of market over- and under-performance are high. Consequently, risk averse managers seek to reduce their exposure to higher MRDs, which for a fixed portfolio size s and IO set j is given by:

$$MRD_{j,s} = \frac{1}{N}\sum_{\tau=1}^{N}\sigma_{j,s,\tau}\,, \tag{3.3}$$

where $\sigma_{j,s,\tau}$ is the cross-sectional standard deviation for the 5000 randomly selected portfolios for IO set j with a portfolio size of s for month τ; and N is the number of months in the sample (i.e., 156 months from January 1985 untill December 1997). The diversification benefits, which are reported in tables 3.5 and 3.6, exhibit similar patterns across all (un)differentiated IO sets. The overall MRD is reduced, on average, by 76-80% for a SMB-determined PS of 35 to 40 bonds.

The third metric examined in this sub-section of the chapter is the normalized portfolio variance (NPV) metric (e.g., Goetzmann and Kumar, 2004). A portfolio variance is defined as:

$$\sigma_{j,s}^{2} = \frac{\overline{\sigma_{j}}^{2}}{s} + \left(\frac{s-1}{s}\right)\overline{\text{cov}}_{j,s} \tag{3.4}$$

where $\overline{\sigma}_j^2$ is the average variance of all bonds for a portfolio of size *s* in IO set *j*, and $\overline{\text{cov}}_{j,s}$ is the average covariance of the bonds in the portfolio. Normalizing both sides of equation (3.4) by $\overline{\sigma}_j^2$ yields the normalized portfolio variance:

$$NPV_{j,s} = \frac{\sigma_{j,sP}^2}{\overline{\sigma}_j^2} = \frac{1}{N} + \left(\frac{N-1}{N}\right)\left(\frac{\overline{\text{cov}}_{j,s}}{\overline{\sigma}_j^2}\right) = \frac{1}{N} + \left(\frac{N-1}{N}\right)\overline{corr}_{j,s} \tag{3.5}$$

where $\overline{corr}_{j,s}$ is the average correlation among the bonds in the portfolio. The NPVs are then averaged over the 5000 portfolios of size *s* for IO set *j*. An examination of equation (3.5) shows that portfolio risk can be reduced by increasing the number of bonds N in the portfolio and/or by selecting bonds that, on average, have a low correlation with each other.

Based on the NPV results reported in table 3.7 for IO sets differentiated by issuer type and maturities, a SMB-determined minimum PS of around 20-30 bonds achieves a high percentage of reduction in potential diversification benefits of 91-98% (except for a reduction of only 83% for the foreign IO set for both short and long maturities). The average diversification benefits as measured by NPV, which are achieved at the SMB-determined minimum PS, are similar for most IO sets differentiated by rating with a PS of 20-40 that corresponds to 87-98% of the potential overall diversification benefits.

The last metric examined in this sub-section is the semi-variance. Since return distributions may not be symmetric and investors dislike negative returns, some investors prefer to measure downside risk. Assuming that the risk-free rate is the target return, the semi-variance is defined as:

$$SV_{j,s} = \frac{1}{T^-} \sum_{t \text{ s.t. } R_t \le R_{f,t}}^{T^-} (R_t - R_{f,t})^2 \tag{3.6}$$

where T^- is the number of returns below the risk-free rate in our sample period.[34]

The semi-variance results that are reported in tables 3.9 and 3.10 indicate that the SMB minimum PS is in general between 20 and 25. Based on an examination of the IO sets differentiated by issuer type, the SMB minimum PS is 20-25. The overall reduction in *SV* is considerable at 93-96%. The same pattern is observed for issuer type IO sets differentiated by maturities. In contrast, the IO sets differentiated by credit rating exhibit a slightly wider range of SMB-determined minimum PS of 20-30. However, the associated reductions in SV are as high as for the issuer type IO sets at 91-97%.

3.3.3 Composite Return and Risk Metrics

Investors are interested in holding portfolios that provide the best return-risk tradeoffs. Consequently, a diversification strategy, such as increasing PS, which diminishes risk also needs to result in a higher return-to-risk tradeoff. Accordingly, we now examine how different return-to-risk metrics react to a changing PS for the various IO sets.

Metrics commonly used for this purpose normalize the excess return over the risk-free rate of the portfolio by the risk of that portfolio. One such metric is the Sharpe ratio, which is defined as

$$Sh_{j,s} = \frac{\bar{r}_{j,s} - \bar{r}_f}{\sigma_{j,s}} \tag{3.7}$$

where $\bar{r}_{j,s}$ is the mean return on the portfolios of size s for IO set j ; $\sigma_{j,s}$ is the average volatility of returns for portfolios of size s for IO set j ; and $\bar{r}_f$ is the mean risk-free rate.

[34] 30-day T-Bills rates (TBWK4 series downloadable from the Federal Reserve Board website) are used as the proxy for the risk–free rate.

The Sharpe ratio results differentiated by issuer type and by maturity are reported in table 3.11. When differentiated by issuer type, the SMB-determined minimum PS ranges from 30 (utility) to 50 (industrial). The corresponding increases in *Sh* range from 80% (Tr./Ag.) to 95% (foreign). When differentiated by maturity, the SMB-determined minimum PS range is tighter for short maturities where the SMB-determined minimum PS range is 35-45 and the associated *Sh* range is 82-93%. The foreign IO set exhibits the lowest SMB-determined minimum PS of 20, which in turn results in the lowest increase in *Sh* of 70%. The long-maturity IO sets have wider ranges than the short-maturity IO sets, where the former have a SMB-determined minimum PS range of 25 to 50 with associated *Sh* increases in the range of 65-94%. For these short-maturity IO sets, the foreign IO set continues to have the lowest SMB-determined minimum PS of 25 with the lowest associated *Sh* increase of 65%.

When differentiated by rating, the SMB-determined minimum PS ranges from 25 (Aa) to 60 (Aaa), and the associated *Sh* increases from 67% (Aaa) to 92% (Aa-A). Thus, the Aa IO has the lowest SMB-determined minimum PS with the highest associated increase in *Sh*. In contrast, the Aaa IO set has the highest SMB-determined minimum PS with the lowest associated increase in *Sh*. Based on comparisons between the IO sets differentiated by rating and maturity, we observe a much wider range for the long maturities with a SMB-determined minimum PS of 20 (A) to 75(Aaa) with associated *Sh* increases that are in the range of 73-93%. The ranges are narrower for short maturities (specifically, a SMB-determined minimum PS range of 25 for Aa and A to 45 for speculative with a range of 82-98% for the associated increases in *Sh*).

The second metric examined in this sub-section is the Sortino ratio, which is used in the literature to investigate the effect of portfolio size on downside risk (e.g., Lee et al., 2006). The Sortino ratio is defined as:

$$Sor_{j,s} = \frac{\overline{r}_{j,s} - \overline{r}_f}{\sigma_{j,s}^-} \tag{3.8}$$

where $\sigma_{j,s}^-$ is the semi-standard deviation based on squared deviations below the mean; and the rest of the variables are as defined previously.

The results for the Sortino metrics are reported in tables 3.13 and 3.14. Based on the results for IO sets differentiated by issuer type, the SMB-determined minimum PS ranges between 20 and 45 for all IO sets, and the associated increases in their *Sor* are in the range of 72-94%. Based on a further differentiation by maturity, the SMB-determined minimum PS are in the range of 20-65 for short-term maturity IO sets (with associated increases in their *Sor* of 74-98%). They are in the range of 10 (foreign) to 30 (Tr./Ag.) for the long-term maturity IO sets (with associated increases in their *Sor* of 74-95%).

The third metric examined in this sub-section is the adjusted excess-return measure (ER) metric (Xu, 2003), which compares the portfolio's actual average return to that of an efficient portfolio on the capital market line with the same total volatility.[35] The ER measure is defined as:

$$ER_{j,s} = \overline{r}_{j,s} - \left(\sigma_{j,s}/\sigma_J\right)\overline{r}_J \tag{3.9}$$

[35] The relative return metric, which scales the ER measure by the absolute value of the market return, produces similar results that are not reported herein for compactness.

where $\bar{r}_J$ and σ_J are the average return and standard deviation of returns for the equal-weighted portfolio of all the bonds in IO set j; and all the other terms are as previously defined.

As expected, the ER starts at negative values and moves monotically towards zero for all IO sets (see tables 3.15 and 3.16). However, the SMB-determined minimum PSs vary from a low of 5 for the long maturity IO set for Tr./Ag. to a high of 50 for the all-maturity IO set of Tr./Ag. Differentiating only by issuer type, the SMB-determined minimum PSs range from 25 (Utility) to 50 (Tr./Ag.) with associated increases in their ER of 86-94%. The range of SMB-determined minimum PSs narrow when differentiating by both issuer type and maturity. Specifically, the range of the SMB-determined minimum PS is 20-35 for short maturities and 25-40 for long maturities (except for the PS of 5 for Tr./Ag). The associated increases in their ER are in the range of 73-92% for short maturities and 71-93% for long maturities (except for the 14% for Tr./Ag).

3.3.4 Metrics based on Higher-order Moments of Bond Returns

Although the metrics used so far have the advantage of being simple, robust and independent of any reference index, they do not capture higher dimensions of risk that may differ across portfolio sizes for the same IO sets. For example, the Sortino ratio ignores the existence of third and fourth moments (i.e., skewness and kurtosis), which may be unfavorable to the investor. Similarly, lower second returns moments may occur for portfolio sizes along with fatter tails. In addition, the Sortino ratio can be manipulated by transferring part of the risk from the first and second–order moments to the third and fourth–order moments (e.g., Lo, 2001).[36]

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[36] By selling out-of-the-money put options on the S&P 500, Lo (2001) obtains a Sharpe ratio of 1.94 for the period from January 1992 to December 1999. This is higher than the corresponding Sharpe ratio of 0.98

The time-series mean of the cross-sectional *Skew* and *Kurt* for a fixed portfolio size *s* and IO set *j* are given by:

$$\mu_{Skew_{j,s}} = \frac{1}{N}\sum_{\tau=1}^{N} Skew_{j,s,\tau} \text{ and } \mu_{Kurt_{j,s}} = \frac{1}{N}\sum_{\tau=1}^{N} Kurt_{j,s,\tau} \quad (3.10)$$

where $Skew_{j,s,\tau}$ and $Kurt_{j,s,\tau}$ are the cross-sectional skewness and kurtosis, respectively, for the 5000 randomly selected portfolios for IO set *j* with a portfolio size of *s* for month τ ; and N is the number of cross-sections.

The literature documents that investors prefer to construct portfolios with positive skewness (e.g., Harvey and Siddique, 2000; Premaratne and Tay, 2002). Consequently, an increase in PS that makes skewness more positive or less negative is considered valuable. Based on tables 3.17 and 3.18, the mean of the time-series of cross-sectional mean skewnesses is highly positive at a PS of 2 and decreases monotonically as the PS increases from 2 to all bonds for all IO sets. Thus, the SMB-determined minimum PS of 2 is preferred for skewness for all IO sets. These results are consistent with those documented by Kryzanowski and Singh (2006) for Canadian equity IO sets who report that further diversification diminishes the positive skewness associated with not well-diversified portfolios.

In contrast, the kurtosis metric, which is always leptokurtic, decreases monotically with an increase in PS from 2 to 100 for all IO sets.[37] If risk-averse investors weigh potential downside returns more than potential upside returns, then these investors will prefer a distribution with low kurtosis since the tails are more likely to fall closer to the

for the S&P 500. In Lo's example, the maximum loss for his fund is -18.3% compared to -8.9% for the S&P 500.

[37] The increase in kurtosis from a PS of 100 to a PS of "All" is caused by the slight differences in the mean returns for the portfolios with N-1 assets. Similar results are obtained with simulations of 10,000 portfolios.

mean. Thus, the risk of an extreme loss decreases as PS increases from 2 to 100.[38] PSs of 20-30 capture most of the decrease in kurtosis as PS increases (84-88% except for the 46% for the foreign IO set). When differentiated by short maturities, the minimum PS range remains at 20-30 with the corresponding average decreases in kurtosis in the range of 41-89%. The minimum PS range drops to 15-25 for longer maturities, and the corresponding average reductions range from 25% (foreign IO set) to 86% ("All" IO set). When further differentiated by credit rating, the range of minimum PS is 20-30, and the corresponding average reductions in kurtosis range from 55% to 87%.

Most interestingly, the relation between kurtosis and PS or s is convex; first decreasing as PS increases and then increasing as PS increases further so that the kurtosis at a PS of All is considerably higher than its corresponding value at a PS of 2 for all (un)differentiated IO sets. This illustrates a potential difficulty when interpreting changes in kurtosis in isolation because kurtosis not only measures the tail heaviness of a distribution relative to that of the normal distribution but it also measures the peakedness of that distribution.[39] Their relative impacts on the skewness measure can vary with changing portfolio size, as is the case herein.[40] Specifically, the convex relation between kurtosis and portfolio size for a fixed IO set j for month τ occurs because the ratio,

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[38] Unlike the other metrics, diversification benefits are captured by the decrease in kurtosis between a PS of 2 and the PS under investigation since measuring the potential diversification benefits as the difference in the kurtosises between a PS of 2 and PS of "All" is not applicable due to the very high kurtosis for a PS of "All".

[39] According to Ruppert (1987), kurtosis measures both peakedness and tail weight, because if probability mass is moved from the flanks to the center of a distribution, then mass has to be moved from the flanks to the tail to keep the scale fixed.

[40] As a result, Brys, Hubert and Struyf (2006) conclude that, since no agreement exists on what kurtosis really estimates, its use is often restricted to symmetric distributions. They also note that the kurtosis coefficient is very sensitive to outliers in the data.

$\left(\sum_{i=1}^{5000}\left(r_{i,j,s,\tau}-\overline{r}_{j,s,\tau}\right)^{4}\right)\Big/\sigma_{j,s,\tau}^{4}$, first declines in value and then increases in values as s increases, where $\left(r_{i,j,s,\tau}-\overline{r}_{j,s,\tau}\right)$ is the return deviation for the i-th portfolio of size s for IO set j for month τ from its cross-sectional mean return for that month, and $\sigma_{j,s,\tau}$ is the cross-sectional standard deviation of returns for the portfolios of size s for IO set j for month τ. In turn, this means that $\sum_{i=1}^{5000}\left(r_{i,j,s,\tau}-\overline{r}_{j,s,\tau}\right)^{4}$ initially declines at a faster rate than $\sigma_{j,s,\tau}^{4}$ as PS increases and later declines a slower rate than $\sigma_{j,s,\tau}^{4}$ as PS increases further. In contrast, the skewness, which is based on raising mean return deviations and the standard deviation of returns to the third and not fourth power declines monotonically with increasing portfolio size.

To measure the left and right tails, we use the left (LQW) and right (RQW) quantile robust measures of tail weight as introduced by Brys et al. (2006).[41] These measures are not sensitive to the presence of outliers and provide robust measures of tail heaviness. Similar to Byris et al. (2006), we choose to measure the tail weight of the left and right 1/8 quantiles. The LQW(0.125) results are reported in tables 3.21 and 3.22, and the RQW(0.875) results are reported in tables 3.23 and 3.24. In all IO sets (without exception), the tail weight of the PS of "All" is significantly higher than those of the PS of 100. This clearly contributes to the high kurtosis measures of a PS of "All" reported in tables 3.19 and 3.20. More interestingly, however, is that the tail weights of a PS of "All"

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[41] For a continuous univariate distribution F, $LQW_F(p)=\dfrac{Q\left(\frac{1-p}{2}\right)+Q\left(\frac{p}{2}\right)-2Q(0.25)}{Q\left(\frac{1-p}{2}\right)-Q\left(\frac{p}{2}\right)}$ and $RQW_F(q)=\dfrac{Q\left(\frac{1+q}{2}\right)+Q\left(1-\frac{q}{2}\right)-2Q(0.75)}{Q\left(\frac{1+q}{2}\right)-Q\left(1-\frac{q}{2}\right)}$ in which $0<p<\frac{1}{2}$ and $\frac{1}{2}<q<1$ and where $Q(p)=Q_F(p)=F^{-1}(p)$ is the quantile function.

are not always the highest reported for the IO set. In fact, some PSs have a higher tail weight (e.g., the tail weight of the IO set "All" for a PS of 10 is 0.380 whereas it is 0.360 for a PS of "All" in table 3.21). Given the fact that the kurtosis measures for "All" are the highest in the IO set even if some PS have a higher tail weight leads us to conclude that the main factor contributing to the high kurtosis is the peakedness of the distribution.[42]

Unlike the other metrics examined above, the difference between the LTW metric values at PSs of 2 and All are not helpful in measuring diversification benefits. This is due to the non linear relationship between the tail weights and the PSs, which results in some of the maximum and/or minimum LTW values being associated with a PS different than 2 or All. Consequently, the total potential diversification benefit for this metric is redefined as the difference between the maximum and minimum LTW values, and the optimal PS is redefined as the PS beyond which no other PS provides a marginal reduction of more than 1% in this measure of total potential diversification benefits. The optimal PSs are between 80 and 100 for the IO sets differentiated by issuer type. Exceptions occur mainly in the long-term maturity IO sets where the optimal PSs for TR/Ag., Foreign and Industrial are 25, 45 and 65, respectively. The optimal PSs are from 60 to 100 for the credit-rating IO sets when undifferentiated by maturity, and are wider when differentiated by maturity (45 to 100 and 35 to 100 for short- and long-term maturities, respectively).

[42] We also test the LMC (left medcouple) and RMC (right medcouple) robust measures of tail weight and the results emit similar implications as those reported in the tables (for further details about these tests refer to Byris et al., 2006). We also test the tail behavior for up to 20,000 randomly selected portfolios and again the results had the same patterns.

3.3.5 Probability of Underperforming a Target Rate of Return

The literature documents that investors are concerned about the probability of portfolio returns falling below a target rate of return (Mao, 1970; Xu, 2003; Byrne and Lee, 2004). As in Xu (2003), we investigate the probability that the cumulative holding-period return of a portfolio of size s is lower than the cumulative return over the same holding period for an equal-weighted portfolio of all the bonds in the IO set.[43]

Based on the results summarized in tables 3.25 and 3.26, the probability that a portfolio of size *s* underperforms the market varies somewhat across IO set and PS. Not unexpectedly, the probability of underperforming the market is almost zero, on average, when the PS is one less than all the available bonds in the IO set. The SMB minimum PS does not exceed 15 for any IO set with corresponding potential benefits that do not exceed 9%.

3.4 SENSITIVITY ANALYSIS

In this section, we conduct various sensitivity analyses to investigate if our choice of bond sample affects the optimal portfolio size. We begin with three samples of time periods of equal length (i.e., 1986-1989, 1990-1993 and 1994-1997), and investigate the SMB-determined minimum PS using the mean realized dispersion metric (MRD) differentiated by issuer type for the different sample periods. As reported in table 3.27, we find that there are no significant changes in the SMB-determined PS across the samples even though the metric values, potential diversification benefits and the form of distribution differ across these three time periods. In general, the optimal portfolio size is

[43] For each month, the cumulative holding-period return is first calculated. Then, the probability is calculated based on the number of times that the holding-period returns for the specific PS underperforms the holding-period return on the market (the target return).

about 40 with associated diversification benefits of about 80%.[44] Second, we restrict our bond choice to straight bonds by excluding bonds with embedded options. As reported in table 3.28, we find that in general there is not much difference between the optimal portfolio size for the straight bond IO sets and for the IO sets that also include bonds with embedded options. The optimal PS for the IO sets of straight bonds exhibit an optimal PS of 30-40 for the MRD metric compared to 35-40 for the samples that include the bonds with embedded options. Similarly, the optimal PS using the skewness metric of 2 and the kurtosis metric of 20-30 are the same for the IO sets with and without the bonds with embedded options.

3.5 CONCLUDING REMARKS

In this chapter, the minimum portfolio sizes required to capture most of the diversification benefits from increasing portfolio size for various measures of diversification benefits are examined for investment opportunity sets differentiated by issuer type, and further differentiated by term to maturity and bond rating. Most of the diversification benefits are taken to be the portfolio size from which the marginal benefits from further diversification become less than 1%.

Based on the results summarized in table 3.29, we find that the minimum portfolio sizes vary not only by issuer type, term-to-maturity and bond rating but also by the metric used to measure the marginal benefits of further diversification. Further, while the marginal benefits of further diversification are generally achieved with portfolio sizes of 25 to 40 bonds, the untapped benefits of full diversification (i.e., holding all bonds in the

[44] The results reported in this section tend to have the same pattern for the IO sets differentiated by rating category.

IO set) at these portfolio sizes are still sizeable compared to IO sets of equities. This may explain the empirical findings that unlike equity funds, bond funds generally are value-neutral for unit holders based on gross returns and value-destroying based on net returns (e.g., Kahn and Rudd, 1995). This is caused by the difficulty and cost for individual investors of forming their own bond portfolios that capture a high percentage of the potential benefits of full diversification.

Chapter 4

DETERMINANTS OF CREDIT SPREAD CHANGES

The moderate explanatory powers of the models used to identify the determinants of changes in credit spreads suggest that alternative models may achieve greater success. To illustrate prior success, the models tested by Collin-Dufresne et al (2001) only explain 26% of the variation in corporate credit spreads. Thus, the primary purpose of this chapter is to investigate whether the moderate explanatory power of corporate credit spread changes previously reported in the literature is enhanced by using models that include a bond diversification factor and expectational data for some previously identified determinants, such as the term premium.

Although the models of Avramov et al. (2004) yield higher R^2 values (35%) than the models of Collin-Dufresne et al. (2001) for investment grade corporates, Avromov et al. (2004) calculate the yield spreads on each individual bond by subtracting the treasury (risk-free) yield for the same maturity from the bond's yield, where the term structure of risk-free yields are obtained by linear interpolation using the benchmark treasury yields for maturities of 3, 5, 7, 10 and 30 years. In contrast, based on the arguments in EGAM (2001), our credit spreads are obtained as the difference between the (term structures of) zero spot rates on corporates and governments (where the latter is derived from all treasury bonds in the database) and not on the yields to maturity for individual bonds. Furthermore, unlike Avramov et al., we do not eliminate bonds with maturities less than 4 years or bonds that are thinly quoted since the literature usually eliminates bonds with maturities less than one year, which are illiquid (e.g. Elton, Gruber, Agrawal, and Mann, 2001) .

This chapter makes three contributions to the literature. The first contribution is the derivation of the spot rate curve and consequently of the credit spreads for different maturities using a large sample of bonds. In turn, this allows for tests of how different factors affect credit spreads for different maturities. To our knowledge, only Van Landschoot (2003) uses this approach to investigate the euro market. In contrast, most of the studies that examine changes in US credit spreads examine the yield to maturity of individual bonds (e.g., Avramov et al., 2004).[45] The second contribution is the use of ex ante estimates instead of ex post realizations for some of the potential determinants. As expected, this approach improves the explanatory power of the chosen determinants since term structures reflect future expectations, while the subsequently reviewed literature has obtained much less explanatory power using realizations for these variables. The third contribution is the use of new variables (such as the undiversifiable risk of bond portfolios) that are identified empirically as being significant determinants of changes in credit spreads, as is expected theoretically.

The remainder of this chapter is organized as follows. The next section provides a brief review of the relevant literature. The second section describes the sample and data examined herein. The third section presents our credit model and the procedure used to estimate the term structures of zero-coupon spot rates and credit spreads (un)differentiated by credit rating for financials and industrials. The fourth section reports and analyzes the results of seemingly unrelated regressions (SUR) used to test our model.

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[45] Elton et al. (2001) present an argument of why zero coupon spots are better for calculating the credit spread. Specifically, using the yield to maturity instead of zero coupon spots makes the credit spreads dependent on coupons and does not differentiate between the credit spreads of bonds with different durations and convexities.

The fifth section provides a test of robustness by estimating a model that is similar to the ones currently used in the literature. The sixth and final section concludes the chapter.

4.1. RELEVANT LITERATURE

The literature examining the determinants of credit spread changes is not extensive. Collin-Dufresne et al. (2001) use a structural approach where credit spread changes depend on leverage, the change in the risk-free rate, the change in the slope of the risk-free term structure, the change in the weighted average of eight near the money options on the OEX index, the change in the slope of the "smirk" of the values of implied volatilities, and the change in S&P returns.[46] Although a principal component analysis suggests that the first factor could explain as much as 76% of the variation in credit spreads, their estimated models are unable to explain more than 26% of the variation in industrial credit spreads. Collin-Dufresne et al. (2001) conclude that local supply/demand shocks that are not related to the common risk and liquidity measures could be the driving forces.

Avramov et al. (2004) show that the poor explanatory power of structural variables is restricted to investment grade bonds. After adding other structural variables (such as stock returns, idiosyncratic volatility, price-to-book ratio at both the aggregate and firm level), the explanatory powers of their models increase to 35% for investment grade bonds and up to 67% for speculative grade bonds.

[46] In their structural approach, debt is treated as a put option on the firm value that is exercised by bondholders in case of default. Consequently, the credit spread is a function of the firm's value, the risk-free rate and all other variables that might affect either the risk-neutral probability of default or the recovery rate.

Using an extended Nelson and Siegel method to derive the spot rate curve for euro market credit spreads, Van Landschoot (2003) examines the explanatory power of structural models that include changing risk-free rates and the slopes of its term structure, the weighted averages of the returns on the DJ Euro Stoxx Financials and Industrials, the change in the implied volatility on the DJ Euro, the change in the bid-ask spread, and the lagged change in credit spreads. As in Collin-Dufresne et al. (2001), Landschoot finds that about 25% of the credit spread changes are explained, on average, by his structural models.

Amato and Remolona (2003) argue that undiversified risk (or the unexpected loss from default) explains the "credit risk puzzle" (i.e., the difference between credit spreads and default risk). Since the returns on bonds are highly negatively skewed, unexpected losses can be diversified away only with large portfolio sizes that are very difficult to attain. Consequently, bondholders need to be compensated for bearing this risk. Amato and Remolona support their argument by examining the collateralized debt obligation (CDO) market where managers have strong incentives to diversify.[47] They find that a relatively small number of bonds are included in the collateral pool, which supports the view that diversification is difficult to achieve.

Bevan and Garzarelli (2000) identify a relationship between the spreads for Moody's Baa yield-spread indexes and the growth in the gross domestic product (GDP). Contrary to the literature, they find a positive relationship between government bond yields and

[47]These managers transform low-quality debt into high-quality debt by taking a long position in low-quality debt paying high spreads and take a short position in high-quality debt paying low spreads. This strategy realizes profits because the gap in spreads between high and low quality debt is wider than the gap in expected default losses. Part of low quality debt serves as collateral for the CDOs in case of default. The issuer of CDOs realizes profits from the spread differential between low and high-rated bonds minus the cost of overcollateralisation. The need to keep a portion of the low-quality debt as collateral declines as the portfolio of low-quality debt becomes more diversified.

this spread. With the inclusion of other explanatory variables (such as leverage, cash flow needed to finance investment plans, and volatility of stock returns), more than half of the variation in yield spreads is explained. In contrast, Bewley at al. (2004) find no relationship between credit spreads and implied stock market volatility for Australia.

Longstaff et al. (2005) investigate the components of individual default-swap spreads using a reduced-form model where the intensity process has a jump risk to measure the size of the default component in credit spreads. For a sample of 68 issuers that have liquid default-swap trading data, Longstaff et al. find that default risk, contrary to the literature, accounts for more than 50% of credit spreads, and that bond-specific illiquidity (such as the bid/ask spread and the outstanding principal amount) are strongly correlated with spreads.

4.2. SAMPLE AND DATA

The bond data are extracted from the Lehman Brothers Fixed Income Database, which contains monthly clean bid prices and accrued interest on all investment grade corporate and government bonds. The database also contains descriptive data such as coupons, maturities, principals, ratings, and callability. The chosen sample includes the eight years of monthly data from 1990 through 1997 to correspond with data availability, which was only available after the year 1990 for most potential determinants and for bond prices only until year-end 1997. Eliminated bonds include those with prices below $5, those with embedded options (such as callable, puttable, convertible, and sinking fund bonds), and all corporate floating-rate bonds with an odd frequency of coupon payment (i.e., other than semi-annual).

Only the prices based on dealer quotes are extracted to calculate the spot rates. Thus, all matrix-based prices are not included since matrix prices include measurement error and might not fully reflect the economic influences in the bond markets. However, the matrix prices are used to calculate the relative monthly frequency of matrix prices to quoted prices as a proxy for liquidity. Since the frequency of payments and the nature of coupons (fixed or variable) are not identifiable in this database, the descriptive statistics from *The Fixed Income Securities Database* (*FISD*) are used to identify various bond characteristics. *FISD* contains all insurance company daily buys and sells of US corporate bonds for the 1995-1999 period.

Since the number of buy and sell prices in the FISD are limited, the term structures of the credit spreads could be extracted for only a few bond categories (such as the Aa-rated industrial bonds) from the FISD database. Consequently, the FISD prices could not be used to derive the components of the credit spreads. The final sample consists of 129,596 bond bid prices from which 70,133 bond prices are financial, 47,000 are industrial and 12,463 are Treasury.[48]

4.3. THE CREDIT-SPREAD MODEL AND ESTIMATION PROCEDURES

The Nelson-Siegel (1987) procedure is used to derive the zero-coupon spot rates. This procedure is used by many central banks to estimate zero-coupon spot rates from coupon carrying bonds. The corporate spot rate curve is estimated for each of the three bond-rating categories of Aa, A and Baa for both the financial and industrial sectors. The treasury spot rate curve is estimated from the treasury bonds. The credit spreads for

[48] The financial bonds consist of 12,035 Aa-rated bonds, 45,708 A-rated bonds, and 12,390 Baa-rated bonds. The industrial bonds consist of 14,754 Aa-rated bonds, 18,031 A-rated bonds and 14,215 Baa-rated bonds.

maturities 1 through 10 years are then calculated by taking the difference between the spot rates for corporates and treasuries for each designated maturity. The resulting credit spreads estimates, which are summarized in panel A of table 4.1, are consistent with the theory. All the empirical bond-spread curve estimates are positive and increasing as the rating class deteriorates.

The following model is used to identify the determinants of changes in credit spreads, ΔCS_t, from month *t-1* to month *t* for industrials (as in Collin-Dufresne et al., 2001) and without the lagged change in the credit spread term for financials: [49]

$$\begin{aligned} \Delta CS_t = {} & \Delta\overline{GDP}_t + \Delta LiqMatrix_t + \Delta RatingVol_t + \Delta\overline{Slope}_t + \Delta\overline{Default}_t \\ & + \Delta UndivRisk_t + \Delta CS_{t-1} \end{aligned} \tag{4.1}$$

where each of the independent variables is now defined.[50]

$\Delta\overline{GDP}_t$ is the change in the consensus expectations from Consensus Economics for GDP over the next 12 months when benchmarked against the actual GDP over the previous 12 months. This variable is a proxy for the business cycle and the state of the economy. Increasing GDP signifies greater prosperity in the economy. In turn, this results in lower default probabilities and higher recovery rates. Thus, the expected sign of this variable is negative, which implies lower credit spreads for higher GDP.

$\Delta LiqMatrix_t$ is the change in market liquidity for month t as proxied by the relative frequency of monthly matrix prices to the total number of monthly corporate quotes

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[49] The lagged changes in the credit spread terms are problematic when included in the model for financials given their correlations with the GDP factor that range between 52% and 58%. However, this problem is not encountered for the industrials.

[50] Other variables, such as the realized S&P500 and risk-free rate, and the expected risk-free rate from Consensus Economics and the S&P500 index from the Livingston Surveys, have little or no explanatory power. The same applies to average firm-specific ratios, such as debt-to-equity (annual debt value from Compustat to equity value from CRSP), price-to-book (monthly price from CRSP to annual book value per share from Compustat), and return on assets (annual from Compustat).

during that month as captured in the dataset used herein.[51] Any lack of liquidity in the corporate bond market should be reflected in the need for greater matrix pricing and consequently higher credit spreads. Thus, the expected sign of this variable is positive.

$\Delta RatingVol_t$ is the mean change from month *t-1* to month *t* in the volatilities of bonds for the bond's rating category that have at least 27 monthly observations in the previous 36-month period. An increase in volatilities signifies a greater risk for the rating category and higher default probabilities. Consequently, the expected sign of this variable is positive.

$\Delta\overline{Slope_t}$ is the expected change in the slope of the risk-free term structure from month *t-1* to month *t*, where the expected slope of the risk-free term structure 12-months forward is equal to the 12-month forward consensus forecast of the 10-year government bond yield minus the 3-month forward consensus forecast of the risk-free interest rate divided by 117 months. The expected slope of the term structure from data collected by Consensus Economics is used as a proxy for future expectations for the short-term interest rate. An increase in the slope of the yield curve suggests an increase in the expected future short-term interest rate, which should lead to an expected increase in credit spreads. Thus, the expected sign of this variable is positive.

$\Delta\overline{Default_t}$ is the change in the expected 1 year default probabilities from month *t-1* to month *t*, which is proxied by the change in the sum of default probabilities of all speculative grade ratings in the one-year transition matrices for 84-month moving windows based on data from Moody's.[52] Thus, the 1-year transition matrix used for

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[51] The relative frequency of matrix to quoted prices is computed for each industry and rating for the Aa-rated bonds in the financial sector.

[52] The one-year default probabilities for investment grade bonds as derived from the one-year transition matrix are zero in the US. Forecasting the default probabilities for a period *n* by multiplying the matrix by

January 1990 is built using data for the period from 1/1983 through 12/1989, and so forth for subsequent months. Since higher default probabilities are associated with riskier corporate bonds, the expected sign of this variable is positive for more risky bonds (Baa-rated herein) and negative for less risky bonds (Aa-rated and possibly A-rated bonds herein) as bondholders migrate to quality with higher default probabilities.

$\Delta UndivRisk_t$ is the change from month $t-1$ to month t in compensated undiversifiable risk. If bondholders are compensated for bearing undiversifiable risk, then the expected sign of this variable is positive. The speed at which mean derived dispersion (MRD) diminishes as portfolio size or PS increases is one of the most common methods used to estimate the marginal benefits of diversification (e.g., Campbell et al., 2001).[53] This measure is implied by taking the difference of MRD from month $t-1$ to month t. The MRD values are first obtained for 5000 randomly generated equal-weighted portfolios without replacement of size N-1 using a Monte Carlo approach from an investment opportunity set of all the bonds in the studied database, where N refers to the number of bonds with reported returns for month t. The MRD for a fixed portfolio of size N-1 for time t is then the cross-sectional standard deviation of the 5000 randomly selected portfolios of size N-1 for month t. An increase in the positive value of this MRD metric

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itself n times also lead to zero probabilities for certain investment grade rating classes. Therefore, the default probabilities are approximated by summing the default probabilities for the speculative grade bonds. The probability of an investment grade bond having a lower rating during one year is used to check the robustness of the results using this approximation. This probability is also significant when included in the model.

53 Risk averse managers seek to reduce their exposure to higher MRDs, which for a fixed portfolio size s and investment opportunity (IO) set j is given by $MRD_{j,s} = \frac{1}{N}\sum_{\tau=1}^{N}\sigma_{j,s,\tau}$,where $\sigma_{j,s,\tau}$ is the cross-sectional standard deviation for the 5000 randomly selected portfolios for IO set j differentiated by rating category with a portfolio size of s for month τ ; and N is the number of months in the sample.

exposes investors to more undiversifiable risk. In turn, this increase in risk should be reflected in higher credit spreads.

4.4. EMPIRICAL RESULTS FOR OUR CREDIT-SPREAD MODEL

Based on the correlation matrices reported in table 4.2 for the financial and industrial sectors, only the correlations between rating volatility and liquidity are above 30% (i.e., 49%, 36% and 32% for Baa-, A- and Aa-rated bonds for the financial sector only). Furthermore, the correlations between the factors, in general, have the expected sign. For example, an increase in GDP is associated with the following: a decrease in default in the economy, a higher ability to diversify risk (which could be attributed to more financial instruments in the economy), higher market liquidity (which could be associated with higher trading activity and higher wealth), a higher expected increase in the risk-free rate, and a lower rating volatility.

The models are estimated using SUR, which account for cross-correlations in the error terms.[54] Based on the regression results summarized in table 4.3, the model explains the changes in credit spreads for the financial sector very well. The adjusted R-squared values are as high as 59% for the A-rated bonds, 45% for the Baa-rated bonds, and 44% for the Aa-rated bonds. All of the independent variables are significant and with their expected signs.[55] Thus, higher credit spreads are significantly related with lower expected GDP, lower liquidity as captured by a higher ratio of matrix to quoted prices, a higher volatility of a rating's returns, and a higher expected increase in the slope of the term

[54] Based on the Breusch-Pagan test, the null hypothesis of constant variance of the error terms is generally rejected.
[55] The Johansen tests at a 5% significance level clearly reject the presence of co-integration and correlation between non-stationary time-series variables.

structure. Most interestingly, the findings strongly suggest that changes in MRD are not only priced in credit spreads but that they provide a reasonable proxy for the priced undiversifiable risk borne by bond investors. This finding provides support for the conjecture of Amato and Remolona (2003).

Based on the regression results summarized in table 4.4, the model is significant for the industrial sector but has less explanatory power. The adjusted R-squared values are about 44%, 35% and 40% for the Baa-, Aa- and A-rated bonds. While expected GDP, default and undiversifiable risk still play a major role in explaining the changes in credit spreads for the Baa-rated bonds with their predicted signs, liquidity plays a more major role for the higher industrial ratings. As conjectured earlier, the results suggest that the bonds in these higher-rating categories (Aa-rated bonds) are playing a substitute role for the Baa- and speculative grade bonds when risk increases. For instance, the credit spreads for the Baa-rated industrial bonds increase and those for the Aa- and A-rated bonds decrease when the default probabilities of the speculative grade bonds increase. This is consistent with the conjecture that the flow of investment to these less risky bonds increases when the economy is unstable. The expected change in the slope of the term structure and rating volatility cease to be significant determinants of credit spreads for industrial bonds. Industrial credit spreads exhibit mean reversion, since a change in credit spreads is followed subsequently by a change in the opposite direction.

4.5. TESTS OF ROBUSTNESS

In order to test the robustness of our model, the variables in our models are replaced with alternative proxies (e.g., realizations instead of expectations). The alternative model is given by:

$$\Delta CS_t = \Delta GDP + \Delta Liq\$Val_t + \Delta \mathrm{Imp}Vol_t + \Delta Slope_t + \Delta Default_t + \Delta Skew_t \qquad (4.2)$$

In (4.2), ΔGDP_t is the change in the realized GDP over the next 12 months based on data obtained from the Bureau of Economic Analysis at the US Department of Commerce. While its sign is expected to remain negative, the statistical significance of realized GDP should be lower than the variable it replaces (expected GDP).

$\Delta Liq\$Val_t$ is the replacement proxy for $\Delta LiqMatrix_t$, and is the average value issued in billions of dollars of investment-grade bonds that are traded during time *t*. Most investment banks rely on this alternate proxy of aggregate market liquidity when forming their bond indices.[56] Proponents of this measure argue that larger issues should trade more often than smaller issues since they are broadly disseminated among investors. Furthermore, Sarig and Warga (1989) and Amihud and Mendelson (1991) argue that small issue bonds are not expected to generate much secondary market activity because they tend to be absorbed in buy-and-hold portfolios more easily. Thus, the expected sign of this alternative liquidity proxy is negative.

$\Delta \overline{\mathrm{ImpVol}}_t$ is the replacement proxy for $\Delta \mathrm{RatingVol}_t$, and is measured as the change in the VIX index from month *t-1* to month t. The VIX, which is obtained from Bloomberg, is a weighted average of eight implied volatilities constructed from near-the-money puts and calls on the S&P 100 Index in the two months closest to expiration. The expected sign of this popular measure of market risk (Collin-Dufresne et al., 2001) is positive since credit spreads should increase with an increase in implied volatility, which suggests that markets expect larger negative jumps in firm value.

[56] For example, Lehman Brothers use this criterion for their Euro-Aggregate Corporate Bond index.

$\Delta Slope_t$ is the realized (not expected) change in the slope of the risk-free term structure from month *t-1* to month *t*, where the slope is calculated as the difference between the interest rate on 10-year constant maturity treasury bonds minus the 3-month risk-free rate divided by 117 months. The data are obtained from FRED (Saint Louis Federal Reserve Bank website). Realized changes in the slope of the term structure reflect information about expectations of future changes in short-term interest rates. Thus, the expected sign of $\Delta Slope_t$ is positive as credit spreads should increase with an increase in the actual slope.

$\Delta Default$ is the difference between the realized returns on market portfolios of long-term corporate and government bonds. Since the default premium is positively associated with expected business conditions, a higher default premium should reflect expectations about deteriorating economic conditions. Thus, the expected sign of this alternative proxy is positive.

$\Delta Skew_t$ is the replacement proxy for $\Delta UndivRisk_t$ in the original model, and is measured as the change in skewness of bond returns for month *t* because investors supposedly prefer to construct portfolios with positive skewness (e.g., Harvey and Siddique, 2000; Premaratne and Tay, 2002). The cross-sectional skewness of the 5000 portfolios with size *N-1* is negative. Changes to more negative skewness (i.e., a positive $\Delta Skew_t$) should lead to higher credit spreads, and vice versa. Therefore, the expected sign for this variable is positive.

Based on the regression results summarized in tables 4.5 and 4.6, all the variables in this alternative model are significant and with their expected sign although the explanatory power of the model is reduced compared to that of the original model.

Specifically, the highest adjusted R–squared value is now 21% for financials and 35% for industrials compared to a high of 59% for the financials and 44% for the industrials in the original model. Nevertheless, credit spreads are higher with lower GDP and liquidity, and with higher implied volatilities, negative skewnesses, term slopes and default premiums. As found earlier and according to expectations, the credit spreads for the Baa-rated bonds widen and the credit spreads for the Aa-rated bonds narrow as the default premium increases.

4.6. CONCLUDING REMARKS

In this chapter we investigated the determinants of changes in credit spreads after introducing some dependent variables that are new to this literature. Our model indicates that the expected changes in GDP and expected changes in the slope of the term structure computed using forecasts from Consencus Economics are determinants of changes in credit spreads. More importantly, undiversifiable risk is priced in the credit spread, which has been suggested but has never tested before in the literature. Other variables (such as default risk, market liquidity and the volatility of returns) also are major determinants of changes in credit spreads. Compared to the findings reported in the literature for other models, our model for explaining the time-series variations in the in credit spreads achieves higher efficiency (higher R^2 values) while being more parsimonious.

Chapter 5

IMPACT OF BOND INDEX REVISIONS

Finance research has dealt more extensively with the equity than the bond market. While the effect of stock index revisions on the stock returns of the issuer firms is the subject of a vast literature that is reviewed in the next section, little is known about the impact of bond index revisions on the bond and stock values of the issuer firms. This may be important for the measurement of financial risk (i.e., the ability of a firm to meet its financial obligations), if the effect of a bond index revision on the underlying firm's bond and stock values is asymmetric in that the value of one changes materially while the other does not change materially. For example, if bond values increase (decrease) significantly with their addition (deletion) to a bond index while the value of the same firm's equity remains unchanged, this would suggest that equity investors do not interpret the increase (decrease) in the same firm's debt-to-equity ratio, when measured at market, as indicating that the firm has higher (lower) financial risk.

Thus, the primary objective of this chapter is two-fold: first, to examine whether the effect of a bond's addition or deletion to a bond index is (a)symmetric for the same firm's bond and stock values; and second, to relate these findings to the measurement of a firm's financial risk. By addressing the first objective, this chapter expands the existing literature from the impact of stock index revisions on stock returns to the impact of bond index revisions on both bond and stock returns. By addressing the second objective, this chapter provides evidence that suggests that changes in debt-to-equity market values may not always be interpreted by investors as signaling changes in financial risk.

This chapter has three major findings. The first is that both index additions and deletions have a significant impact on the bond returns of the affected underlying issuers, which confirms the conjecture that index revision announcements have information content. The second major finding is that both types of bond index revisions do not have a significant impact on the stock returns of the underlying issuers. The third major finding is that debt-to-equity ratios measured at market are noisy proxies for measuring financial risk.

The remainder of this chapter is organized as follows. A brief literature review is presented in the next section. In section two, the sample and data are discussed. In section three, the hypothesis and test methodology are detailed. In section four, the empirical findings are summarized and analyzed. Section five concludes the chapter.

5.1. RELEVANT LITERATURE

The literature on the effect of stock index rebalancing is fairly extensive. Goetzmann and Gary (1986) find a negative return of 1.9% after the removal of seven stocks from the S&P 500, which they attribute to a decrease in future analyst coverage for these stocks. Schleifer (1986) finds no effect (a 2.79% abnormal return or AR) on the announcement day associated with additions to the S&P 500 index prior to (after) September 1976 based on the 1966-83 period. Schleifer dismisses the hypothesis that inclusion in the S&P 500 increases future analyst coverage and consequently stock prices, since additions differentiated by how well they are known generate similar abnormal returns.

Harris and Gurel (1986) find a 3% increase in stock prices for S&P 500 additions upon announcement, which is almost entirely reversed after three weeks. For S&P500 revisions during the 1977-1983 period, Jain (1987) finds a 3.07% announcement-day AR for 87 additions, and a -1.16% announcement-day AR for 22 removals. Jain concludes that S&P decisions have information content. Jain finds no evidence supporting the hypothesis that the demand of index fund managers accounts for the ARs. Pruitt and Wei (1989) report that institutional investors cause buying and selling pressure following a stock's addition or deletion from the S&P 500.

Dhillon and Johnson (1991) find a large return of 3.33% on the announcement day but a subsequent decline of 1.31% after 60 trading days. The finding by Dhillon and Johnson that the prices of call and put options change with index additions suggest that option traders believe that the price changes are permanent. Lynch and Mendenhall (1997) confirm the partial price reversal after the effective date, as do Chung and Kryzanowski (1998) for changes to the TSX Composite index.

Beneish and Whaley (1996) observe abnormal trading volume and a temporary decrease in the quoted spread only after the S&P announcement date. The trading volume spikes on the effective date due supposedly to arbitrageurs, and after 60 days drops to 55% above the pre-announcement-day volumes. They find that the total price effects related with additions and deletions from the S&P500 Index reach 7.2% and -14.1%, respectively. Beneish and Whaley (2002) find that a sample of 49 firms deleted from the S&P index lost 10.8% between the announcement and effective dates but gained 23.7% in the 40 trading days after the effective day. These positive ARs for the post-effective date become insignificant when five firms are removed from the sample. Chen et al. (2004) find a permanent increase in the price of added firms but not a permanent decline in the price of deleted firms. They claim that this supports the notion that the price effect is an investor awareness effect; namely, that adding stocks to the S&P 500 increases investor awareness of the stocks but deletion from the index does not reduce awareness to the same extent.

5.2. SAMPLE AND DATA

Bond data used herein are extracted from the Lehman Brothers Fixed Income Database, which reports month-end bond data and the month in which a bond is added or deleted from a Lehman and Brothers bond index between the years 1987 and 1997.[57] The initial sample consists of bonds added to a Lehman and Brothers index that have at least 24 returns in the past 60 months, and bonds deleted from an index that have more than 1 year to maturity and at least three consecutive monthly returns after the deletion month. The final samples consist of 25 bond index additions and 58 bond index deletions. The sample of stocks consists of the 53 issuers of the bonds in the samples of bond index additions and deletions.[58]

The stock returns for the issuers with bonds added or deleted to an index are obtained from CRSP. The monthly rates of return for each bond are calculated at time $t+1$ using:

$$r_{t+1} = \frac{C_{t+1} + P_{t+1} + A_{t+1} - P_t - A_t}{P_t + A_t} \qquad (5.1)$$

[57] The database does not provide information about the specific indices involved in the index revisions. It simply provides a flag indicating that a bond has been added (deleted) to (from) a Lehman Brothers bond index.

[58] The number of stocks is lower than the total number of bonds in the samples of bond index additions and deletions because many firms have more than one bond that is subject to an index revision. For each stock, we find the corresponding bonds in both bond samples to study the effect of the revision on stock returns around the announcement date and to assign the appropriate values for the dummy variables in equation (5.3).

where P_t and P_{t+1} are the clean prices (closing bids) at month-end *t* and *t+1*, respectively; A_t and A_{t+1} are the accrued interest at month-end *t* and *t+1*, respectively; and C_{t+1} is the coupon payment at month-end *t+1*.

5.3. HYPOTHESES AND METHODOLOGY

A bond may be added or deleted from an index because it satisfies or does not satisfy various criteria, such as minimum number of price providers, minimum maturity, minimum credit rating, and minimum par amount. Nevertheless, an examination of the data suggest that the main drivers for the addition and deletion of bonds are bond liquidity and bond credit rating. A higher (lower) liquidity and a higher (lower) credit rating is more likely to result in an inclusion (exclusion) of the bond in (from) a bond index. Therefore, we believe that the surprise attached to bond index revisions is most likely due to bond liquidity or deterioration in its risk quality. If index revisions have information content, then the surprise attached to the inclusion (exclusion) of a bond in a bond index should convey positive (negative) news that results in positive (negative) abnormal returns. As a result, the market value of debt should increase (decrease) with the addition (deletion) of a firm's bonds to (from) a bond index. If investors' evaluate the same firm's financial risk by its debt-to-equity ratio measured at market, then the same firm's financial risk will be higher (lower) with the addition (deletion) of a firm's bonds in a bond index unless there is an offsetting increase (decrease) in the same firm's equity value. If investors evaluate the same firm's financial risk by its debt-to-equity ratio measured at book, then no offsetting increase (decrease) in the same firm's equity market value is required to maintain the same debt-to-equity ratio measured at book.

The effect of inclusion and exclusion in a bond index is examined around the announcement date, because this is the date at which such information is revealed to the market.[59] Since the one–step dummy variable approach is both equivalent to and more convenient to use than the traditional two-step approach (Karafiath, 1988), the one-step approach is used herein to estimate the abnormal returns (ARs) associated with bond index additions and deletions. Specifically, various variants of the following dummy-variable, return-generating model are used to calculate the factor- and risk-adjusted ARs for the bonds of firm *i*:

$$r_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_{i,k} I_{k,t} + \sum_{tev=t_0}^{T} \tau_1 D1_{i,tev} + \tau_2 D2_{i,tn} + \tau_3 D3_{i,tn} + \sum_{ts=t1}^{T2} \tau_4 D4_{i,ts} + e_{i,t} \qquad (5.2)$$

where $r_{i,t}$ and $I_{k,t}$ are the excess returns for firm *i* and factor *k* for month *t* ($k = 1, \ldots, K$); τ_1 is the coefficient of the dummy variable $D1_{i,tev}$, which represents the AR for bond *i* for month *tev* in the event period [t_0, T]; $D1_{i,tev}$ is a dummy variable that is equal to one for month *tev* in the event period [t_0 , T],where t_0 and T are the first and last month in the event period, respectively, and is zero otherwise;[60] $\hat{\alpha}_j$ and $\hat{\beta}_{ik}$ are parameters of the model; τ_2 and τ_3 are the coefficients that capture the effect of the index inclusion and exclusion, respectively, of another bond for the same issuer; $D2_{i,tn}$ and $D3_{i,tn}$ are dummy variables equal to one when another bond by the same issuer is added and deleted, respectively, to an index at month *tn* and are zero otherwise; τ_4 is a coefficient used to

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[59] The effective date on which a bond is included or excluded from the index is at most a month after the announcement date.

[60] For example, if we are studying an event period of [-1], then t_0 = T=-1. Similarly, if we are studying an event period of [-1,1], then t_0 =-1 and T=1.

capture any effect that the event has on factor sensitivities in the unconditional models only; $D4_{i,ts}$ is a dummy variable that has a value of one starting from the event date and zero before the event date; T2 is the end of the estimation period; and $\hat{e}_{jt}$ is a random error term that is assumed to have the standard properties.

The longest estimation period begins five years before the event window and ends five years thereafter. If the data for the full estimation period are unavailable, shorter estimation periods must have at least 24 observations prior to the event window and at least six observations after the event window.

The first model used to estimate the ARs for the bonds of firm *i* is an *unconditional single-factor market* model where a bond index (the Aggregate Lehman Brothers bond index) is used to capture bond market movements. Not only is it commonly used in the bond pricing literature but it is frequently used to assess the performance of bond mutual funds (e.g., Ayadi and Kryzanowski, 2005). The second model used is a *two-factor bond-stock model,* where the factors are the returns on the Aggregate Lehman Brothers bond index and the S&P500 index, as in Blume et al. (1991) and Cornell and Green (1991).[61] This model also captures equity-like characteristics embedded in some corporate bond issues such as bond convertibility. The third model used is an *unconditional three factor model,* which reflects differences in maturity structure and default risk. The three factors are the Lehman Brothers mortgage bond index; TERM or the difference between the monthly long- and short-term government bond returns, which proxies for the deviations

[61] Factors in other two-factor bond models include: instantaneous yields on maturity and consol bonds, which represent the short and long ends of the yield curve, respectively (Brennan and Schwartz, 1982); real and nominal factors (Pennacchi, 1991); and a short-term factor and the stochastic volatility of an interest-rate factor (Longstaff and Schwartz, 1992). Other multifactor return models for bonds include an APT (Gultekin and Rogalski, 1985; Elton et al., 1988); a relative APT model with four or six fundamental economic variables (Elton et al., 1995); and up to six bond indices (Blake et al, 1993).

of long-term bond returns from expected returns due to shifts in interest rates; and DEF or the difference between the returns on market portfolios of long-term corporate and government bonds, which proxies for default resulting from shifts in economic conditions. Data for the TERM and DEF factors are obtained from the Ibbotson and Associates database.

The Fama and French (1993) three-factor model is used to test the effect of bond index inclusions or deletions on stock returns. Similar to the bond models, a dummy variable is added to this three-factor model to capture the effects of possible multiple bond index revisions on the stock when the issuer has more than one bond that is subject to a bond index inclusion or deletion within the estimation period. The modified Fama and French three-factor model becomes:

$$\begin{aligned} r_{i,t} = \alpha_i + \beta_{i,M} R_{i,Mt} + \beta_{i,SMB} SMB_{i,t} + \beta_{i.HML} HML_{i,t} + \sum_{tev=t_0}^{T} \tau_1 D1_{tev} \\ + \tau_2 D2_{i,tn} + \tau_3 D3_{i,tn} + e_{i,t}, \end{aligned} \tag{5.3}$$

where $r_{i,t}$ is the excess stock return; $R_{i,Mt}$ is the excess market return; $SMB_{i,t}$ is the return on a portfolio of small stocks minus the return on a portfolio of large stocks; and $HML_{i,t}$ is the return on a portfolio of stocks with high book to market values minus the return on a portfolio of stocks with low book to market values; τ_1 , τ_2 , τ_3 , $D1_{i,tev}$, $D2_{i,tn}$ and $D3_{i,tn}$ are as in equation (5.2).

Each of these unconditional models is extended to a conditional setting to account for time variation in the betas, especially on and after the effective dates of the index revisions. As in Ferson and Schadt (1996), the betas are conditioned according to the following linear function:

$$\beta_{i,t} = b_{i0} + b_i' Z_{t-1} \quad (5.4)$$

where the intercept b_{i0} is the unconditional mean of the conditional beta; and the vector of slope coefficients b_i' measures the response of the conditional beta to Z_{t-1} or the movements in the information available to investors at time *t-1*. The four conditioning variables in Z_{t-1} are lagged values of the dividend yield on the CRSP stock index, the slope of the term structure, the corporate credit spread and the risk-free rate.[62] These conditioning variables are reduced to the dividend yield on the CRSP stock index and the risk-free rate when using the three-factor bond model.[63]

Multi-month cumulative AR (or CAR) for the bonds of firm *i* are obtained by summing up the individual monthly abnormal returns for the various event windows. The average multi-month AR (or AAR) are then obtained by finding the cross-sectional mean of the (multi-)month CARs for the individual firms, and the significance of this mean is tested using the cross-sectional standard deviation of the (multi-)month AAR for the individual firms. As a test of robustness, the cross-sectional medians of the (multi-)month AAR for the individual firms are tested using the Wilcoxon test, which is a non-parametric alternative to the paired Student's t-test. The Wilcoxon test does not require assumptions about the form of the distribution of the measurements.

[62] The monthly dividend yields are computed using CRSP data following the approach of Campbell and Schiller (1988) and Bansal et al. (2005). They are the difference between the NYSE/Amex and Nasdaq value-weighted returns with and without dividends. Data to compute the slope of the term structure is obtained from the Federal Reserve Board using the 3 months and 10 years constant maturity rates.

[63] The Kalman Filter approach is used also to estimate time-varying betas. The beta is defined by the state equation $\beta_{it} = \phi_i \beta_{i,t-1}$ where the beta coefficient is modeled usually as a random walk (ϕ_i=1) or an AR(1) process (ϕ_i<1). The Kalman filter, then estimates the unobserved state variables using the MLE method and a recursive algorithm based on the prediction and Bayesian sequential updating.

5.4. EMPIRICAL RESULTS

The impact of bond index additions on the bonds and stocks of the same-firm issuers based on the ARs from various unconditional return-generating models are summarized in table 5.1. Based on panels A-C of table 5.1, the mean and median ARs for bonds are positive and significant for single month [-1] through month [2] based on three unconditional bond return-generating models. The mean and median ARs for bonds are also significant for month [3] for the one- and two-factor unconditional return-generating models. The mean and median average ARs (or AARs) for bonds are also positive and significant for all the multi-month event windows with the exception of the [1, 2] event window for the three-factor unconditional return-generating model only. The mean cumulative AARs (or CAARs) for the three-month event window [-1, 1] range from 1.329% to 1.584% based on the unconditional three- and one-factor return-generating models, respectively. In contrast, none of the AARs for the monthly or multi-month periods in the event window are significant for the same-firm stocks (see panel D of table 5.1).

Based on the results reported in table 5.2, the AR effects of bond index additions using the conditional return-generating models are somewhat weaker based on the mean (not median) AARs for bonds and are still insignificant for stocks.[64] The mean single month ARs are now insignificant with the exception of month [-1]. However, both the mean and median multi-month AARs are still positive and significant for windows of [-1, 1], [-1, 0], [0, 1], [0, 2] and [0, 3]. The mean CAARs for the three-month event widow [-1, 1] range from 1.185% to 1.584% based on the conditional three- and one-factor return-

[64] There is a possibility that we are not able to capture the impact on bond index revisions around the announcement dates using monthly returns. If and when the exact announcement dates become available, a test of the impact of index revisions using daily returns can be conducted.

generating models, respectively. Thus, as was the case for the unconditional findings, the CAARs for the three months centered on the event month decrease with an increase in the number of factors in the return-generating model.

The impact of bond index deletions on the bonds and stocks of the same-firm issuers based on the event-window ARs from various (un)conditional return-generating models are in general weaker than those reported above for bond index additions. The impact of bond index additions on the bonds and stocks of the same-firm issuers based on the ARs from various unconditional return-generating models are summarized in table 5.3. Based on panels A-C of table 5.3, the mean and median ARs for bonds are negative and significant for only the single month [2] based on the three unconditional bond return-generating models. The mean and median AARs for bonds are also negative and significant for all the multi-month windows with the exception of the [1, 2] and [1, 3] event windows (medians for the latter multi-month window only). The mean CAARs for the three-month event window [-1, 1] range from -3.855% to -4.074% based on the unconditional one- and three-factor return-generating models, respectively. As was the case for index additions, none of the mean or median AARs for the monthly or multi-month event windows are significant for the same-firm stocks (see panel D of table 5.3).

Based on the results reported in table 5.4, the AR effects of bond index deletions using the conditional return-generating models are similar in both magnitude and significance for same-firm bonds, and are still insignificant for same-firm stocks. The mean CAARs for the three-month event widow [-1, 1] range from -3.753% to -4.647% based on the conditional three- and two-factor return-generating models, respectively. Thus, as was the case for the unconditional findings, the CAARs for the three months centered on the event month decrease with an increase in the number of factors in the return-generating model.

5.5. CONCLUDING REMARKS

The impact of bond index additions and deletions on the single and multi-month abnormal returns of the stocks and bonds of the same-firm issuers of the bonds so affected were examined in this chapter. Using (un)conditional return-generating models to estimate the effect of index additions and deletions, we find that these index revisions have their expected effects on bonds. Specifically, announcements of index additions and deletions result in positive and negative abnormal bond returns, respectively. However, the impact of index deletions, as measured by the three-month CAARs centered on the announcement month, have a larger impact for bond index deletions than bond index additions. In contrast, the impacts of bond index additions and deletions on the returns of the stocks of the same-firm bond issuers are insignificant.

These results have interesting implications for the measurement of capital structures. Since theory suggests that debt-to-equity ratios are best measured using market values, a significant reduction is the market value of a firm's debt and an insignificant change in the market value of the same firm's equity results in a decrease in this firm's debt-to-equity ratio when measured at market. If we consider that index revisions are sometimes due to liquidity changes, which consequently has no consequences for the firm's ability to meet its financial obligations, then this implies that investors are perceptive enough to realize that not all index revisions (and subsequently any changes in the debt-to-equity ratio measured at market) are associated with a change in that firm's financial risk.

Chapter 6

Conclusion

In this thesis, we investigated and reexamined various issues dealing with bonds. In the first essay (second chapter), we reexamined the components of credit spreads after correcting the measures introduced in the EGAM (2001) paper. The aim of this chapter was to provide for a better understanding of why corporate spot rates are higher than government spot rates. By investigating the factors that contribute to this spread and their magnitudes, we offered a better insight into spread determination for fixed income security investors. For example, investors in lower grade bonds could now better assess the expected after-tax rewards of their riskier investments and evaluate whether the associated after-tax reward provides adequate compensation for the additional risk.

To this end, we improved the measurements of the previously identified spread components (default and tax spreads) and introduced a liquidity spread component to explain the remaining (unexplained) spread. We used derived term structures that accounted for the expected loss in case of default to compute the after-default spot rates. The default probabilities used in these derivations conform to the findings of Nickel et al. (2000) who found that a transition matrix conditional on the industry and the state of business cycle is significantly different from an unconditional transition matrix. Therefore, unlike EGAM (2001) who used all-sector unconditional default probabilities, we used industrial default probabilities that are conditional on the state of the business cycle. Our approach of using actual bond prices to derive the after-default spot rates is theoretically and practically more sound than the EGAM (2001) approach that was based on a risk neutral argument and calculations of the spread based on a single theoretical 10 year bond with a theoretical coupon rate. The results reported in the second chapter show lower default spreads than those reported by EGAM (2001). Our default spreads for the industrial Aa-, A-, and Baa-rated bonds do not exceed 0.014%, 0.050% and 0.351%, respectively, while the corresponding values in EGAM (2001) are 0.048%, 0.14% and 0.409%.

We also extended the default spread approach to the calculations of the tax spreads in chapter 2 by deriving term structures from actual bonds that considered the expected loss from default and the intricacies of the U.S. actual tax code. Our tax spread measures are comparable to those reported by EGAM (2001) for the Baa-rated bonds with a tax spread of 0.69%. However, our tax spreads for the Aa- and A-rated bonds are higher with a spread that could be as high as 0.41%and 0.50% compared to 0.34% and 0.42%, respectively, reported by EGAM (2001). Our modifications not only lead to different values for the default and tax spreads but the remaining (unexplained) credit spread was no longer explained by the Fama and French three-factor model, as reported in EGAM (2001). Instead, we found that liquidity, when approximated by variables such as the dollar amount of bonds issued and traded, relative frequency of matrix prices to total quoted prices, ages of bonds traded, and yield volatility, played an important role in explaining the spread unexplained by default and taxes. The liquidity factor accounted for about 33% of the unexplained spread.

Overall our methodology explains between 83% and 97% of the spread for the Aa- and Baa-rated bonds, respectively, using the default, tax and liquidity components. The tax spread is the largest component of the spread ranging from 56.6% for Baa-rated bond to 70.5 % for the Aa-rated bonds. The default spreads are the second largest component for the Baa-rated bonds, which explain about 28.7% of the spread. The role of the default spread diminishes for the Aa- and A-rated bonds where it explains as much as 2.4% and 6.9 % of the variation in credit spreads, respectively. The liquidity spread plays a more important role than default for the Aa- and A-rated bonds, where it explains about 10.4% and 12.9% of the variation in credit spreads, respectively. However, the liquidity spread is the smallest component of the credit spreads for the Baa-rated bonds with a magnitude as high as 11.3% of the spread.

In the second essay (third chapter), we examined the diversification benefits of bond portfolios to provide a guideline about the optimal portfolio size for fixed income security investors depending on their risk perception. This chapter filled a gap in the literature since the McEnally and Boardman (1979) study is the last study that dealt with bond diversification benefits. This previous study used only unconditional excess standard deviations and investment opportunity sets of straight bonds differentiated by credit rating to investigate what is the optimal portfolio size. In this chapter, we examined larger and more recent samples (sample years 1985-1997). In our portfolios, we all type of bonds and used investment opportunity sets differentiated by issuer type, credit ratings, and maturity. We also used a wide set of risk metrics to capture risk dimensions that are likely to be of interest to investors. The time-varying distribution of the returns also suggests that a number of metrics should be used in determining the optimal portfolio size. Thus, we investigated the optimal portfolio size using four groups of metrics: dispersion of bond returns metrics, composite return and risk metrics, metrics based on higher-order moments of bond returns, and the probabilities of underperforming various target rates of return.

As expected, no optimal portfolio size was identified since the use of each metric led to a different optimal portfolio size. A sensitivity analysis conducted on three samples of time periods of equal length (1986-1989, 1990-1993 and 1994-1997) as well as a sample of straight bonds indicates that the results for these samples are consistent with the results of the overall sample. It also suggests that the optimal portfolio sizes for these sub-samples are not significantly different from the ones reported for the initial sample. While a portfolio size of 25-40 bonds manages to capture most of the benefits for the metrics measuring dispersion of returns, other metrics require other minimum portfolio size ranges. For instance, if the investor's objective is right skewness, then a portfolio size of 2 is optimal. However, if the investor's objective is to diversify the left tail weight, then a larger number of bonds (70-100) are required in the portfolio. Accordingly, how investors perceive risk and which risk they are interested in diversifying, play a key role in the choice of which portfolio size is appropriate for that investor.

In the third essay (fourth chapter), we investigated the determinants of credit spread changes. The models used in the existing literature do not explain much of the changes in credit spreads. Specifically, the R-squared values obtained for tests of these models do not exceed 35%. Term structures reflect expectations about the future and consequently changes in the expectations about the variables that determine the level of term structures should better capture the changes in credit spreads than the realized values of these variables. Therefore, our models included expectations about GDP, default probability, and the slope of the term structure of interest rate instead of the realized values used previously in the literature. Also, we introduced for the first time, diversification benefits as an explanatory variable. Eliminating the unsystematic risk in bond portfolios requires portfolios with large number of bonds that are beyond the reach of most investors, which implies that bondholders should be compensated for this unsystematic risk that they hold in their portfolios. Consistent with these expectations, we found that credit spreads are better explained by variables that measure changes in expectations about future values than the variables that measure realized values. We also found that diversification benefits in the corporate bond markets are one of the determinants of credit spread changes. Other variables (such as liquidity and volatility of returns within a rating category) also play a major role in determining the changes in credit spreads. Compared to competing models, our model is more parsimonious and has greater explanatory power (with an adjusted R-squared value as high as 59%). Using an alternate model with other variables to proxy for the same factors, such as substituting realized for expectational values, resulted in lower explanatory power but indicated that our model was robust.

In the fourth essay (chapter five), we investigated the effect of bond index additions and deletions on the returns of added and deleted bonds as well as on the returns of the underlying stocks. This essay is the first study that addresses the effect of bond index revisions, since the literature has focused solely on the effects of stock index revisions. The results of this essay are of interest to both bondholders and stockholders since the market value of debt, and subsequently the financial ratios of the firm that use the market value of debt, change as a result of these revisions. Using different (un)conditional bond return models and (un)conditional Fama and French stock return models, we identified an asymmetric effect of bond index revisions on the same firm's bonds and stocks. While bond index additions have a significant positive abnormal return around the announcement dates, index deletions have a more severe negative effect. For instance, for the three months centered on the announcement month, the average cumulative abnormal bond returns based on the various return-generating models ranged from 1.329% to 1.584% for additions and from -3.753% to -4.647% for deletions. In contrast, stock returns are unaffected by index revisions. These results have implications for the measurement of capital structures. An index revision that is due to factors not related to the financial risk of the firm, such as changes in the liquidity of its bonds, has no material impact on that firm's ability to meet its financial obligations but affects that firm's debt-to-equity ratio when measured at market. This implies that investors are perceptive enough to realize that not all changes in the debt-to-equity ratios measured at market for a firm are associated with a change in that firm's financial risk.

REFERENCES

Alexander, G. J., A. K. Edwards, and M. G. Ferri, 2000. The determinants of trading volume of high-yield corporate bonds, *Journal of Financial Markets* 3(2), 177-204.

Altman, E., and V. Kishore, 1998. Defaults and returns analysis through 1997, *Working Paper*, NYU Salomon Center.

Amato, J., and E. Remolona, 2003. The credit spread puzzle, *BIS Quarterly Review* (December), 51-63.

Amihud, Y., 2002. Illiquidity and stock returns: Cross-section and time-series effects, *Journal of Financial Markets* 5(1), 31–56.

Amihud, Y., and H. Mendelson, 1991. Liquidity, maturity, and the yields on U.S. Treasury securities, *Journal of Finance* 46(4), 1411-1425.

Ang, J., D. Peterson, and P. Peterson, 1985. Marginal tax rates: Evidence from nontaxable corporate bonds: A note, *Journal of Finance* 40(1), 327-332.

Avramov, D., G. Jostova, and A. Philipov, 2004. Corporate credit risk changes: Common factors and firm-level fundamentals, *Working Paper*, University of Maryland.

Ayadi, M., and L. Kryzanowski, 2005. Performance of Canadian fixed income mutual funds, *Working Paper*, Concordia University.

Bansal, R., Dittmar R., and C. Lundblad, 2005. Consumption, dividends, and the cross section of equity returns, *Journal of Finance* 60(4), 1639-1672.

Baraton, X., and T. Cuillere, 2001. Modélisation des spreads de swap, credit special focus, *Working Paper*, Crédit Agricole Indosuez Credit and Bond Research.

Beneish, M., and R.Whaley, 1996. The anatomy of the 'S&P game': The effects of changing rules, *Journal of Finance* 51(5), 1909-1930.

Beneish, M., and R.Whaley, 2002. S&P 500 index replacements, a new game in town, *Journal of Portfolio Management* 28, 51-60.

Bennett, J., and R. Sias, 2005. Why has firm-specific risk increased over time?, SSRN *Working Paper* 633484.

Bevan, A., and F. Garzarelli, 2000. Corporate bond spreads and the business cycle, *Journal of Fixed Income* 9, 8-18.

Bewley , R., D. Rees, and P. Berg, 2004. The impact of stock market volatility on corporate bond credit spreads, *Mathematics and Computers in Simulation* 64, 363-372.

Blake, C. R., E. J. Elton, and M. J. Gruber, 1993. The performance of bond mutual funds, *Journal of Business* 66, 371-403.

Blume, M. E., D. B. Keim, and S. A. Patel, 1991. Returns and volatility of low-grade bonds:

1977-1989, *Journal of Finance* 46(1), 49-74.

Bolder, D., 2001. Affine term-structure models: Theory and implementation, *Working Paper* 2001-15, Bank of Canada.

Bolder, D., and S. Gusba, 2002. Exponentials, polynomials, and Fourier series: More yield curve modelling at the Bank of Canada, *Working Paper* No. 2002-29, Bank of Canada.

Brennan, M. J., and E. S. Schwartz, 1982. An equilibrium model of bond pricing and a test of market efficiency, *Journal of Financial and Quantitative Analysis* 62, 301-329.

Brys, Guy, Hubert Mia, and Anja Struyf, 2006. Robust measures of tail weight, *Computational statistics and data analysis* 50(3), 733-759.

Byrne, P., and S. Lee, 2004. Different risk measures: Different portfolio compositions?, *Journal of Property Investment and Finance* 22(6), 501-511.

Campbell, J., M. Lettau, B. Malkiel, and Y. Xu, 2001. Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk, *Journal of Finance* 56(1), 1-43.

Campbell, J., and R. Shiller, 1988. The dividend-price ratio and expectations of future dividends and discount factors, *Review of Financial Studies* 1, 195–228.

Cappiello, L., R. Engle, and K. Sheppard, 2003. Asymmetric dynamics in the correlations of global equity and bond returns, ECB *Working Paper* 204.

Carty, L., and J. Fons, 1994. Measuring changes in corporate credit quality, *The Journal of Fixed Income* 4, 27-4.

Carty, L.V., 1997. Moody's rating migration and credit quality correlation, 1920-1996. Special comment, Moody's Investors Service, New York.

Chen, H., G. Noronha, and V. Singal, 2004. The price response to S&P 500 index additions and deletions: Evidence of asymmetry and a new explanation, *Journal of Finance* 59(4), 1901-29.

Chollerton, K., P. Pieraerts, and B. Solnik , 1986. Why invest in foreign currency bonds, *Journal of Portfolio Management* (Summer), 4-8.

Chordia, T., R. Roll, and V. R. Anshuman, 2001. Trading activity and expected stock returns, *Journal of Financial Economics* 59(1), 3-32.

Chung, R., and L. Kryzanowski, 1998. Are the market effects associated with revision of TSE 300 index robust?, *Multinational Finance Journal* 2(1), 1-36.

Collin-Dufresne, P., R. Goldstein, and J.S. Martin, 2001. The determinants of credit spread changes, *Journal of Finance* 56(6), 2177-2208.

Cornell, B., and K. Green, 1991. The investment performance of low-grade bond funds, *Journal of Finance* 46(1), 29-48.

Cox, J., J. Ingersoll, and S.. Ross, 1985. A theory of term structure of interest rates, *Econometrica* 53, 385-407.

Demirer, R., and D. Lien, 2004. Firm-level return dispersion and correlation asymmetry: challenges for portfolio diversification, *Applied Financial Economics* 14(6), 447-456.

Diebold, F., and C. Li, 2006. Forecasting the term structure of government bond yields, *Journal of Econometrics* 130, 337–364.

Dionne, G., G. Gauthier, K. Hammami, M. Maurice, and J.G. Simonato, 2004. Default risk on corporate yield spreads, *Working Paper*, HEC Montreal.

Dhillon, U., and H. Johnson. 1991. Changes in the S&P 500 list, *Journal of Business* 64(1), 75-85.

Driessen, J., 2002. Is default event risk priced in corporate bonds?, *Working Paper*, University of Amsterdam.

Duffee, G., 1998. The relationship between treasury yields and corporate bond yield spreads, *Journal of Finance* 53(6), 2225-2241.

Elton, E., and M. Gruber, 1977. Risk reduction and portfolio size: An analytical solution, *Journal of Business* 50(4), 415-437.

Elton, E., M. Gruber, D. Agrawal, and C. Mann, 2001. Explaining the rate spread on corporate bonds, *Journal of Finance* 56(1), 247-277.

Elton, E. J., M. J. Gruber, and C. R. Blake, 1995. Fundamental economic variables, expected returns, and bond fund performance, *Journal of Finance* 50(4), 1229-1256.

Elton, E. J., M. J. Gruber, and P. Nabar, 1988. Bond returns, immunization, and the return generating process, *Studies in Banking and Finance* 5, 125-154.

Eom, Y., J. Helwege, and J. Huang, 2004. Structural models of corporate bond pricing: An empirical analysis, *Review of Financial Studies* 17, 499-544.

Ericsson, J., and O. Renault, 2001. Credit and liquidity risk, *Working Paper,* McGill University.

Evans, J., and S. Archer, 1968. Diversification and the reduction of dispersion: An empirical analysis, *Journal of Finance* 23(5), 761-767.

Fama, E., 1965. Portfolio analysis in a stable paretian market, *Management Science* 11(3), 404-419.

Fama, E., and K. French, 1992. The cross-section of expected stock returns, *Journal of Finance* 47(2), 427-465.

Fama, E. F., and K. R. French, 1993. Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33(1), 3-56.

Ferson, W., and R. Schadt, 1996. Measuring fund strategy and performance in changing economic conditions, *Journal of Finance* 51(2), 425-462.

Fisher, M., D. Nychka, and D. Zervos, 1995. Fitting the term structure of interest rates with smoothing splines, *Working Paper* 95-1, Federal Reserve Board.

Goetzmann, W., and M. Garry, 1986. Does delisting from the S&P 500 affect stock price?, *Financial Analysts Journal* 42(2), 64-69.

Goetzmann, W., and A. Kumar, 2004. Equity portfolio diversification, *Working Paper*, Yale School of Management.

Green, R., 1983. A simple model of the taxable and tax-exempt yield curves, *Review of Financial Studies* 6(2), 233-264.

Green, R. C., and B. A. Odegaard, 1997. Are there tax effects in the U.S. Government bonds?, *Journal of Finance* 52(2), 609-633.

Gultekin, N.B, and R.J. Rogalski, 1985. Government bond returns, measurement of interest rate risk and the arbitrage pricing theory, *Journal of Finance* 40(1), 43-61.

Harris, L., and E. Gurel, 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures, *Journal of Finance* 41(4), 815-829.

Harvey, C., and A. Siddique, 2000. Conditional skewness in asset pricing tests, *Journal of Finance* 55(3), 1263-1295.

Hong, G., and A. Warga, 2000. An empirical study of bond market transactions, *Financial Analysts Journal* 56(2), 32-46.

Houweling, P., A. Mentink, and T. Worst, 2003. Comparing possible proxies for corporate bond liquidity. SSRN *Working Paper*.

Huang, J.-Z., and M. Huang, 2003. How much of the corporate-treasury yield spread is due to credit risk?, *Working Paper*, Penn State and Stanford Universities.

Hunter, D., and D. Simon, 2004. Benefits of international bond diversification , *Journal of Fixed Income* 13, 57-72.

Hunter, D., and D. Simon, 2005. A conditional assessment of the relationships between the major world bond markets, *European Financial Management* 11(4), 463-482.

Jain, P., 1987. The effect on stock price of inclusion or exclusion from the S&P 500, *Financial Analysts Journal* 43(1), 58-65.

Jennings, E., 1971. An empirical analysis of some aspects of common stock diversification, *Journal of Financial and Quantitative Analysis* 6(2), 797-813.

Jorion P., 1987. Why buy international bonds?, *Investment Management Review* (September-October), 19-28.

Jorion P., 1989. Asset allocation with hedged and unhedged foreign stocks and bonds, *The Journal of Portfolio Management* (Summer), 49-54.

Kahn, R.N., and A. Rudd, 1995. Does historical performance predict future performance?, *Financial Analysts Journal* (November-December), 43-52.

Karafiath, I., 1988. Using dummy variables in the event methodology, *The Financial Review* 23(3), 351-357.

Kaplanis E. and S. Schaefer, 1991. Exchange risk and international diversification in bond and equity portfolios, *Journal of Economics and Business* 43(4), 287-307.

Khotari, S. P., and J. B. Warner, 2005. Econometrics of event studies, *Working Paper*, Tuck Center for Corporate Governance, Tuck School of Business at Dartmouth.

Kryzanowski, L., A. Rahman, and A. Sim, 1985. Diversification, the reduction of dispersion, and the effect of Canadian regulations and self-imposed limits on foreign investment, *Working Paper*, Concordia University.

Kryzanowski, L., and S. Singh, 2006. Should minimum portfolio sizes be prescribed for achieving sufficiently well-diversified equity portfolios?, *Working Paper*, Concordia University.

Kryzanowski, L., and K. Xu, 1997. Long-term equilibria of taxable and tax-exempt bonds, *International Review of Economics and Finance* 6(2), 119-143.

Kryzanowski, L., K. Xu and H. Zhang, 1995. Determinants of the decreasing term structure of relative yield spreads for taxable and tax-exempt bonds, *Applied Economics* 27, 583-590.

Latane, H., and W. Young, 1969. Test for portfolio building rules, *Journal of Finance* 24, 595-612.

Lee, C., J. Robinson, and R. Reed, 2006. An exploration of the relationship between size and risk in a downside risk framework applied to Malaysian property shares, *Working Paper*, University of Melbourne.

Leland, H., and K. Toft, 1996. Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads, *Journal of Finance* 51(3), 987-1019.

Li, B., E. DeWetering, G. Lucas, R. Brenner, and A. Shapiro, 2001. Merrill Lynch exponential spline model, *Working Paper*, Merrill Lynch.

Liu, S., J. Shi, J. Wang, and C. Wu, 2005. How much of the corporate bond spread is due to personal taxes?, *Working Paper*, Syracuse, Youngstown State and Marshall Universities.

Lo, A., 2001. Risk management for hedge funds: Introduction and overview, *Financial Analysts Journal* 57, 16–33.

Longstaff, F., S. Mithal, and E. Neis, 2005. Corporate yield spreads: Default risk or liquidity? New evidence from the credit-default swap market, *Journal of Finance* 60(5), 2213-2253.

Longstaff, F., and E. S. Schwartz, 1992a. Interest rate volatility and the term structure: A two factor general equilibrium model, *Journal of Finance* 47(4), 1259-1282.

Longstaff, F., and E. S. Schwartz, 1992b. A two factor interest rate model and contingent claims valuation, *Journal of Fixed Income* 2:3, 16-23.

Lynch, A., and R. Mendenhall, 1997. New evidence on stock price effects associated with changes in the S&P 500, *Journal of Business* 70, 351-384.

Malkiel, B., and Y. Xu, 2006. Idiosyncratic risk and security returns, *Working Paper* University of Texas.

Mao, J., 1970. Survey of capital budgeting: Theory and practice, *Journal of Finance* 25(2), 349-360.

Markowitz, H., 1952. Portfolio selection, *Journal of Finance* 7(1), 77-91.

McEnally, R., and C. Boardman, 1979. Aspects of corporate bonds portfolio diversification, *Journal of Financial Research* (Spring), 27-36.

Merton, R. C., 1974. On the pricing of corporate debt: The risk structure of interest rates, *Journal of Finance* 29(2), 449–470.

Morris, C., R. Neal, and D. Rolph, 2000. Interest rates and credit spread dynamics, *Working Paper*, Indiana University.

Nelson, C., and A. Siegel, 1987. Parsimonious modeling of yield curves, *Journal of Business* 60, 473-89.

Nickell, P., W. Perraudin, and S. Varotto, 2000. Stability of ratings transitions, *Journal of Banking and Finance* 24, 203–227.

Pennacchi, G., 1991. Identifying the dynamics of real interest rates and inflation: Evidence using survey data, *Review of Financial Studies* 4, 53-86.

Premaratne, G., and A. Tay, 2002. How should we interpret evidence of time varying conditional skewness?, *Working Paper*, University of Singapore.

Pruitt, S., and K. Wei, 1989. Institutional ownership and changes in the S&P 500, *Journal of Finance* 44(2), 509-513.

Ruppert, D., 1987. What is kurtosis? An influence function approach, *The American Statistician* 41, 1–5.

Sancetta, A., and S. Satchell, 2003. Changing correlation and Sortino's model, *Working Paper*, University of Cambridge.

Sarig, O., and A. Warga, 1989. Bond price data and bond market liquidity, *Journal of Financial and Quantitative Analysis* 24(3), 367-378.

Schleifer, A., 1986. Do demand curves for stocks slope down?, *Journal of Finance* 41, 579-90.

Schultz, P., 2001. Corporate bond trading costs and practices: A peek behind the curtain, *Journal of Finance* 56(2), 677-698.

Silvapulle, P., and C. Granger, 2001. Large returns, conditional correlation and portfolio diversification: A value-at-risk approach, *Quantitative Finance* 1(2), 542-551.

Skelton, J., 1983. Banks, firms and the relative pricing of tax-exempt and taxable bonds, *Journal of Financial Economics* 12, 343-355.

Solnik, B., C. Boucelle, and Y. Le Fur, 1996. International market correlation and volatility, *Financial Analysts Journal* 52(5), 17–33.

Statman, M., 1987. How many stocks make a diversified portfolio, *Journal of Financial and Quantitative Analysis* 22(3), 353-363.

Statman, M., 2004. The diversification puzzle, *Financial Analysts Journal* 60(4), 44-53.

Statman, M. and J. Scheid, 2004. Dispersion, correlation, and the benefits of diversification, SSRN *Working Paper* 603681.

Svensson, L., 1994. Estimating and interpreting forward interest rates: Sweden 1992-4, *Working Paper*, Centre for Economic Policy Research.

Tang, G. and D. Choi, 1998. Impact of diversification on the distribution of stock returns: International evidence, *Journal of Economics and Finance* 22(2), 119-127.

Thomas, L., 1989. The performance of currency-hedged foreign bonds, *Financial Analysts Journal* (May-June), 25-31.

Van Landschoot, A., 2004. Determinants of Euro term structure of credit spreads, *Working Paper*, National Bank of Belgium.

Van Nieuwerburg, S. and L. Veldkamp, 2005. Information acquisition and portfolio under-diversification, *Working Paper*, New York University.

Vasicek, O. ,1977. An equilibrium characterization of the term structure, *Journal of Financial Economics* 5, 177-188.

Wagner, W. and S. Lau, 1971. The effect of diversification on risk, *Financial Analysts Journal* 27(6), 48-53.

Xu, Y., 2003. Diversification in the Chinese stock market, *Working Paper*, University of Texas at Dallas.

TABLES

Table 2.1. Measured Spreads from Treasuries and Average Root Mean Squared Errors

Panel A reports the mean of monthly credit spreads from Treasuries for Aa-, A-, and Baa-rated bonds in the industrial sector for the 1987-1996 period. The treasury and spot rates are derived using the Nelson and Siegel approach and do not account for default and taxes. Treasury average spot rates are reported as annualized spot rates (in %). Corporate credit spreads are reported as the difference between the derived corporate spot rates and the derived treasury spot rates. The corporate term structures are those with the lower error and the least number of outliers. Panel B reports the average root mean squared errors of the differences at a monthly frequency between the theoretical prices derived from using the theoretical spot rates and the actual bond prices for Treasuries and Aa-, A- and Baa-rated coupon-paying corporate bonds for the entire 1987-1996 period and for first and last 5-year periods. Root mean squared errors are measured in cents per $100.

Maturities/ Period	**Our Results**				**EGAM Results**			
	Treasuries	**Aa**	**A**	**Baa**	**Treasuries**	**Aa**	**A**	**Baa**
Panel A: Measured spreads from treasuries (in %)								
2	6.128	0.484	0.522	0.975	6.414	0.414	0.621	1.167
3	6.305	0.510	0.566	1.052	6.689	0.419	0.680	1.205
4	6.460	0.530	0.603	1.107	6.925	0.455	0.715	1.210
5	6.598	0.546	0.633	1.147	7.108	0.493	0.738	1.205
6	6.721	0.559	0.659	1.177	7.246	0.526	0.753	1.199
7	6.831	0.568	0.680	1.198	7.351	0.552	0.764	1.193
8	6.930	0.575	0.698	1.212	7.432	0.573	0.773	1.188
9	7.019	0.579	0.712	1.221	7.496	0.589	0.779	1.184
10	7.099	0.582	0.724	1.224	7.548	0.603	0.785	1.180
Panel B: Average root mean squared errors (cents per $100)								
1987-1996	0.362	0.933	1.027	1.570	0.210	0.728	0.874	1.516
1987-1991	0.602	1.303	1.434	1.880	0.185	0.728	0.948	1.480
1991-1996	0.232	0.682	0.781	1.517	0.234	0.727	0.800	1.552

Table 2.2. Average One-Year Rating All-Sectors and Industrial Transition Matrices and All-Sectors Recovery Rates

This table presents the average rating transition probabilities (in %) for a one-year tracking horizon. The all-sectors probabilities as reported in panel A are taken from Carty and Fons (1994). The industrial-sector probabilities are based on the ratings of industrial, US domicile, senior unsecured corporate debt as found in the Moody's DRS database for the 1970-1998 period. These industrial sector probabilities do not account for the effect of the business cycle. Each entry in a row shows the probability that a bond with a rating shown in the first column ends up one year later in the category shown in the column headings. Panel C reports the recovery rates in (%) for each ratings category from Altman and Kishore (1998).

Rating	Aaa	Aa	A	Baa	Ba	B	Caa	Default
Panel A: All-sectors transition matrix								
Aaa	91.90	7.39	0.72	0.00	0.00	0.00	0.00	0.00
Aa	1.13	91.26	7.09	0.31	0.21	0.00	0.00	0.00
A	0.10	2.56	91.19	5.33	0.62	0.21	0.00	0.00
Baa	0.00	0.21	5.36	87.94	5.46	0.83	0.10	0.10
Ba	0.00	0.11	0.43	5.00	85.12	7.33	0.43	1.59
B	0.00	0.11	0.11	0.54	5.97	82.19	2.17	8.90
Caa	0.00	0.44	0.44	0.87	2.51	5.90	67.80	22.05
Panel B: Industrial-sector transition matrix with business cycle effects not accounted for								
Aaa	93.29	6.25	0.46	0.00	0.00	0.00	0.00	0.00
Aa	1.12	90.34	8.09	0.23	0.18	0.03	0.00	0.00
A	0.07	1.75	92.80	4.64	0.55	0.18	0.02	0.00
Baa	0.03	0.10	4.55	89.02	4.87	0.90	0.32	0.21
Ba	0.00	0.02	0.65	6.68	85.32	6.14	0.83	0.36
B	0.00	0.00	0.04	0.31	6.67	84.31	5.82	2.85
Caa	0.00	0.00	0.00	0.66	1.59	4.58	80.94	12.23
Panel C: All-sectors recovery rates								
Recovery	68.34	59.59	60.63	49.42	39.05	37.54	38.02	0.00

Table 2.3. Evolution of Default Probabilities

This table reports the conditional default probabilities in (%) that a bond with either an Aa, A or Baa rating defaults after *n* number of years. These probabilities are derived using the one-year all-sectors transition matrix reported by Carty and Fons (1994), and the industrial transaction matrix derived from this all-sectors transition matrix.

	All-sectors default probabilities			Industrial default probabilities		
Year	**Aa**	**A**	**Baa**	**Aa**	**A**	**Baa**
1	0.000	0.000	0.103	0.000	0.000	0.208
2	0.004	0.034	0.274	0.002	0.019	0.268
3	0.011	0.074	0.441	0.006	0.041	0.330
4	0.022	0.121	0.598	0.012	0.065	0.392
5	0.036	0.172	0.743	0.020	0.091	0.454
6	0.053	0.225	0.874	0.030	0.118	0.514
7	0.073	0.280	0.991	0.041	0.147	0.571
8	0.095	0.336	1.095	0.054	0.177	0.625
9	0.120	0.391	1.186	0.068	0.207	0.676
10	0.146	0.446	1.264	0.083	0.238	0.723

Table 2.4. Average Default Spreads Assuming Risk Neutrality

This table reports the average default spreads of corporate spot rates over government spot rates (in %) when taxes are assumed to be zero. These default spreads are computed under the assumption of risk neutrality using equation (2.2) and after accounting for the recovery and default rates reported in tables 2.2 and 2.3, respectively. The default rates are derived from both an all-sectors transition matrix (TM) and an industrial-sector TM.

	Default spreads, all-sectors TM						Default spreads, industrial-sector TM		
	Our Results			EGAM Results			Our Results		
Years	Aa	A	Baa	Aa	A	Baa	Aa	A	Baa
2	0.001	0.007	0.103	0.004	0.053	0.145	0.000	0.004	0.130
3	0.002	0.016	0.148	0.008	0.063	0.181	0.001	0.009	0.146
4	0.004	0.025	0.191	0.012	0.074	0.217	0.002	0.013	0.162
5	0.006	0.035	0.232	0.017	0.084	0.252	0.004	0.019	0.178
6	0.009	0.045	0.272	0.023	0.095	0.286	0.005	0.024	0.194
7	0.012	0.056	0.309	0.028	0.106	0.319	0.007	0.030	0.210
8	0.016	0.067	0.344	0.034	0.117	0.351	0.009	0.035	0.226
9	0.020	0.078	0.377	0.041	0.128	0.380	0.011	0.041	0.242
10	0.025	0.090	0.408	0.048	0.140	0.409	0.014	0.048	0.257

Table 2.5. Average One-Year Rating Transition Matrices for the Industrial Sector During Normal, Trough, and Peak Phases of the Business Cycle

This table presents the average rating transition probabilities in (%) for a one-year tracking horizon as estimated from Moody's DRS database for the 1970-1997 period. These estimates are based on the ratings of industrial, US domicile, senior unsecured corporate debt during normal, trough and peak phases of the business cycle. The state of the business cycle is identified using the growth in GNP rates as a benchmark. Each entry in a row shows the probability that a bond with a rating shown in the first column ends up one year later in the category shown in the subsequent column headings.

Rating	Aaa	Aa	A	Baa	Ba	B	Caa	Default
Panel A: Normal Phases of the Business Cycle								
Aaa	93.55	6.05	0.40	0.00	0.00	0.00	0.00	0.00
Aa	1.01	87.04	11.10	0.41	0.37	0.07	0.00	0.00
A	0.07	1.43	91.79	5.27	1.08	0.36	0.00	0.00
Baa	0.07	0.16	4.55	88.00	5.13	1.44	0.36	0.30
Ba	0.00	0.05	0.33	5.86	85.26	7.17	1.03	0.30
B	0.00	0.00	0.09	0.40	6.30	83.70	6.57	2.93
Caa	0.00	0.00	0.00	1.37	2.92	8.05	78.46	9.19
Panel B: Trough Phases of the Business Cycle								
Aaa	94.32	5.28	0.40	0.00	0.00	0.00	0.00	0.00
Aa	1.47	90.89	7.64	0.00	0.00	0.00	0.00	0.00
A	0.07	2.32	92.35	5.10	0.07	0.00	0.07	0.00
Baa	0.00	0.10	5.55	86.65	6.92	0.47	0.10	0.20
Ba	0.00	0.00	0.62	5.48	85.71	6.50	0.81	0.88
B	0.00	0.00	0.00	0.33	5.95	81.47	6.57	5.68
Caa	0.00	0.00	0.00	0.00	0.00	1.31	81.24	17.45
Panel C: Peak Phases of the Business Cycles								
Aaa	91.93	7.45	0.63	0.00	0.00	0.00	0.00	0.00
Aa	1.02	95.62	3.23	0.13	0.00	0.00	0.00	0.00
A	0.06	1.80	94.96	3.14	0.05	0.00	0.00	0.00
Baa	0.00	0.00	3.68	92.87	2.64	0.31	0.44	0.06
Ba	0.00	0.00	1.25	9.16	85.08	4.03	0.48	0.00
B	0.00	0.00	0.00	0.15	7.93	87.85	3.83	0.24
Caa	0.00	0.00	0.00	0.00	0.63	1.39	84.73	13.26

Table 2.6. T-Tests for the Differences between the Means of the One-Year Rating Transition Matrices for the Industrial Sector During Normal, Trough and Peak Phases of the Business Cycle

This table presents the results of various t-tests for the differences between the means of the different transition matrices reported in table 2.5. Differences that are significantly different from zero at the 10, 5 and 1% levels are indicated by *, ** and ***, respectively.

Rating	Aaa	Aa	A	Baa	Ba	B	Caa	Default
Panel A: T-statistics for the differences in means for the peak and normal transition matrices								
Aaa	-0.46	0.44	0.32	-	-	-	-	-
Aa	0.01	3.15***	-3.00***	-0.82	-1.38	-0.75	-	-
A	-0.09	0.59	1.94*	-1.87*	-2.14**	-1.57	-	-
Baa	-0.75	-0.75	-0.80	2.08**	-1.81	-2.03	0.21	-1.66
Ba	-	-0.75	1.96*	1.89*	-0.09	-1.65	-0.87	-1.46
B	-	-	-0.99	-0.78	0.52	1.19	-1.15	-2.28**
Caa	-	-	-	-0.75	-0.93	-2.03*	1.15	0.86
Panel B: T-statistics for the differences in means for the peak and trough transition matrices								
Aaa	-0.60	0.63	0.30	-	-	-	-	-
Aa	-0.51	1.96*	-1.66	0.93	-	-	-	-
A	-0.14	-0.66	1.01	-0.87	-0.33	-	-1.08	-
Baa	-	-1.08	-1.26	1.88*	-1.73	-0.46	0.90	-1.04
Ba	-	-	0.72	1.46	-0.17	-0.66	-0.50	-1.63
B	-	-	-	-0.71	0.42	0.99	-0.67	-2.14**
Caa	-	-	-	-	0.93	0.19	1.09	-0.20
Panel C: T-statistics for the differences in means for the normal and trough transition matrices								
Aaa	-0.27	0.29	0.00	-	-	-	-	-
Aa	-0.59	-1.28	1.16	1.18	1.29	0.70	-	-
A	-0.08	-1.24	-0.25	0.09	1.94*	1.47	-1.45	-
Baa	0.70	0.23	-0.74	0.46	-0.86	1.62	0.86	0.58
Ba	-	0.70	-0.64	0.21	-0.14	0.21	0.34	-1.26
B	-	-	0.92	0.20	0.14	0.57	0.00	-1.22
Caa	-	-	-	0.70	1.16	1.97*	0.24	-1.24

Table 2.7. Average Default and Tax Spreads Derived Using After-Default and After-Tax Spot Rates

Panel A reports the average default spreads (in %) calculated as the differences between the pre-default and tax corporate spot rates and their after-default but pre-tax counterparts. Panel B reports the average tax spreads (in %) calculated as the difference between the after-default spot rates, which are reported in panel A, and the after-default and tax spot rates, which are reported in this panel. The after-default and tax spot rates are derived after accounting for default and tax price effects.

Years	Aa	A	Baa	Aa	A	Baa
Panel A: After-default spot rates and average default spreads						
	After-default Spot Rates (in %)			**Average Default Spreads (in %)**		
2	6.604	6.637	6.609	0.009	0.013	0.228
3	6.808	6.854	6.875	0.007	0.017	0.264
4	6.984	7.041	7.093	0.006	0.021	0.289
5	7.138	7.205	7.278	0.006	0.026	0.308
6	7.272	7.349	7.437	0.007	0.030	0.322
7	7.391	7.476	7.575	0.008	0.035	0.333
8	7.495	7.587	7.695	0.010	0.040	0.341
9	7.586	7.686	7.800	0.012	0.045	0.347
10	7.667	7.773	7.892	0.014	0.050	0.351
Panel B: After-tax spot rates and average tax spreads						
	After-tax Spot Rates (in %)			**Average Tax Spreads (in %)**		
2	6.101	6.102	6.181	0.238	0.261	0.411
3	6.304	6.306	6.383	0.284	0.316	0.476
4	6.479	6.481	6.555	0.317	0.360	0.526
5	6.633	6.635	6.703	0.341	0.396	0.565
6	6.769	6.772	6.831	0.361	0.425	0.598
7	6.889	6.894	6.942	0.377	0.449	0.627
8	6.996	7.003	7.040	0.390	0.469	0.652
9	7.092	7.100	7.125	0.401	0.485	0.673
10	7.176	7.187	7.200	0.409	0.498	0.692

Table 2.8. Average Tax Spreads Assuming Risk Neutrality

This table reports the average tax spreads of corporate spot rates over government spot rates (in %) when the effective tax rate is assumed to be equal to 4% as in EGAM (2001). These tax spreads are computed under the assumption of risk neutrality using equation (2.3). The EGAM results also are presented to facilitate comparison.

	Our Results			EGAM Results		
Years	**Aa**	**A**	**Baa**	**Aa**	**A**	**Baa**
2	0.353	0.358	0.509	0.296	0.344	0.436
3	0.358	0.368	0.531	0.301	0.354	0.47
4	0.363	0.378	0.552	0.305	0.364	0.504
5	0.368	0.388	0.574	0.309	0.374	0.537
6	0.374	0.398	0.595	0.314	0.383	0.569
7	0.381	0.409	0.615	0.319	0.393	0.600
8	0.387	0.419	0.634	0.324	0.403	0.629
9	0.394	0.430	0.653	0.329	0.413	0.657
10	0.402	0.440	0.670	0.335	0.423	0.683

Table 2.9. Relationship between Returns and Fama-French Risk Factors

This table reports the results of the regressions of returns due to changes in the unexplained spreads on industrial corporate bonds and returns on the Fama-French (FF) risk factors (the market excess return, the small minus big factor, and the high minus low book-to-market factors). The FF-factors are obtained from French's online data library. The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. The last column reports the p-values for the regressions. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

		Fama-French Risk Factors				
Maturities	**Constant**	**Market**	**SMB**	**HTML**	**Adj-R^2(%)**	**P-value**
Panel A: Industrial Aa-rated bonds						
2	-0.001(0.99)	-0.004(0.76)	-0.015(0.47)	0.006(0.78)	-1.626	0.774
3	-0.001(0.99)	-0.005(0.79)	-0.026(0.38)	0.007(0.84)	-1.451	0.727
4	-0.002(0.98)	-0.005(0.83)	-0.037(0.33)	0.008(0.85)	-1.359	0.702
5	-0.004(0.97)	-0.006(0.86)	-0.049(0.31)	0.011(0.84)	-1.287	0.683
6	-0.006(0.97)	-0.007(0.87)	-0.062(0.29)	0.014(0.84)	-1.219	0.665
7	-0.008(0.96)	-0.008(0.87)	-0.076(0.28)	0.017(0.83)	-1.155	0.649
8	-0.010(0.96)	-0.008(0.88)	-0.092(0.27)	0.020(0.83)	-1.096	0.634
9	-0.013(0.95)	-0.008(0.90)	-0.108(0.25)	0.023(0.83)	-1.045	0.621
10	-0.017(0.95)	-0.007(0.92)	-0.126(0.24)	0.026(0.83)	-1.002	0.610
Panel B: Industrial A-rated bonds						
2	-0.019(0.69)	0.014(0.26)	-0.006(0.76)	0.041(0.07)[a]	0.738	0.280
3	-0.023(0.75)	0.019(0.34)	-0.003(0.92)	0.049(0.15)	-0.538	0.502
4	-0.024(0.81)	0.019(0.48)	0.002(0.96)	0.052(0.27)	-1.434	0.722
5	-0.021(0.87)	0.015(0.68)	0.008(0.88)	0.052(0.40)	-1.961	0.866
6	-0.016(0.93)	0.007(0.88)	0.013(0.85)	0.051(0.52)	-2.221	0.932
7	-0.008(0.97)	-0.004(0.94)	0.016(0.85)	0.047(0.62)	-2.307	0.952
8	0.001(1.00)	-0.017(0.79)	0.017(0.86)	0.044(0.69)	-2.291	0.949
9	0.009(0.97)	-0.031(0.68)	0.015(0.89)	0.040(0.75)	-2.221	0.932
10	0.017(0.95)	-0.044(0.60)	0.012(0.93)	0.037(0.79)	-2.129	0.910
Panel C: Industrial Baa-rated bonds						
2	-0.015(0.80)	0.028(0.08)[a]	-0.025(0.30)	0.007(0.79)	0.673	0.289
3	-0.032(0.72)	0.050(0.04)[b]	-0.037(0.31)	0.017(0.68)	1.730	0.173
4	-0.051(0.68)	0.072(0.03)[b]	-0.049(0.34)	0.028(0.64)	1.711	0.174
5	-0.071(0.67)	0.094(0.04)[b]	-0.062(0.37)	0.038(0.63)	1.377	0.206
6	-0.092(0.67)	0.116(0.05)[b]	-0.077(0.38)	0.049(0.63)	1.063	0.240
7	-0.115(0.67)	0.138(0.06)[a]	-0.094(0.39)	0.060(0.63)	0.846	0.266
8	-0.140(0.66)	0.161(0.06)[a]	-0.110(0.40)	0.071(0.64)	0.722	0.283
9	-0.165(0.65)	0.186(0.07)[a]	-0.127(0.40)	0.082(0.64)	0.672	0.289
10	-0.192(0.65)	0.211(0.06)[a]	-0.143(0.40)	0.094(0.63)	0.678	0.289

Table 2.10. Relationship between Unexplained Credit Spreads and Aggregate Liquidity Proxies for the 1987-1996 Period

This table reports the results of the regressions of unexplained credit spreads (in %) (i.e., the portion not explained by default and taxes) for years two through ten. The variable "Amount" represents the average dollar amount (in billions) of issues for the bonds traded during the month. The variable "Age" represents the average age of bonds (in thousands of years) traded during the month. The variable "Matrix" is the relative frequency of matrix prices during the month. The variable "Volatility" is the average yield volatility for all bonds (in hundreds) quoted during the month. The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. The last column reports the p-values for the regressions. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Coefficient Estimates (p-values in parentheses)					Adj. R^2	P-
Maturity	**Constant**	**Amount**	**Age**	**Matrix**	**Volatility**	**(%)**	**value**
Panel A: Industrial Aa-rated bonds							
2	0.48(0.036)[b]	-3.62(0.001)[c]	-36.84(0.008)[c]	0.53(0.001)[c]	38.17(0.010)[c]	21.23	0.000[c]
3	0.38(0.094)[a]	-3.03(0.005)	-42.40(0.002)[c]	0.66(0.000)[c]	32.78(0.024)[b]	22.71	0.000[c]
4	0.25(0.267)	-2.34(0.030)[b]	-44.87(0.001)[c]	0.77(0.000)[c]	27.84(0.060)[a]	23.76	0.000[c]
5	0.14(0.541)	-1.72(0.123)	-46.08(0.002)[c]	0.86(0.000)[c]	22.70(0.137)	24.26	0.000[c]
6	0.05(0.823)	-1.17(0.310)	-46.51(0.002)[c]	0.92(0.000)[c]	17.26(0.276)	24.37	0.000[c]
7	-0.02(0.944)	-0.70(0.557)	-46.29(0.003)[c]	0.98(0.000)[c]	11.55(0.480)	24.20	0.000[c]
8	-0.08(0.770)	-0.29(0.815)	-45.47(0.005)[c]	1.01(0.000)[c]	5.64(0.738)	23.83	0.000[c]
9	-0.12(0.642)	0.08(0.949)	-44.06(0.007)[c]	1.04(0.000)[c]	-0.40(0.982)	23.26	0.000[c]
10	-0.16(0.548)	0.41(0.749)	-42.09(0.012)[b]	1.05(0.000)[c]	-6.49(0.712)	22.53	0.000[c]
Panel B: Industrial A-rated bonds							
2	0.29(0.167)	-2.55(0.011)[b]	24.33(0.057)[a]	-0.41(0.006)[c]	67.53(0.000)[c]	27.06	0.000[c]
3	0.31(0.135)	-2.04(0.040)[b]	23.79(0.063)[a]	-0.44(0.003)[c]	51.18(0.000)[c]	19.91	0.000[c]
4	0.34(0.127)	-1.59(0.125)	22.45(0.092)[a]	-0.45(0.004)[c]	36.18(0.011)[b]	12.95	0.000[c]
5	0.35(0.127)	-1.20(0.269)	20.73(0.140)	-0.44(0.007)[c]	22.70(0.129)	8.06	0.008[c]
6	0.37(0.130)	-0.88(0.444)	18.97(0.200)	-0.43(0.012)[b]	10.84(0.490)	5.24	0.037[c]
7	0.38(0.137)	-0.60(0.620)	17.38(0.262)	-0.42(0.021)[b]	0.58(0.972)	3.82	0.075[c]
8	0.39(0.148)	-0.34(0.782)	16.04(0.319)	-0.40(0.034)[b]	-8.16(0.633)	3.22	0.101[c]
9	0.38(0.165)	-0.12(0.928)	15.02(0.366)	-0.37(0.052)[a]	-15.47(0.381)	3.03	0.110[c]
10	0.37(0.187)	0.10(0.939)	14.32(0.399)	-0.35(0.075)[a]	-21.48(0.235)	3.04	0.110[c]
Panel C: Industrial Baa-rated bonds							
2	0.96(0.000)[c]	-6.74(0.000)[c]	-43.42(0.007)[c]	0.50(0.007)[c]	63.47(0.000)[c]	32.90	0.000[c]
3	0.74(0.004)[c]	-5.44(0.000)[c]	-46.41(0.003)[c]	0.70(0.000)[c]	49.96(0.003)[c]	29.79	0.000[c]
4	0.57(0.035)[b]	-4.34(0.001)[c]	-49.00(0.003)[c]	0.86(0.000)[c]	36.53(0.036)[b]	25.55	0.000[c]
5	0.43(0.134)	-3.41(0.013)[b]	-50.80(0.004)[c]	1.00(0.000)[c]	23.29(0.211)	22.24	0.000[c]
6	0.32(0.294)	-2.61(0.073)[a]	-51.89(0.006)[c]	1.11(0.000)[c]	10.37(0.601)	20.07	0.000[c]
7	0.24(0.470)	-1.93(0.209)	-52.39(0.009)[c]	1.19(0.000)[c]	-2.15(0.918)	18.73	0.000[c]
8	0.17(0.627)	-1.34(0.404)	-52.41(0.012)[b]	1.26(0.000)[c]	-14.22(0.517)	17.94	0.000[c]
9	0.11(0.755)	-0.83(0.618)	-52.05(0.016)[b]	1.31(0.000)[c]	-25.81(0.259)	17.50	0.000[c]
10	0.07(0.854)	-0.39(0.820)	-51.37(0.022)[b]	1.35(0.000)[c]	-36.87(0.120)	17.26	0.000[c]

Table 2.11. Summary of the Determinants of Credit Spreads

This table summarizes the findings of this chapter. We report the percentage explanatory power of each factor that we have investigated in this chapter. The default and tax spreads explanatory power was computed directly from dividing the default and tax spreads by the credit spreads. On the other hand, the explanatory powers of the Fama and French risk premiums and liquidity premiums were computed by multiplying the adjusted R^2 of the regressions by the unexplained (after tax and default) portion of the credit spreads.

	Default Spreads			**Tax Spreads**			**Liquidity Premiums**		
Maturity/Rating	**Aa**	**A**	**Baa**	**Aa**	**A**	**Baa**	**Aa**	**A**	**Baa**
2	1.86	2.49	23.38	49.17	50.00	42.15	10.40	12.86	11.34
3	1.37	3.00	25.10	55.68	55.83	45.24	9.75	8.20	8.83
4	1.13	3.48	26.11	59.81	59.70	47.51	9.28	4.77	6.74
5	1.10	4.11	26.85	62.45	62.55	49.25	8.84	2.69	5.31
6	1.25	4.55	27.36	64.58	64.49	50.80	8.32	1.62	4.38
7	1.41	5.15	27.80	66.37	66.02	52.33	7.79	1.10	3.72
8	1.74	5.73	28.14	67.82	67.19	53.79	7.25	0.87	3.24
9	2.07	6.32	28.42	69.25	68.11	55.12	6.67	0.77	2.88
10	2.41	6.91	28.68	70.27	68.78	56.54	6.15	0.74	2.55

Table 3.1. Summary Statistics for the Time-Series of the Cross-Sectional Mean Correlations of Bond Returns for the IO Sets Differentiated by Issuer Type and Credit Rating

Summary statistics for the time-series of cross-sectional mean correlations of the returns for the investment opportunity (IO) sets differentiated by issuer type and credit rating but undifferentiated by maturity are reported in panel A of this table. Summary statistics for these IO sets, when further differentiated by maturities of less than and more than 10 years, are reported in panels B and C, respectively. For each month, the mean cross-sectional correlation for each differentiated IO set *j* is calculated from the correlations between every unique pair of bonds in the different IO sets for bonds that have at least 27 monthly returns over a 36-month moving window. "Tr./Ag." refers to Treasury/Agency.

Panel A: Statistics for IO sets differentiated by issuer type and credit rating												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Mean	0.347	0.526	0.224	0.419	0.27	0.426	0.324	0.458	0.414	0.365	0.329	0.108
Median	0.311	0.533	0.218	0.444	0.243	0.448	0.316	0.48	0.407	0.339	0.314	0.108
Std dev	0.08	0.101	0.073	0.067	0.097	0.063	0.044	0.063	0.061	0.083	0.092	0.039
Min.	0.244	0.353	0.106	0.276	0.151	0.324	0.264	0.357	0.301	0.256	0.202	0.046
Max.	0.482	0.687	0.342	0.524	0.455	0.514	0.435	0.557	0.528	0.521	0.493	0.176
Panel B: Statistics for IO set differentiated by issuer type and credit rating and with maturities < 10 yrs												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Mean	0.268	0.409	0.173	0.291	0.249	0.351	0.245	0.344	0.321	0.303	0.278	0.098
Median	0.239	0.387	0.169	0.28	0.229	0.356	0.223	0.335	0.293	0.281	0.247	0.099
Std dev	0.078	0.096	0.056	0.096	0.091	0.069	0.046	0.055	0.083	0.085	0.096	0.035
Min.	0.175	0.282	0.103	0.149	0.131	0.241	0.197	0.268	0.213	0.179	0.141	0.044
Max.	0.399	0.574	0.273	0.459	0.421	0.467	0.362	0.482	0.478	0.462	0.449	0.162
Panel C: Statistics for IO set differentiated by issuer type and credit rating and with maturities > 10 yrs												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
IO	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Mean	0.513	0.817	0.363	0.484	0.385	0.53	0.531	0.728	0.506	0.476	0.416	0.163
Median	0.479	0.841	0.323	0.515	0.345	0.543	0.500	0.752	0.528	0.453	0.409	0.149
Std dev	0.109	0.10	0.130	0.075	0.130	0.075	0.106	0.098	0.075	0.092	0.094	0.079
Min.	0.348	0.415	0.139	0.321	0.229	0.384	0.383	0.518	0.353	0.333	0.266	0.055
Max.	0.688	0.928	0.546	0.587	0.635	0.648	0.714	0.884	0.642	0.63	0.573	0.310

Table 3.2. Correlations between the Time-Series of Cross-Sectional Mean Correlations of Monthly Returns for Various IO Sets Differentiated by Issuer Type and Credit Rating

This table reports the correlations between the time-series of cross-sectional mean correlations of monthly returns for the investment opportunity (IO) sets differentiated by issuer type and credit rating, where the latter are reported in the parentheses. For each month, the mean cross-sectional correlation for each differentiated IO set *j* is calculated from the correlations between every unique pair of bonds in the IO set for bonds that have at least 27 monthly returns over a 36-month moving window. The correlations for a further differentiation by bond maturity are reported in panel B, where the lower and upper diagonals are based on maturities less than and greater than 10 years, respectively. "Tr./Ag." refers to Treasury/Agency.

Panel A: Correlations for IO sets differentiated by issuer type and credit rating

IO	All (All)	Treasury/ Agency (Aaa)	Industrial (Aa)	Utility (A)	Financial (Baa)	Foreign (Spec.)
All (All)	1.00 (1.00)					
Treasury/Agency (Aaa)	0.89 (0.89)	1.00 (1.00)				
Industrial (Aa)	0.93 (0.22)	0.78 (0.32)	1.00 (1.00)			
Utility (A)	0.45 (0.58)	0.12 (0.38)	0.28 (0.94)	1.00 (1.00)		
Financial (Baa)	0.94 (0.62)	0.74 (0.52)	0.82 (0.92)	0.65 (0.98)	1.00 (1.00)	
Foreign (Spec.)	0.63 (0.08)	0.47 (0.03)	0.42 (0.06)	0.75 (0.19)	0.67 (0.12)	1.00 (1.00)

Panel B: Correlations for IO sets differentiated by issuer type, credit rating and maturity

IO	All (All)	Treasury/ Agency (Aaa)	Industrial (Aa)	Utility (A)	Financial (Baa)	Foreign (Spec.)
All (All)	1.00 (1.00)	0.84 (0.91)	0.97(0.33)	0.23 (0.84)	0.90 (0.74)	0.34 (0.76)
Treasury/Agency (Aaa)	0.92 (0.83)	1.00 (1.00)	0.87 (0.07)	-0.13 (0.57)	0.62 (0.44)	-0.07 (0.82)
Industrial (Aa)	0.94 (0.86)	0.81 (0.49)	1.00 (1.00)	0.08 (0.71)	0.83 (0.81)	0.17 (0.15)
Utility (A)	0.92 (0.74)	0.73 (0.42)	0.84 (0.98)	1.00 (1.00)	0.55 (0.97)	0.92 (0.48)
Financial (Baa)	0.94 (0.90)	0.79 (0.67)	0.84 (0.97)	0.98 (0.97)	1.00 (1.00)	0.64 (0.39)
Foreign (Spec.)	0.83 (-0.21)	0.85 (-0.21)	0.72 (0.21)	0.74 (0.10)	0.76 (0.11)	1.00 (1.00)

Table 3.3. Excess Standard Deviations (MDD) for IO sets Differentiated by Issuer Type and Maturity

This table reports the excess standard deviations (MDD) of quoted returns (i.e., differences between the standard deviations of the 5000 random portfolios and an equally weighted index of all bonds in that IO set *j* for the whole period) differentiated by issuer type and maturity for various portfolio sizes (PS). The percentage reduction in MDD from a benchmark PS of 2 as PS increases is reported in the parentheses. [a] indicates that the means for PS of 2 and All (i.e., all bonds in the IO set) are significantly different at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in a reduction in the MDD of not more than 1% provided that the difference in the means for *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Excess standard deviations for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	24.2[a]	12.7(47)	8.6(64)	6.7(72)	5.4(78)	4.4(82)	3.7(85)	3.1(87)	2.6(89)	2.2(91)[b]	1.8(92)
Tr./Ag.	16.8[a]	8.3(50)	4.9(71)	3.2(81)	2.2(87)	1.5(91)	1.0(94)	0.7(96)[b]	0.6(97)	0.4(97)	0.3(98)
Industrial	26.2[a]	12.7(51)	8.2(69)	6.5(75)	5.4(79)	4.7(82)	4.1(84)	3.6(86)	3.2(88)[b]	2.9(89)	2.6(90)
Utility	32.2[a]	18.4(43)	11.7(64)	9.3(71)	8.1(75)	7.1(78)	6.3(80)	5.7(82)	5.1(84)	4.7(86)[b]	4.2(87)
Financial	20.7[a]	12.1(42)	9.1(56)	7.8(63)	6.9(67)	6.1(70)	5.6(73)	5.2(75)	4.8(77)	4.4(79)[b]	4.1(80)
Foreign	27.7[a]	16.8(39)	12.9(53)	10.9(60)	9.5(66)	8.6(69)	7.9(71)	7.4(73)	6.9(75)[b]	6.6(76)	6.3(77)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	1.5(94)	1.3(95)	1.1(95)	0.9(96)	0.8(97)	0.7(97)	0.6(98)	0.5(98)	0.4(98)	0.4(98)	0.0
Tr./Ag.	0.2(99)	0.2(99)	0.1(99)	0.1(99)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	2.4(91)	2.2(92)	1.9(93)	1.8(93)	1.6(94)	1.5(94)	1.3(95)	1.2(95)	1.1(96)	1.0(96)	0.0
Utility	3.9(88)	3.6(89)	3.3(90)	3.0(91)	2.8(91)	2.5(92)	2.3(93)	2.1(93)	1.9(94)	1.8(94)	0.0
Financial	3.9(81)	3.6(83)	3.4(84)	3.2(85)	2.9(86)	2.7(87)	2.5(88)	2.3(89)	2.2(90)	2.0(90)	0.0
Foreign	6.0(78)	5.8(79)	5.6(80)	5.5(80)	5.3(81)	5.2(81)	5.1(82)	4.9(82)	4.8(83)	4.6(83)	0.0
Panel B: Excess standard deviations for maturities < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	21.0[a]	11.2(47)	7.1(66)	5.5(74)	4.4(79)	3.6(83)	2.9(86)	2.4(89)[b]	2.0(90)	1.7(92)	1.4(93)
Tr./Ag.	14.0[a]	7.3(47)	4.5(68)	3.0(78)	2.1(85)	1.4(90)	1.0(93)	0.8(95)[b]	0.6(96)	0.4(97)	0.3(98)
Industrial	22.9[a]	11.0(52)	7.0(70)	5.6(76)	4.8(79)	4.2(82)	3.7(84)[b]	3.3(85)	3.0(87)	2.7(88)	2.4(90)
Utility	22.2[a]	12.5(44)	8.6(61)	7.3(67)	6.5(71)	6.0(73)	5.5(75)	5.1(77)[b]	4.8(79)	4.5(80)	4.1(82)
Financial	18.9[a]	11.2(41)	8.2(57)	6.9(63)	6.2(67)	5.6(70)	5.2(73)	4.8(75)[b]	4.5(76)	4.2(78)	3.9(79)
Foreign	24.3[a]	15.8(35)	12.7(48)	11.3(53)	10.6(56)	10.1(58)	9.6(60)	9.3(62)[b]	9.0(63)	8.7(64)	8.5(65)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	1.2(94)	0.9(95)	0.8(96)	0.7(97)	0.6(97)	0.5(98)	0.4(98)	0.3(99)	0.3(99)	0.2(99)	0.0
Tr./Ag.	0.2(98)	0.2(99)	0.1(99)	0.1(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	2.1(91)	1.9(92)	1.7(92)	1.6(93)	1.4(94)	1.3(94)	1.2(95)	1.1(95)	0.9(96)	0.9(96)	0.0
Utility	3.8(83)	3.5(84)	3.3(85)	3.0(86)	2.8(87)	2.6(88)	2.4(89)	2.3(90)	2.1(90)	2.0(91)	0.0
Financial	3.6(81)	3.4(82)	3.2(83)	2.9(84)	2.7(86)	2.5(87)	2.4(88)	2.2(88)	2.1(89)	1.9(90)	0.0
Foreign	8.3(66)	8.1(67)	7.9(68)	7.7(68)	7.5(69)	7.4(70)	7.1(71)	7.0(71)	6.8(72)	6.6(73)	0.0
Panel B: Excess standard deviations for maturities > 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	32.0[a]	19.0(41)	14.1(56)	11.8(63)	9.8(69)	8.4(74)	7.2(78)	6.1(81)	5.3(83)	4.7(85)	4.2(87)[b]
Tr./Ag.	39.8[a]	21.6(46)	11.6(71)	7.2(82)	4.5(89)	2.9(93)	1.9(95)	1.3(97)[b]	0.9(98)	0.6(98)	0.4(99)
Industrial	31.9[a]	19.0(41)	13.7(57)	11.1(65)	9.4(71)	8.1(75)	7.0(78)	6.2(80)	5.6(82)	5.1(84)[b]	4.7(85)
Utility	40.1[a]	25.9(36)	18.3(54)	15.4(62)	13.6(66)	12.3(69)	11.2(72)	10.3(74)	9.5(76)	8.7(78)	8.0(80)
Financial	23.8[a]	17.5(26)	14.7(38)	12.8(46)	11.3(53)	10.1(58)	9.0(62)	8.3(65)	7.6(68)	7.1(70)	6.7(72)[b]
Foreign	31.6[a]	19.7(38)	13.9(56)	11.1(65)	9.4(70)	8.1(74)	7.3(77)	6.7(79)[b]	6.2(80)	5.9(81)	5.6(82)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	3.8(88)	3.4(89)	3.1(90)	2.7(91)	2.5(92)	2.2(93)	2.0(94)	1.8(94)	1.6(95)	1.5(95)	0.0
Tr./Ag.	0.3(99)	0.2(100)	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	4.4(86)	4.1(87)	3.8(88)	3.5(89)	3.3(90)	3.1(90)	3.0(91)	2.8(91)	2.6(92)	2.5(92)	0.0
Utility	7.4(82)[b]	6.7(83)	6.2(85)	5.7(86)	5.3(87)	4.9(88)	4.5(89)	4.2(90)	3.9(90)	3.6(91)	0.0
Financial	6.4(73)	6.1(75)	5.8(76)	5.6(77)	5.4(77)	5.1(78)	5.0(79)	4.8(80)	4.6(81)	4.4(81)	0.0
Foreign	5.4(83)	5.1(84)	4.9(84)	4.8(85)	4.6(85)	4.4(86)	4.3(86)	4.2(87)	4.0(87)	3.9(88)	0.0

Table 3.4. Excess Standard Deviations (MDD) for IO sets Differentiated by Credit Rating

This table reports the excess standard deviations (MDD) of quoted returns (i.e., differences between the standard deviations of the 5000 random portfolios and an equally weighted index of all bonds in the IO set *j*) differentiated by rating category and maturity for various portfolio sizes (PS). The percentage reductions in MDD from a benchmark PS of 2 as PS increases are reported in the parentheses. [a] indicates that the means for a PS of 2 and All (i.e., all bonds in the IO set *j*) are significantly different at the 0.05 level. [b] refers to the lowest PS beyond which increasing the PS results in a reduction in the MDD of not more than 1% provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Excess standard deviations for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	23.2 [a]	12.1(48)	8.3(64)	6.5(72)	5.3(77)	4.4(81)	3.7(84)	3.1(87)	2.6(89) [b]	2.2(90)	1.9(92)
Aaa	16.6 [a]	9.7(42)	6.8(59)	5.1(70)	3.8(77)	3.0(82)	2.4(86)	1.8(89)	1.5(91)	1.2(93) [b]	0.9(94)
Aa	22.3 [a]	14.0(37)	11.5(48)	10.3(54)	9.4(58)	8.6(62)	7.9(64)	7.4(67)	6.8(70)	6.3(72) [b]	5.9(73)
A	22.5 [a]	13.6(39)	10.6(53)	9.0(60)	7.8(65)	6.9(69)	6.1(73)	5.5(75)	5.0(78)	4.5(80)	4.1(82) [b]
Baa	20.3 [a]	11.7(42)	8.4(59)	6.8(67)	5.8(71)	5.1(75)	4.5(78)	4.1(80)	3.7(82)	3.3(84) [b]	3.0(85)
Speculative	26.6 [a]	13.5(49)	9.3(65)	7.6(72)	6.5(76)	5.6(79)	4.8(82)	4.4(84) [b]	3.9(85)	3.5(87)	3.1(88)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	1.6(93)	1.4(94)	1.2(95)	1.0(96)	0.8(96)	0.7(97)	0.6(97)	0.6(98)	0.5(98)	0.4(98)	0.0
Aaa	0.8(95)	0.6(96)	0.5(97)	0.4(98)	0.3(98)	0.3(98)	0.2(99)	0.2(99)	0.2(99)	0.1(99)	0.0
Aa	5.6(75)	5.2(77)	4.9(78)	4.6(79)	4.3(81)	4.1(82)	3.8(83)	3.6(84)	3.4(85)	3.2(86)	0.0
A	3.7(83)	3.4(85)	3.0(86)	2.8(88)	2.6(89)	2.3(90)	2.1(91)	1.9(92)	1.7(92)	1.6(93)	0.0
Baa	2.7(87)	2.4(88)	2.2(89)	2.0(90)	1.8(91)	1.6(92)	1.4(93)	1.3(94)	1.1(94)	1.0(95)	0.0
Speculative	2.8(89)	2.5(91)	2.3(92)	2.0(92)	1.8(93)	1.6(94)	1.4(95)	1.3(95)	1.2(96)	1.0(96)	0.0
Panel B: Excess standard deviations for maturities < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	20.2 [a]	10.6(48)	7.0(65)	5.3(74)	4.2(79)	3.4(83)	2.8(86)	2.3(89)	1.9(91) [b]	1.6(92)	1.3(94)
Aaa	13.7 [a]	7.6(45)	4.8(65)	3.5(75)	2.5(82)	1.9(86)	1.4(90)	1.0(92)	0.8(94)	0.6(96) [b]	0.5(97)
Aa	16.4 [a]	10.7(35)	9.0(45)	8.2(50)	7.6(54)	7.1(57)	6.7(59)	6.3(61)	6.0(63)	5.8(65) [b]	5.5(66)
A	18.4 [a]	11.2(39)	8.6(53)	7.5(59)	6.8(63)	6.2(66)	5.7(69)	5.2(72)	4.7(74)	4.4(76)	4.0(78)
Baa	16.2 [a]	9.5(41)	7.0(57)	6.0(63)	5.3(67)	4.8(71)	4.3(73)	3.9(76)	3.5(78)	3.1(81)	2.8(83)
Speculative	26.2 [a]	13.0(50)	8.8(66)	7.1(73)	6.1(77)	5.3(80)	4.7(82)	4.2(84)	3.7(86)	3.2(88) [b]	2.8(89)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	1.1(95)	0.9(96)	0.8(96)	0.6(97)	0.5(97)	0.4(98)	0.4(98)	0.3(99)	0.3(99)	0.2(99)	0.0
Aaa	0.4(97)	0.3(98)	0.2(98)	0.2(99)	0.1(99)	0.1(99)	0.1(99)	0.1(99)	0.1(100)	0.0(100)	0.0
Aa	5.2(68)	4.9(70)	4.7(72)	4.4(73)	4.2(74)	4.0(76)	3.8(77)	3.6(78)	3.4(80)	3.2(81)	0.0
A	3.7(80) [b]	3.4(81)	3.2(83)	3.0(84)	2.7(85)	2.5(86)	2.3(87)	2.2(88)	2.0(89)	1.8(90)	0.0
Baa	2.5(85) [b]	2.3(86)	2.0(88)	1.8(89)	1.6(90)	1.4(91)	1.3(92)	1.2(93)	1.0(94)	0.9(94)	0.0
Speculative	2.5(90)	2.2(91)	1.9(93)	1.7(93)	1.5(94)	1.4(95)	1.2(95)	1.1(96)	1.0(96)	0.8(97)	0.0
Panel C: Excess standard deviations for maturities >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	27.0 [a]	16.1(40)	12.2(55)	9.9(63)	8.2(70)	6.8(75)	5.8(78)	5.0(81)	4.4(84)	3.8(86)	3.3(88) [b]
Aaa	19.7 [a]	12.8(35)	9.9(50)	8.2(59)	6.9(65)	5.9(70)	4.9(75)	4.2(79)	3.6(82)	3.0(85)	2.6(87)
Aa	29.8 [a]	19.6(34)	16.1(46)	14.0(53)	12.4(59)	11.0(63)	9.8(67)	8.6(71)	7.6(74)	6.8(77)	6.0(80)
A	29.4 [a]	19.4(34)	15.2(48)	12.9(56)	11.0(63)	9.6(67)	8.5(71)	7.6(74)	6.7(77)	5.9(80)	5.3(82)
Baa	24.5 [a]	14.3(41)	10.0(59)	7.9(68)	6.6(73)	5.6(77)	4.9(80)	4.4(82)	3.9(84)	3.5(86) [b]	3.2(87)
Speculative	29.4 [a]	15.4(48)	9.1(69)	5.9(80)	4.2(86)	3.0(90)	2.3(92)	1.8(94) [b]	1.4(95)	1.1(96)	0.9(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	2.9(89)	2.5(91)	2.2(92)	1.9(93)	1.7(94)	1.5(94)	1.3(95)	1.2(96)	1.0(96)	0.9(97)	0.0
Aaa	2.2(89)	1.9(90) [b]	1.6(92)	1.4(93)	1.1(94)	1.0(95)	0.8(96)	0.7(97)	0.6(97)	0.5(98)	0.0
Aa	5.4(82)	4.8(84) [b]	4.4(85)	4.0(87)	3.6(88)	3.2(89)	2.9(90)	2.7(91)	2.4(92)	2.2(92)	0.0
A	4.8(84)	4.4(85) [b]	4.0(86)	3.7(88)	3.4(89)	3.1(89)	2.8(90)	2.6(91)	2.4(92)	2.3(92)	0.0
Baa	2.9(88)	2.6(89)	2.3(91)	2.1(92)	1.9(92)	1.7(93)	1.5(94)	1.4(94)	1.3(95)	1.1(95)	0.0
Speculative	0.7(98)	0.6(98)	0.5(98)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.1(100)	0.1(100)	0.0

Table 3.5. Mean Realized Dispersion Differentiated by Issuer Type

This table reports the mean realized dispersion (MRD) of quoted returns (i.e., the mean of the cross-sectional standard deviations of IO set *j* for the whole period) as defined in equation (3.3) and differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a PS of 2 and All are significantly different at the 0.05 level [b] refers to the lowest PS beyond which increasing PS would result in a reduction in MRD from a benchmark PS of 2 of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Mean realized dispersions for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	39.8[a]	25.3(36)	17.7(55)	14.4(64)	12.5(69)	11.2(72)	10.2(74)	9.4(76)	8.8(78)[b]	8.3(79)	7.9(80)
Tr./Ag.	48.3[a]	30.9(36)	22.0(55)	17.9(63)	15.5(68)	13.9(71)	12.7(74)	11.8(76)[b]	11.0(77)	10.4(79)	9.9(80)
Industrial	59.6[a]	37.2(38)	26.2(56)	21.5(64)	18.5(69)	16.5(72)	15.1(75)	13.9(77)[b]	13.0(78)	12.2(80)	11.6(81)
Utility	17.7[a]	11.1(37)	7.8(56)	6.4(64)	5.6(69)	5.0(72)	4.6(74)	4.2(76)	3.9(78)[b]	3.7(79)	3.5(80)
Financial	27.3[a]	17.1(38)	12.0(56)	9.8(64)	8.4(69)	7.5(73)	6.9(75)	6.4(77)	6.0(78)	5.6(80)[b]	5.3(81)
Foreign	12.0[a]	7.6(37)	5.4(55)	4.4(64)	3.8(69)	3.4(72)	3.1(74)	2.9(76)	2.7(78)[b]	2.5(79)	2.4(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	7.5(81)	7.2(82)	6.9(83)	6.7(83)	6.4(84)	6.2(84)	6.0(85)	5.9(85)	5.7(86)	5.6(86)	0.0
Tr./Ag.	9.4(81)	9.0(81)	8.7(82)	8.4(83)	8.1(83)	7.8(84)	7.6(84)	7.4(85)	7.2(85)	7.0(86)	0.1
Industrial	11.0(82)	10.5(82)	10.2(83)	9.8(84)	9.4(84)	9.1(85)	8.8(85)	8.6(86)	8.4(86)	8.2(86)	0.1
Utility	3.4(81)	3.2(82)	3.1(83)	3.0(83)	2.9(84)	2.8(84)	2.7(85)	2.6(85)	2.5(86)	2.5(86)	0.0
Financial	5.1(82)	4.9(82)	4.7(83)	4.5(84)	4.3(84)	4.2(85)	4.1(85)	4.0(86)	3.9(86)	3.8(86)	0.0
Foreign	2.3(81)	2.2(82)	2.1(83)	2.0(83)	2.0(84)	1.9(84)	1.9(85)	1.8(85)	1.8(86)	1.7(86)	0.0
Panel B: Mean realized dispersions for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	27.8[a]	17.7(36)	12.6(55)	10.3(63)	8.9(68)	7.9(71)	7.2(74)	6.7(76)[b]	6.3(77)	5.9(79)	5.6(80)
Tr./Ag.	10.6[a]	6.7(37)	4.8(55)	3.9(63)	3.4(68)	3.0(72)	2.7(74)	2.5(76)	2.4(78)[b]	2.2(79)	2.1(80)
Industrial	57.6[a]	35.8(38)	25.0(57)	20.5(65)	17.6(69)	15.8(73)	14.4(75)	13.3(77)	12.4(79)[b]	11.7(80)	11.2(81)
Utility	16.4[a]	10.4(37)	7.3(56)	6.0(64)	5.2(69)	4.6(72)	4.2(75)	3.9(77)[b]	3.7(78)	3.5(79)	3.3(80)
Financial	23.7[a]	14.5(39)	10.3(56)	8.4(64)	7.3(69)	6.5(73)	5.9(75)	5.5(77)[b]	5.1(78)	4.9(80)	4.6(81)
Foreign	9.0[a]	5.7(37)	4.0(56)	3.3(64)	2.9(69)	2.5(72)	2.3(75)	2.2(77)[b]	2.0(78)	1.9(79)	1.8(81)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.3(81)	5.1(82)	4.9(82)	4.7(83)	4.6(84)	4.4(84)	4.3(85)	4.2(85)	4.1(85)	4.0(86)	0.0
Tr./Ag.	2.0(81)	1.9(82)	1.9(83)	1.8(83)	1.7(84)	1.7(84)	1.6(85)	1.6(85)	1.5(86)	1.5(86)	0.0
Industrial	10.6(82)	10.2(82)	9.8(83)	9.4(84)	9.1(84)	8.8(85)	8.5(85)	8.3(86)	8.0(86)	7.8(87)	0.1
Utility	3.1(81)	3.0(82)	2.9(83)	2.8(84)	2.7(84)	2.6(85)	2.5(85)	2.4(86)	2.4(86)	2.3(86)	0.1
Financial	4.4(82)	4.2(82)	4.0(83)	3.9(84)	3.7(84)	3.6(85)	3.5(85)	3.4(86)	3.3(86)	3.2(86)	0.0
Foreign	1.7(81)	1.6(82)	1.6(83)	1.5(84)	1.5(84)	1.4(85)	1.4(85)	1.3(86)	1.3(86)	1.3(86)	0.1
Panel C: Mean realized dispersions for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	47.7[a]	30.2(37)	21.3(55)	17.3(64)	15.0(69)	13.5(72)	12.3(74)	11.4(76)	10.6(78)[b]	10.0(79)	9.5(80)
Tr./Ag.	95.5[a]	60.5(37)	42.9(55)	35.0(64)	30.3(68)	27.0(72)	24.7(74)	22.9(76)	21.4(78)[b]	20.2(79)	19.1(80)
Industrial	53.7[a]	33.4(38)	23.9(56)	19.6(64)	17.1(68)	15.3(72)	14.0(74)	12.9(76)	12.1(78)[b]	11.4(79)	10.8(80)
Utility	15.3[a]	9.7(36)	6.9(55)	5.6(63)	4.9(68)	4.3(72)	4.0(74)	3.7(76)	3.4(78)[b]	3.2(79)	3.1(80)
Financial	22.2[a]	14.1(37)	9.9(56)	8.1(64)	7.0(69)	6.3(72)	5.7(75)	5.3(77)	5.0(78)	4.7(80)[b]	4.4(81)
Foreign	12.3[a]	7.8(37)	5.5(56)	4.5(64)	3.9(69)	3.5(72)	3.2(75)	2.9(77)	2.7(78)	2.6(80)[b]	2.5(81)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	9.1(81)	8.7(82)	8.3(83)	8.0(83)	7.7(84)	7.5(84)	7.2(85)	7.0(85)	6.8(86)	6.7(86)	0.0
Tr./Ag.	18.3(81)	17.5(82)	16.8(83)	16.2(83)	15.6(84)	15.1(84)	14.7(85)	14.2(85)	13.9(86)	13.5(86)	0.3
Industrial	10.3(81)	9.9(82)	9.5(83)	9.1(83)	8.8(84)	8.5(84)	8.3(85)	8.1(85)	7.9(86)	7.7(86)	0.1
Utility	2.9(81)	2.8(82)	2.7(83)	2.6(83)	2.5(84)	2.4(84)	2.4(85)	2.3(85)	2.2(86)	2.2(86)	0.0
Financial	4.2(82)	4.1(82)	3.9(83)	3.7(84)	3.6(84)	3.5(85)	3.4(85)	3.3(86)	3.2(86)	3.1(87)	0.2
Foreign	2.3(82)	2.2(83)	2.2(83)	2.1(84)	2.0(84)	1.9(85)	1.9(85)	1.8(86)	1.8(86)	1.7(87)	0.1

Table 3.6. Mean Realized Dispersion Differentiated by Portfolio Size and Credit Rating

This table reports the mean realized dispersion (MRD) of quoted returns (i.e., the mean of the cross-sectional standard deviations of IO set *j* for the whole period) as defined in equation (3.3) and differentiated by portfolio size, rating category and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in a reduction in MRD from a benchmark PS of 2 of 1% or less provided that the difference in the means for a PS of 2 and All are significantly different at the 0.05 level.

Panel A: Mean realized dispersions for all maturities (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	34.1[a]	21.6(37)	15.1(56)	12.4(64)	10.7(69)	9.6(72)	8.7(74)	8.1(76)	7.6(78)[b]	7.2(79)	6.8(80)
Aaa	41.4[a]	25.9(38)	18.4(56)	15.0(64)	13.0(69)	11.6(72)	10.5(75)	9.8(77)[b]	9.2(78)	8.6(79)	8.2(80)
Aa	13.5[a]	8.5(37)	6.0(55)	4.9(64)	4.3(68)	3.8(72)	3.5(74)	3.2(76)	3.0(78)[b]	2.8(79)	2.7(80)
A	14.7[a]	9.3(37)	6.6(55)	5.4(64)	4.6(69)	4.2(72)	3.8(74)	3.5(76)	3.3(78)[b]	3.1(79)	2.9(80)
Baa	16.3[a]	10.3(37)	7.3(55)	5.9(64)	5.1(69)	4.6(72)	4.2(74)	3.9(76)	3.6(78)[b]	3.4(79)	3.2(80)
Speculative	93.7[a]	59.6(37)	42.2(55)	34.4(63)	29.7(68)	26.5(72)	24.2(74)	22.5(76)	21.1(78)[b]	19.8(79)	18.8(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	6.5(81)	6.2(82)	5.9(83)	5.7(83)	5.5(84)	5.4(84)	5.2(85)	5.1(85)	4.9(86)	4.8(86)	0.0
Aaa	7.8(81)	7.5(82)	7.2(83)	6.9(83)	6.7(84)	6.5(84)	6.3(85)	6.1(85)	6.0(86)	5.8(86)	0.0
Aa	2.6(81)	2.5(82)	2.4(83)	2.3(83)	2.2(84)	2.1(84)	2.1(85)	2.0(85)	2.0(86)	1.9(86)	0.0
A	2.8(81)	2.7(82)	2.6(83)	2.5(83)	2.4(84)	2.3(84)	2.3(85)	2.2(85)	2.1(86)	2.1(86)	0.0
Baa	3.1(81)	3.0(82)	2.9(83)	2.7(83)	2.7(84)	2.6(84)	2.5(85)	2.4(85)	2.4(86)	2.3(86)	0.0
Speculative	17.9(81)	17.2(82)	16.5(83)	15.9(83)	15.3(84)	14.9(84)	14.4(85)	14.0(85)	13.6(86)	13.3(86)	0.2

Panel B: Mean realized dispersions for portfolios for bonds with maturity < 10 years (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	25.1[a]	15.9(36)	11.1(56)	9.1(64)	7.9(69)	7.1(72)	6.4(74)	6.0(76)	5.6(78)[b]	5.3(79)	5.0(80)
Aaa	9.8[a]	6.2(37)	4.4(56)	3.6(64)	3.1(69)	2.8(72)	2.5(74)	2.3(76)	2.2(78)[b]	2.1(79)	2.0(80)
Aa	10.1[a]	6.4(37)	4.5(55)	3.7(64)	3.2(69)	2.9(72)	2.6(74)	2.4(76)	2.3(78)[b]	2.1(79)	2.0(80)
A	11.5[a]	7.2(37)	5.1(56)	4.2(64)	3.6(69)	3.2(72)	2.9(75)	2.7(76)	2.6(78)[b]	2.4(79)	2.3(80)
Baa	12.7[a]	8.0(37)	5.7(56)	4.6(64)	4.0(69)	3.6(72)	3.3(75)	3.0(77)[b]	2.8(78)	2.7(79)	2.5(80)
Speculative	84.9[a]	52.9(38)	37.3(56)	30.4(64)	26.3(69)	23.5(73)	21.5(75)	20.0(77)[b]	18.7(78)	17.5(80)	16.6(81)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	4.8(81)	4.6(82)	4.4(83)	4.2(83)	4.1(84)	3.9(84)	3.8(85)	3.7(85)	3.6(86)	3.5(86)	0.0
Aaa	1.9(81)	1.8(82)	1.7(83)	1.7(83)	1.6(84)	1.5(84)	1.5(85)	1.5(85)	1.4(86)	1.4(86)	0.0
Aa	1.9(81)	1.9(82)	1.8(83)	1.7(83)	1.7(84)	1.6(84)	1.6(85)	1.5(85)	1.5(86)	1.4(86)	0.0
A	2.2(81)	2.1(82)	2.0(83)	1.9(83)	1.9(84)	1.8(84)	1.8(85)	1.7(85)	1.7(86)	1.6(86)	0.0
Baa	2.4(81)	2.3(82)	2.2(83)	2.1(84)	2.1(84)	2.0(85)	1.9(85)	1.9(86)	1.8(86)	1.8(86)	0.1
Speculative	15.9(82)	15.2(82)	14.6(83)	14.0(84)	13.5(84)	13.1(85)	12.7(85)	12.4(86)	12.0(86)	11.7(87)	0.3

Panel C: Mean realized dispersions for portfolios for bonds with maturity >10 years (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	43.3[a]	27.5(37)	19.6(55)	16.0(63)	13.8(68)	12.4(71)	11.3(74)	10.5(76)	9.8(78)[b]	9.2(79)	8.7(80)
Aaa	56.8[a]	35.9(37)	25.5(55)	20.9(63)	18.2(68)	16.3(71)	14.8(74)	13.7(76)	12.8(78)[b]	12.1(79)	11.5(80)
Aa	13.6[a]	8.6(37)	6.1(56)	5.0(64)	4.3(69)	3.9(72)	3.5(74)	3.3(76)	3.1(78)[b]	2.9(79)	2.7(80)
A	15.4[a]	9.7(37)	6.9(55)	5.6(64)	4.9(68)	4.4(72)	4.0(74)	3.7(76)	3.4(78)[b]	3.3(79)	3.1(80)
Baa	17.0[a]	10.8(37)	7.6(55)	6.3(64)	5.4(69)	4.8(72)	4.4(74)	4.1(76)	3.8(78)[b]	3.6(79)	3.4(80)
Speculative	86.8[a]	54.0(38)	38.0(57)	31.1(65)	27.0(69)	24.1(73)	22.0(75)	20.3(77)	19.1(79)[b]	18.0(80)	17.0(81)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	8.3(81)	7.9(82)	7.6(82)	7.3(83)	7.1(84)	6.9(84)	6.7(85)	6.5(85)	6.3(85)	6.2(86)	0.0
Aaa	10.9(81)	10.5(82)	10.1(82)	9.7(83)	9.3(84)	9.1(84)	8.8(85)	8.5(85)	8.3(86)	8.1(86)	0.1
Aa	2.6(81)	2.5(82)	2.4(83)	2.3(83)	2.2(84)	2.2(85)	2.1(85)	2.0(85)	2.0(86)	1.9(86)	0.1
A	2.9(81)	2.8(82)	2.7(83)	2.6(83)	2.5(84)	2.4(84)	2.4(85)	2.3(85)	2.2(86)	2.2(86)	0.0
Baa	3.3(81)	3.1(82)	3.0(83)	2.9(83)	2.8(84)	2.7(85)	2.6(85)	2.6(85)	2.5(86)	2.4(86)	0.1
Speculative	16.2(82)	15.5(83)	14.9(83)	14.4(84)	13.9(85)	13.4(85)	13.0(86)	12.7(86)	12.3(86)	12.0(87)	0.7

Table 3.7. NPV Differentiated by Portfolio Size and Issuer Type

This table reports the normalized portfolio variance (NPV) of quoted returns as defined in equation (3.5) differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in a reduction in NPV of 1% or less provided that the difference in the means for a PS of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: NPV for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	25.0[a]	7.0(72)	3.2(87)	2.0(92)	1.3(95)	0.9(97)[b]	0.6(98)	0.4(98)	0.3(99)	0.2(99)	0.1(99)
Tr./Ag.	23.6[a]	5.7(76)	2.0(92)	0.8(96)	0.4(98)[b]	0.2(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)
Industrial	20.8[a]	5.0(76)	2.1(90)	1.3(94)	0.9(96)[b]	0.7(97)	0.5(98)	0.4(98)	0.3(98)	0.3(99)	0.2(99)
Utility	41.9[a]	13.7(67)	5.5(87)	3.5(92)	2.6(94)[b]	2.0(95)	1.6(96)	1.3(97)	1.1(97)	0.9(98)	0.7(98)
Financial	22.9[a]	7.8(66)	4.4(81)	3.2(86)	2.5(89)	2.0(91)	1.7(93)[b]	1.4(94)	1.2(95)	1.0(95)	0.9(96)
Foreign	37.6[a]	13.9(63)	8.1(78)	5.9(84)	4.5(88)	3.7(90)	3.1(92)[b]	2.7(93)	2.4(94)	2.1(94)	2.0(95)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Tr./Ag.	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	0.2(99)	0.1(99)	0.1(99)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Utility	0.6(99)	0.5(99)	0.4(99)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.2(100)	0.1(100)	0.1(100)	0.0
Financial	0.8(97)	0.7(97)	0.6(97)	0.5(98)	0.5(98)	0.4(98)	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.0
Foreign	1.8(95)	1.7(96)	1.6(96)	1.5(96)	1.4(96)	1.3(96)	1.3(97)	1.2(97)	1.1(97)	1.0(97)	0.0
Panel B: NPV for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	21.7[a]	6.1(72)	2.5(88)	1.5(93)	1.0(96)[b]	0.6(97)	0.4(98)	0.3(99)	0.2(99)	0.1(99)	0.1(100)
Tr./Ag.	26.5[a]	7.2(73)	2.7(90)	1.2(95)	0.6(98)[b]	0.3(99)	0.1(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)
Industrial	18.0[a]	4.1(77)	1.6(91)	1.0(94)	0.7(96)[b]	0.6(97)	0.5(97)	0.4(98)	0.3(98)	0.2(99)	0.2(99)
Utility	36.2[a]	11.4(68)	5.5(85)	3.9(89)	3.1(91)	2.6(93)[b]	2.3(94)	1.9(95)	1.7(95)	1.5(96)	1.2(97)
Financial	18.4[a]	6.2(66)	3.6(81)	2.6(86)	2.1(89)	1.7(91)[b]	1.5(92)	1.3(93)	1.1(94)	1.0(95)	0.8(95)
Foreign	37.8[a]	16.1(57)	10.4(73)	8.3(78)	7.2(81)	6.6(83)[b]	6.0(84)	5.6(85)	5.2(86)	4.9(87)	4.7(88)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Tr./Ag.	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	0.1(99)	0.1(99)	0.1(99)	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Utility	1.1(97)	0.9(97)	0.8(98)	0.7(98)	0.6(98)	0.5(99)	0.4(99)	0.4(99)	0.3(99)	0.3(99)	0.0
Financial	0.7(96)	0.6(97)	0.6(97)	0.5(97)	0.4(98)	0.4(98)	0.3(98)	0.3(99)	0.2(99)	0.2(99)	0.0
Foreign	4.4(88)	4.2(89)	4.0(89)	3.8(90)	3.7(90)	3.5(91)	3.3(91)	3.2(92)	3.0(92)	2.8(93)	0.0
Panel C: NPV for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	36.8[a]	13.1(64)	7.1(81)	5.0(86)	3.5(91)	2.6(93)	1.9(95)[b]	1.4(96)	1.0(97)	0.8(98)	0.6(98)
Tr./Ag.	43.4[a]	12.8(71)	3.7(91)	1.4(97)	0.5(99)[b]	0.2(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)
Industrial	32.7[a]	11.6(65)	6.1(81)	4.0(88)	2.8(91)	2.1(94)[b]	1.6(95)	1.3(96)	1.0(97)	0.9(97)	0.7(98)
Utility	51.4[a]	21.3(59)	10.7(79)	7.6(85)	5.9(89)	4.8(91)[b]	4.0(92)	3.4(93)	2.9(94)	2.4(95)	2.1(96)
Financial	36.8[a]	19.7(46)	13.9(62)	10.6(71)	8.2(78)	6.6(82)	5.3(86)	4.5(88)	3.8(90)[b]	3.2(91)	2.9(92)
Foreign	40.7[a]	15.6(62)	7.8(81)	5.0(88)	3.6(91)	2.7(93)	2.1(95)[b]	1.8(96)	1.6(96)	1.4(97)	1.3(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.5(99)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.2(100)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.0
Tr./Ag.	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Industrial	0.6(98)	0.5(98)	0.5(99)	0.4(99)	0.4(99)	0.3(99)	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.0
Utility	1.7(97)	1.4(97)	1.2(98)	1.1(98)	0.9(98)	0.8(98)	0.7(99)	0.6(99)	0.5(99)	0.4(99)	0.0
Financial	2.7(93)	2.4(94)	2.2(94)	2.0(95)	1.9(95)	1.7(95)	1.6(96)	1.5(96)	1.4(96)	1.3(97)	0.0
Foreign	1.2(97)	1.1(97)	1.0(98)	0.9(98)	0.9(98)	0.8(98)	0.8(98)	0.7(98)	0.7(98)	0.6(99)	0.0

Table 3.8. NPV Differentiated by Portfolio Size and Credit Rating

This table reports the normalized portfolio variance (NPV) of quoted returns as defined in equation (3.5) differentiated by portfolio size, rating category and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in a reduction in NPV of 1% or less provided that the difference in the means for a PS of 2 and All are significantly different at the 0.05 level.

Panel A: NPV for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	25.3[a]	7.0(72)	3.3(87)	2.0(92)	1.3(95)[b]	0.9(96)	0.6(97)	0.4(98)	0.3(99)	0.2(99)	0.2(99)
Aaa	22.3[a]	7.6(66)	3.8(83)	2.1(91)	1.2(95)	0.7(97)[b]	0.5(98)	0.3(99)	0.2(99)	0.1(99)	0.1(100)
Aa	28.6[a]	11.3(60)	7.7(73)	6.2(78)	5.1(82)	4.2(85)	3.6(87)	3.1(89)	2.7(91)[b]	2.3(92)	2.0(93)
A	32.8[a]	12.0(63)	7.2(78)	5.2(84)	3.9(88)	3.0(91)	2.4(93)[b]	1.9(94)	1.6(95)	1.3(96)	1.1(97)
Baa	24.9[a]	8.2(67)	4.2(83)	2.8(89)	2.1(92)	1.6(94)[b]	1.3(95)	1.0(96)	0.8(97)	0.7(97)	0.5(98)
Speculative	14.6[a]	3.7(75)	1.6(89)	1.1(92)	0.8(94)	0.6(96)[b]	0.5(97)	0.4(97)	0.3(98)	0.2(98)	0.2(99)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Aaa	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Aa	1.8(94)	1.6(94)	1.4(95)	1.2(96)	1.1(96)	1.0(97)	0.9(97)	0.8(97)	0.7(98)	0.6(98)	0.0
A	0.9(97)	0.7(98)	0.6(98)	0.5(98)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.2(100)	0.0
Baa	0.4(98)	0.4(99)	0.3(99)	0.2(99)	0.2(99)	0.2(99)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.0
Speculative	0.2(99)	0.1(99)	0.1(99)	0.1(99)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Panel B: NPV for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	21.5[a]	6.2(71)	2.7(87)	1.5(93)	1.0(95)[b]	0.6(97)	0.4(98)	0.3(99)	0.2(99)	0.1(99)	0.1(100)
Aaa	25.1[a]	7.7(69)	3.1(87)	1.6(94)	0.8(97)[b]	0.5(98)	0.3(99)	0.1(99)	0.1(100)	0.0(100)	0.0(100)
Aa	32.5[a]	13.8(58)	9.8(70)	8.1(75)	7.0(79)	6.1(81)	5.4(83)	4.9(85)	4.4(87)[b]	4.0(88)	3.7(89)
A	32.4[a]	12.0(63)	7.1(78)	5.4(83)	4.4(86)	3.6(89)	3.0(91)[b]	2.5(92)	2.1(93)	1.8(94)	1.6(95)
Baa	25.5[a]	8.9(65)	4.8(81)	3.5(86)	2.8(89)	2.2(91)	1.8(93)[b]	1.5(94)	1.2(95)	1.0(96)	0.8(97)
Speculative	15.6[a]	3.6(77)	1.6(90)	1.1(93)	0.8(95)[b]	0.6(96)	0.5(97)	0.4(98)	0.3(98)	0.2(99)	0.2(99)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Aaa	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Aa	3.3(90)	2.9(91)	2.6(92)	2.4(93)	2.1(93)	1.9(94)	1.7(95)	1.5(95)	1.4(96)	1.2(96)	0.0
A	1.3(96)	1.1(97)	1.0(97)	0.8(97)	0.7(98)	0.6(98)	0.5(98)	0.4(99)	0.4(99)	0.3(99)	0.0
Baa	0.6(98)	0.5(98)	0.4(98)	0.3(99)	0.2(99)	0.2(99)	0.2(99)	0.1(99)	0.1(100)	0.1(100)	0.0
Speculative	0.1(99)	0.1(99)	0.1(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Panel C: NPV for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	29.2[a]	10.4(65)	6.0(79)	3.9(87)	2.7(91)	1.9(94)[b]	1.4(95)	1.0(97)	0.8(97)	0.6(98)	0.4(98)
Aaa	22.4[a]	9.3(58)	5.6(75)	3.8(83)	2.7(88)	2.0(91)	1.4(94)	1.0(96)[b]	0.7(97)	0.5(98)	0.4(98)
Aa	33.7[a]	14.6(57)	9.9(71)	7.5(78)	5.8(83)	4.6(86)	3.7(89)	2.9(92)[b]	2.2(93)	1.8(95)	1.4(96)
A	41.0[a]	17.8(56)	11.0(73)	7.8(81)	5.8(86)	4.4(89)	3.4(92)	2.7(93)	2.1(95)[b]	1.7(96)	1.3(97)
Baa	27.2[a]	9.3(66)	4.5(83)	2.8(90)	1.9(93)	1.4(95)[b]	1.1(96)	0.9(97)	0.7(97)	0.6(98)	0.5(98)
Speculative	20.0[a]	5.4(73)	1.9(90)	0.8(96)	0.4(98)[b]	0.2(99)	0.1(99)	0.1(100)	0.0(100)	0.0(100)	0.0(100)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0
Aaa	0.3(99)	0.2(99)	0.1(99)	0.1(100)	0.1(100)	0.1(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0
Aa	1.1(97)	0.9(97)	0.7(98)	0.6(98)	0.5(99)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.2(99)	0.0
A	1.1(97)	0.9(98)	0.8(98)	0.6(98)	0.5(99)	0.5(99)	0.4(99)	0.3(99)	0.3(99)	0.2(99)	0.0
Baa	0.4(99)	0.3(99)	0.2(99)	0.2(99)	0.2(99)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.1(100)	0.0
Speculative	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0(100)	0.0

Table 3.9. Semi-Variance Differentiated by Portfolio Size and Issuer Type

This table reports the semi-variance (SV) of quoted returns as defined in equation (3.6) differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in a reduction in SV of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Semi-variances for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	23.1 [a]	9.9(64)	5.3(86)	4.1(92)	3.5(94)	3.2(96) [b]	3.0(97)	2.9(97)	2.8(98)	2.7(98)	2.7(98)
Tr./Ag.	66.4 [a]	30.7(60)	18.2(81)	14.1(88)	12.1(91)	11.1(93) [b]	10.4(94)	9.8(95)	9.4(95)	9.1(96)	8.9(96)
Industrial	37.0 [a]	13.3(66)	5.6(87)	3.5(93)	2.6(95) [b]	2.1(96)	1.8(97)	1.6(98)	1.5(98)	1.4(98)	1.4(99)
Utility	7.6 [a]	5.5(63)	4.8(83)	4.6(89)	4.5(92)	4.5(94) [b]	4.4(95)	4.4(96)	4.4(96)	4.4(97)	4.4(97)
Financial	13.0 [a]	4.9(66)	2.3(86)	1.6(92)	1.3(95) [b]	1.1(96)	1.0(97)	0.9(98)	0.9(98)	0.8(98)	0.8(98)
Foreign	6.7 [a]	5.5(61)	5.1(82)	4.9(89)	4.9(91)	4.8(94) [b]	4.8(95)	4.8(96)	4.8(96)	4.8(97)	4.8(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	2.6(99)	2.6(99)	2.6(99)	2.6(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.3
Tr./Ag.	8.7(97)	8.5(97)	8.4(97)	8.3(97)	8.2(98)	8.1(98)	8.0(98)	7.9(98)	7.9(98)	7.8(98)	6.7
Industrial	1.3(99)	1.3(99)	1.2(99)	1.2(99)	1.2(99)	1.1(99)	1.1(99)	1.1(99)	1.1(99)	1.1(99)	0.8
Utility	4.4(97)	4.4(97)	4.3(98)	4.3(98)	4.3(98)	4.3(98)	4.3(98)	4.3(98)	4.3(99)	4.3(99)	4.3
Financial	0.8(99)	0.8(99)	0.7(99)	0.7(99)	0.7(99)	0.7(99)	0.7(99)	0.7(99)	0.7(99)	0.7(99)	0.6
Foreign	4.8(97)	4.8(97)	4.8(97)	4.8(97)	4.8(97)	4.8(98)	4.8(98)	4.8(98)	4.8(98)	4.8(98)	4.7
Panel B: Semi-variances for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	8.5 [a]	3.3(65)	1.5(86)	1.0(92)	0.8(94)	0.7(96) [b]	0.6(97)	0.6(97)	0.6(98)	0.5(98)	0.5(98)
Tr./Ag.	2.3 [a]	1.4(61)	1.1(81)	1.1(87)	1.0(90)	1.0(93) [b]	1.0(94)	0.9(95)	0.9(95)	0.9(96)	0.9(96)
Industrial	26.9 [a]	8.7(69)	3.5(88)	2.1(94)	1.5(96) [b]	1.2(97)	1.0(98)	0.9(98)	0.8(99)	0.8(99)	0.7(99)
Utility	3.6 [a]	1.9(65)	1.4(84)	1.2(90)	1.2(93) [b]	1.1(94)	1.1(95)	1.1(96)	1.1(97)	1.1(97)	1.0(97)
Financial	10.9 [a]	3.8(67)	1.8(86)	1.2(91)	0.9(94)	0.8(96) [b]	0.7(96)	0.6(97)	0.6(98)	0.5(98)	0.5(98)
Foreign	3.2 [a]	2.6(61)	2.4(82)	2.4(87)	2.3(91)	2.3(93) [b]	2.3(94)	2.3(95)	2.3(96)	2.3(96)	2.3(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.5(98)	0.5(98)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.4(99)	0.4(99)	0.4
Tr./Ag.	0.9(96)	0.9(97)	0.9(97)	0.9(97)	0.9(97)	0.9(97)	0.9(98)	0.9(98)	0.9(98)	0.9(98)	0.9
Industrial	0.7(99)	0.6(99)	0.6(99)	0.6(99)	0.6(99)	0.6(99)	0.5(100)	0.5(100)	0.5(100)	0.5(100)	0.4
Utility	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(99)	1.0(99)	1.0(99)	1.0
Financial	0.5(98)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.4(99)	0.3
Foreign	2.3(97)	2.3(97)	2.3(97)	2.3(98)	2.3(98)	2.3(98)	2.3(98)	2.3(98)	2.3(98)	2.3(98)	2.3
Panel C: Semi-variances for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	46.7 [a]	22.2(66)	14.9(86)	12.7(92)	11.8(94)	11.2(96) [b]	10.9(97)	10.7(97)	10.5(98)	10.4(98)	10.3(98)
Tr./Ag.	210.9 [a]	110.9(63)	80.2(82)	69.9(89)	64.7(92)	61.8(94) [b]	59.7(95)	58.5(96)	57.3(97)	56.3(97)	55.5(98)
Industrial	53.6 [a]	19.1(68)	9.4(87)	6.8(93)	5.6(95) [b]	5.1(96)	4.6(97)	4.4(98)	4.2(98)	4.0(98)	3.9(98)
Utility	8.3 [a]	7.0(62)	6.6(82)	6.5(87)	6.4(91)	6.3(93) [b]	6.3(94)	6.3(95)	6.3(96)	6.3(96)	6.3(97)
Financial	10.1 [a]	3.2(74)	1.5(92)	1.2(96) [b]	1.0(97)	1.0(98)	0.9(98)	0.9(99)	0.9(99)	0.9(99)	0.9(99)
Foreign	10.9 [a]	9.5(63)	9.0(83)	8.9(88)	8.8(91)	8.8(94) [b]	8.7(95)	8.7(96)	8.7(96)	8.7(97)	8.7(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	10.3(98)	10.2(99)	10.2(99)	10.1(99)	10.1(99)	10.1(99)	10.1(99)	10.0(99)	10.0(99)	10.0(99)	9.7
Tr./Ag.	54.8(98)	54.3(98)	53.9(99)	53.5(99)	53.2(99)	52.9(99)	52.7(99)	52.5(100)	52.3(100)	52.1(100)	51.8
Industrial	3.8(99)	3.8(99)	3.7(99)	3.6(99)	3.6(99)	3.6(99)	3.5(99)	3.5(99)	3.5(99)	3.5(99)	3.1
Utility	6.3(97)	6.3(97)	6.2(97)	6.2(98)	6.2(98)	6.2(98)	6.2(98)	6.2(98)	6.2(98)	6.2(99)	6.2
Financial	0.9(99)	0.9(99)	0.8(100)	0.8(100)	0.8(100)	0.8(100)	0.8(100)	0.8(100)	0.8(100)	0.8(100)	0.8
Foreign	8.7(97)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.7(98)	8.6

Table 3.10. Semi-Variance Differentiated by Portfolio Size and Credit Rating

This table reports the semi-variance (SV) of quoted returns as defined in equation (3.6) differentiated by portfolio size, rating category and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in a reduction in SV of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Semi-variances for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	20.2[a]	9.2(61)	5.0(85)	3.9(91)	3.3(94)	3.0(96)[b]	2.8(97)	2.7(98)	2.7(98)	2.6(98)	2.6(98)
Aaa	45.0[a]	19.7(63)	11.9(83)	9.2(89)	8.0(92)	7.3(94)[b]	6.8(95)	6.5(96)	6.2(97)	6.1(97)	5.9(97)
Aa	5.8[a]	4.5(64)	4.1(82)	4.0(88)	4.0(91)	3.9(93)[b]	3.9(94)	3.9(95)	3.9(95)	3.9(96)	3.8(97)
A	4.2[a]	2.9(64)	2.5(83)	2.4(88)	2.3(91)	2.3(93)[b]	2.3(94)	2.3(95)	2.3(96)	2.2(96)	2.2(97)
Baa	5.5[a]	2.6(67)	1.8(86)	1.5(91)	1.4(94)[b]	1.4(95)	1.3(96)	1.3(97)	1.3(97)	1.3(98)	1.2(98)
Speculative	115.9[a]	38.4(67)	15.6(87)	9.8(92)	7.0(94)	5.6(96)[b]	4.6(97)	4.0(97)	3.5(98)	3.2(98)	2.9(98)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	2.6(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.5(99)	2.4(99)	2.4(99)	2.4(99)	2.3
Aaa	5.8(98)	5.8(98)	5.7(98)	5.6(98)	5.6(98)	5.5(99)	5.5(99)	5.4(99)	5.4(99)	5.4(99)	4.9
Aa	3.8(97)	3.8(97)	3.8(97)	3.8(98)	3.8(98)	3.8(98)	3.8(98)	3.8(98)	3.8(98)	3.8(98)	3.8
A	2.2(97)	2.2(97)	2.2(98)	2.2(98)	2.2(98)	2.2(98)	2.2(98)	2.2(98)	2.2(98)	2.2(98)	2.2
Baa	1.2(98)	1.2(98)	1.2(98)	1.2(99)	1.2(99)	1.2(99)	1.2(99)	1.2(99)	1.2(99)	1.2(99)	1.2
Speculative	2.7(98)	2.5(98)	2.4(99)	2.2(99)	2.1(99)	2.1(99)	2.0(99)	1.9(99)	1.9(99)	1.8(99)	0.7
Panel B: Semi-variances for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	7.6[a]	2.9(65)	1.4(86)	1.0(91)	0.8(94)	0.7(96)[b]	0.6(96)	0.6(97)	0.6(97)	0.5(98)	0.5(98)
Aaa	1.8[a]	1.2(61)	0.9(82)	0.8(88)	0.8(91)	0.8(93)[b]	0.8(94)	0.8(95)	0.8(96)	0.8(96)	0.7(97)
Aa	1.8[a]	1.3(59)	1.2(80)	1.1(86)	1.1(89)	1.1(91)	1.1(93)[b]	1.1(94)	1.1(95)	1.1(95)	1.0(96)
A	1.8[a]	1.2(63)	1.0(81)	0.9(87)	0.9(90)	0.9(92)	0.9(94)[b]	0.9(95)	0.9(95)	0.8(95)	0.8(96)
Baa	4.3	1.7(66)	1.0(83)	0.8(90)	0.7(92)	0.6(94)[b]	0.6(95)	0.5(96)	0.5(96)	0.5(97)	0.5(97)
Speculative	76.7	26.3(67)	12.8(85)	8.8(90)	6.7(93)[b]	5.6(94)	4.9(95)	4.5(96)	4.0(96)	3.7(97)	3.5(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.5(98)	0.5(98)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.5(99)	0.4(99)	0.4
Aaa	0.7(97)	0.7(97)	0.7(97)	0.7(98)	0.7(98)	0.7(98)	0.7(98)	0.7(98)	0.7(98)	0.7(98)	0.7
Aa	1.0(97)	1.0(97)	1.0(97)	1.0(97)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0(98)	1.0
A	0.8(96)	0.8(97)	0.8(97)	0.8(97)	0.8(98)	0.8(98)	0.8(98)	0.8(98)	0.8(98)	0.8(98)	0.8
Baa	0.5(97)	0.5(98)	0.5(98)	0.4(98)	0.4(98)	0.4(98)	0.4(98)	0.4(99)	0.4(99)	0.4(99)	0.4
Speculative	3.3(97)	3.1(98)	2.9(98)	2.8(98)	2.7(98)	2.6(98)	2.6(98)	2.5(98)	2.4(98)	2.4(98)	1.2
Panel C: Semi-variances for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	47.7[a]	22.1(67)	14.3(87)	12.2(93)	11.2(95)[b]	10.7(96)	10.4(97)	10.2(98)	10.1(98)	10.0(98)	9.9(99)
Aaa	106.9[a]	58.0(62)	41.4(83)	36.5(89)	34.1(92)	32.6(94)[b]	31.7(95)	31.1(96)	30.6(96)	30.3(97)	30.1(97)
Aa	9.5[a]	8.2(61)	7.8(80)	7.6(86)	7.6(89)	7.5(91)	7.5(93)[b]	7.5(94)	7.4(95)	7.4(96)	7.4(97)
A	7.4[a]	6.0(62)	5.6(82)	5.5(87)	5.4(91)[b]	5.4(92)	5.3(93)	5.3(94)	5.3(95)	5.3(95)	5.3(95)
Baa	7.5[a]	4.8(67)	3.9(87)	3.7(92)	3.6(94)[b]	3.6(95)	3.5(96)	3.5(97)	3.5(97)	3.5(97)	3.5(97)
Speculative	82.8[a]	28.2(66)	11.6(87)	6.7(93)	4.6(95)	3.4(97)[b]	2.7(97)	2.2(98)	1.9(98)	1.6(99)	1.4(99)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	9.8(99)	9.8(99)	9.8(99)	9.7(99)	9.7(99)	9.7(99)	9.6(99)	9.6(99)	9.6(99)	9.6(99)	9.3
Aaa	29.9(97)	29.8(97)	29.6(98)	29.5(98)	29.3(98)	29.2(98)	29.1(98)	29.1(98)	29.0(98)	28.9(99)	27.8
Aa	7.4(97)	7.4(97)	7.4(97)	7.4(97)	7.4(97)	7.4(98)	7.4(98)	7.4(98)	7.4(98)	7.4(98)	7.3
A	5.3(96)	5.3(96)	5.3(97)	5.2(97)	5.2(97)	5.2(98)	5.2(98)	5.2(98)	5.2(98)	5.2(98)	5.2
Baa	3.5(98)	3.5(98)	3.5(98)	3.4(98)	3.4(98)	3.4(98)	3.4(99)	3.4(99)	3.4(99)	3.4(99)	3.4
Speculative	1.2(99)	1.1(99)	1.0(99)	0.9(100)	0.8(100)	0.8(100)	0.7(100)	0.7(100)	0.6(100)	0.6(100)	0.6

Table 3.11. Sharpe ratio Differentiated by Portfolio Size and User Type

This table reports the Sharpe ratio (Sh) of quoted returns as defined in equation (3.7) differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in Sh of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Sharpe ratios for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	21.6[a]	24.3(31)	26.3(53)	27.3(65)	27.9(71)	28.2(75)	28.5(79)	28.7(81)	28.9(83)	29.0(85)[b]	29.2(86)
Tr./Ag.	15.9[a]	17.3(23)	18.5(43)	19.2(55)	19.6(62)	20.0(68)	20.2(72)	20.4(75)	20.5(78)	20.7(80)[b]	20.8(81)
Industrial	19.2[a]	22.6(23)	25.8(44)	27.5(56)	28.7(63)	29.4(68)	30.0(72)	30.5(75)	30.8(77)	31.0(79)	31.3(81)[b]
Utility	25.0[a]	26.4(53)	26.9(75)	27.1(82)	27.2(87)	27.3(89)	27.3(91)[b]	27.4(92)	27.4(93)	27.4(94)	27.4(95)
Financial	27.3[a]	30.1(30)	32.1(53)	33.2(65)	33.9(72)	34.4(77)	34.7(81)	34.9(83)	35.1(85)[b]	35.2(86)	35.3(88)
Foreign	24.4[a]	25.3(53)	25.7(77)	25.8(85)	25.8(88)	25.9(91)	25.9(93)	25.9(95)[b]	25.9(95)	26.0(96)	26.0(96)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	29.3(87)	29.3(88)	29.4(89)	29.5(90)	29.5(91)	29.6(91)	29.6(92)	29.7(92)	29.7(93)	29.7(93)	30.4
Tr./Ag.	20.9(83)	20.9(84)	21.0(86)	21.1(87)	21.1(88)	21.2(88)	21.2(89)	21.2(89)	21.3(90)	21.3(90)	21.9
Industrial	31.5(82)	31.7(83)	31.8(84)	31.9(85)	32.1(86)	32.2(87)	32.3(88)	32.4(88)	32.5(89)	32.5(89)	34.2
Utility	27.4(95)	27.4(95)	27.5(96)	27.5(96)	27.5(96)	27.5(97)	27.5(97)	27.5(97)	27.5(97)	27.5(97)	27.6
Financial	35.4(89)	35.5(89)	35.5(90)	35.6(91)	35.7(92)	35.7(92)	35.7(93)	35.8(93)	35.8(93)	35.8(94)	36.4
Foreign	26.0(96)	26.0(97)	26.0(97)	26.0(97)	26.0(97)	26.0(98)	26.0(98)	26.0(98)	26.0(98)	26.0(98)	26.0
Panel B: Sharpe ratios for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	26.8[a]	30.0(31)	32.5(55)	33.7(67)	34.4(73)	34.9(78)	35.2(81)	35.4(84)[b]	35.6(85)	35.7(87)	35.9(88)
Tr./Ag.	20.5[a]	21.9(26)	23.2(49)	23.8(61)	24.1(68)	24.4(73)	24.6(76)	24.8(79)	24.9(81)	25.0(83)[b]	25.0(84)
Industrial	20.6[a]	24.7(27)	28.1(49)	29.9(62)	31.1(69)	31.8(74)	32.3(77)	32.7(80)	33.0(82)[b]	33.2(83)	33.4(84)
Utility	30.2[a]	32.4(53)	33.3(75)	33.6(83)	33.8(87)	33.9(89)	33.9(91)	34.0(93)[b]	34.0(93)	34.0(94)	34.1(95)
Financial	29.4[a]	32.2(32)	34.1(54)	35.1(65)	35.7(72)	36.1(76)	36.3(79)	36.5(82)[b]	36.7(83)	36.8(85)	36.9(86)
Foreign	28.1[a]	29.0(46)	29.3(63)	29.3(67)	29.4(70)[b]	29.4(71)	29.4(72)	29.4(73)	29.4(73)	29.4(74)	29.4(74)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	36.0(89)	36.0(89)	36.1(90)	36.2(91)	36.2(91)	36.3(92)	36.3(92)	36.4(93)	36.4(93)	36.4(93)	37.1
Tr./Ag.	25.1(85)	25.1(86)	25.2(87)	25.2(88)	25.3(89)	25.3(89)	25.3(90)	25.4(91)	25.4(91)	25.4(91)	25.9
Industrial	33.5(85)	33.7(86)	33.8(87)	33.9(88)	34.0(88)	34.0(89)	34.1(89)	34.2(90)	34.3(90)	34.4(91)	35.8
Utility	34.1(95)	34.1(96)	34.1(96)	34.1(96)	34.2(97)	34.2(97)	34.2(97)	34.2(97)	34.2(97)	34.2(97)	34.3
Financial	37.0(87)	37.1(88)	37.1(89)	37.2(89)	37.3(90)	37.3(90)	37.4(91)	37.4(91)	37.4(92)	37.5(92)	38.1
Foreign	29.5(74)	29.5(75)	29.5(75)	29.5(75)	29.5(75)	29.5(76)	29.5(76)	29.5(76)	29.5(76)	29.5(76)	29.9
Panel C: Sharpe ratios for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	17.4[a]	19.2(29)	20.4(50)	21.1(61)	21.4(67)	21.7(72)	21.9(75)	22.1(78)	22.3(81)	22.4(83)[b]	22.5(84)
Tr./Ag.	15.1[a]	16.8(23)	18.3(43)	19.2(55)	19.8(63)	20.3(69)	20.6(73)	20.8(76)	21.0(79)	21.2(81)	21.3(83)[b]
Industrial	17.6[a]	20.4(25)	22.9(46)	24.2(57)	25.0(64)	25.6(69)	26.0(73)	26.3(76)	26.6(78)	26.9(80)	27.0(82)[b]
Utility	23.7[a]	24.6(57)	24.9(77)	25.1(84)	25.1(88)	25.2(90)	25.2(92)	25.2(94)[b]	25.2(94)	25.2(95)	25.2(95)
Financial	26.9[a]	29.8(37)	31.6(60)	32.3(70)	32.7(75)	33.0(78)	33.1(80)[b]	33.2(81)	33.3(82)	33.4(83)	33.4(84)
Foreign	21.2[a]	21.8(39)	22.0(54)	22.1(60)	22.2(63)	22.2(65)[b]	22.2(66)	22.2(67)	22.2(68)	22.2(68)	22.2(68)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	22.5(86)	22.6(87)	22.7(88)	22.7(88)	22.7(89)	22.8(90)	22.8(90)	22.9(91)	22.9(91)	22.9(92)	23.4
Tr./Ag.	21.4(84)	21.5(85)	21.6(86)	21.7(87)	21.7(88)	21.8(89)	21.8(90)	21.9(90)	21.9(91)	22.0(91)	22.6
Industrial	27.2(83)	27.3(84)	27.4(85)	27.5(86)	27.6(87)	27.7(87)	27.8(88)	27.8(89)	27.9(89)	28.0(90)	29.1
Utility	25.2(95)	25.2(96)	25.3(96)	25.3(97)	25.3(97)	25.3(97)	25.3(97)	25.3(97)	25.3(98)	25.3(98)	25.3
Financial	33.5(85)	33.5(85)	33.6(86)	33.6(86)	33.6(86)	33.6(87)	33.6(87)	33.7(87)	33.7(87)	33.7(87)	34.7
Foreign	22.3(69)	22.3(69)	22.3(69)	22.3(70)	22.3(70)	22.3(70)	22.3(69)	22.3(70)	22.3(70)	22.3(70)	22.7

Table 3.12. Sharpe Ratio Differentiated by Portfolio Size and Credit Rating

This table reports the Sharpe ratio (Sh) of quoted returns as defined in equation (3.7) differentiated by portfolio size, rating category and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in Sh of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Sharpe ratios for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	22.8[a]	24.9(30)	26.5(53)	27.3(64)	27.8(71)	28.2(77)	28.4(80)	28.6(82)	28.7(84)	28.9(86)[b]	29.0(87)
Aaa	19.7[a]	20.6(19)	21.0(26)	21.4(34)	21.7(40)	22.0(45)	22.2(50)	22.4(53)	22.6(57)	22.7(60)	22.8(62)
Aa	25.8[a]	27.1(58)	27.6(79)	27.7(86)	27.8(89)	27.9(92)[b]	27.9(93)	27.9(94)	27.9(95)	27.9(95)	28.0(96)
A	27.3[a]	28.9(57)	29.5(78)	29.7(85)	29.8(88)	29.9(90)	29.9(92)[b]	30.0(93)	30.0(94)	30.0(95)	30.0(95)
Baa	26.7[a]	28.8(50)	29.8(73)	30.2(82)	30.4(86)	30.5(89)	30.6(91)[b]	30.6(92)	30.7(93)	30.7(94)	30.7(94)
Speculative	14.2[a]	18.1(19)	21.8(38)	23.9(49)	25.4(56)	26.5(62)	27.2(65)	27.8(69)	28.3(71)	28.8(73)	29.2(75)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	29.0(88)	29.1(89)	29.2(90)	29.2(91)	29.3(91)	29.3(92)	29.3(93)	29.3(93)	29.4(93)	29.4(94)	29.9
Aaa	23.0(65)	23.1(67)[b]	23.1(68)	23.2(70)	23.3(72)	23.4(73)	23.5(75)	23.5(76)	23.6(77)	23.6(78)	24.7
Aa	28.0(96)	28.0(96)	28.0(97)	28.0(97)	28.0(97)	28.0(97)	28.0(97)	28.0(97)	28.0(98)	28.0(98)	28.0
A	30.0(96)	30.0(96)	30.1(97)	30.1(97)	30.1(97)	30.1(97)	30.1(97)	30.1(98)	30.1(98)	30.1(98)	30.2
Baa	30.8(95)	30.8(95)	30.8(96)	30.8(96)	30.8(96)	30.8(96)	30.8(97)	30.8(97)	30.8(97)	30.8(97)	31.0
Speculative	29.5(77)[b]	29.8(78)	30.0(80)	30.2(81)	30.4(82)	30.6(82)	30.8(83)	30.9(84)	31.1(85)	31.2(85)	34.1
Panel B: Sharpe ratios for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	27.7[a]	30.8(34)	32.9(58)	33.9(69)	34.5(75)	34.8(79)	35.1(82)	35.3(84)	35.5(86)[b]	35.6(87)	35.7(89)
Aaa	32.3[a]	34.1(53)	34.9(77)	35.1(84)	35.2(88)	35.3(91)[b]	35.4(92)	35.4(93)	35.4(94)	35.5(95)	35.5(95)
Aa	32.0[a]	33.4(53)	34.0(74)	34.2(82)	34.3(86)	34.4(89)[b]	34.4(90)	34.5(92)	34.5(93)	34.5(94)	34.5(95)
A	31.5[a]	33.2(53)	33.9(74)	34.2(82)	34.3(86)	34.4(89)	34.5(91)[b]	34.5(92)	34.5(93)	34.5(94)	34.6(94)
Baa	29.5[a]	31.8(50)	32.9(72)	33.3(81)	33.5(86)	33.7(89)	33.7(91)[b]	33.8(92)	33.8(93)	33.9(94)	33.9(95)
Speculative	15.8[a]	19.7(28)	22.8(50)	24.4(61)	25.4(68)	26.0(72)	26.5(76)	26.8(78)	27.1(80)	27.3(82)[b]	27.5(83)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	35.8(90)	35.9(90)	35.9(91)	36.0(92)	36.0(92)	36.1(92)	36.1(93)	36.1(93)	36.2(94)	36.2(94)	36.7
Aaa	35.5(96)	35.5(96)	35.5(96)	35.5(96)	35.5(97)	35.6(97)	35.6(97)	35.6(97)	35.6(97)	35.6(98)	35.7
Aa	34.6(95)	34.6(96)	34.6(96)	34.6(97)	34.6(97)	34.6(97)	34.6(97)	34.6(97)	34.6(97)	34.6(98)	34.7
A	34.6(95)	34.6(95)	34.6(96)	34.6(96)	34.6(97)	34.7(97)	34.7(97)	34.7(97)	34.7(97)	34.7(97)	34.8
Baa	33.9(95)	33.9(96)	34.0(96)	34.0(96)	34.0(96)	34.0(97)	34.0(97)	34.0(97)	34.0(97)	34.0(97)	34.1
Speculative	27.7(84)	27.8(85)	28.0(86)	28.1(87)	28.2(88)	28.3(88)	28.4(89)	28.4(89)	28.5(90)	28.6(90)	29.9
Panel C: Sharpe ratios for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	18.1[a]	19.4(25)	20.4(46)	20.9(57)	21.2(63)	21.5(68)	21.7(72)	21.8(75)	22.0(78)	22.0(80)[b]	22.1(81)
Aaa	12.4[a]	12.6(5)	13.0(20)	13.3(29)	13.6(38)	13.8(45)	14.1(51)	14.2(56)	14.3(60)	14.5(64)	14.5(66)
Aa	22.7[a]	23.5(59)	23.8(78)	23.9(85)	23.9(89)	24.0(91)	24.0(93)[b]	24.0(94)	24.0(95)	24.0(96)	24.1(97)
A	24.0[a]	25.0(56)	25.4(79)	25.5(86)	25.6(89)[b]	25.6(90)	25.6(92)	25.6(93)	25.6(93)	25.6(94)	25.6(94)
Baa	24.3[a]	25.8(53)	26.4(76)	26.6(84)	26.7(88)	26.8(90)	26.8(92)[b]	26.9(93)	26.9(94)	26.9(94)	26.9(95)
Speculative	17.8[a]	21.3(20)	24.7(38)	26.7(50)	28.0(57)	29.1(63)	29.8(67)	30.4(70)	30.9(73)[b]	31.2(74)	31.6(77)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	22.2(83)	22.3(84)	22.3(85)	22.4(86)	22.4(87)	22.4(88)	22.5(88)	22.5(89)	22.5(89)	22.6(90)	23.1
Aaa	14.6(68)	14.7(70)	14.7(72)	14.8(74)	14.8(76)[b]	14.9(77)	14.9(78)	15.0(80)	15.0(80)	15.0(81)	15.6
Aa	24.1(97)	24.1(97)	24.1(97)	24.1(97)	24.1(98)	24.1(98)	24.1(99)	24.1(99)	24.1(99)	24.1(99)	24.1
A	25.7(95)	25.7(96)	25.7(96)	25.7(97)	25.7(97)	25.7(97)	25.7(97)	25.7(97)	25.7(98)	25.7(98)	25.7
Baa	26.9(95)	26.9(96)	27.0(96)	27.0(96)	27.0(97)	27.0(97)	27.0(97)	27.0(97)	27.0(97)	27.0(97)	27.1
Speculative	31.9(78)	32.2(80)	32.4(81)	32.6(82)	32.8(84)	33.0(85)	33.1(85)	33.3(86)	33.4(87)	33.9(89)	35.8

Table 3.13. Sortino Ratio Differentiated by Portfolio Size and Issuer Type

This table reports the Sortino ratios (*Sor*) of quoted returns as defined in equation (3.8) differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS would result in an increase in *Sor* of around 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Sortino ratios for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	26.3[a]	35.5(27)	44.6(54)	49.5(69)	52.5(78)	54.4(84)	55.8(88)	56.7(91)	57.4(93)[b]	57.9(94)	58.2(95)
Tr./Ag.	14.5[a]	18.3(19)	21.6(37)	23.7(48)	25.2(55)	26.1(60)	26.9(64)	27.6(68)	28.0(70)	28.4(72)[b]	28.7(73)
Industrial	35.0[a]	37.0(57)	38.2(88)	38.3(92)	38.4(94)[b]	38.4(94)	38.4(94)	38.4(94)	38.4(95)	38.4(95)	38.4(95)
Utility	39.8[a]	44.8(51)	46.8(71)	47.4(77)	47.8(81)	48.0(83)	48.2(85)[b]	48.3(86)	48.4(87)	48.4(87)	48.4(87)
Financial	36.0[a]	37.0(59)	37.3(77)	37.4(85)	37.5(89)	37.6(93)[b]	37.6(93)	37.5(90)	37.5(89)	37.5(92)	37.5(91)
Foreign	34.3[a]	37.0(47)	38.2(68)	38.5(74)	38.6(75)	38.7(78)[b]	38.8(79)	38.9(80)	38.8(80)	38.9(81)	38.9(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	58.4(96)	58.6(96)	58.7(96)	58.8(97)	58.9(97)	59.0(97)	59.0(97)	59.0(97)	59.0(97)	59.0(97)	59.9
Tr./Ag.	28.9(74)	29.1(75)	29.2(76)	29.5(77)	29.7(78)	29.8(79)	29.9(80)	30.0(80)	30.1(81)	30.2(81)	33.8
Industrial	38.4(95)	38.4(95)	38.4(96)	38.4(96)	38.4(96)	38.4(96)	38.4(96)	38.4(96)	38.4(96)	38.5(96)	38.6
Utility	48.4(87)	48.5(88)	48.5(88)	48.6(88)	48.6(89)	48.6(89)	48.6(89)	48.6(89)	48.7(90)	48.7(90)	49.7
Financial	37.5(93)	37.5(92)	37.6(93)	37.6(94)	37.6(95)	37.6(96)	37.6(97)	37.6(98)	37.6(98)	37.6(97)	37.7
Foreign	38.9(80)	38.8(80)	38.9(80)	38.8(80)	38.8(80)	38.8(80)	38.9(80)	38.8(80)	38.8(80)	38.8(80)	40.0
Panel B: Sortino ratios for maturities < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	38.6[a]	56.4(17)	78.4(39)	91.7(51)	100.3(60)	107.0(66)	111.5(71)	115.1(74)	117.8(77)	120.0(79)[b]	121.7(80)
Tr./Ag.	46.2[a]	58.7(43)	65.1(65)	67.8(75)	69.2(79)	70.1(83)[b]	70.5(84)	71.0(86)	71.3(87)	71.4(87)	71.5(87)
Industrial	34.7[a]	35.9(52)	36.5(79)	36.6(84)	36.8(98)[b]	36.8(98)	36.8(98)	36.9(99)	36.9(99)	36.9(99)	37.0(99)
Utility	56.0[a]	73.8(40)	83.9(63)	88.4(73)	90.6(78)	91.9(81)	93.0(84)[b]	93.8(85)	94.3(87)	94.7(87)	94.9(88)
Financial	42.8[a]	62.4(15)	81.3(29)	94.4(39)	104.6(46)	113.4(53)	119.8(58)	125.2(62)	129.3(65)	132.6(67)	136.1(70)
Foreign	44.9[a]	49.4(44)	51.2(62)	51.5(65)	51.8(69)	52.0(70)	52.1(72)	52.2(72)	52.2(73)	52.3(73)	52.3(74)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	123.3(82)	124.5(83)	125.7(84)	126.4(85)	127.2(86)	128.0(86)	128.3(87)	128.9(87)	129.4(88)	129.9(88)	141.9
Tr./Ag.	71.5(87)	71.5(88)	71.6(88)	71.7(88)	71.7(88)	71.7(88)	71.8(88)	71.8(88)	71.8(88)	71.9(89)	75.1
Industrial	36.0(99)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	37.0(100)	77.0
Utility	95.2(88)	95.3(89)	95.5(89)	95.6(89)	95.7(90)	95.8(90)	95.9(90)	96.0(90)	96.0(90)	96.2(91)	100.3
Financial	139.1(72)	141.4(74)	143.8(76)[b]	145.7(77)	147.7(79)	148.7(80)	149.8(80)	150.8(81)	152.3(82)	153.3(83)	176.0
Foreign	52.4(74)[b]	52.4(74)	52.4(75)	52.5(75)	52.5(75)	52.5(76)	52.5(76)	52.6(76)	52.6(76)	52.6(76)	55.0
Panel C: Sortino ratios for maturities > 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	19.1[a]	24.2(40)	27.7(68)	29.4(81)	30.3(88)	30.9(93)[b]	31.1(94)	31.4(96)	31.5(98)	31.5(98)	31.6(98)
Tr./Ag.	8.2[a]	9.8(36)	10.9(60)	11.5(73)	11.8(80)	11.9(83)	12.0(86)[b]	12.1(87)	12.2(89)	12.2(91)	12.3(92)
Industrial	35.3[a]	38.3(65)	39.3(88)	39.5(91)[b]	39.5(92)	39.6(93)	39.7(97)	39.8(98)	39.8(99)	39.8(99)	39.8(99)
Utility	38.6[a]	41.5(50)	42.4(66)	42.6(70)	42.8(74)[b]	42.8(74)	42.9(75)	42.9(75)	42.9(76)	43.0(77)	43.0(77)
Financial	31.9 a	32.5(55)	32.8(83)	32.9(95)	33.0(97)[b]	33.0(98)	33.0(98)	33.0(98)	33.0(99)	33.0(99)	33.0(99)
Foreign	28.6[a]	30.0(45)	30.4(56)[b]	30.4(57)	30.4(57)	30.5(58)	30.5(58)	30.5(58)	30.5(58)	30.5(58)	30.5(58)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	31.7(99)	31.7(99)	31.7(99)	31.8(99)	31.7(99)	31.7(99)	31.7(99)	31.7(99)	31.7(99)	31.7(99)	31.8
Tr./Ag.	12.4(94)	12.4(95)	12.5(96)	12.5(96)	12.5(97)	12.5(97)	12.5(97)	12.6(98)	12.6(98)	12.6(98)	12.7
Industrial	39.8(99)	39.9(100)	39.9(100)	39.8(100)	39.9(100)	39.9(100)	39.9(100)	39.9(100)	39.9(100)	39.9(100)	39.9
Utility	43.0(76)	43.0(76)	43.0(77)	43.0(77)	43.0(77)	43.0(77)	43.0(77)	43.0(77)	43.0(78)	43.1(78)	44.3
Financial	33.0(99)	33.0(100)	33.0(100)	33.0(100)	33.0(1030)	33.0(100)	33.0(100)	33.0(100)	33.0(100)	33.0(100)	33.0
Foreign	30.5(58)	30.5(58)	30.5(57)	30.5(58)	30.5(59)	30.5(59)	30.5(59)	30.5(59)	30.5(59)	30.5(59)	31.8

Table 3.14. Sortino Ratio Differentiated by Portfolio Size and Credit Rating

This table reports the Sortino ratios (*Sor*) of quoted returns as defined in equation (3.8) differentiated by portfolio size, rating category and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in *Sor* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Sortino ratios for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	27.8 [a]	35.8(26)	44.1(53)	48.7(68)	51.6(78)	53.6(84)	54.7(87)	55.4(90)	56.0(92) [b]	56.4(93)	56.6(94)
Aaa	17.4 [a]	22.0(24)	25.6(42)	28.0(55)	29.6(63)	30.7(69)	31.6(73)	32.2(77)	32.8(79)	33.1(81) [b]	33.4(82)
Aa	39.0 [a]	43.9(49)	45.3(63)	45.7(67)	46.0(70)	46.2(72) [b]	46.2(72)	46.3(73)	46.4(74)	46.5(75)	46.5(75)
A	49.7 [a]	58.5(53)	61.9(73)	62.7(78)	63.2(81) [b]	63.5(82)	63.6(83)	63.8(84)	63.9(85)	64.0(86)	64.0(86)
Baa	48.9 [a]	66.9(36)	79.7(61)	85.4(72)	88.6(79)	90.4(82)	91.7(85)	92.6(87) [b]	93.2(88)	93.6(89)	94.0(89)
Speculative	14.8 [a]	24.9(7)	38.6(17)	48.4(23)	56.7(29)	63.2(34)	68.6(38)	73.9(41)	78.1(44)	81.4(47)	84.7(49) [b]
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	56.7(94)	56.9(95)	57.0(95)	57.1(95)	57.2(96)	57.3(96)	57.3(96)	57.3(96)	57.3(96)	57.3(96)	58.5
Aaa	33.6(83)	33.8(84)	33.9(85)	34.1(86)	34.2(87)	34.3(87)	34.4(88)	34.5(88)	34.6(89)	34.7(89)	36.8
Aa	46.6(76)	46.6(76)	46.7(77)	46.7(77)	46.7(77)	46.7(77)	46.7(77)	46.7(77)	46.7(77)	46.7(77)	49.0
A	64.1(86)	64.1(86)	64.2(87)	64.1(86)	64.1(86)	64.2(87)	64.2(87)	64.2(87)	64.2(87)	64.2(87)	66.4
Baa	94.2(90)	94.5(90)	94.6(91)	94.8(91)	94.9(91)	95.0(91)	95.1(92)	95.3(92)	95.4(92)	95.4(92)	99.4
Speculative	86.9(50)	89.7(52)	92.3(54)	94.4(56)	96.2(57)	97.6(58)	99.1(59)	100.7(60)	101.8(61)	103.5(62)	158.0
Panel B: Sortino ratios for maturities < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	41.5 [a]	60.6(19)	80.7(40)	92.2(51)	100.8(60)	106.9(66)	111.5(71)	114.6(74)	117.3(77)	119.4(79)	121.3(81)
Aaa	52.8 [a]	66.4(45)	74.1(70)	76.4(78)	77.6(82)	78.4(84) [b]	78.6(85)	79.1(87)	79.2(87)	79.4(88)	79.5(88)
Aa	64.0 [a]	74.4(47)	78.9(67)	80.1(72)	81.1(76)	81.6(79) [b]	81.9(80)	82.2(81)	82.5(83)	82.7(83)	82.9(84)
A	67.5 [a]	82.7(45)	89.8(66)	92.4(74)	93.7(78)	94.6(81)	95.3(83) [b]	95.8(84)	96.0(85)	96.1(85)	96.3(86)
Baa	51.8 [a]	77.0(21)	97.1(39)	110.6(50)	119.2(57)	125.8(63)	130.2(67)	133.9(70)	137.0(73)	139.4(75)	141.7(77) [b]
Speculative	18.6 [a]	30.3(14)	43.0(28)	51.3(38)	57.8(45)	62.1(50)	65.6(54)	68.3(57)	71.1(61)	73.9(64)	75.6(66)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	122.8(83) [b]	123.9(84)	124.8(85)	125.4(85)	125.8(86)	126.3(86)	127.0(87)	127.6(87)	127.8(88)	128.3(88)	140.0
Aaa	79.5(88)	79.7(89)	79.8(89)	79.8(89)	79.8(89)	79.8(89)	79.8(89)	79.9(89)	79.9(89)	80.0(90)	83.1
Aa	83.0(85)	83.2(85)	83.2(86)	83.3(86)	83.3(86)	83.4(86)	83.4(86)	83.3(86)	83.4(86)	83.4(87)	86.4
A	96.5(86)	96.7(87)	96.8(87)	97.0(88)	97.1(88)	97.3(89)	97.3(89)	97.4(89)	97.5(89)	97.5(89)	101.1
Baa	143.5(78)	145.1(80)	146.4(81)	147.4(82)	148.3(82)	149.4(83)	150.4(84)	151.4(85)	152.0(85)	152.6(86)	169.1
Speculative	77.3(68) [b]	78.8(69)	80.3(71)	81.4(72)	82.3(73)	83.1(74)	84.1(76)	84.6(76)	85.5(77)	86.2(78)	105.3
Panel C: Sortino ratios for maturities > 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	18.7 [a]	23.4(37)	27.1(66)	28.8(79)	29.5(84)	30.1(89)	30.4(92) [b]	30.6(93)	30.7(94)	30.7(94)	30.8(94)
Aaa	10.6 [a]	12.6(27)	14.4(53)	15.1(63)	15.6(70)	15.9(74)	16.1(77)	16.2(79) [b]	16.3(80)	16.4(82)	16.4(82)
Aa	32.9 [a]	34.9(53)	35.6(71)	35.8(77) [b]	35.8(77)	35.8(78)	35.9(79)	35.9(80)	35.9(80)	35.9(80)	35.9(81)
A	40.8 [a]	44.5(54)	45.6(71)	45.9(75) [b]	46.0(76)	46.0(76)	46.0(76)	46.0(76)	46.0(76)	46.0(76)	46.0(76)
Baa	44.3 [a]	53.1(54)	57.7(82)	58.9(90)	59.4(93) [b]	59.5(94)	59.6(94)	59.7(95)	59.6(94)	59.7(95)	59.7(95)
Speculative	20.5	32.4(7)	48.9(16)	63.2(24)	76.4(32)	88.8(39)	99.2(45)	109.3(51)	118.2(56)	126.5(61)	134.8(65)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	30.8(94)	30.8(94)	30.8(94)	30.8(95)	30.8(95)	30.8(95)	30.9(95)	30.9(95)	30.8(95)	30.8(95)	31.5
Aaa	16.4(82)	16.5(83)	16.5(83)	16.6(84)	16.6(84)	16.6(84)	16.6(85)	16.7(85)	16.7(85)	16.7(86)	17.7
Aa	35.9(80)	35.9(80)	35.9(80)	35.9(79)	35.9(79)	35.9(79)	35.9(80)	35.9(80)	35.9(79)	35.9(79)	36.7
A	46.1(77)	46.1(77)	46.1(77)	46.1(78)	46.1(78)	46.2(79)	46.1(78)	46.2(79)	46.2(79)	46.2(79)	47.6
Baa	59.7(95)	59.7(95)	59.7(95)	59.7(95)	59.7(95)	59.7(95)	59.7(95)	59.7(95)	59.6(94)	59.7(94)	60.5
Speculative	142.8(70)	149.6(74)	157.3(78)	164.0(82)	169.7(85)	175.4(89)	179.9(91)	184.7(94)	190.1(97)	195.3(100) [b]	195.4

Table 3.15. Adjusted Excess Returns Differentiated by Portfolio Size and Issuer Type

This table reports the adjusted excess returns (*ER*) of quoted returns as defined in equation (3.9) differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in a increase in *ER* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Adjusted excess returns for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-9.6[a]	-5.4(43)	-3.2(67)	-2.2(77)	-1.8(81)	-1.5(84)	-1.2(87)	-1.1(89)[b]	-0.9(90)	-0.8(91)	-0.7(92)
Tr./Ag.	-10.3[a]	-6.8(33)	-4.5(56)	-3.5(66)	-2.8(73)	-2.4(76)	-2.1(79)	-1.9(81)	-1.7(83)	-1.5(85)	-1.4(86)[b]
Industrial	-21.9[a]	-13.0(41)	-8.2(62)	-6.2(71)	-5.0(77)	-4.2(81)	-3.6(83)	-3.1(85)	-2.8(87)	-2.5(88)[b]	-2.3(89)
Utility	-2.1[a]	-0.9(56)	-0.4(78)	-0.3(85)	-0.2(89)	-0.2(91)[b]	-0.1(92)	-0.1(93)	-0.1(94)	-0.1(95)	-0.1(95)
Financial	-7.9[a]	-4.3(45)	-2.5(68)	-1.7(78)	-1.3(83)	-1.1(86)	-0.9(89)[b]	-0.8(90)	-0.7(91)	-0.6(92)	-0.5(93)
Foreign	-1.2[a]	-0.5(56)	-0.3(78)	-0.2(86)	-0.1(89)	-0.1(92)	-0.1(94)[b]	-0.1(95)	-0.1(95)	-0.1(96)	-0.1(96)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	-0.7(93)	-0.6(93)	-0.6(94)	-0.5(94)	-0.5(95)	-0.5(95)	-0.4(95)	-0.4(96)	-0.4(96)	-0.4(96)	0.0
Tr./Ag.	-1.3(87)	-1.2(88)	-1.1(89)	-1.0(90)	-1.0(90)	-0.9(91)	-0.9(91)	-0.8(92)	-0.8(92)	-0.8(92)	0.0
Industrial	-2.1(90)	-1.9(91)	-1.8(92)	-1.7(92)	-1.6(93)	-1.5(93)	-1.4(93)	-1.3(94)	-1.2(94)	-1.2(94)	0.0
Utility	0.0(96)	0.0(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0
Financial	-0.5(93)	-0.4(94)	-0.4(94)	-0.4(95)	-0.4(95)	-0.3(96)	-0.3(96)	-0.3(96)	-0.3(96)	-0.3(96)	0.0
Foreign	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0
Panel B: Adjusted excess returns for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-8.2[a]	-4.5(45)	-2.7(67)	-1.9(77)	-1.5(82)	-1.2(85)	-1.0(88)[b]	-0.9(89)	-0.8(90)	-0.7(91)	-0.6(92)
Tr./Ag.	-2.1[a]	-0.9(57)	-0.5(78)	-0.3(85)	-0.2(90)	-0.2(92)[b]	-0.1(93)	-0.1(94)	-0.1(95)	-0.1(96)	-0.1(96)
Industrial	-21.0[a]	-12.3(41)	-7.6(64)	-5.7(73)	-4.5(78)	-3.8(82)	-3.3(84)	-2.9(86)[b]	-2.6(87)	-2.4(88)	-2.2(89)
Utility	-2.8[a]	-1.3(54)	-0.7(76)	-0.5(84)	-0.3(88)	-0.3(90)	-0.2(92)[b]	-0.2(93)	-0.2(94)	-0.2(94)	-0.1(95)
Financial	-7.2[a]	-3.8(47)	-2.3(68)	-1.6(77)	-1.3(82)	-1.0(85)	-0.9(87)	-0.8(89)[b]	-0.7(90)	-0.6(91)	-0.6(92)
Foreign	-1.0[a]	-0.5(49)	-0.4(66)	-0.3(70)	-0.3(73)[b]	-0.3(74)	-0.3(75)	-0.3(76)	-0.3(76)	-0.3(77)	-0.3(77)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	-0.6(93)	-0.5(93)	-0.5(94)	-0.5(94)	-0.4(95)	-0.4(95)	-0.4(95)	-0.4(95)	-0.3(96)	-0.3(96)	0.0
Tr./Ag.	-0.1(96)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0
Industrial	-2.1(90)	-1.9(91)	-1.8(91)	-1.7(92)	-1.6(92)	-1.5(93)	-1.4(93)	-1.3(94)	-1.2(94)	-1.2(94)	0.0
Utility	-0.1(96)	-0.1(96)	-0.1(96)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(98)	0.0
Financial	-0.5(92)	-0.5(93)	-0.5(94)	-0.4(94)	-0.4(94)	-0.4(95)	-0.3(95)	-0.3(95)	-0.3(96)	-0.3(96)	0.0
Foreign	-0.3(77)	-0.3(78)	-0.3(78)	-0.3(78)	-0.3(79)	-0.3(79)	-0.3(79)	-0.3(79)	-0.3(79)	-0.2(79)	0.0
Panel C: Adjusted excess returns for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-8.8[a]	-5.0(43)	-3.0(65)	-2.1(75)	-1.7(80)	-1.4(83)	-1.2(86)	-1.0(88)[b]	-0.9(89)	-0.8(90)	-0.7(91)
Tr./Ag.	-4.7[a]	-4.0(14)[b]	-4.0(15)	-4.0(15)	-4.0(16)	-3.9(16)	-3.9(17)	-3.9(18)	-3.8(18)	-3.7(20)	-3.7(22)
Industrial	-17.8[a]	-10.0(44)	-6.2(65)	-4.6(74)	-3.7(79)	-3.1(82)	-2.7(85)	-2.3(87)[b]	-2.0(88)	-1.8(89)	-1.7(90)
Utility	-1.2[a]	-0.5(59)	-0.2(79)	-0.1(85)	-0.1(89)	0.0(91)	0.0(93)[b]	0.0(94)	0.0(95)	0.0(95)	0.0(96)
Financial	-0.4[a]	-0.2(45)	-0.1(67)	-0.1(77)	-0.1(83)	-0.1(87)	-0.1(89)	0.0(91)	0.0(93)[b]	0.0(94)	0.0(95)
Foreign	-1.3[a]	-0.7(45)	-0.5(60)	-0.4(66)	-0.4(69)	-0.3(71)[b]	-0.3(72)	-0.3(73)	-0.3(74)	-0.3(74)	-0.3(74)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	-0.6(92)	-0.6(93)	-0.5(93)	-0.5(94)	-0.4(94)	-0.4(95)	-0.4(95)	-0.4(95)	-0.3(95)	-0.3(96)	0.0
Tr./Ag.	-3.6(24)	-3.4(27)	-3.3(29)	-3.2(33)	-3.0(36)	-2.7(42)	-2.4(48)	-1.9(60)	-0.9(80)	-0.9(80)	0.0
Industrial	-1.5(91)	-1.4(92)	-1.3(92)	-1.2(93)	-1.1(93)	-1.1(94)	-1.0(94)	-0.9(94)	-0.9(95)	-0.8(95)	0.0
Utility	0.0(96)	0.0(96)	0.0(96)	0.0(97)	0.0(97)	0.1(97)	0.1(97)	0.1(97)	0.1(98)	0.1(98)	0.0
Financial	0.0(96)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(99)	0.0(99)	0.0(99)	0.0(100)	0.0(100)	0.0
Foreign	-0.3(75)	-0.3(75)	-0.3(75)	-0.3(75)	-0.3(76)	-0.3(76)	-0.3(75)	-0.3(76)	-0.3(76)	-0.3(76)	0.0

Table 3.16. Adjusted Excess Returns Differentiated by Portfolio Size and Credit Rating

This table reports the adjusted excess returns (*ER*) of quoted returns as defined in equation (3.9) differentiated by portfolio size, credit rating and maturity. [a] indicates that the means for a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in *ER* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Adjusted excess returns for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-7.6 [a]	-4.4(43)	-2.5(67)	-1.8(76)	-1.4(81)	-1.1(85)	-0.9(87)	-0.8(89)[b]	-0.7(90)	-0.6(92)	-0.6(92)
Aaa	-8.9 [a]	-5.7(35)	-4.1(54)	-3.2(64)	-2.6(70)	-2.2(75)	-2.0(78)	-1.8(80)	-1.6(82)	-1.4(84)[b]	-1.3(85)
Aa	-1.5 [a]	-0.6(60)	-0.3(80)	-0.2(86)	-0.1(90)	-0.1(92)[b]	-0.1(93)	-0.1(94)	0.0(95)	0.0(95)	0.0(96)
A	-1.9 [a]	-0.8(60)	-0.4(80)	-0.2(86)	-0.2(89)	-0.1(91)	-0.1(93)[b]	-0.1(94)	-0.1(95)	-0.1(95)	0.0(96)
Baa	-3.0 [a]	-1.3(56)	-0.6(78)	-0.4(85)	-0.3(89)	-0.2(91)	-0.1(93)[b]	-0.1(94)	-0.1(95)	-0.1(95)	0.0(96)
Speculative	-42.3 [a]	-25.5(40)	-16.5(61)	-12.4(71)	-10.0(76)	-8.4(80)	-7.3(83)[b]	-6.6(84)	-5.9(86)	-5.3(87)	-4.8(88)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	-0.5(93)	-0.5(94)	-0.4(94)	-0.4(95)	-0.4(95)	-0.3(95)	-0.3(96)	-0.3(96)	-0.3(96)	-0.3(96)	0.0
Aaa	-1.2(86)	-1.1(87)	-1.1(88)	-1.0(89)	-0.9(89)	-0.9(90)	-0.8(91)	-0.8(91)	-0.8(91)	-0.7(92)	0.0
Aa	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0
A	0.0(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0
Baa	0.0(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0
Speculative	-4.5(89)	-4.2(90)	-3.9(91)	-3.7(91)	-3.4(92)	-3.2(92)	-3.1(93)	-2.9(93)	-2.8(93)	-2.6(94)	0.0
Panel B: Adjusted excess returns for portfolios for bonds with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-6.9 [a]	-3.7(46)	-2.1(70)	-1.5(79)	-1.1(84)	-1.0(86)	-0.8(88)	-0.7(90)[b]	-0.6(91)	-0.5(92)	-0.5(93)
Aaa	-1.7 [a]	-0.7(56)	-0.3(79)	-0.2(86)	-0.2(89)	-0.1(92)[b]	-0.1(93)	-0.1(94)	-0.1(95)	-0.1(95)	-0.1(96)
Aa	-1.4 [a]	-0.6(56)	-0.3(77)	-0.2(84)	-0.2(88)	-0.1(90)	-0.1(92)[b]	-0.1(93)	-0.1(94)	-0.1(95)	-0.1(95)
A	-1.8 [a]	-0.8(57)	-0.4(78)	-0.3(85)	-0.2(88)	-0.2(91)[b]	-0.1(92)	-0.1(93)	-0.1(94)	-0.1(95)	-0.1(95)
Baa	-2.8 [a]	-1.2(58)	-0.6(78)	-0.4(85)	-0.3(89)	-0.2(92)[b]	-0.2(93)	-0.1(94)	-0.1(95)	-0.1(95)	-0.1(96)
Speculative	-29.3 [a]	-16.5(44)	-10.5(64)	-7.8(73)	-6.3(78)	-5.2(82)	-4.6(84)	-4.1(86)[b]	-3.7(87)	-3.3(89)	-3.0(90)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	-0.4(93)	-0.4(94)	-0.4(95)	-0.3(95)	-0.3(95)	-0.3(95)	-0.3(96)	-0.3(96)	-0.3(96)	-0.3(96)	0.0
Aaa	-0.1(96)	-0.1(97)	-0.1(97)	-0.1(97)	-0.1(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0
Aa	-0.1(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0
A	-0.1(96)	-0.1(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0
Baa	-0.1(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0(98)	0.0
Speculative	-2.8(91)	-2.5(91)	-2.4(92)	-2.2(92)	-2.0(93)	-1.9(93)	-1.8(94)	-1.7(94)	-1.6(94)	-1.6(95)	0.0
Panel C: Adjusted excess returns for portfolios for bonds with maturity >10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	-7.7 [a]	-4.5(41)	-2.8(64)	-2.0(73)	-1.6(79)	-1.3(82)	-1.1(85)	-1.0(87)[b]	-0.9(88)	-0.8(89)	-0.7(90)
Aaa	-8.3 [a]	-5.4(34)	-3.6(56)	-2.8(66)	-2.3(72)	-2.0(76)	-1.7(79)	-1.5(82)	-1.3(84)	-1.2(86)[b]	-1.1(87)
Aa	-1.1 [a]	-0.4(60)	-0.2(79)	-0.1(86)	-0.1(89)	0.0(91)	0.0(93)[b]	0.0(94)	0.0(95)	0.0(96)	0.0(97)
A	-1.3 [a]	-0.5(58)	-0.2(80)	-0.1(86)	-0.1(90)	-0.1(91)	0.0(92)	0.0(94)[b]	0.0(94)	0.0(95)	0.0(95)
Baa	-2.2 [a]	-0.8(58)	-0.4(79)	-0.2(86)	-0.1(89)	-0.1(91)	0.0(93)[b]	0.0(94)	0.0(94)	0.0(95)	0.0(95)
Speculative	-39.3 [a]	-23.1(41)	-14.5(63)	-10.8(72)	-8.6(78)	-7.2(82)	-6.2(84)	-5.4(86)[b]	-4.9(87)	-4.4(89)	-4.0(90)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	-0.6(91)	-0.6(92)	-0.5(92)	-0.5(93)	-0.5(93)	-0.4(94)	-0.4(94)	-0.4(95)	-0.3(95)	-0.3(95)	0.0
Aaa	-1.0(88)	-0.9(88)	-0.9(89)	-0.8(90)	-0.8(91)	-0.7(91)	-0.7(92)	-0.6(92)	-0.6(93)	-0.6(93)	0.0
Aa	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(99)	0.0(98)	0.0(99)	0.0
A	0.0(96)	0.0(96)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(97)	0.0(98)	0.0(98)	0.0(98)	0.0
Baa	0.0(96)	0.1(96)	0.1(97)	0.1(97)	0.1(97)	0.1(97)	0.1(97)	0.1(98)	0.1(98)	0.1(98)	0.0
Speculative	-3.6(91)	-3.3(91)	-3.1(92)	-2.8(93)	-2.6(93)	-2.5(94)	-2.3(94)	-2.2(94)	-2.1(95)	-2.0(95)	0.0

Table 3.17. Skewness Differentiated by Portfolio Size and Issuer Type

This table reports the skewness (*Skew*) of quoted returns as defined in equation (3.10) differentiated by portfolio size, issuer type and maturity. [a] indicates that the Bera-Jarque parametric hypothesis test departs from normality for a *s* of 2 at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in *Skew* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Skewness for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	1.17 [a,b]	0.79	0.60	0.49	0.43	0.38	0.34	0.32	0.30	0.28	0.26
Tr./Ag.	1.37 [a,b]	0.88	0.63	0.51	0.45	0.39	0.36	0.34	0.31	0.29	0.28
Industrial	1.17 [a,b]	0.69	0.49	0.40	0.36	0.32	0.29	0.27	0.25	0.23	0.22
Utility	0.40 [a,b]	0.24	0.17	0.14	0.13	0.12	0.10	0.10	0.09	0.08	0.08
Financial	0.38 [a,b]	0.23	0.17	0.14	0.12	0.12	0.11	0.10	0.09	0.09	0.08
Foreign	0.07 [a,b]	0.05	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.20	0.19	0.18	-2.09
Tr./Ag.	0.27	0.25	0.24	0.23	0.23	0.22	0.21	0.21	0.20	0.20	-1.89
Industrial	0.21	0.20	0.19	0.19	0.18	0.18	0.17	0.17	0.16	0.16	-1.33
Utility	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.05	-0.43
Financial	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.06	0.06	-0.63
Foreign	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	-0.11
Panel B: Skewness for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	1.32 [a,b]	0.79	0.57	0.49	0.41	0.36	0.34	0.31	0.29	0.27	0.26
Tr./Ag.	0.91 [a,b]	0.59	0.42	0.34	0.29	0.26	0.24	0.22	0.20	0.19	0.18
Industrial	0.54 [a,b]	0.36	0.26	0.22	0.19	0.15	0.14	0.14	0.12	0.12	0.11
Utility	0.22 [a,b]	0.13	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04
Financial	0.01 [a,b]	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Foreign	0.15 [a,b]	0.09	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.03
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.25	0.24	0.23	0.22	0.21	0.20	0.19	0.19	0.18	0.18	-1.60
Tr./Ag.	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.14	0.14	0.13	-1.29
Industrial	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	-0.86
Utility	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	-0.29
Financial	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.16
Foreign	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-0.21
Panel C: Skewness for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	1.29 [a,b]	0.82	0.58	0.47	0.40	0.36	0.34	0.31	0.29	0.27	0.26
Tr./Ag.	1.18 [a,b]	0.72	0.50	0.41	0.36	0.33	0.30	0.28	0.25	0.24	0.23
Industrial	1.43 [a,b]	0.93	0.68	0.56	0.48	0.43	0.39	0.36	0.34	0.32	0.30
Utility	0.46 [a,b]	0.31	0.23	0.19	0.16	0.14	0.13	0.12	0.11	0.10	0.10
Financial	0.16 [a,b]	0.10	0.08	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.03
Foreign	0.01 [a,b]	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.20	0.19	0.19	-1.89
Tr./Ag.	0.22	0.21	0.20	0.19	0.19	0.18	0.18	0.17	0.16	0.16	-1.07
Industrial	0.28	0.27	0.26	0.25	0.24	0.23	0.23	0.22	0.22	0.21	-2.14
Utility	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	-0.77
Financial	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	-0.18
Foreign	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.03

Table 3.18. Skewness Differentiated by Portfolio Size and Credit Rating

This table reports the skewness (*Skew*) of quoted returns as defined in equation (3.10) differentiated by portfolio size, credit rating and maturity. [a] indicates that the Bera-Jarque parametric hypothesis test departs from normality for a *s* of 2 at the 0.05 level. [b] refers to the lowest PS from a benchmark PS of 2 beyond which increasing PS results in an increase in *Skew* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Skewness for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	1.12 [a,b]	0.72	0.51	0.42	0.37	0.33	0.29	0.27	0.25	0.24	0.22
Aaa	0.82 [a,b]	0.53	0.38	0.30	0.26	0.24	0.22	0.20	0.19	0.18	0.17
Aa	0.26 [a,b]	0.17	0.11	0.10	0.08	0.07	0.07	0.06	0.06	0.05	0.05
A	0.52 [a,b]	0.33	0.24	0.20	0.17	0.15	0.14	0.13	0.12	0.12	0.11
Baa	0.02 [a,b]	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Speculative	0.78 [a,b]	0.49	0.35	0.29	0.25	0.22	0.20	0.19	0.18	0.16	0.15
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.21	0.21	0.20	0.19	0.19	0.19	0.18	0.17	0.17	0.17	-1.63
Aaa	0.16	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.13	0.12	-1.18
Aa	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	-0.35
A	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.07	0.07	-0.68
Baa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Speculative	0.15	0.14	0.14	0.13	0.12	0.12	0.11	0.11	0.11	0.11	-1.13
Panel B: Skewness for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.88 [a,b]	0.58	0.42	0.35	0.31	0.29	0.26	0.24	0.22	0.21	0.20
Aaa	0.89 [a,b]	0.60	0.42	0.34	0.30	0.27	0.24	0.22	0.21	0.20	0.19
Aa	0.39 [a,b]	0.26	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.08	0.08
A	0.44 [a,b]	0.28	0.20	0.17	0.15	0.12	0.11	0.10	0.10	0.09	0.09
Baa	0.07 [a,b]	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Speculative	0.39 [a,b]	0.26	0.16	0.12	0.10	0.10	0.10	0.09	0.08	0.08	0.07
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.19	0.18	0.18	0.17	0.16	0.16	0.15	0.15	0.14	0.14	-1.20
Aaa	0.19	0.18	0.17	0.16	0.15	0.15	0.14	0.14	0.13	0.13	-1.28
Aa	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	-0.54
A	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	-0.69
Baa	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.12
Speculative	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.05	0.05	-0.55
Panel C: Skewness for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	1.01 [a,b]	0.67	0.47	0.39	0.33	0.30	0.28	0.26	0.24	0.23	0.22
Aaa	0.29 [a,b]	0.20	0.14	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.06
Aa	0.01 [a,b]	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A	0.61 [a,b]	0.37	0.25	0.20	0.17	0.16	0.14	0.13	0.12	0.12	0.11
Baa	0.13 [a,b]	0.08	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03
Speculative	0.98 [a,b]	0.61	0.43	0.34	0.30	0.27	0.25	0.23	0.21	0.20	0.19
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.21	0.20	0.19	0.19	0.17	0.17	0.17	0.17	0.16	0.16	-1.43
Aaa	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04	-0.45
Aa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
A	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	-0.80
Baa	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-0.01
Speculative	0.19	0.18	0.17	0.17	0.16	0.16	0.16	0.15	0.14	0.14	-0.96

Table 3.19. Kurtosis Differentiated by Portfolio Size and Issuer Type

This table reports the kurtosis (*Kurt*) of quoted returns as defined in equation (3.11) differentiated by portfolio size, issuer type and maturity. [a] indicates that the Bera-Jarque parametric hypothesis test departs from normality for a *s* of 2 at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in a decrease in *Kurt* of 1% or less. "Tr./Ag." refers to Treasury/Agency.

Panel A: Kurtosis for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	50.8[a]	22.4(56)	12.9(75)	9.7(81)	8.0(84)	7.0(86)	6.2(88)[b]	5.8(89)	5.5(89)	5.2(90)	5.0(90)
Tr./Ag.	29.4[a]	13.7(53)	8.6(71)	6.7(77)	5.8(80)	5.2(82)	4.8(84)[b]	4.6(85)	4.4(85)	4.2(86)	4.1(86)
Industrial	48.8[a]	21.4(56)	12.3(75)	9.2(81)	7.7(84)	6.7(86)[b]	6.1(87)	5.7(88)	5.3(89)	5.1(90)	4.9(90)
Utility	20.7[a]	10.0(52)	6.5(69)	5.4(74)	4.8(77)	4.5(78)	4.2(80)[b]	4.0(81)	3.9(81)	3.8(82)	3.7(82)
Financial	55.6[a]	24.8(55)	13.7(75)	10.4(81)	8.5(85)	7.4(87)[b]	6.8(88)	6.2(89)	5.8(90)	5.5(90)	5.3(91)
Foreign	6.1[a]	4.2(31)	3.6(41)	3.4(44)	3.3(46)[b]	3.3(47)	3.2(48)	3.2(48)	3.2(49)	3.1(49)	3.1(49)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	4.8(91)	4.6(91)	4.5(91)	4.4(91)	4.3(92)	4.2(92)	4.1(92)	4.1(92)	4.0(92)	4.0(92)	111.8
Tr./Ag.	4.0(86)	3.9(87)	3.8(87)	3.8(87)	3.7(87)	3.7(87)	3.6(88)	3.6(88)	3.6(88)	3.6(88)	55.8
Industrial	4.7(90)	4.6(91)	4.4(91)	4.3(91)	4.3(91)	4.2(91)	4.1(92)	4.0(92)	4.0(92)	3.9(92)	96.1
Utility	3.6(82)	3.6(83)	3.5(83)	3.5(83)	3.5(83)	3.5(83)	3.4(83)	3.4(84)	3.4(84)	3.4(84)	37.5
Financial	5.0(91)	4.8(91)	4.7(92)	4.6(92)	4.5(92)	4.4(92)	4.3(92)	4.2(92)	4.1(93)	4.1(93)	115.8
Foreign	3.1(49)	3.1(49)	3.1(49)	3.1(50)	3.1(50)	3.1(50)	3.1(50)	3.1(50)	3.1(50)	3.1(50)	8.9
Panel B: Kurtosis for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	63.5[a]	27.2(57)	15.0(76)	11.5(82)	9.2(85)	8.0(87)	7.0(89)[b]	6.4(90)	6.1(90)	5.7(91)	5.5(91)
Tr./Ag.	15.7[a]	8.1(49)	5.5(65)	4.7(70)	4.3(73)	4.0(75)[b]	3.8(76)	3.7(76)	3.6(77)	3.5(78)	3.5(78)
Industrial	46.4[a]	20.1(57)	11.4(75)	8.7(81)	7.3(84)	6.4(86)[b]	5.9(87)	5.5(88)	5.2(89)	4.9(89)	4.7(90)
Utility	12.6[a]	6.9(45)	5.0(60)	4.3(66)	4.0(68)	3.8(70)[b]	3.6(71)	3.6(72)	3.5(72)	3.4(73)	3.4(73)
Financial	54.0[a]	23.9(56)	13.3(75)	9.8(82)	8.1(85)	7.1(87)[b]	6.5(88)	6.0(89)	5.6(90)	5.3(90)	5.1(91)
Foreign	5.5[a]	4.1(27)	3.5(36)	3.3(39)	3.3(41)[b]	3.2(42)	3.2(43)	3.1(43)	3.1(44)	3.1(44)	3.1(44)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.2(92)	5.0(92)	4.9(92)	4.7(93)	4.6(93)	4.5(93)	4.4(93)	4.3(93)	4.2(93)	4.2(93)	116.1
Tr./Ag.	3.4(78)	3.4(78)	3.4(78)	3.4(79)	3.3(79)	3.3(79)	3.3(79)	3.3(79)	3.3(79)	3.2(79)	27.6
Industrial	4.6(90)	4.4(90)	4.3(91)	4.2(91)	4.2(91)	4.1(91)	4.0(91)	4.0(91)	3.9(92)	3.9(92)	87.6
Utility	3.4(73)	3.3(73)	3.3(74)	3.3(74)	3.3(74)	3.3(74)	3.2(74)	3.2(74)	3.2(74)	3.2(75)	22.5
Financial	4.9(91)	4.7(91)	4.6(91)	4.5(92)	4.3(92)	4.3(92)	4.2(92)	4.1(92)	4.1(92)	4.0(93)	111.9
Foreign	3.1(44)	3.1(44)	3.1(44)	3.1(44)	3.1(45)	3.1(45)	3.1(45)	3.1(45)	3.0(45)	3.0(45)	7.9
Panel C: Kurtosis for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	44.2[a]	19.0(57)	11.1(75)	8.4(81)	7.0(84)	6.2(86)[b]	5.7(87)	5.3(88)	5.0(89)	4.8(89)	4.6(90)
Tr./Ag.	22.1[a]	10.3(53)	6.5(71)	5.2(76)	4.7(79)[b]	4.4(80)	4.1(81)	4.0(82)	3.9(82)	3.8(83)	3.7(83)
Industrial	35.2[a]	16.1(54)	9.5(73)	7.3(79)	6.3(82)	5.6(84)[b]	5.1(85)	4.8(86)	4.6(87)	4.4(88)	4.2(88)
Utility	15.7[a]	8.2(48)	5.6(64)	4.8(70)	4.3(73)[b]	4.1(74)	3.9(75)	3.7(76)	3.7(77)	3.6(77)	3.5(78)
Financial	13.4[a]	7.0(47)	5.0(63)	4.3(68)	4.0(70)	3.8(72)[b]	3.7(73)	3.6(73)	3.5(74)	3.4(74)	3.4(75)
Foreign	4.2[a]	3.5(18)	3.2(23)	3.2(25)[b]	3.1(26)	3.1(27)	3.1(27)	3.1(28)	3.1(28)	3.1(28)	3.1(28)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	4.4(90)	4.3(90)	4.2(90)	4.1(91)	4.0(91)	4.0(91)	3.9(91)	3.9(91)	3.8(91)	3.8(91)	84.0
Tr./Ag.	3.6(83)	3.6(84)	3.6(84)	3.5(84)	3.5(84)	3.4(84)	3.4(85)	3.4(85)	3.4(85)	3.4(85)	12.7
Industrial	4.1(88)	4.0(88)	4.0(89)	3.9(89)	3.8(89)	3.8(89)	3.7(89)	3.7(89)	3.7(90)	3.6(90)	68.3
Utility	3.5(78)	3.4(78)	3.4(78)	3.4(78)	3.3(79)	3.3(79)	3.3(79)	3.3(79)	3.3(79)	3.2(79)	29.6
Financial	3.3(75)	3.3(75)	3.3(75)	3.3(76)	3.3(76)	3.2(76)	3.2(76)	3.2(76)	3.2(76)	3.2(76)	22.4
Foreign	3.0(28)	3.0(28)	3.0(28)	3.0(28)	3.0(29)	3.0(29)	3.0(29)	3.0(29)	3.0(29)	3.0(29)	5.5

Table 3.20. Kurtosis Differentiated by Portfolio Size and Credit Rating

This table reports the kurtosis (*Kurt*) of quoted returns as defined in equation (3.11) differentiated by portfolio size, credit rating and maturity. [a] indicates that the Bera-Jarque parametric hypothesis test departs from normality for a *s* of 2 at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in a decrease in *Kurt* of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level.

Panel A: Kurtosis for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	57.4[a]	24.2(58)	13.8(76)	10.2(82)	8.4(85)	7.4(87)[b]	6.6(88)	6.1(89)	5.7(90)	5.4(91)	5.2(91)
Aaa	36.2[a]	16.4(55)	9.6(73)	7.3(80)	6.3(82)	5.7(84)	5.2(86)[b]	4.9(87)	4.6(87)	4.4(88)	4.3(88)
Aa	14.5[a]	7.6(47)	5.3(63)	4.6(68)	4.2(71)	3.9(73)[b]	3.8(74)	3.7(75)	3.6(75)	3.5(76)	3.5(76)
A	22.8[a]	10.9(52)	6.9(70)	5.6(75)	5.0(78)	4.6(80)[b]	4.3(81)	4.1(82)	4.0(83)	3.9(83)	3.8(83)
Baa	11.1[a]	6.2(44)	4.6(59)	4.1(64)	3.8(66)[b]	3.6(67)	3.5(68)	3.5(69)	3.4(70)	3.3(70)	3.3(70)
Speculative	33.1[a]	15.2(54)	9.1(73)	7.1(79)	6.0(82)	5.4(84)[b]	5.0(85)	4.7(86)	4.5(86)	4.3(87)	4.2(87)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.0(91)	4.9(92)	4.7(92)	4.6(92)	4.5(92)	4.4(92)	4.4(92)	4.3(93)	4.2(93)	4.1(93)	110.1
Aaa	4.1(89)	4.1(89)	4.0(89)	3.9(89)	3.9(89)	3.8(89)	3.8(90)	3.7(90)	3.7(90)	3.6(90)	67.1
Aa	3.4(76)	3.4(77)	3.4(77)	3.3(77)	3.3(77)	3.3(77)	3.3(77)	3.3(78)	3.2(78)	3.2(78)	26.5
A	3.7(84)	3.6(84)	3.6(84)	3.6(84)	3.5(85)	3.5(85)	3.5(85)	3.4(85)	3.4(85)	3.4(85)	41.2
Baa	3.3(71)	3.3(71)	3.2(71)	3.2(71)	3.2(71)	3.2(71)	3.2(72)	3.2(72)	3.2(72)	3.1(72)	18.8
Speculative	4.1(88)	4.0(88)	4.0(88)	3.9(88)	3.8(88)	3.8(89)	3.7(89)	3.7(89)	3.7(89)	3.6(89)	63.7
Panel B: Kurtosis for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	56.1[a]	24.6(56)	14.0(75)	10.3(82)	8.6(85)	7.5(87)[b]	6.8(88)	6.3(89)	5.8(90)	5.5(90)	5.3(91)
Aaa	18.6[a]	9.9(47)	6.3(66)	5.1(72)	4.6(75)	4.3(77)[b]	4.1(78)	3.9(79)	3.8(79)	3.7(80)	3.7(80)
Aa	7.5[a]	4.9(34)	3.9(48)	3.6(52)	3.5(53)	3.4(55)[b]	3.3(56)	3.3(56)	3.2(57)	3.2(57)	3.2(57)
A	11.8[a]	6.6(44)	4.8(59)	4.2(64)	3.9(67)[b]	3.7(68)	3.6(69)	3.5(70)	3.5(71)	3.4(71)	3.4(71)
Baa	7.8[a]	5.0(36)	4.0(49)	3.7(53)	3.5(55)[b]	3.4(56)	3.3(57)	3.3(58)	3.2(58)	3.2(59)	3.2(59)
Speculative	29.1[a]	14.0(52)	8.5(71)	6.7(77)	5.7(80)	5.2(82)[b]	4.8(83)	4.6(84)	4.3(85)	4.2(86)	4.1(86)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.0(91)	4.9(91)	4.7(92)	4.6(92)	4.5(92)	4.4(92)	4.3(92)	4.3(92)	4.2(92)	4.1(93)	103.5
Aaa	3.6(81)	3.6(81)	3.5(81)	3.5(81)	3.4(82)	3.4(82)	3.4(82)	3.4(82)	3.3(82)	3.3(82)	39.7
Aa	3.2(58)	3.1(58)	3.1(58)	3.1(58)	3.1(58)	3.1(58)	3.1(58)	3.1(59)	3.1(59)	3.1(59)	12.3
A	3.3(72)	3.3(72)	3.3(72)	3.3(72)	3.2(72)	3.2(73)	3.2(73)	3.2(73)	3.2(73)	3.2(73)	25.4
Baa	3.2(59)	3.2(59)	3.1(59)	3.1(60)	3.1(60)	3.1(60)	3.1(60)	3.1(60)	3.1(60)	3.1(60)	12.9
Speculative	4.0(86)	3.9(87)	3.8(87)	3.8(87)	3.7(87)	3.7(87)	3.6(88)	3.6(88)	3.6(88)	3.5(88)	56.7
Panel C: Kurtosis for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	29.1[a]	14.0(52)	8.5(71)	6.7(77)	5.7(80)	5.2(82)[b]	4.8(83)	4.6(84)	4.3(85)	4.2(86)	4.1(86)
Aaa	44.3[a]	19.5(56)	11.2(75)	8.5(81)	7.2(84)	6.3(86)[b]	5.7(87)	5.3(88)	5.1(89)	4.8(89)	4.6(90)
Aa	16.8[a]	8.5(49)	5.8(65)	4.9(71)	4.4(74)	4.1(76)[b]	3.9(77)	3.8(77)	3.7(78)	3.6(79)	3.6(79)
A	10.2[a]	5.7(44)	4.3(58)	3.9(62)	3.6(64)	3.5(66)[b]	3.4(66)	3.4(67)	3.3(67)	3.3(68)	3.3(68)
Baa	19.9[a]	9.6(52)	6.4(68)	5.2(74)	4.6(77)[b]	4.3(78)	4.1(79)	3.9(80)	3.8(81)	3.7(81)	3.7(81)
Speculative	7.9[a]	5.0(37)	4.0(49)	3.7(53)	3.5(56)[b]	3.4(57)	3.3(58)	3.3(58)	3.2(59)	3.2(59)	3.2(60)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	4.0(86)	3.9(87)	3.8(87)	3.8(87)	3.7(87)	3.7(87)	3.6(88)	3.6(88)	3.6(88)	3.5(88)	56.7
Aaa	4.5(90)	4.4(90)	4.3(90)	4.2(91)	4.1(91)	4.0(91)	4.0(91)	3.9(91)	3.9(91)	3.8(91)	85.2
Aa	3.5(79)	3.5(79)	3.4(80)	3.4(80)	3.4(80)	3.3(80)	3.3(80)	3.3(80)	3.3(80)	3.3(81)	30.7
A	3.2(68)	3.2(69)	3.2(69)	3.2(69)	3.2(69)	3.2(69)	3.2(69)	3.1(69)	3.1(69)	3.1(69)	15.6
Baa	3.6(82)	3.6(82)	3.5(82)	3.5(83)	3.4(83)	3.4(83)	3.4(83)	3.4(83)	3.3(83)	3.3(83)	36.2
Speculative	3.2(60)	3.2(60)	3.2(60)	3.2(60)	3.1(60)	3.1(60)	3.1(61)	3.1(61)	3.1(61)	3.1(61)	12.8

Table 3.21. Left Tail Weight Differentiated by Portfolio Size and Issuer Type

This table reports the left tail weights (LTWs) of quoted returns differentiated by portfolio size, issuer type and maturity. [a] indicates that the LTW is at a minimum in that increasing the PS to the next higher PS value provide a marginal reduction of 1% or less in the difference between the maximum and minimum LTW values for this IO set. "Tr./Ag." refers to Treasury/Agency.

Panel A: Left tail weight for all maturities										
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.35(13)	0.38(0)	0.38(2)	0.38(5)	0.36(16)	0.34(34)	0.33(45)	0.32(52)	0.31(58)	0.30(64)	0.29(70)
Tr./Ag.	0.27(9)	0.31(0)	0.29(25)	0.27(49)	0.27(49)	0.26(67)	0.25(77)	0.24(85)	0.24(90)	0.23(93)	0.23(97)
Industrial	0.43(17)	0.44(0)	0.41(17)	0.39(31)	0.37(42)	0.35(52)	0.34(59)	0.33(66)	0.32(72)	0.31(76)	0.30(81)
Utility	0.29(5)	0.30(20)	0.29(31)	0.29(35)	0.28(43)	0.28(41)	0.28(47)	0.28(55)	0.28(59)	0.27(63)	0.27(73)
Financial	0.33(7)	0.35(3)	0.35(0)	0.35(2)	0.34(14)	0.34(25)	0.33(35)	0.33(34)	0.33(40)	0.32(48)	0.32(55)
Foreign	0.26(4)	0.26(82)	0.26(75)	0.26(80)	0.26(80)	0.26(82)	0.25(84)	0.25(89)	0.25(91)	0.25(93)	0.25(91)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.29(76)	0.28(80)	0.27(85)	0.27(89)	0.26(94)	0.26(95)	0.26(98)[a]	0.26(98)	0.26(99)	0.25(100)	0.36(17)
Tr./Ag.	0.23(95)	0.23(98)	0.23(95)	0.23(98)[a]	0.23(99)	0.23(100)	0.23(99)	0.23(98)	0.23(97)	0.23(94)	0.27(47)
Industrial	0.30(84)	0.29(87)	0.29(89)	0.29(91)	0.28(92)	0.28(94)	0.28(97)[a]	0.28(98)	0.27(99)	0.27(100)	0.44(4)
Utility	0.26(84)	0.26(88)	0.26(92)	0.26(94)	0.26(94)	0.26(96)	0.25(100)[a]	0.26(98)	0.26(96)	0.26(96)	0.31(0)
Financial	0.31(58)	0.31(63)	0.31(66)	0.30(72)	0.30(75)	0.30(80)	0.30(85)	0.29(91)	0.29(97)	0.29(100)[a]	0.34(11)
Foreign	0.25(93)	0.25(95)	0.25(98)	0.25(100)	0.25(100)	0.25(98)	0.25(100)	0.25(100)	0.25(98)	0.25(100)[a]	0.29(0)
Panel B: Left tail weight for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.37(13)	0.40(0)	0.40(1)	0.39(13)	0.37(24)	0.36(35)	0.35(45)	0.34(53)	0.33(60)	0.32(66)	0.31(71)
Tr./Ag.	0.22(3)	0.25(40)	0.26(4)	0.26(0)	0.26(8)	0.25(24)	0.25(36)	0.25(24)	0.25(52)	0.25(56)	0.24(68)
Industrial	0.46(20)	0.46(8)	0.43(24)	0.40(37)	0.38(47)	0.37(55)	0.35(62)	0.34(68)	0.33(73)	0.32(76)	0.31(80)
Utility	0.29(7)	0.30(22)	0.30(28)	0.28(49)	0.27(66)	0.26(83)	0.26(89)	0.26(88)	0.25(91)	0.25(91)	0.25(91)
Financial	0.33(7)	0.35(3)	0.36(0)	0.35(7)	0.34(21)	0.33(35)	0.33(35)	0.32(46)	0.32(54)	0.31(61)	0.31(64)
Foreign	0.24(4)	0.26(67)	0.26(67)	0.25(74)	0.25(90)	0.25(95)	0.24(97)	0.24(100)	0.24(100)	0.24(100)	0.24(97)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.31(76)	0.30(80)	0.30(83)	0.29(86)	0.29(89)	0.29(91)	0.28(94)	0.28(95)	0.28(98)[a]	0.28(100)	0.39(9)
Tr./Ag.	0.24(72)	0.24(80)	0.24(84)	0.24(92)	0.24(96)	0.24(92)	0.24(92)[a]	0.24(100)	0.24(100)	0.24(100)	0.24(76)
Industrial	0.31(84)	0.30(87)	0.30(89)	0.29(92)	0.29(94)	0.28(95)	0.28(97)[a]	0.28(98)	0.28(99)	0.27(100)	0.48(0)
Utility	0.25(91)	0.25(92)	0.25(92)	0.25(92)	0.25(94)	0.25(92)	0.25(97)[a]	0.25(98)	0.25(98)	0.25(100)	0.31(0)
Financial	0.31(65)	0.31(71)	0.30(75)	0.30(78)	0.30(82)	0.29(88)	0.29(89)	0.29(94)	0.29(97)	0.28(100)[a]	0.33(33)
Foreign	0.24(97)	0.24(97)	0.24(97)	0.24(97)	0.25(95)	0.24(100)[a]	0.25(95)	0.25(95)	0.24(97)	0.24(97)	0.28(0)
Panel C: Left tail weight for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.37(14)	0.38(14)	0.38(14)	0.36(31)	0.34(45)	0.32(54)	0.31(63)	0.30(73)	0.29(80)	0.28(85)	0.27(89)
Tr./Ag.	0.29(13)	0.28(41)	0.26(62)	0.24(78)	0.22(92)	0.21(100)[a]	0.22(96)	0.22(90)	0.23(82)	0.23(81)	0.24(79)
Industrial	0.42(21)	0.41(19)	0.37(39)	0.34(54)	0.32(63)	0.30(71)	0.29(76)	0.28(79)	0.28(83)	0.27(86)	0.27(88)
Utility	0.30(9)	0.29(57)	0.28(65)	0.28(70)	0.28(71)	0.27(75)	0.27(82)	0.26(85)	0.26(87)	0.26(90)	0.26(90)
Financial	0.32(13)	0.32(41)	0.30(50)	0.29(60)	0.28(66)	0.27(74)	0.27(79)	0.26(83)	0.26(85)	0.26(86)	0.26(86)
Foreign	0.27(4)	0.26(71)	0.26(74)	0.25(86)	0.25(93)	0.25(88)	0.25(88)	0.25(90)	0.25(98)	0.24(100)[a]	0.25(98)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.27(92)	0.27(94)	0.26(96)	0.26(96)	0.27(94)	0.26(95)	0.26(95)	0.26(97)	0.26(99)[a]	0.26(100)	0.40(0)
Tr./Ag.	0.24(78)	0.24(80)	0.23(81)	0.23(85)	0.23(84)	0.23(85)	0.23(86)	0.23(87)	0.23(87)	0.23(87)	0.34(0)
Industrial	0.26(90)	0.26(92)	0.25(94)[a]	0.25(95)	0.25(96)	0.25(97)	0.25(98)	0.24(99)	0.24(100)	0.24(100)	0.45(0)
Utility	0.26(94)	0.25(96)	0.25(96)	0.26(95)	0.25(97)	0.25(96)	0.25(98)[a]	0.25(99)	0.25(100)	0.25(100)	0.34(0)
Financial	0.26(88)	0.26(88)	0.25(89)	0.25(90)	0.25(92)	0.25(95)	0.24(98)[a]	0.24(98)	0.24(100)	0.24(100)	0.37(0)
Foreign	0.25(93)	0.25(93)	0.25(93)	0.25(93)	0.25(90)	0.25(90)	0.25(88)	0.25(93)	0.25(90)	0.25(88)	0.29(0)

Table 3.22. Left Tail Weight Differentiated by Portfolio Size and Credit Rating

This table reports the left tail weights of quoted returns differentiated by portfolio size, credit rating and maturity. [a] indicates that the LTW is at a minimum in that increasing the PS to the next higher PS value provides a marginal reduction of 1% or less in the difference between the maximum and minimum LTW values for this IO set.

Panel A: Left tail weight for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.34(12)	0.38(11)	0.39(0)	0.39(6)	0.37(19)	0.36(30)	0.35(40)	0.33(50)	0.32(59)	0.32(65)	0.31(72)
Aaa	0.27(10)	0.34(1)	0.34(0)	0.33(4)	0.31(30)	0.27(62)	0.27(68)	0.27(68)	0.26(71)	0.26(72)	0.26(77)
Aa	0.25(2)	0.27(20)	0.27(0)	0.27(20)	0.27(25)	0.26(35)	0.26(50)	0.26(60)	0.26(70)	0.26(80)	0.25(90)
A	0.26(3)	0.29(0)	0.29(0)	0.28(10)	0.28(7)	0.28(13)	0.28(20)	0.28(33)	0.28(33)	0.27(43)	0.27(47)
Baa	0.31(9)	0.30(44)	0.29(58)	0.28(68)	0.28(73)	0.27(80)	0.27(82)	0.27(86)	0.27(88)	0.26(91)	0.26(93)
Speculative	0.55(32)	0.47(30)	0.42(48)	0.38(59)	0.36(67)	0.34(73)	0.32(77)	0.31(82)	0.30(84)	0.29(87)	0.29(89)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.30(75)	0.30(81)	0.29(83)	0.29(87)	0.29(89)	0.28(92)	0.28(94)	0.28(96)	0.28(98)	0.27(100)[a]	0.34(43)
Aaa	0.25(84)	0.24(90)	0.24(95)	0.24(98)	0.23(100)[a]	0.23(100)	0.24(99)	0.24(98)	0.24(98)	0.24(97)	0.28(58)
Aa	0.26(80)	0.25(85)	0.25(85)	0.25(90)	0.25(90)	0.25(85)	0.25(90)	0.25(95)	0.25(90)	0.25(100)[a]	0.27(20)
A	0.27(53)	0.27(60)	0.27(67)	0.26(77)	0.26(83)	0.26(83)	0.26(90)	0.26(90)	0.26(93)	0.26(100)[a]	0.28(10)
Baa	0.26(93)	0.26(94)	0.26(97)[a]	0.26(97)	0.26(98)	0.26(97)	0.26(98)	0.26(98)	0.26(99)	0.25(100)	0.34(0)
Speculative	0.28(91)	0.27(93)[a]	0.27(94)	0.27(95)	0.26(96)	0.26(97)	0.26(98)	0.26(99)	0.25(99)	0.25(100)	0.57(0)
Panel B: Left tail weight for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.36(12)	0.39(0)	0.39(0)	0.38(10)	0.36(23)	0.35(33)	0.34(42)	0.34(48)	0.33(56)	0.32(62)	0.31(68)
Aaa	0.23(1)	0.26(0)	0.26(7)	0.26(0)	0.26(0)	0.25(29)	0.25(50)	0.25(50)	0.25(57)	0.25(50)	0.25(36)
Aa	0.25(5)	0.26(74)	0.26(77)	0.25(81)	0.25(87)	0.25(89)	0.25(89)	0.25(89)	0.25(92)	0.25(92)	0.25(94)
A	0.28(6)	0.29(30)	0.28(46)	0.27(55)	0.27(64)	0.27(66)	0.26(71)	0.26(79)	0.26(79)	0.26(80)	0.26(82)
Baa	0.31(10)	0.29(55)	0.28(72)	0.27(80)	0.26(86)	0.26(89)	0.26(91)	0.25(95)	0.25(95)	0.25(98)[a]	0.25(98)
Speculative	0.55(32)	0.47(31)	0.41(49)	0.38(60)	0.35(68)	0.33(75)	0.32(80)	0.30(84)	0.30(86)	0.29(89)	0.28(91)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.31(73)	0.30(76)	0.30(80)	0.29(84)	0.29(87)	0.29(91)	0.28(93)	0.28(96)	0.28(97)	0.27(100)[a]	0.38(11)
Aaa	0.25(57)	0.25(64)	0.25(71)	0.25(79)	0.25(86)	0.24(93)	0.24(93)	0.24(100)[a]	0.24(93)	0.24(100)	0.25(57)
Aa	0.25(94)	0.25(96)	0.25(96)	0.24(98)	0.24(98)	0.24(98)	0.24(98)	0.24(100)[a]	0.24(98)	0.24(98)	0.30(0)
A	0.26(88)	0.26(88)	0.25(89)	0.25(91)	0.25(95)	0.25(95)	0.25(96)	0.25(98)	0.25(100)[a]	0.25(100)	0.30(0)
Baa	0.25(99)	0.25(98)	0.25(99)	0.25(100)	0.25(98)	0.25(99)	0.25(99)	0.25(100)	0.25(99)	0.25(99)	0.35(0)
Speculative	0.28(92)	0.27(93)	0.27(94)	0.27(96)[a]	0.26(97)	0.26(98)	0.26(98)	0.25(99)	0.25(100)	0.25(100)	0.57(0)
Panel C: Left tail weight for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.36(14)	0.40(2)	0.40(0)	0.38(11)	0.37(21)	0.35(33)	0.34(44)	0.32(55)	0.31(63)	0.30(71)	0.29(78)
Aaa	0.35(12)	0.35(0)	0.29(47)	0.27(69)	0.25(80)	0.25(86)	0.23(98)	0.23(100)	0.23(100)	0.23(99)	0.24(94)
Aa	0.28(6)	0.28(61)	0.27(75)	0.26(83)	0.26(92)	0.26(94)	0.26(91)	0.26(89)	0.26(89)	0.26(91)	0.26(91)
A	0.30(10)	0.29(62)	0.29(64)	0.29(65)	0.29(67)	0.28(70)	0.28(74)	0.28(76)	0.27(80)	0.27(83)	0.27(87)
Baa	0.34(11)	0.31(50)	0.29(70)	0.28(81)	0.27(86)	0.27(89)	0.26(92)	0.26(94)	0.26(94)	0.26(96)[a]	0.26(96)
Speculative	0.46(27)	0.37(50)	0.31(72)	0.28(83)	0.27(88)	0.26(91)	0.26(94)	0.25(97)[a]	0.24(98)	0.24(99)	0.24(99)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.28(83)	0.28(87)	0.27(90)	0.27(91)	0.27(93)	0.27(94)	0.26(96)	0.26(97)	0.26(99)[a]	0.26(100)	0.36(30)
Aaa	0.24(89)	0.24(88)	0.24(89)	0.24(90)	0.24(95)	0.23(96)	0.23(98)	0.23(97)	0.23(98)	0.23(100)[a]	0.28(55)
Aa	0.26(92)	0.26(92)	0.26(94)	0.26(95)	0.25(97)	0.25(97)	0.25(97)	0.25(98)	0.25(100)[a]	0.25(100)	0.32(0)
A	0.27(88)	0.26(90)	0.26(93)	0.26(93)	0.26(94)	0.26(97)	0.26(97)	0.26(97)	0.25(99)[a]	0.25(100)	0.36(0)
Baa	0.26(96)	0.26(96)	0.26(97)	0.26(98)	0.26(98)	0.26(98)	0.25(99)	0.25(100)	0.25(99)	0.25(100)	0.37(0)
Speculative	0.24(99)	0.24(99)	0.24(99)	0.24(99)	0.24(99)	0.24(100)	0.24(99)	0.24(100)	0.24(100)	0.24(100)	0.51(0)

Table 3.23. Right Tail Weight Differentiated by Portfolio Size and Issuer Type

This table reports the right tail weight of quoted returns differentiated by portfolio size, issuer type and maturity. [a] indicates that the means for a *s* of 100 and All are significantly different at the 0.05 level and that the tail weight of All is higher than the tail weight of a *s* of 100. "Tr./Ag." refers to Treasury/Agency.

Panel A: Right tail weight for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.371	0.353	0.346	0.342	0.336	0.333	0.329	0.325	0.320	0.316	0.312
Tr./Ag.	0.313	0.299	0.292	0.294	0.295	0.295	0.292	0.292	0.287	0.282	0.276
Industrial	0.380	0.369	0.358	0.350	0.343	0.336	0.329	0.324	0.318	0.314	0.309
Utility	0.291	0.288	0.286	0.286	0.284	0.284	0.281	0.280	0.279	0.277	0.275
Financial	0.342	0.341	0.339	0.334	0.331	0.328	0.325	0.323	0.323	0.322	0.320
Foreign	0.264	0.261	0.260	0.258	0.256	0.256	0.256	0.253	0.254	0.253	0.252
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.309	0.308	0.302	0.301	0.298	0.279	0.257	0.257	0.255	0.254	0.360 [a]
Tr./Ag.	0.271	0.269	0.261	0.260	0.258	0.206	0.228	0.229	0.230	0.232	0.273 [a]
Industrial	0.307	0.304	0.300	0.296	0.294	0.379	0.277	0.275	0.273	0.271	0.436 [a]
Utility	0.274	0.273	0.271	0.270	0.268	0.202	0.254	0.255	0.256	0.256	0.305 [a]
Financial	0.317	0.314	0.312	0.308	0.302	0.279	0.296	0.292	0.288	0.286	0.344 [a]
Foreign	0.252	0.251	0.251	0.252	0.252	0.233	0.247	0.247	0.248	0.247	0.291 [a]
Panel B: Right tail weight for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.366	0.357	0.350	0.343	0.338	0.334	0.331	0.327	0.324	0.320	0.317
Tr./Ag.	0.306	0.304	0.295	0.289	0.283	0.280	0.270	0.266	0.263	0.261	0.262
Industrial	0.372	0.364	0.356	0.349	0.343	0.334	0.329	0.323	0.315	0.309	0.303
Utility	0.284	0.280	0.273	0.270	0.266	0.263	0.261	0.259	0.255	0.252	0.250
Financial	0.339	0.330	0.321	0.317	0.317	0.316	0.315	0.314	0.309	0.305	0.303
Foreign	0.259	0.257	0.257	0.256	0.255	0.254	0.251	0.250	0.250	0.250	0.249
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.316	0.313	0.311	0.308	0.306	0.299	0.283	0.281	0.278	0.275	0.391 [a]
Tr./Ag.	0.266	0.260	0.260	0.259	0.258	0.178	0.237	0.235	0.235	0.235	0.241 [a]
Industrial	0.298	0.293	0.290	0.288	0.284	0.431	0.281	0.278	0.276	0.274	0.478 [a]
Utility	0.249	0.250	0.250	0.251	0.251	0.252	0.250	0.249	0.249	0.248	0.313 [a]
Financial	0.297	0.292	0.288	0.285	0.283	0.263	0.292	0.288	0.286	0.284	0.332 [a]
Foreign	0.248	0.250	0.251	0.250	0.251	0.210	0.245	0.245	0.244	0.244	0.282 [a]
Panel C: Right tail weight for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.362	0.354	0.346	0.338	0.332	0.327	0.322	0.317	0.314	0.311	0.308
Tr./Ag.	0.280	0.263	0.264	0.261	0.261	0.259	0.259	0.261	0.258	0.258	0.258
Industrial	0.355	0.343	0.333	0.327	0.326	0.321	0.317	0.313	0.309	0.306	0.302
Utility	0.287	0.286	0.287	0.284	0.283	0.283	0.281	0.278	0.277	0.277	0.276
Financial	0.285	0.276	0.271	0.266	0.253	0.247	0.246	0.249	0.250	0.251	0.250
Foreign	0.251	0.250	0.249	0.248	0.249	0.250	0.249	0.248	0.250	0.249	0.250
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.302	0.300	0.295	0.292	0.290	0.341	0.264	0.261	0.258	0.257	0.399 [a]
Tr./Ag.	0.258	0.260	0.262	0.262	0.257	0.267	0.227	0.226	0.226	0.226	0.335 [a]
Industrial	0.299	0.296	0.293	0.290	0.286	0.422	0.246	0.243	0.242	0.241	0.449 [a]
Utility	0.273	0.272	0.271	0.269	0.268	0.277	0.252	0.251	0.250	0.250	0.343 [a]
Financial	0.250	0.249	0.253	0.250	0.249	0.292	0.242	0.241	0.239	0.239	0.367 [a]
Foreign	0.249	0.248	0.248	0.248	0.247	0.272	0.249	0.247	0.248	0.249	0.286 [a]

Table 3.24. Right Tail Weight Differentiated by Portfolio Size and Credit Rating

This table reports the right tail weight of quoted returns differentiated by portfolio size, credit rating and maturity. [a] indicates that the means for a *s* of 100 and All are significantly different at the 0.05 level and that the tail weight of All is higher than the tail weight of a *s* of 100.

Panel A: Right tail weight for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.377	0.367	0.355	0.345	0.338	0.330	0.323	0.318	0.313	0.310	0.306
Aaa	0.311	0.304	0.299	0.293	0.291	0.286	0.278	0.272	0.263	0.262	0.260
Aa	0.273	0.272	0.271	0.270	0.270	0.268	0.268	0.265	0.264	0.264	0.265
A	0.300	0.298	0.295	0.292	0.290	0.289	0.286	0.283	0.282	0.281	0.280
Baa	0.270	0.267	0.265	0.262	0.262	0.261	0.258	0.257	0.255	0.256	0.256
Speculative	0.361	0.348	0.337	0.328	0.319	0.311	0.304	0.299	0.295	0.291	0.288
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.303	0.302	0.300	0.298	0.297	0.260	0.280	0.278	0.275	0.273	0.342 [a]
Aaa	0.259	0.258	0.258	0.258	0.259	0.193	0.235	0.236	0.236	0.237	0.278 [a]
Aa	0.262	0.262	0.260	0.259	0.258	0.166	0.253	0.252	0.253	0.251	0.267 [a]
A	0.278	0.277	0.277	0.275	0.274	0.219	0.259	0.259	0.258	0.256	0.283 [a]
Baa	0.256	0.254	0.254	0.254	0.252	0.281	0.256	0.256	0.255	0.254	0.344 [a]
Speculative	0.284	0.282	0.279	0.277	0.267	0.595	0.257	0.255	0.253	0.251	0.570 [a]
Panel B: Right tail weight for portfolios for bonds with maturity < 10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.361	0.350	0.342	0.334	0.328	0.324	0.321	0.318	0.315	0.311	0.309
Aaa	0.304	0.303	0.299	0.298	0.296	0.293	0.287	0.285	0.284	0.280	0.279
Aa	0.271	0.269	0.266	0.262	0.262	0.261	0.260	0.260	0.259	0.258	0.258
A	0.278	0.276	0.275	0.273	0.271	0.269	0.268	0.268	0.268	0.267	0.266
Baa	0.264	0.261	0.261	0.258	0.258	0.256	0.254	0.249	0.248	0.250	0.250
Speculative	0.346	0.333	0.320	0.311	0.304	0.298	0.293	0.289	0.286	0.282	0.279
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.306	0.304	0.303	0.300	0.298	0.282	0.282	0.279	0.277	0.274	0.378 [a]
Aaa	0.276	0.273	0.270	0.268	0.262	0.163	0.244	0.243	0.244	0.243	0.249 [a]
Aa	0.258	0.258	0.257	0.257	0.256	0.184	0.244	0.243	0.244	0.244	0.296 [a]
A	0.266	0.264	0.263	0.263	0.263	0.228	0.250	0.249	0.248	0.248	0.304 [a]
Baa	0.252	0.250	0.250	0.249	0.249	0.296	0.250	0.249	0.250	0.250	0.349 [a]
Speculative	0.275	0.265	0.263	0.261	0.260	0.578	0.258	0.254	0.252	0.251	0.573 [a]
Panel C: Right tail weight for portfolios for bonds with maturity >10 years											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.357	0.348	0.342	0.337	0.330	0.325	0.319	0.315	0.311	0.306	0.303
Aaa	0.263	0.246	0.244	0.241	0.245	0.248	0.254	0.257	0.256	0.253	0.251
Aa	0.260	0.259	0.261	0.259	0.258	0.256	0.256	0.255	0.254	0.254	0.253
A	0.303	0.299	0.298	0.297	0.295	0.292	0.289	0.285	0.282	0.280	0.278
Baa	0.258	0.257	0.255	0.254	0.252	0.252	0.250	0.249	0.248	0.247	0.248
Speculative	0.299	0.293	0.288	0.284	0.277	0.269	0.266	0.263	0.261	0.259	0.257
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.300	0.297	0.294	0.291	0.288	0.319	0.262	0.261	0.259	0.257	0.356 [a]
Aaa	0.238	0.235	0.235	0.237	0.238	0.274	0.232	0.233	0.231	0.229	0.284 [a]
Aa	0.253	0.253	0.252	0.252	0.251	0.251	0.254	0.253	0.252	0.252	0.316 [a]
A	0.276	0.273	0.271	0.269	0.268	0.292	0.256	0.256	0.254	0.253	0.357 [a]
Baa	0.248	0.248	0.248	0.248	0.248	0.318	0.254	0.253	0.254	0.253	0.366 [a]
Speculative	0.259	0.258	0.256	0.253	0.251	0.507	0.240	0.239	0.239	0.238	0.510 [a]

Table 3.25. Probability of Observing Market Underperformance Differentiated by Portfolio Size and Issuer Type

This table reports the mean probabilities that a portfolio of size *s* that is randomly drawn from investment opportunity (IO) set *j* differentiated by issuer type will, on average, underperform the market return over holding periods of three years. All of the differences between a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in an increase in the probability of underperforming the market return of 1% or less. "Tr./Ag." refers to Treasury/Agency.

Panel A: Probability of market return underperformance for all maturity IO sets (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	57.1[a,b]	56.9(0)	55.8(2)	55.3(3)	55.1(3)	54.7(4)	54.4(5)	54.3(5)	54.1(5)	53.9(6)	53.8(6)
Tr./Ag.	63.1[a]	61.1(3)	58.8(7)	57.3(9)[b]	57.0(10)	56.0(11)	55.3(12)	54.8(13)	54.2(14)	54.3(14)	54.4(14)
Industrial	61.1[a]	59.8(2)	58.3(5)[b]	57.3(6)	56.8(7)	56.3(8)	55.9(9)	55.4(9)	55.2(10)	54.9(10)	54.7(10)
Utility	55.5[a]	53.7(3)	52.7(5)[b]	52.2(6)	51.8(7)	51.5(7)	51.3(7)	51.0(8)	50.8(8)	50.7(9)	50.6(9)
Financial	55.9[a,b]	55.4(1)	55.1(2)	55.1(2)	55.3(1)	55.5(1)	55.4(1)	55.4(1)	55.5(1)	55.5(1)	55.5(1)
Foreign	53.5[a]	52.3(2)	51.6(4)[b]	50.8(5)	50.7(5)	50.5(6)	50.2(6)	49.9(7)	50.0(7)	49.9(7)	49.9(7)

IO set/ PS	55	60	65	70	75	80	85	90	95	100	All
All	53.7(6)	53.6(6)	53.5(6)	53.6(6)	53.5(6)	53.4(6)	53.4(6)	53.3(7)	53.2(7)	53.2(7)	0.0
Tr./Ag.	54.8(13)	53.9(15)	53.4(15)	53.6(15)	54.3(14)	53.6(15)	53.4(15)	53.3(16)	52.9(16)	53.1(16)	0.0
Industrial	54.6(11)	54.5(11)	54.4(11)	54.2(11)	54.1(11)	54.1(11)	53.9(12)	53.9(12)	53.6(12)	53.7(12)	0.0
Utility	50.6(9)	50.5(9)	50.5(9)	50.4(9)	50.4(9)	50.3(9)	50.2(9)	50.2(10)	50.3(9)	50.3(9)	0.0
Financial	55.4(1)	55.2(1)	55.1(1)	55.0(2)	54.8(2)	54.8(2)	54.7(2)	54.6(2)	54.6(2)	54.5(3)	0.0
Foreign	49.9(7)	49.9(7)	49.8(7)	49.9(7)	49.9(7)	49.8(7)	49.8(7)	49.9(7)	49.9(7)	50.0(7)	0.0

Panel B: Probability of market return underperformance for all maturity IO sets with maturity < 10 years (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	58.0[a,b]	57.4(1)	56.5(3)	55.9(4)	55.3(5)	54.8(5)	54.7(6)	54.4(6)	54.3(6)	54.1(7)	54.0(7)
Tr./Ag.	54.5[a,b]	53.8(1)	53.2(2)	52.6(4)	52.2(4)	52.0(5)	51.8(5)	51.4(6)	51.4(6)	51.4(6)	51.2(6)
Industrial	61.9[a]	60.0(3)[b]	58.5(6)	57.5(7)	56.9(8)	56.4(9)	56.0(9)	55.7(10)	55.5(10)	55.2(11)	55.0(11)
Utility	55.9[a]	54.5(3)	53.1(5)	52.2(7)[b]	51.6(8)	51.4(8)	50.9(9)	50.6(10)	50.5(10)	50.5(10)	50.4(10)
Financial	56.5[a,b]	56.1(1)	56.0(1)	56.4(0)	56.2(0)	56.3(0)	56.5(0)	56.3(0)	56.2(0)	56.2(1)	56.1(1)
Foreign	55.6[a,b]	55.2(1)	54.3(2)	54.2(2)	54.4(2)	54.2(2)	54.2(3)	54.2(3)	54.1(3)	54.1(3)	54.2(3)

IO set/ PS	55	60	65	70	75	80	85	90	95	100	All
All	53.9(7)	53.7(7)	53.5(8)	53.3(8)	53.2(8)	53.0(8)	53.0(9)	52.9(9)	53.0(9)	52.9(9)	0.0
Tr./Ag.	51.0(6)	51.0(6)	51.0(6)	50.9(7)	50.9(7)	50.9(7)	51.0(6)	50.9(7)	50.9(7)	50.7(7)	0.0
Industrial	54.8(11)	54.7(12)	54.4(12)	54.4(12)	54.3(12)	54.1(13)	53.9(13)	53.7(13)	53.6(13)	53.5(14)	0.0
Utility	50.2(10)	50.1(10)	50.1(10)	50.2(10)	50.2(10)	50.1(10)	50.1(10)	50.1(10)	50.1(10)	50.1(10)	0.0
Financial	56.0(1)	55.8(1)	55.7(1)	55.5(2)	55.2(2)	55.2(2)	55.0(3)	54.8(3)	54.7(3)	54.6(3)	0.0
Foreign	54.3(2)	54.2(3)	54.3(2)	54.3(2)	54.4(2)	54.3(2)	54.4(2)	54.3(2)	54.2(2)	54.3(2)	0.0

Panel C: Probability of market return underperformance for all maturity IO sets with maturity > 10 years (multiplied by 100)

IO set/ PS	2	5	10	15	20	25	30	35	40	45	50
All	57.6[a,b]	57.1(1)	56.6(2)	56.2(2)	55.9(3)	55.6(3)	55.5(4)	55.2(4)	54.9(5)	54.8(5)	54.6(5)
Tr./Ag.	56.9[a,b]	54.9(4)	54.9(4)	54.7(4)	53.3(6)	53.6(6)	53.6(6)	53.1(7)	52.6(8)	52.3(8)	52.4(8)
Industrial	59.5[a]	58.5(2)	57.1(4)[b]	56.5(5)	56.2(6)	55.9(6)	55.6(7)	55.3(7)	55.2(7)	54.9(8)	54.9(8)
Utility	55.7[a]	53.5(4)[b]	52.9(5)	52.6(6)	52.2(6)	52.0(7)	52.0(7)	51.8(7)	51.6(7)	51.5(8)	51.5(8)
Financial	52.2[a]	50.4(3)	49.6(5)[b]	49.4(5)	49.2(6)	49.1(6)	48.9(6)	48.7(7)	48.6(7)	48.3(7)	48.3(7)
Foreign	54.8[a]	52.9(3)	51.8(6)[b]	51.2(7)	50.8(7)	50.6(8)	50.4(8)	50.5(8)	50.6(8)	50.6(8)	50.4(8)

IO set/ PS	55	60	65	70	75	80	85	90	95	100	All
All	54.4(6)	54.2(6)	54.1(6)	54.1(6)	54.0(6)	54.0(6)	54.0(6)	53.8(7)	53.8(7)	53.8(7)	0.0
Tr./Ag.	52.5(8)	52.2(8)	53.6(6)	53.5(6)	53.1(7)	52.6(8)	53.3(6)	53.1(7)	53.0(7)	53.4(6)	0.0
Industrial	54.7(8)	54.7(8)	54.5(8)	54.3(9)	54.3(9)	54.2(9)	54.1(9)	54.0(9)	54.0(9)	53.8(10)	0.0
Utility	51.5(8)	51.5(8)	51.3(8)	51.2(8)	51.3(8)	51.2(8)	51.2(8)	51.1(8)	51.0(8)	50.9(9)	0.0
Financial	48.2(8)	48.0(8)	47.9(8)	47.8(9)	47.9(8)	47.8(8)	47.8(8)	47.9(8)	47.8(8)	47.8(8)	0.0
Foreign	50.4(8)	50.4(8)	50.4(8)	50.4(8)	50.4(8)	50.3(8)	50.4(8)	50.3(8)	50.3(8)	50.3(8)	0.0

Table 3.26. Probability of Observing Market Underperformance Differentiated by Portfolio Size and Credit Rating

This table reports the mean probabilities that a portfolio of size *s* that is randomly drawn from investment opportunity (IO) set *j* differentiated by rating category will, on average, underperform the market return over holding periods of three years. All of the differences between a *s* of 2 and All are significantly different at the 0.05 level. [b] refers to the lowest PS beyond which increasing PS results in an increase in the probability of underperforming the market return of 1% or less.

Panel A: Probability of market return underperformance for all maturity IO sets (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	56.4[a,b]	56.1(1)	55.8(1)	54.8(3)	54.2(4)	53.8(5)	54.2(4)	54.3(4)	54.0(4)	54.0(4)	53.2(6)
Aaa	55.2[a,b]	55.1(0)	55.1(0)	55.1(0)	55.1(0)	55.0(0)	55.0(0)	54.9(1)	54.9(1)	54.8(1)	54.6(1)
Aa	54.6[a]	53.1(3)[b]	52.3(4)	52.1(5)	51.8(5)	51.8(5)	51.7(5)	51.6(5)	51.6(6)	51.5(6)	51.4(6)
A	54.0[a]	52.5(3)[b]	51.9(4)	51.3(5)	51.0(6)	50.9(6)	51.0(6)	50.8(6)	50.7(6)	50.5(6)	50.6(6)
Baa	52.8[a]	51.7(2)[b]	51.2(3)	51.0(3)	50.8(4)	50.7(4)	50.7(4)	50.6(4)	50.4(4)	50.4(5)	50.5(4)
Speculative	65.4[a]	64.0(2)	62.5(4)	61.3(6)[b]	60.6(7)	59.9(8)	59.5(9)	59.1(10)	58.8(10)	58.6(10)	58.3(11)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	53.0(6)	53.4(5)	53.1(6)	53.2(6)	52.9(6)	53.2(6)	53.2(6)	52.7(7)	53.0(6)	52.2(7)	0.0
Aaa	54.6(1)	54.6(1)	54.2(2)	54.1(2)	54.0(2)	53.8(3)	53.6(3)	53.6(3)	53.5(3)	53.3(3)	0.0
Aa	51.3(6)	51.2(6)	51.3(6)	51.3(6)	51.3(6)	51.2(6)	51.1(6)	51.0(7)	51.0(7)	51.1(6)	0.0
A	50.6(6)	50.7(6)	50.5(6)	50.3(7)	50.3(7)	50.3(7)	50.2(7)	50.2(7)	50.1(7)	50.2(7)	0.0
Baa	50.5(4)	50.6(4)	50.5(4)	50.3(5)	50.3(5)	50.3(5)	50.3(5)	50.4(5)	50.4(4)	50.4(5)	0.0
Speculative	58.1(11)	57.9(11)	57.8(12)	57.4(12)	57.3(12)	57.1(13)	56.9(13)	56.8(13)	56.6(13)	56.5(14)	0.0
Panel B: Probability of market return underperformance for all maturity IO sets with maturity < 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	57.0[a,b]	56.2(1)	55.5(3)	55.1(3)	54.8(4)	54.5(4)	54.2(5)	54.2(5)	53.9(5)	53.7(6)	53.6(6)
Aaa	53.3[a,b]	52.7(1)	52.2(2)	52.0(2)	51.7(3)	51.7(3)	51.8(3)	51.7(3)	51.6(3)	51.6(3)	51.4(3)
Aa	54.1[a]	53.2(2)[b]	52.7(3)	52.5(3)	52.1(4)	52.0(4)	51.6(5)	51.4(5)	51.2(5)	51.1(5)	51.1(6)
A	53.3[a,b]	52.7(1)	52.3(2)	51.9(3)	51.7(3)	51.6(3)	51.5(3)	51.5(3)	51.5(3)	51.6(3)	51.5(3)
Baa	51.7[a,b]	51.3(1)	51.1(1)	50.9(2)	50.5(2)	50.5(2)	50.5(2)	50.6(2)	50.6(2)	50.5(2)	50.5(2)
Speculative	64.0[a]	62.6(2)	61.3(4)[b]	60.3(6)	59.4(7)	58.9(8)	58.4(9)	58.1(9)	57.9(10)	57.5(10)	57.4(10)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	53.5(6)	53.4(6)	53.4(6)	53.3(7)	53.2(7)	53.2(7)	53.1(7)	52.8(7)	52.7(8)	52.5(8)	0.0
Aaa	51.5(3)	51.5(3)	51.5(3)	51.5(3)	51.5(3)	51.4(3)	51.5(3)	51.4(3)	51.5(3)	51.4(3)	0.0
Aa	50.9(6)	50.8(6)	50.9(6)	50.8(6)	50.9(6)	50.8(6)	50.8(6)	50.9(6)	50.8(6)	50.7(6)	0.0
A	51.5(4)	51.3(4)	51.3(4)	51.2(4)	51.3(4)	51.3(4)	51.3(4)	51.2(4)	51.2(4)	51.2(4)	0.0
Baa	50.4(2)	50.3(3)	50.3(3)	50.4(3)	50.2(3)	50.2(3)	50.2(3)	50.0(3)	49.9(3)	49.9(3)	0.0
Speculative	57.2(11)	56.9(11)	56.8(11)	56.7(11)	56.6(12)	56.6(12)	56.4(12)	56.4(12)	56.2(12)	56.1(12)	0.0
Panel C: Probability of market return underperformance for all maturity IO sets with maturity > 10 years (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	61.2[a]	59.2(3)	57.9(5)	56.0(9)[b]	56.0(9)	55.5(9)	55.2(10)	54.9(10)	54.4(11)	54.7(11)	54.7(11)
Aaa	53.3[a,b]	53.2(0)	53.0(1)	53.0(1)	53.0(1)	53.0(1)	52.8(1)	52.8(1)	52.8(1)	52.8(1)	52.8(1)
Aa	56.0[a]	53.8(4)	52.7(6)[b]	52.4(6)	52.4(6)	52.1(7)	52.0(7)	51.9(7)	51.7(8)	51.8(8)	51.6(8)
A	54.8[a]	53.2(3)	52.2(5)[b]	51.8(5)	51.8(5)	51.9(5)	51.8(5)	51.6(6)	51.6(6)	51.5(6)	51.5(6)
Baa	54.1[a]	51.9(4)[b]	51.1(5)	50.8(6)	50.8(6)	50.6(6)	50.7(6)	50.7(6)	50.6(7)	50.6(7)	50.5(7)
Speculative	69.9[a]	68.5(2)	66.6(5)[b]	65.6(6)	65.1(7)	65.0(7)	64.9(7)	65.0(7)	64.8(7)	64.9(7)	64.9(7)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	All
All	54.2(12)	54.9(10)	54.6(11)	55.0(10)	55.0(10)	55.3(10)	54.2(11)	54.9(10)	54.0(12)	54.2(11)	0.0
Aaa	52.7(1)	52.7(1)	52.7(1)	52.6(1)	52.5(1)	52.4(2)	52.3(2)	52.3(2)	52.3(2)	52.2(2)	0.0
Aa	51.4(8)	51.4(8)	51.4(8)	51.5(8)	51.4(8)	51.4(8)	51.2(8)	51.1(9)	51.0(9)	51.0(9)	0.0
A	51.4(6)	51.2(6)	51.1(7)	51.2(7)	51.0(7)	51.0(7)	50.8(7)	50.8(7)	50.7(7)	50.7(8)	0.0
Baa	50.5(7)	50.4(7)	50.3(7)	50.3(7)	50.2(7)	50.2(7)	50.3(7)	50.3(7)	50.3(7)	50.4(7)	0.0
Speculative	64.7(7)	64.6(8)	64.5(8)	64.4(8)	64.3(8)	64.2(8)	64.3(8)	64.2(8)	64.1(8)	64.1(8)	0.0

Table 3.27. Mean realized dispersion differentiated by issuer type for different sample periods

This table reports the mean realized dispersion (MRD) of quoted returns (i.e., the mean of the cross-sectional standard deviations of IO set *j* for the whole period) as defined in equation (3.3) and differentiated by portfolio size and issuer type for all maturities. In panel A,B,C we report the MRD for years 1986-1989,1990-1993,and 1994-1997 respectively. [a] indicates that the means for a PS of 2 and All are significantly different at the 0.05 level [b] refers to the lowest PS beyond which increasing PS would result in a reduction in MRD from a benchmark PS of 2 of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Mean realized dispersions for all maturities (multiplied by 100) for the 1986-1989 period											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	77.5 [a]	49.1(37)	34.3(56)	27.8(64)	24.1(69)	21.7(72)	19.7(74)	18.3(76)	17.0(78)[b]	16.1(79)	15.3(80)
Tr./Ag.	121.3 [a]	78.1(36)	55.6(54)	45.4(63)	39.4(68)	35.4(71)	32.3(73)	30.0(75)	28.0(77)[b]	26.4(78)	25.1(79)
Industrial	112.5 [a]	69.0(39)	48.1(57)	39.7(65)	34.1(70)	30.5(73)	27.8(75)	25.6(77)	23.8(79)[b]	22.4(80)	21.2(81)
Utility	22.0 [a]	13.6(38)	9.6(56)	7.9(64)	6.8(69)	6.1(72)	5.6(74)	5.2(76)	4.9(78)[b]	4.6(79)	4.3(80)
Financial	32.5 [a]	20.8(36)	14.7(55)	12.1(63)	10.5(68)	9.3(71)	8.5(74)	7.8(76)	7.3(77)	6.9(79)[b]	6.6(80)
Foreign	14.1 [a]	8.9(37)	6.3(55)	5.2(63)	4.5(68)	4.0(72)	3.7(74)	3.4(76)	3.2(77)	3.0(79)[b]	2.8(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	14.5(81)	13.9(82)	13.4(83)	12.9(83)	12.4(84)	12.0(85)	11.7(85)	11.3(85)	11.0(86)	10.8(86)	0.0
Tr./Ag.	23.9(80)	22.9(81)	22.0(82)	21.3(83)	20.5(83)	19.9(84)	19.2(84)	18.7(85)	18.2(85)	17.8(85)	0.1
Industrial	20.1(82)	19.3(83)	18.6(84)	17.9(84)	17.3(85)	16.7(85)	16.2(86)	15.7(86)	15.4(86)	15.0(87)	0.1
Utility	4.1(81)	4.0(82)	3.8(83)	3.7(83)	3.5(84)	3.4(84)	3.3(85)	3.2(85)	3.1(86)	3.1(86)	0.0
Financial	6.3(81)	6.0(82)	5.8(82)	5.6(83)	5.4(84)	5.2(84)	5.0(85)	4.9(85)	4.8(85)	4.7(86)	0.1
Foreign	2.7(81)	2.6(82)	2.5(83)	2.4(83)	2.3(84)	2.2(84)	2.2(85)	2.1(85)	2.1(86)	2.0(86)	0.1
Panel B: Mean realized dispersions for all maturities (multiplied by 100) for the 1990-1993 period											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	30.9 [a]	19.8(36)	14.0(55)	11.3(63)	9.8(68)	8.8(71)	8.0(74)	7.4(76)	6.9(78)[b]	6.5(79)	6.2(80)
Tr./Ag.	17.2 [a]	10.8(37)	7.6(56)	6.2(64)	5.4(69)	4.8(72)	4.4(75)	4.0(77)[b]	3.8(78)	3.5(79)	3.4(80)
Industrial	50.7 [a]	32.5(36)	23.4(54)	19.1(62)	16.4(68)	14.6(71)	13.4(74)	12.3(76)[b]	11.5(77)	10.9(79)	10.4(80)
Utility	17.0 [a]	10.8(37)	7.6(55)	6.2(64)	5.4(68)	4.8(72)	4.4(74)	4.1(76)	3.8(78)[b]	3.6(79)	3.4(80)
Financial	30.2 [a]	18.9(37)	13.5(55)	11.0(64)	9.5(68)	8.5(72)	7.8(74)	7.2(76)	6.7(78)[b]	6.3(79)	6.0(80)
Foreign	12.0 [a]	7.6(36)	5.4(55)	4.4(63)	3.8(68)	3.4(72)	3.1(74)	2.9(76)	2.7(77)	2.5(79)[b]	2.4(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.9(81)	5.7(82)	5.4(82)	5.2(83)	5.1(84)	4.9(84)	4.8(85)	4.6(85)	4.5(85)	4.4(86)	0.0
Tr./Ag.	3.2(81)	3.1(82)	3.0(83)	2.8(84)	2.7(84)	2.7(85)	2.6(85)	2.5(86)	2.4(86)	2.4(86)	0.0
Industrial	9.9(81)	9.5(81)	9.1(82)	8.7(83)	8.4(83)	8.2(84)	7.9(84)	7.7(85)	7.5(85)	7.3(86)	0.1
Utility	3.2(81)	3.1(82)	3.0(83)	2.9(83)	2.8(84)	2.7(84)	2.6(85)	2.5(85)	2.5(86)	2.4(86)	0.0
Financial	5.7(81)	5.5(82)	5.3(83)	5.1(83)	4.9(84)	4.8(84)	4.6(85)	4.5(85)	4.4(86)	4.2(86)	0.1
Foreign	2.3(81)	2.2(82)	2.1(83)	2.0(83)	2.0(84)	1.9(85)	1.9(85)	1.8(85)	1.8(86)	1.7(86)	0.1
Panel C: Mean realized dispersions for all maturities (multiplied by 100) for the 1994-1997 period											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	15.5 [a]	9.9(36)	7.0(55)	5.7(63)	4.9(68)	4.4(72)	4.0(74)	3.7(76)	3.5(77)	3.3(79)[b]	3.1(80)
Tr./Ag.	12.1 [a]	7.6(37)	5.4(55)	4.4(64)	3.8(69)	3.4(72)	3.1(74)	2.9(76)	2.7(78)[b]	2.5(79)	2.4(80)
Industrial	22.4 [a]	14.3(36)	10.1(55)	8.2(64)	7.1(68)	6.3(72)	5.8(74)	5.4(76)	5.0(78)[b]	4.7(79)	4.5(80)
Utility	14.4 [a]	9.1(36)	6.4(56)	5.2(64)	4.5(69)	4.0(72)	3.7(74)	3.4(76)	3.2(78)[b]	3.0(79)	2.9(80)
Financial	22.9 [a]	13.7(40)	9.5(59)	7.5(67)	6.5(72)	5.8(75)	5.2(77)	4.9(79)[b]	4.6(80)	4.3(81)	4.1(82)
Foreign	10.6 [a]	6.7(37)	4.8(55)	3.9(64)	3.4(69)	3.0(72)	2.8(74)	2.6(76)	2.4(78)[b]	2.3(79)	2.1(80)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	3.0(81)	2.9(82)	2.7(82)	2.6(83)	2.6(84)	2.5(84)	2.4(85)	2.3(85)	2.3(85)	2.2(86)	0.0
Tr./Ag.	2.3(81)	2.2(82)	2.1(83)	2.0(83)	2.0(84)	1.9(84)	1.8(85)	1.8(85)	1.7(86)	1.7(86)	0.0
Industrial	4.3(81)	4.1(82)	3.9(82)	3.8(83)	3.7(84)	3.5(84)	3.4(85)	3.3(85)	3.3(86)	3.2(86)	0.0
Utility	2.7(81)	2.6(82)	2.5(83)	2.4(83)	2.3(84)	2.3(84)	2.2(85)	2.1(85)	2.1(86)	2.0(86)	0.0
Financial	3.9(83)	3.7(84)	3.6(85)	3.4(85)	3.3(86)	3.2(86)	3.1(87)	3.0(87)	2.9(87)	2.9(88)	0.0
Foreign	2.0(81)	1.9(82)	1.9(83)	1.8(83)	1.7(84)	1.7(84)	1.6(85)	1.6(85)	1.6(86)	1.5(86)	0.0

Table 3.28. Mean realized dispersion, skewness, and kurtosis for straight bonds differentiated by issuer type

This table reports the mean realized dispersion (MRD), skewness and kurtosis of quoted returns for IO sets differentiated by issuer type for all maturity. [a] indicates that the means for a PS of 2 and All are significantly different at the 0.05 level [b] refers to the lowest PS beyond which increasing PS would result in a reduction in MRD from a benchmark PS of 2 of 1% or less provided that the difference in the means for a *PS* of 2 and All are significantly different at the 0.05 level. "Tr./Ag." refers to Treasury/Agency.

Panel A: Mean realized dispersions for all maturities (multiplied by 100)											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	17.3 [a]	11.3(35)	7.9(54)	6.5(62)	5.6(67)	5.1(71)	4.6(73)	4.3(75)	4.0(77)[b]	3.8(78)	3.6(79)
Tr./Ag.	28.1 [a]	17.0(39)	12.0(57)	9.8(65)	8.6(69)	7.7(73)	7.0(75)	6.6(76)	6.2(78)[b]	5.8(79)	5.5(81)
Industrial	2.4 [a]	1.5(37)	1.1(55)	0.9(64)	0.8(68)	0.7(72)	0.6(74)	0.6(76)	0.5(78)[b]	0.5(79)	0.5(80)
Utility	0.8 [a]	0.5(38)	0.4(56)	0.3(65)	0.3(70)	0.2(73)	0.2(76)[b]	0.2(77)	0.2(78)	0.2(80)	0.2(80)
Financial	9.3 [a]	5.6(40)	4.0(57)	3.3(65)	2.8(70)	2.5(73)	2.3(76)[b]	2.1(77)	2.0(79)	1.9(80)	1.8(81)
Foreign	6.6 [a]	4.2(37)	3.0(55)	2.4(64)	2.1(69)	1.9(72)	1.7(75)[b]	1.6(76)	1.5(78)	1.4(79)	1.3(81)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	3.4(80)	3.3(81)	3.2(82)	3.0(82)	2.9(83)	2.8(84)	2.7(84)	2.7(85)	2.6(85)	2.5(85)	0.0
Tr./Ag.	5.2(81)	5.0(82)	4.8(83)	4.6(84)	4.4(84)	4.3(85)	4.2(85)	4.0(86)	3.9(86)	3.8(86)	0.0
Industrial	0.5(81)	0.4(82)	0.4(83)	0.4(83)	0.4(84)	0.4(85)	0.4(85)	0.4(85)	0.4(86)	0.3(86)	0.0
Utility	0.2(82)	0.2(83)	0.2(83)	0.1(84)	0.1(84)	0.1(85)	0.1(85)	0.1(87)	0.1(87)	0.1(87)	0.0
Financial	1.7(82)	1.6(83)	1.5(84)	1.5(84)	1.4(85)	1.4(85)	1.4(86)	1.3(86)	1.3(86)	1.3(87)	0.0
Foreign	1.3(81)	1.2(82)	1.2(83)	1.1(84)	1.1(84)	1.1(85)	1.0(85)	1.0(86)	1.0(86)	0.9(86)	0.1
Panel B: Skewness for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	0.8 [a,b]	0.4(23)	0.3(31)	0.2(34)	0.2(36)	0.2(37)	0.2(38)	0.2(39)	0.1(40)	0.1(40)	0.1(41)
Tr./Ag.	0.3 [a,b]	0.2(5)	0.2(10)	0.2(12)	0.1(14)	0.1(15)	0.1(16)	0.1(17)	0.1(17)	0.1(17)	0.1(18)
Industrial	0.7 [a,b]	0.4(19)	0.3(27)	0.2(30)	0.2(32)	0.2(33)	0.2(34)	0.2(35)	0.1(36)	0.1(37)	0.1(37)
Utility	0.4 [a,b]	0.3(20)	0.2(30)	0.1(34)	0.1(37)	0.1(38)	0.1(39)	0.1(41)	0.1(42)	0.1(43)	0.1(43)
Financial	0.7 [a,b]	0.4(15)	0.3(23)	0.2(28)	0.2(29)	0.2(30)	0.2(31)	0.2(32)	0.1(33)	0.1(33)	0.1(34)
Foreign	1.2 [a,b]	0.8(16)	0.5(24)	0.4(27)	0.4(30)	0.3(31)	0.3(32)	0.3(33)	0.3(33)	0.3(34)	0.2(34)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	0.1(41)	0.1(41)	0.1(42)	0.1(42)	0.1(42)	0.1(43)	0.1(43)	0.1(43)	0.1(43)	0.1(43)	-0.8
Tr./Ag.	0.1(18)	0.1(19)	0.1(19)	0.1(19)	0.1(19)	0.1(19)	0.1(20)	0.1(20)	0.1(20)	0.1(20)	-0.9
Industrial	0.1(38)	0.1(38)	0.1(38)	0.1(39)	0.1(39)	0.1(39)	0.1(39)	0.1(39)	0.1(40)	0.1(40)	-0.8
Utility	0.1(44)	0.1(44)	0.1(45)	0.1(45)	0.1(45)	0.1(46)	0.1(45)	0.1(45)	0.1(45)	0.1(46)	-0.4
Financial	0.1(34)	0.1(34)	0.1(35)	0.1(35)	0.1(36)	0.1(36)	0.1(36)	0.1(36)	0.1(36)	0.1(36)	-0.9
Foreign	0.2(35)	0.2(35)	0.2(35)	0.2(36)	0.2(36)	0.2(36)	0.2(36)	0.2(36)	0.2(37)	0.2(37)	-1.7
Panel C: Kurtosis for all maturities											
IO set/ PS	**2**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
All	75.4 [a]	30.0(60)	16.5(78)	11.8(84)	9.5(87)	8.1(89)[b]	7.3(90)	6.7(91)	6.2(92)	5.8(92)	5.5(93)
Tr./Ag.	50.5 [a]	22.9(55)	13.1(74)	9.8(81)	8.0(84)	6.9(86)	6.2(88)[b]	5.7(89)	5.4(89)	5.2(90)	5.0(90)
Industrial	39.3 [a]	17.7(55)	10.3(74)	7.9(80)	6.7(83)	5.9(85)[b]	5.4(86)	5.1(87)	4.8(88)	4.6(88)	4.4(89)
Utility	10.8 [a]	6.2(43)	4.5(59)	4.0(63)	3.8(65)[b]	3.6(66)	3.5(67)	3.5(68)	3.4(69)	3.3(69)	3.3(70)
Financial	89.0 [a]	37.6(58)	20.5(77)	14.7(84)	11.8(87)[b]	10.3(88)	9.1(90)	8.2(91)	7.6(91)	7.0(92)	6.6(93)
Foreign	43.6 [a]	18.7(57)	10.8(75)	8.3(81)	6.9(84)	6.2(86)[b]	5.6(87)	5.2(88)	5.0(89)	4.7(89)	4.5(90)
IO set/ PS	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**	**All**
All	5.2(93)	5.0(93)	4.9(94)	4.7(94)	4.6(94)	4.5(94)	4.4(94)	4.4(94)	4.3(94)	4.3(94)	123.4
Tr./Ag.	4.9(90)	4.7(91)	4.6(91)	4.4(91)	4.3(91)	4.2(92)	4.2(92)	4.1(92)	4.1(92)	4.0(92)	85.1
Industrial	4.3(89)	4.2(89)	4.1(90)	4.0(90)	4.0(90)	3.9(90)	3.9(90)	3.8(90)	3.8(90)	3.7(91)	73.3
Utility	3.3(70)	3.3(70)	3.2(70)	3.2(70)	3.2(70)	3.2(71)	3.2(70)	3.2(71)	3.2(71)	3.2(71)	13.8
Financial	6.3(93)	6.0(93)	5.7(94)	5.5(94)	5.4(94)	5.2(94)	5.1(94)	5.0(94)	4.9(95)	4.8(95)	191.8
Foreign	4.4(90)	4.3(90)	4.2(90)	4.1(91)	4.0(91)	4.0(91)	3.9(91)	3.9(91)	3.8(91)	3.8(91)	84.5

Table 3.29. Summary of the Minimum Portfolio Size Beyond which the Marginal Benefits are less than 1%.

This table reports the minimum portfolio sizes beyond which the marginal benefits of increasing the portfolio size are less than 1% for various diversification metrics. These include: *MDD* (mean excess standard deviation), *MRD* (mean cross-sectional dispersion), *NPV* (normalized portfolio variance), and *SV* (semi variances), skewness (*skew*), left tail weight (*LTW*), *Sor* (Sortino ratio), and probabilities of earning less than the market return over a 3-year holding period (*Prob3yr*). "Tr./Ag." refers to Treasury/Agency;

Panel A: PS of IO sets differentiated by issuer type (credit rating) with bonds of all maturites										
IO set	**MDD**	**MRD**	**NPV**	**SV**	**ER**	**Sh**	**Sor**	**skew**	**LTW**	**Prob3yr.**
All (All)	45(40)	40(40)	25(20)	25(25)	45(45)	40(40)	35(35)	2(2)	85(100)	2(2)
Tr./Ag. (Aaa)	35(45)	35(35)	20(25)	25(25)	45(60)	45(45)	50(45)	2(2)	70(75)	15(2)
Industrial (Aa)	40(45)	35(40)	20(40)	20(25)	50(25)	20(25)	45(25)	2(2)	85(100)	10(5)
Utility (A)	45(50)	40(40)	20(30)	25(25)	30(30)	30(20)	25(30)	2(2)	85(100)	10(5)
Financial (Baa)	45(45)	45(40)	30(25)	20(20)	40(30)	25(35)	30(30)	2(2)	100(65)	2(5)
Foreign (Speculative)	40(35)	40(40)	30(25)	25(20)	35(55)	25(50)	30(30)	2(2)	100(60)	10(15)
Panel B: PS of IO sets differentiated by issuer type (credit rating) with bonds of having maturities less than 10 years										
All (All)	35(40)	35(40)	20(20)	25(25)	35(40)	45(55)	30(35)	2(2)	95(100)	2(2)
Tr./Ag. (Aaa)	35(45)	40(40)	20(20)	25(25)	45(25)	25(25)	25(25)	2(2)	85(90)	2(2)
Industrial (Aa)	30(45)	40(40)	20(40)	20(30)	40(25)	20(25)	35(30)	2(2)	85(90)	5(5)
Utility (A)	35(55)	35(40)	25(30)	20(30)	35(30)	30(30)	30(25)	2(2)	85(95)	15(5)
Financial (Baa)	35(55)	35(35)	25(30)	25(25)	35(30)	65(50)	35(25)	2(2)	100(45)	2(2)
Foreign (Speculative)	35(45)	35(35)	25(20)	25(20)	20(45)	55(55)	20(35)	2(2)	80(70)	2(10)
Panel C: PS of IO sets differentiated by issuer type (credit rating) with bonds of having maturities more than 10 years										
All (All)	50(50)	40(40)	30(25)	25(20)	45(45)	25(30)	35(35)	2(2)	95 (95)	2(15)
Tr./Ag. (Aaa)	35(60)	40(40)	20(35)	25(25)	50(75)	30(35)	5(45)	2(2)	25(100)	2(2)
Industrial (Aa)	45(60)	40(40)	25(35)	20(30)	50(30)	15(15)	35(30)	2(2)	65(85)	10(10)
Utility (A)	55(60)	40(40)	25(40)	25(20)	35(20)	20(15)	30(35)	2(2)	85(100)	5(10)
Financial (Baa)	50(45)	45(40)	25(25)	15(20)	30(30)	20(20)	40(30)	2(2)	85(45)	10(5)
Foreign (Speculative)	35(35)	45(40)	25(20)	25(25)	25(40)	10(100)	25(35)	2(2)	45(35)	10(10)

Table 4.1. Estimated Spreads from Treasuries and Average Root Mean Squared Errors

This table reports the mean of monthly credit spreads from Treasuries for Aa-, A- and Baa rated bonds in the financial and industrial sectors for the 1990-97 period. The treasury spot rates, which are reported as annualized spot rates (in %), are derived using the Nelson and Siegel approach. Corporate credit spreads are reported as the difference between the derived spot rates for corporates and treasuries. The average root mean squared errors (ARMSE) for each derived term structure as measured in cents per $100 are reported in the last row of the table.

Maturities/ Period	Treasuries	Measured spreads from treasuries (in %)					
		Financial			Industrial		
		Aa	A	Baa	Aa	A	Baa
1	4.922	0.380	0.415	0.683	0.342	0.329	0.733
2	5.200	0.413	0.471	0.782	0.381	0.381	0.840
3	5.414	0.459	0.539	0.881	0.425	0.443	0.929
4	5.594	0.500	0.600	0.962	0.463	0.498	0.997
5	5.751	0.533	0.651	1.025	0.493	0.544	1.048
6	5.890	0.560	0.694	1.072	0.514	0.581	1.085
7	6.015	0.581	0.728	1.108	0.529	0.611	1.112
8	6.126	0.597	0.756	1.134	0.538	0.635	1.129
9	6.226	0.609	0.779	1.153	0.543	0.653	1.140
10	6.317	0.618	0.797	1.165	0.545	0.668	1.145
ARMSE	0.277	0.696	0.761	1.166	0.748	0.816	1.475

Table 4.2. Correlations between the Independent Variables in the Model of Credit Risk Changes for the Financial and Industrial Sectors

This table reports the correlations between the independent variables of equation (4.1) for the financial sector in the lower diagonal cells of each panel and in italics in the upper diagonal cells for the industrial sector. "GDP" represents the change in expected GDP. "Liq" represents the change in the relative frequency of matrix prices. "RatingVol" is the change in the average volatility of bonds for the Aa- or A- or Baa- ratings. "Slope" is the change in the expected slope of the yield curve as calculated from consensus expectations of 3-month and 10-year forward rates. "Default" represents changes in the sum of default probabilities of all speculative grade ratings in the one-year transition matrices for a 84-month moving window. "UndivRisk" is the change in the undiversifiable risk as proxied by the change in the MRD.

Factors	GDP	Liq	RatingVol	Slope	Default	UndivRisk
Panel A: Aa Rating						
GDP	1	*0.2798*	*0.0223*	*0.1883*	*-0.1207*	*-0.1549*
Liq	0.0991	1	*0.06*	*-0.1112*	*-0.0769*	*-0.003*
RatingVol	-0.0475	0.0739	1	*-0.0489*	*-0.0125*	*-0.0163*
Slope	0.1883	0.0448	0.0667	1	*0.068*	*0.0338*
Default	-0.1403	-0.325	-0.0595	-0.0044	1	*0.2679*
UndivRisk	-0.1549	0.184	-0.0101	0.0338	-0.1608	1
Panel B: A Rating						
GDP	1	*0.1422*	*-0.1042*	*0.1883*	*-0.1207*	*-0.1549*
Liq	0.1751	1	*0.182*	*-0.2076*	*0.0751*	*0.0254*
RatingVol	0.0219	0.3622	1	*-0.4535*	*0.003*	*-0.0175*
Slope	0.1883	0.149	0.2125	1	*0.068*	*0.0338*
Default	-0.1403	-0.1165	-0.0108	-0.0044	1	*0.2679*
UndivRisk	-0.1549	-0.1821	0.0364	0.0338	-0.1608	1
Panel C: Baa Rating						
GDP	1	*0.2013*	*0.1049*	*0.1883*	*-0.1207*	*-0.1549*
Liq	-0.0367	1	*0.1484*	*-0.1478*	*-0.0745*	*-0.1043*
RatingVol	0.0219	0.4976	1	*-0.0054*	*-0.036*	*-0.0528*
Slope	0.1883	0.1799	0.2125	1	*0.068*	*0.0338*
Default	-0.1403	-0.1959	-0.0108	-0.0044	1	*0.2679*
UndivRisk	-0.1549	0.1294	0.0364	0.0338	-0.1608	1

Table 4.3. The Determinants of Credit Spread Changes for Corporate Bonds in the Financial Sector for the 1990-1997 Period

This table reports regression results for the determinants of the changes in credit spreads from month *t-1* to month *t* for the period 1990-97 for maturities one through ten for corporate bonds in the financial sector using seemingly unrelated regressions (SUR). "GDP" represents the change in expected GDP. "Liq" represents the change in relative frequency of matrix prices. "RatingVol" is the change in the average volatilities of bonds for the Aa- or A- or Baa-rating category. "Slope" is the change in the expected slope of the yield curve calculated from the expected 3 month and 10 year forward rates. "Default" represents changes in the sum of default probabilities of all speculative grade ratings in the one-year transition matrices for a 84-month moving window. "UndivRisk" is the change in the undiversifiable risk as proxied by the change in the MRD. The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Coefficient Estimates (p-values in parentheses)							Adj. R^2
Maturity	**Constant**	**GDP**	**Liq**	**RatingVol**	**Slope**	**Default**	**UndivRisk**	**(%)**
Panel A: Financial Aa-rated bonds								
1	-0.21(0.22)	-1.20(0.00) [c]	1.70(0.07) [a]	45.42(0.00) [c]	22.88(0.02) [b]	1.70(0.00) [c]	15.51(0.00) [c]	44.17
2	-0.21(0.23)	-1.22(0.00) [c]	1.65(0.08) [a]	47.12(0.00) [c]	23.15(0.02) [b]	1.52(0.00) [c]	14.92(0.00) [c]	42.23
3	-0.21(0.22)	-1.22(0.00) [c]	1.68(0.07) [a]	47.07(0.00) [c]	23.46(0.02) [b]	1.48(0.00) [c]	14.70(0.00) [c]	41.81
4	-0.22(0.21)	-1.22(0.00) [c]	1.73(0.07) [a]	46.79(0.00) [c]	23.72(0.02) [b]	1.46(0.00) [c]	14.60(0.00) [c]	41.57
5	-0.22(0.20)	-1.22(0.00) [c]	1.78(0.06) [a]	46.54(0.00) [c]	23.93(0.01) [c]	1.46(0.00) [c]	14.56(0.00) [c]	41.29
6	-0.23(0.20)	-1.22(0.00) [c]	1.82(0.06) [a]	46.37(0.00) [c]	24.11(0.01) [c]	1.46(0.00) [c]	14.54(0.00) [c]	41.02
7	-0.23(0.19)	-1.22(0.00) [c]	1.87(0.05) [b]	46.29(0.00) [c]	24.27(0.01) [c]	1.47(0.00) [c]	14.54(0.00) [c]	40.81
8	-0.23(0.19)	-1.22(0.00) [c]	1.91(0.05) [b]	46.27(0.00) [c]	24.41(0.01) [c]	1.47(0.00) [c]	14.54(0.00) [c]	40.7
9	-0.23(0.19)	-1.23(0.00) [c]	1.96(0.04) [b]	46.31(0.00) [c]	24.55(0.01) [c]	1.48(0.00) [c]	14.54(0.00) [c]	40.71
10	-0.24(0.19)	-1.24(0.00) [c]	2.00(0.04) [b]	46.40(0.00) [c]	24.69(0.01) [c]	1.49(0.00) [c]	14.55(0.00) [c]	40.85

Table 4.3. Continued

Maturity	Coefficient Estimates (p-values in parentheses)							Adj. R^2 (%)
	Constant	GDP	Liq	RatingVol	Slope	Default	UndivRisk	
Panel B: Financial A-rated bonds								
1	-0.05(0.74)	-1.13(0.00) [c]	-2.49(0.14)	18.89(0.00) [c]	18.94(0.02) [b]	1.52(0.00) [c]	17.07(0.00) [c]	59.34
2	-0.05(0.75)	-1.17(0.00) [c]	-2.32(0.17)	18.98(0.00) [c]	19.09(0.02) [b]	1.51(0.00) [c]	16.54(0.00) [c]	59.31
3	-0.05(0.76)	-1.18(0.00) [c]	-2.16(0.20)	19.12(0.00) [c]	19.10(0.02) [b]	1.47(0.00) [c]	16.26(0.00) [c]	58.62
4	-0.04(0.78)	-1.17(0.00) [c]	-2.07(0.23)	19.29(0.00) [c]	19.07(0.03) [b]	1.43(0.00) [c]	16.11(0.00) [c]	57.59
5	-0.04(0.80)	-1.16(0.00) [c]	-2.03(0.25)	19.47(0.00) [c]	19.04(0.03) [b]	1.39(0.00) [c]	15.97(0.00) [c]	56.4
6	-0.04(0.81)	-1.16(0.00) [c]	-2.04(0.25)	19.67(0.00) [c]	19.04(0.03) [b]	1.35(0.00) [c]	15.82(0.00) [c]	55.22
7	-0.04(0.83)	-1.16(0.00) [c]	-2.08(0.25)	19.88(0.00) [c]	19.08(0.04) [b]	1.32(0.00) [c]	15.65(0.00) [c]	54.17
8	-0.03(0.83)	-1.17(0.00) [c]	-2.16(0.24)	20.09(0.00) [c]	19.15(0.04) [b]	1.29(0.00) [c]	15.46(0.00) [c]	53.32
9	-0.03(0.84)	-1.18(0.00) [c]	-2.27(0.23)	20.30(0.00) [c]	19.26(0.04) [b]	1.27(0.00) [c]	15.26(0.00) [c]	52.68
10	-0.03(0.84)	-1.19(0.00) [c]	-2.39(0.21)	20.50(0.00) [c]	19.39(0.04) [b]	1.26(0.00) [c]	15.06(0.00) [c]	52.26
Panel C: Financial Baa-rated bonds								
1	-0.10(0.72)	-0.86(0.00) [c]	6.80(0.00) [c]	14.97(0.30)	4.96(0.79)	1.24(0.00) [c]	19.13(0.00) [c]	45.5
2	-0.11(0.69)	-0.78(0.01) [c]	6.74(0.00) [c]	14.44(0.31)	5.78(0.76)	1.19(0.00) [c]	18.88(0.00) [c]	45.2
3	-0.13(0.64)	-0.73(0.01) [c]	6.90(0.00) [c]	13.65(0.33)	7.04(0.71)	1.20(0.00) [c]	18.52(0.00) [c]	46
4	-0.15(0.60)	-0.70(0.02) [b]	7.04(0.00) [c]	13.11(0.36)	7.99(0.67)	1.22(0.00) [c]	18.22(0.00) [c]	45.58
5	-0.16(0.59)	-0.67(0.02) [b]	7.11(0.00) [c]	12.80(0.38)	8.61(0.66)	1.25(0.00) [c]	17.97(0.00) [c]	44.42
6	-0.17(0.58)	-0.66(0.03) [b]	7.13(0.00) [c]	12.67(0.39)	9.03(0.65)	1.29(0.00) [c]	17.77(0.00) [c]	43.09
7	-0.17(0.58)	-0.66(0.03) [b]	7.13(0.00) [c]	12.65(0.41)	9.33(0.65)	1.33(0.00) [c]	17.63(0.00) [c]	41.87
8	-0.18(0.58)	-0.66(0.03) [b]	7.10(0.00) [c]	12.70(0.41)	9.56(0.64)	1.37(0.00) [c]	17.54(0.00) [c]	40.88
9	-0.18(0.58)	-0.68(0.03) [b]	7.07(0.00) [c]	12.79(0.42)	9.76(0.64)	1.42(0.00) [c]	17.51(0.00) [c]	40.16
10	-0.18(0.57)	-0.71(0.03) [b]	7.03(0.00) [c]	12.92(0.42)	9.93(0.64)	1.48(0.00) [c]	17.53(0.00) [c]	39.7

Table 4.4. The Determinants of Credit Spread Changes for Corporate Bonds in the Industrial Sector for the 1990-1997 Period

This table reports regression results for the determinants of the changes in credit spreads from month *t-1* to month *t* for the period 1990-97 for years one through ten for corporate bonds in the industrial sector using seemingly unrelated regressions (SUR). "GDP" represents the change in expected GDP. "Liq" represents the change in relative frequency of matrix prices. "RatingVol" is the change in the average volatilities of bonds for the Aa- or A- or Baa-rating category. "Slope" is the change in the expected slope of the yield curve calculated from the expected 3 month and 10 year forward rates. "Default" represents changes in the sum of default probabilities of all speculative grade ratings in the one-year transition matrices for 84-month moving windows. "UndivRisk" is the change in the undiversifiable risk as proxied by the change in the MRD . The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. "CS" is the one period lag in the change of credit spreads. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Coefficient Estimates (p-values in parentheses)								Adj. R^2
Maturity	**Constant**	**GDP**	**Liq**	**RatingVol**	**Slope**	**Default**	**UndivRisk**	**CS**	**(%)**
Panel A: Industrial Aa-rated bonds									
1	-0.06(0.61)	-0.06(0.78)	1.78(0.08) [a]	0.85(0.92)	4.69(0.52)	0.09(0.76)	1.91(0.45)	-0.31(0.00) [c]	6.11
2	-0.03(0.59)	-0.02(0.85)	2.11(0.00) [c]	0.48(0.91)	3.04(0.39)	0.10(0.46)	1.50(0.23)	-0.33(0.00) [c]	21.91
3	-0.02(0.67)	0.02(0.76)	1.87(0.00) [c]	0.10(0.97)	1.98(0.40)	0.04(0.66)	0.86(0.30)	-0.34(0.00) [c]	32.74
4	-0.01(0.78)	0.05(0.39)	1.54(0.00) [c]	-0.07(0.97)	1.34(0.47)	-0.02(0.77)	0.35(0.60)	-0.35(0.00) [c]	35.62
5	0.00(0.87)	0.07(0.19)	1.23(0.00) [c]	-0.14(0.94)	0.94(0.57)	-0.07(0.27)	-0.03(0.97)	-0.35(0.00) [c]	33.47
6	0.00(0.95)	0.07(0.11)	0.96(0.00) [c]	-0.17(0.93)	0.67(0.66)	-0.11(0.07) [a]	-0.28(0.60)	-0.36(0.00) [c]	28.95
7	0.00(1.00)	0.08(0.08) [a]	0.73(0.00) [c]	-0.21(0.91)	0.47(0.75)	-0.14(0.02) [b]	-0.44(0.39)	-0.36(0.00) [c]	23.88
8	0.00(0.97)	0.08(0.07) [a]	0.54(0.01) [c]	-0.26(0.88)	0.33(0.82)	-0.15(0.01) [c]	-0.53(0.30)	-0.36(0.00) [c]	19.13
9	0.00(0.95)	0.08(0.06) [a]	0.40(0.04) [b]	-0.32(0.85)	0.21(0.88)	-0.16(0.00) [c]	-0.54(0.27)	-0.36(0.00) [c]	14.65
10	0.00(0.93)	0.08(0.06) [a]	0.28(0.13)	-0.40(0.80)	0.12(0.93)	-0.17(0.00) [c]	-0.50(0.29)	-0.37(0.00) [c]	9.94

Table 4.4. Continued

Maturity	Coefficient Estimates (p-values in parentheses)								Adj. R^2 (%)
	Constant	GDP	Liq	RatingVol	Slope	Default	UndivRisk	CS	
Panel B: Industrial A-rated bonds									
1	0.02(0.60)	0.03(0.70)	0.18(0.73)	-2.04(0.67)	-1.64(0.60)	0.04(0.70)	-1.00(0.32)	-0.49(0.00) [c]	27.35
2	0.02(0.53)	0.03(0.56)	0.27(0.39)	-2.24(0.45)	-1.46(0.45)	0.00(0.95)	-0.81(0.18)	-0.49(0.00) [c]	26.18
3	0.01(0.49)	0.01(0.78)	0.31(0.14)	-1.89(0.34)	-1.11(0.40)	-0.02(0.59)	-0.81(0.05) [b]	-0.50(0.00) [c]	29.67
4	0.01(0.51)	-0.01(0.52)	0.33(0.02) [b]	-1.42(0.29)	-0.71(0.42)	-0.03(0.32)	-0.85(0.00) [c]	-0.50(0.00) [c]	35.67
5	0.00(0.64)	-0.04(0.03) [b]	0.35(0.00) [c]	-0.94(0.32)	-0.35(0.58)	-0.03(0.21)	-0.85(0.00) [c]	-0.51(0.00) [c]	40.29
6	0.00(0.91)	-0.06(0.00) [c]	0.35(0.00) [c]	-0.50(0.54)	-0.05(0.92)	-0.02(0.31)	-0.82(0.00) [c]	-0.51(0.00) [c]	37.57
7	0.00(0.83)	-0.07(0.00) [c]	0.34(0.00) [c]	-0.12(0.89)	0.18(0.75)	-0.01(0.69)	-0.75(0.00) [c]	-0.51(0.00) [c]	31.53
8	0.00(0.68)	-0.08(0.00) [c]	0.33(0.00) [c]	0.20(0.82)	0.35(0.56)	0.00(0.81)	-0.66(0.00) [c]	-0.52(0.00) [c]	28.49
9	0.00(0.59)	-0.09(0.00) [c]	0.31(0.00) [c]	0.47(0.62)	0.46(0.45)	0.02(0.39)	-0.56(0.01) [c]	-0.52(0.00) [c]	28.38
10	-0.01(0.54)	-0.10(0.00) [c]	0.30(0.00) [c]	0.67(0.48)	0.54(0.39)	0.03(0.14)	-0.46(0.03) [b]	-0.52(0.00) [c]	29.27
Panel C: Industrial Baa-rated bonds									
1	0.03(0.57)	-0.25(0.02) [b]	0.03(0.91)	-11.54(0.14)	-1.65(0.65)	0.06(0.70)	-3.23(0.01) [c]	-0.45(0.00) [c]	20.3
2	0.01(0.85)	-0.42(0.00) [c]	0.21(0.32)	-6.46(0.34)	-0.07(0.98)	0.16(0.23)	-4.25(0.00) [c]	-0.44(0.00) [c]	40.56
3	0.00(0.97)	-0.49(0.00) [c]	0.34(0.10) [a]	-3.58(0.58)	0.46(0.88)	0.28(0.03) [b]	-3.99(0.00) [c]	-0.44(0.00) [c]	44.58
4	0.00(0.95)	-0.53(0.00) [c]	0.41(0.06) [a]	-1.88(0.79)	0.82(0.80)	0.37(0.01) [c]	-3.54(0.00) [c]	-0.44(0.00) [c]	41.83
5	-0.01(0.89)	-0.56(0.00) [c]	0.45(0.06) [a]	-0.98(0.90)	1.11(0.75)	0.43(0.00) [c]	-3.10(0.01) [c]	-0.44(0.00) [c]	38.54
6	-0.01(0.84)	-0.57(0.00) [c]	0.44(0.06) [a]	-0.61(0.94)	1.34(0.70)	0.46(0.00) [c]	-2.67(0.04) [b]	-0.44(0.00) [c]	36.1
7	-0.02(0.78)	-0.57(0.00) [c]	0.42(0.08) [a]	-0.61(0.94)	1.51(0.66)	0.47(0.00) [c]	-2.27(0.07) [a]	-0.44(0.00) [c]	34.2
8	-0.02(0.73)	-0.56(0.00) [c]	0.36(0.11)	-0.86(0.91)	1.61(0.63)	0.46(0.00) [c]	-1.88(0.12)	-0.44(0.00) [c]	32.36
9	-0.02(0.68)	-0.54(0.00) [c]	0.30(0.17)	-1.28(0.85)	1.65(0.60)	0.43(0.00) [c]	-1.50(0.18)	-0.44(0.00) [c]	30.06
10	-0.02(0.63)	-0.51(0.00) [c]	0.21(0.28)	-1.83(0.77)	1.64(0.57)	0.40(0.00) [c]	-1.15(0.27)	-0.44(0.00) [c]	26.65

Table 4.5. Robustness Test for the Determinants of Credit Spread Changes for the 1990-1997 Period for Financial Bond

This table reports the robustness results for the seemingly unrelated regressions (SUR) of the changes in credit spreads from month t-1 to month t for the period 1990-1997 for years one through ten. "GDP" represents the change in realized GDP. "Liq" represents the average dollar amount (in billions) at issuance date for the bonds traded during month t. "ImpVol" is the change in the Vix index which measures the market implied volatility. "Slope" is the change in the slope of the yield curve calculated from the 3 month and 10 year constant maturity treasury rates. "Default" represents the difference between long-term corporate and government indexes as obtained from the Ibbotson database. "UndivRisk" is the change in the skewness of bond returns for 5000 randomly selected portfolios with size *N-1*. The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. ^{a}, ^{b} and ^{c} indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

	Coefficient Estimates (p-values in parentheses)							Adj.
Maturity	Constant	GDP	Liq	ImpVol	Slope	Default	UndivRisk	R^2 (%)
Panel A: Financial Aa-rated bonds								
1	-0.86(0.01) ^{c}	-0.03(0.01) ^{c}	-28.78(0.14)	0.08(0.03) ^{b}	2.20(0.07) ^{a}	1.01(0.02) ^{b}	0.35(0.04) ^{b}	21.35
2	-0.86(0.01) ^{c}	-0.03(0.01) ^{c}	-28.13(0.15)	0.07(0.04) ^{b}	2.32(0.05) ^{b}	0.86(0.05) ^{b}	0.34(0.05) ^{b}	19.03
3	-0.87(0.01) ^{c}	-0.03(0.01) ^{c}	-28.83(0.14)	0.07(0.05) ^{b}	2.36(0.05) ^{b}	0.83(0.06) ^{a}	0.32(0.06) ^{a}	18.33
4	-0.87(0.01) ^{c}	-0.03(0.01) ^{c}	-29.85(0.13)	0.07(0.05) ^{b}	2.38(0.05) ^{b}	0.82(0.06) ^{a}	0.30(0.08) ^{a}	17.98
5	-0.87(0.01) ^{c}	-0.03(0.01) ^{c}	-30.94(0.12)	0.07(0.05) ^{b}	2.38(0.05) ^{b}	0.82(0.06) ^{a}	0.28(0.10) ^{a}	17.73
6	-0.87(0.01) ^{c}	-0.03(0.01) ^{c}	-32.06(0.11)	0.07(0.05) ^{b}	2.38(0.05) ^{b}	0.82(0.06) ^{a}	0.27(0.12)	17.55
7	-0.87(0.01) ^{c}	-0.03(0.02) ^{b}	-33.17(0.10) ^{a}	0.07(0.05) ^{b}	2.36(0.05) ^{b}	0.83(0.06) ^{a}	0.26(0.13)	17.44
8	-0.87(0.01) ^{c}	-0.03(0.02) ^{b}	-34.29(0.09) ^{a}	0.07(0.04) ^{b}	2.35(0.06) ^{a}	0.83(0.06) ^{a}	0.25(0.14)	17.4
9	-0.87(0.01) ^{c}	-0.03(0.02) ^{b}	-35.42(0.08) ^{a}	0.07(0.04) ^{b}	2.32(0.06) ^{a}	0.84(0.06) ^{a}	0.25(0.15)	17.44
10	-0.86(0.01) ^{c}	-0.03(0.02) ^{b}	-36.56(0.07) ^{a}	0.07(0.04) ^{b}	2.30(0.06) ^{b}	0.84(0.06) ^{a}	0.25(0.15)	17.55

Table 4.5. Continued

Maturity	Coefficient Estimates (p-values in parentheses)							Adj. R^2 (%)
	Constant	GDP	Liq	ImpVol	Slope	Default	UndivRisk	
Panel B: Financial A-rated bonds								
1	-0.77(0.03)[b]	-0.02(0.04)[b]	-13.20(0.50)	0.10(0.01)[c]	2.16(0.08)[a]	1.02(0.02)[b]	0.28(0.10)[a]	21.21
2	-0.77(0.03)[b]	-0.02(0.04)[b]	-17.73(0.37)	0.09(0.01)[c]	2.10(0.09)[a]	1.04(0.02)[b]	0.27(0.11)	20.8
3	-0.77(0.04)[b]	-0.02(0.04)[b]	-22.01(0.27)	0.09(0.01)[c]	2.10(0.09)[a]	1.01(0.02)[b]	0.27(0.13)	20.8
4	-0.76(0.04)[b]	-0.02(0.05)[b]	-25.69(0.20)	0.10(0.01)[c]	2.11(0.09)[a]	0.96(0.03)[b]	0.26(0.14)	20.71
5	-0.76(0.04)[b]	-0.02(0.05)[b]	-28.79(0.15)	0.10(0.01)[c]	2.11(0.09)[a]	0.92(0.04)[b]	0.25(0.15)	20.49
6	-0.75(0.04)[b]	-0.02(0.05)[b]	-31.38(0.12)	0.10(0.01)[c]	2.11(0.09)[a]	0.88(0.05)[b]	0.25(0.16)	20.18
7	-0.75(0.05)[b]	-0.02(0.05)[b]	-33.54(0.10)[a]	0.10(0.01)[c]	2.10(0.10)[a]	0.85(0.06)[a]	0.25(0.16)	19.85
8	-0.74(0.05)[b]	-0.02(0.06)[a]	-35.33(0.09)[a]	0.10(0.01)[c]	2.09(0.10)[a]	0.83(0.07)[a]	0.25(0.16)	19.52
9	-0.74(0.05)[b]	-0.02(0.06)[a]	-36.81(0.08)[a]	0.10(0.01)[c]	2.07(0.11)	0.82(0.08)[a]	0.25(0.16)	19.23
10	-0.74(0.05)[b]	-0.02(0.06)[a]	-38.02(0.07)[a]	0.10(0.01)[c]	2.05(0.11)	0.81(0.08)[a]	0.26(0.16)	19
Panel C: Financial Baa-rated bonds								
1	-1.77(0.00)[c]	-0.06(0.00)[c]	2.05(0.92)	0.09(0.02)[b]	2.24(0.10)	0.41(0.40)	0.32(0.09)	14.58
2	-1.79(0.00)[c]	-0.06(0.00)[c]	-7.31(0.73)	0.10(0.02)[b]	2.06(0.12)	0.39(0.42)	0.28(0.12)	13.94
3	-1.80(0.00)[c]	-0.06(0.00)[c]	-14.80(0.48)	0.10(0.01)[c]	2.16(0.10)[a]	0.42(0.38)	0.23(0.21)	14.62
4	-1.81(0.00)[c]	-0.06(0.00)[c]	-21.01(0.32)	0.10(0.01)[c]	2.21(0.09)[a]	0.46(0.33)	0.18(0.32)	15.26
5	-1.81(0.00)[c]	-0.06(0.00)[c]	-26.13(0.22)	0.11(0.01)[c]	2.21(0.10)[a]	0.50(0.30)	0.15(0.41)	15.69
6	-1.82(0.00)[c]	-0.06(0.00)[c]	-30.26(0.16)	0.11(0.01)[c]	2.18(0.10)[a]	0.54(0.26)	0.13(0.47)	15.97
7	-1.82(0.00)[c]	-0.06(0.00)[c]	-33.51(0.12)	0.11(0.01)[c]	2.12(0.12)	0.59(0.22)	0.13(0.50)	16.14
8	-1.82(0.00)[c]	-0.06(0.00)[c]	-35.97(0.10)[a]	0.11(0.01)[c]	2.07(0.13)	0.65(0.19)	0.13(0.50)	16.24
9	-1.82(0.00)[c]	-0.06(0.00)[c]	-37.74(0.09)[a]	0.12(0.01)[c]	2.02(0.15)	0.71(0.16)	0.13(0.49)	16.3
10	-1.82(0.00)[c]	-0.06(0.00)[c]	-38.91(0.08)[a]	0.12(0.00)[c]	1.98(0.16)	0.76(0.13)	0.14(0.47)	16.32

Table 4.6. Robustness Test for the Determinants of Credit Spread Changes for the 1990-1997 Period for Industrial Bonds

This table reports the robustness results for the seemingly unrelated regressions (SUR) of the changes in credit spreads from month t-1 to month t for the period 1990-1997 for years one through ten. "GDP" represents the changes in realized GDP. "Liq" represents the average dollar amount (in billions) at issuance date for the bonds traded during month t. "ImpVol" is the change in the Vix index which measures the market implied volatility. "Slope" is the change in the slope of the yield curve calculated from the 3 month and 10 year constant maturity treasury rates. "Default" represents the difference between long-term corporate and government indexes as obtained from the Ibbotson database. "UndivRisk" is the change in the skewness of bond returns for 5000 randomly selected portfolios with size *N-1*. The p-values for the parameter estimates are reported in the parentheses next to their coefficient estimates. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Maturity	Coefficient Estimates (p-values in parentheses)								Adj. R^2 (%)
	Constant	GDP	Liq	ImpVol	Slope	Default	UndivRisk	CS	
Panel A: Industrial Aa-rated bonds									
1	-0.05(0.79)	0.00(0.81)	8.88(0.44)	-0.00(0.92)	1.98(0.01)[c]	-0.30(0.25)	0.16(0.11)	-0.28(0.00)[c]	13.57
2	-0.07(0.49)	0.00(0.51)	9.77(0.10)[a]	0.01(0.56)	1.18(0.00)[c]	-0.21(0.11)	0.08(0.11)	-0.30(0.00)[c]	20.74
3	-0.08(0.27)	0.00(0.28)	9.05(0.03)[b]	0.01(0.41)	0.68(0.01)[c]	-0.19(0.05)[b]	0.03(0.40)	-0.32(0.00)[c]	20.62
4	-0.08(0.16)	0.00(0.16)	7.98(0.02)[b]	0.01(0.40)	0.36(0.09)[a]	-0.17(0.03)[b]	0.00(0.95)	-0.33(0.00)[c]	18.86
5	-0.09(0.11)	0.00(0.10)	6.82(0.03)[b]	-0.00(0.45)	0.16(0.40)	-0.16(0.02)[b]	-0.02(0.37)	-0.33(0.00)[c]	17.62
6	-0.08(0.08)[a]	0.00(0.08)[a]	5.68(0.04)[b]	-0.00(0.56)	0.02(0.91)	-0.16(0.01)[c]	-0.04(0.12)	-0.34(0.00)[c]	16.99
7	-0.08(0.08)[a]	0.00(0.07)[a]	4.59(0.07)[a]	-0.00(0.71)	-0.08(0.61)	-0.15(0.01)[c]	-0.05(0.04)[b]	-0.34(0.00)[c]	16.56
8	-0.07(0.08)[a]	0.00(0.07)[a]	3.57(0.14)	-0.00(0.91)	-0.15(0.32)	-0.15(0.01)[c]	-0.05(0.02)[b]	-0.34(0.00)[c]	15.94
9	-0.07(0.10)[a]	0.00(0.08)[a]	2.65(0.25)	-0.00(0.87)	-0.19(0.17)	-0.14(0.01)[c]	-0.05(0.01)[c]	-0.35(0.00)[c]	14.76
10	-0.06(0.12)	0.00(0.10)[a]	1.81(0.40)	-0.00(0.64)	-0.22(0.10)	-0.13(0.01)[c]	-0.05(0.01)[c]	-0.35(0.00)[c]	12.7

Table 4.6. Continued

Maturity	Coefficient Estimates (p-values in parentheses)								Adj. R^2 (%)
	Constant	GDP	Liq	ImpVol	Slope	Default	UndivRisk	CS	
Panel B: Industrial A-rated bonds									
1	0.06(0.43)	0.00(0.46)	-3.78(0.39)	0.02(0.01)[c]	-0.26(0.34)	0.11(0.25)	-0.04(0.33)	-0.49(0.00)[c]	34.99
2	0.04(0.42)	0.00(0.43)	-2.46(0.38)	0.01(0.26)	-0.14(0.42)	0.04(0.51)	-0.01(0.63)	-0.49(0.00)[c]	28.35
3	0.03(0.37)	0.00(0.36)	-1.09(0.57)	-0.00(0.25)	-0.10(0.42)	0.01(0.75)	0.00(0.79)	-0.50(0.00)[c]	29.19
4	0.03(0.27)	0.00(0.25)	-0.06(0.96)	0.00(0.06)[a]	-0.08(0.34)	0.00(0.88)	0.00(0.97)	-0.50(0.00)[c]	31.88
5	0.02(0.16)	0.00(0.13)	0.66(0.50)	0.01(0.00)[c]	-0.07(0.28)	0.00(0.86)	0.00(0.75)	-0.50(0.00)[c]	31.8
6	0.02(0.11)	0.00(0.08)[a]	1.11(0.21)	0.01(0.00)[c]	-0.05(0.32)	0.01(0.71)	0.01(0.48)	-0.51(0.00)[c]	25.72
7	0.02(0.10)[a]	0.00(0.07)[a]	1.35(0.14)	0.01(0.00)[c]	-0.04(0.47)	0.01(0.52)	0.01(0.32)	-0.51(0.00)[c]	19.67
8	0.03(0.09)[a]	0.00(0.07)[a]	1.43(0.14)	0.01(0.00)[c]	-0.03(0.65)	0.02(0.35)	0.01(0.22)	-0.51(0.00)[c]	17.79
9	0.03(0.07)[a]	0.00(0.05)[b]	1.39(0.17)	0.01(0.00)[c]	-0.01(0.84)	0.03(0.21)	0.01(0.15)	-0.52(0.00)[c]	18.46
10	0.03(0.05)[b]	0.00(0.03)[b]	1.26(0.21)	0.01(0.00)[c]	0.00(0.99)	0.04(0.11)	0.01(0.09)[a]	-0.52(0.00)[c]	19.55
Panel C: Industrial Baa-rated bonds									
1	0.20(0.05)[b]	0.01(0.05)[b]	-9.73(0.10)[a]	0.03(0.00)[c]	-0.08(0.83)	0.24(0.07)[a]	-0.09(0.08)[a]	-0.43(0.00)[c]	24.51
2	0.18(0.07)[a]	0.01(0.07)[a]	-7.85(0.18)	0.03(0.02)[b]	-0.29(0.41)	0.31(0.02)[b]	-0.03(0.53)	-0.42(0.00)[c]	27.46
3	0.18(0.07)[a]	0.01(0.07)[a]	-3.31(0.56)	0.03(0.01)[c]	-0.31(0.38)	0.37(0.01)[c]	0.02(0.69)	-0.42(0.00)[c]	27.56
4	0.18(0.09)	0.01(0.08)[a]	0.00(1.00)	0.03(0.00)[c]	-0.29(0.44)	0.41(0.00)[c]	0.05(0.29)	-0.42(0.00)[c]	26.9
5	0.18(0.10)[a]	0.01(0.09)[a]	1.89(0.76)	0.03(0.00)[c]	-0.25(0.52)	0.44(0.00)[c]	0.08(0.17)	-0.42(0.00)[c]	26.04
6	0.17(0.11)	0.01(0.10)[a]	2.72(0.67)	0.04(0.00)[c]	-0.21(0.60)	0.45(0.00)[c]	0.09(0.12)	-0.42(0.00)[c]	24.96
7	0.17(0.11)	0.01(0.10)[a]	2.81(0.65)	0.04(0.00)[c]	-0.17(0.66)	0.44(0.00)[c]	0.09(0.10)[a]	-0.42(0.00)[c]	23.46
8	0.16(0.11)	0.01(0.10)[a]	2.40(0.69)	0.03(0.00)[c]	-0.14(0.71)	0.43(0.00)[c]	0.09(0.10)[a]	-0.42(0.00)[c]	21.28
9	0.16(0.10)	0.01(0.09)[a]	1.65(0.77)	0.03(0.00)[c]	-0.11(0.74)	0.41(0.00)[c]	0.08(0.11)	-0.43(0.00)[c]	17.98
10	0.15(0.10)	0.01(0.08)[a]	0.67(0.90)	0.03(0.00)[c]	-0.10(0.77)	0.38(0.00)[c]	0.07(0.13)	-0.43(0.00)[c]	12.91

Table 5.1. Cross-sectional Averages of Various Single Month ARs and Multi-month AAR for the Bonds and Stocks of Firms after their Addition from the LBA Bond Index Using Unconditional Models

This table reports the cross-sectional averages of various single month Abnormal Returns (ARs) and multi-month Average Abnormal Returns (AARs) (both in %) for the bonds and stocks of firms after additions of their bonds to the Lehman and Brothers aggregate (LBA) bond index using four unconditional models. The factors are the LBA bond index in panel A; the LBA bond and S&P500 stock indexes in panel B; and the LB mortgage bond index, term premium (difference in monthly returns between the long- and short-term government bond indexes), and default premium (difference between the returns on a market portfolio of long-term corporate and government bonds) in panel C. AAR [.,.] refers to the % AAR for the (multi-) month period beginning and ending with the first and second month in the brackets relative to the revision announcement month depicted as 0. The p-value for the mean significance and the Wilcoxon p-value that tests whether the median AAR is significantly different from zero are also reported. The sample sizes are 25 and 59 for bond inclusions and deletions, respectively, for the bond AAR, and correspondingly are 20 and 52 for the stock AAR. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Event Period	[-1]	[0]	[1]	[-1,1]	[-1,0]	[0, 1]	[0,2]	[0,3]	[1,2]	[1,3]	[2]	[3]
Panel A: Unconditional one-factor bond model												
Mean	0.351	0.643	0.480	0.528	0.523	0.551	0.346	0.358	0.202	0.351	0.264	0.101
P-Val	0.008[c]	0.004[c]	0.019[b]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.053[a]	0.008[c]	0.002[c]	0.341
Median	0.336	0.460	0.198	0.434	0.437	0.337	0.278	0.243	0.148	0.336	0.287	0.024
Wilcoxon	0.001[c]	0.000[c]	0.003[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.018[b]	0.001[c]	0.001[c]	0.268
Panel B: Unconditional two-factor bond model												
Mean	0.377	0.589	0.554	0.550	0.505	0.555	0.309	0.341	0.182	0.377	0.589	0.554
P-Val	0.006[c]	0.001[c]	0.007[c]	0.000[c]	0.000[c]	0.000[c]	0.001[c]	0.000[c]	0.080[a]	0.006[c]	0.001[c]	0.007[c]
Median	0.242	0.410	0.243	0.418	0.397	0.374	0.276	0.226	0.122	0.242	0.410	0.243
Wilcoxon	0.001[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.033[b]	0.001[c]	0.000[c]	0.000[c]
Panel C: Unconditional three-factor bond model												
Mean	0.292	0.556	0.373	0.443	0.455	0.439	0.206	0.254	0.053	0.292	0.556	0.373
P-Val	0.036[b]	0.015[b]	0.040[b]	0.000[c]	0.000[c]	0.000[c]	0.012[b]	0.003[c]	0.576	0.036[b]	0.015[b]	0.040[b]
Median	0.303	0.426	0.165	0.339	0.329	0.337	0.196	0.152	0.029	0.303	0.426	0.165
Wilcoxon	0.004[c]	0.001[c]	0.036[b]	0.000[c]	0.000[c]	0.000[c]	0.003[c]	0.001[c]	0.667	0.004[c]	0.001[c]	0.036[b]
Panel D: Unconditional three–factor stock model of Fama and French												
Mean	-0.080	-0.591	1.578	-0.161	-0.769	0.514	-0.230	-0.378	0.009	-0.080	-0.591	1.578
P-Val	0.976	0.857	0.686	0.942	0.700	0.838	0.907	0.820	0.997	0.976	0.857	0.686
Median	-2.503	0.402	-0.857	-1.608	-0.705	-0.711	-1.321	-1.117	-1.646	-2.503	0.402	-0.857
Wilcoxon	0.898	0.999	0.375	0.850	0.850	0.695	0.695	0.557	0.695	0.898	0.999	0.375

Table 5.2. Cross-sectional Averages of Various Single Month ARs and Multi-month AAR for the Bonds and Stocks of Firms after their Addition from the LBA Bond Index Using Conditional Models

This table reports the cross-sectional averages of various single month Abnormal Returns (ARs) and multi-month Average Abnormal Returns (AARs) (both in %) for the bonds and stocks of firms after additions of their bonds to the Lehman and Brothers aggregate (LBA) bond index using four models conditioned on four lagged macroeconomic variables: dividend yield of the CRSP stock index, the slope of the term structure, the corporate credit spread and the risk free rate as in Ferson and Schadt (1996). The factors are the LBA bond index in panel A; the LBA bond and S&P500 stock indexes in panel B; and the LB mortgage bond index, term premium (difference in monthly returns between the long- and short-term government bond indexes), and default premium (difference between the returns on a market portfolio of long-term corporate and government bonds) in panel C. AAR [.,.] refers to the % AAR for the multi-month period beginning and ending with the first and second month in the brackets relative to the revision announcement month depicted as 0. We also report the p-value for the mean significance and the Wilcoxon p-value that tests whether the median of AAR is significantly different from zero. The sample sizes are 25 and 59 for bond inclusions and deletions, respectively, for the bond AAR, and are correspondingly 20 and 52 for the stock AAR. [a, b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Event Period	[-1]	[0]	[1]	[-1,1]	[-1,0]	[0, 1]	[0,2]	[0,3]	[1,2]	[1,3]	[2]	[3]
Panel A: Conditional one-factor bond model												
Mean	0.446	0.702	0.312	0.528	0.644	0.490	0.285	0.264	0.101	0.446	-1.607	-0.021
P-Val	0.001[c]	0.200	0.145	0.000[c]	0.000[c]	0.000[c]	0.001[c]	0.002[c]	0.341	0.001[c]	0.785	0.887
Median	0.322	0.399	0.174	0.373	0.420	0.367	0.316	0.287	0.024	0.322	-2.212	-0.055
Wilcoxon	0.000[c]	0.000[c]	0.103	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.001[c]	0.268	0.000[c]	0.001[c]	0.828
Panel B: Conditional two-factor bond model												
Mean	0.305	0.740	0.406	0.499	0.601	0.495	0.377	0.350	0.248	0.305	-1.908	-0.057
P-Val	0.095[c]	0.159	0.101	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.023[b]	0.095[a]	0.666	0.707
Median	0.213	0.443	0.165	0.391	0.509	0.319	0.338	0.361	0.177	0.213	-2.808	-0.151
Wilcoxon	0.002[c]	0.000[c]	0.087[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.001[c]	0.006[c]	0.002[c]	0.000[c]	0.388
Panel C: Conditional three-factor bond model												
Mean	0.257	0.522	0.316	0.395	0.455	0.421	0.302	0.271	0.185	0.257	-1.341	0.120
P-Val	0.089[a]	0.494	0.104	0.000[c]	0.000[c]	0.001[c]	0.000[c]	0.002[c]	0.024[b]	0.089	0.940	0.451
Median	0.282	0.416	0.109	0.289	0.324	0.220	0.297	0.268	0.175	0.282	-2.264	0.215
Wilcoxon	0.005[c]	0.002[c]	0.036[b]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.005[c]	0.001[c]	0.251
Panel D: Conditional three–factor stock model of Fama and French												
Mean	0.354	2.812	3.298	1.678	0.506	2.151	0.877	0.811	1.135	0.354	-3.314	-0.211
P-Val	0.875	0.894	0.411	0.484	0.793	0.379	0.615	0.576	0.674	0.875	0.779	0.954
Median	0.327	2.131	-0.140	0.875	0.542	2.446	0.729	-0.227	-0.987	0.327	-4.994	-0.459
Wilcoxon	0.831	0.432	0.922	0.569	0.677	0.557	0.770	0.922	0.999	0.831	0.250	0.999

Table 5.3. Cross-sectional Averages of Various Single Month ARs and Multi-month AAR for the Bonds and Stocks of Firms after their Deletion from the LBA Bond Index Using Unconditional Models

This table reports the cross-sectional averages of various single month Abnormal Returns (ARs) and multi-month Average Abnormal Returns (AARs) (both in %) for the bonds and stocks of firms after deletions of their bonds from the Lehman and Brothers aggregate (LBA) bond index using four unconditional models. The factors are the LBA bond index in panel A; the LBA bond and S&P500 stock indexes in panel B; and the LB mortgage bond index, term premium (difference in monthly returns between the long- and short-term government bond indexes), and default premium (difference between the returns on a market portfolio of long-term corporate and government bonds) in panel C. AAR [.,.] refers to the % AAR for the multi-month period beginning and ending with the first and second month in the brackets relative to the revision announcement month depicted as 0. We also report the p-value for the mean significance and the Wilcoxon p-value that tests whether the median of AAR is significantly different from zero. The sample sizes are 25 and 59 for bond inclusions and deletions, respectively, for the bond AAR, and are correspondingly 20 and 52 for the stock AAR. [a], [b] and [c] indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Event Period	[-1]	[0]	[1]	[-1,1]	[-1,0]	[0, 1]	[0,2]	[0,3]	[1,2]	[1,3]	[2]	[3]
Panel A: Unconditional one-factor bond model												
Mean	-1.694	-1.104	0.085	-1.285	-1.485	-1.812	-1.075	-0.783	0.225	-1.694	-0.783	0.225
P-Val	0.016[b]	0.441	0.553	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.258	0.016[b]	0.000[c]	0.258
Median	0.103	-2.070	0.113	-0.706	-1.152	-1.349	-0.562	-0.442	0.030	0.103	-0.443	0.030
Wilcoxon	0.991	0.001[c]	0.119	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.001[c]	0.706	0.991	0.001[c]	0.706
Panel B: Unconditional two-factor bond model												
Mean	-1.798	-1.014	-0.067	-1.319	-1.470	-1.822	-0.990	-0.644	0.268	-1.798	-0.644	0.268
P-Val	0.010[c]	0.092	0.702	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.005[c]	0.194	0.010[c]	0.005[c]	0.194
Median	0.029	-2.072	0.058	-0.945	-1.235	-1.374	-0.603	-0.449	0.035	0.029	-0.449	0.035
Wilcoxon	0.643	0.004[c]	0.744	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.002[c]	0.366	0.643	0.002[c]	0.366
Panel C: Unconditional three-factor bond model												
Mean	-1.844	-1.101	-0.015	-1.358	-1.547	-1.853	-1.021	-0.691	0.284	-1.844	-0.691	0.284
P-Val	0.010[c]	0.321	0.923	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.002[c]	0.186	0.010[c]	0.002[c]	0.187
Median	0.029	-2.128	0.104	-0.695	-1.160	-1.349	-0.522	-0.392	-0.005	0.029	-0.393	-0.005
Wilcoxon	0.722	0.001[c]	0.867	0.000[c]	0.000[c]	0.000[c]	0.000[c]	0.002[c]	0.993	0.722	0.002[c]	0.993
Panel D: Unconditional three–factor stock model of Fama and French												
Mean	0.471	0.454	0.490	0.461	0.475	0.455	0.451	0.459	0.499	0.471	0.193	-0.024
P-Val	0.313	0.514	0.320	0.325	0.322	0.339	0.338	0.328	0.309	0.313	0.646	0.950
Median	0.435	0.406	0.469	0.457	0.435	0.470	0.498	0.471	0.496	0.435	0.417	0.126
Wilcoxon	0.313	0.469	0.250	0.250	0.313	0.250	0.250	0.250	0.250	0.313	0.468	0.843

Table 5.4. Cross-sectional Averages of Various Single Month ARs and Multi-month AARs for the Bonds and Stocks of Firms after their Deletion from the LBA Bond Index Using Conditional Models

This table reports the cross-sectional averages of various single month Abnormal Returns (ARs) and multi-month Average Abnormal Returns (AARs) (both in %) for the bonds (panels A-C) and stocks (panel D) of firms after deletions of their bonds from the Lehman and Brothers aggregate (LBA) bond index using four models conditioned on four lagged macroeconomic variables: dividend yield of the CRSP stock index, the slope of the term structure, the corporate credit spread and the risk free rate as in Ferson and Schadt (1996). The factors are the LBA bond index in panel A; the LBA bond and S&P500 stock indexes in panel B; and the LB mortgage bond index, term premium (difference in monthly returns between the long- and short-term government bond indexes), and default premium (difference,between the returns on a market portfolio of long-term corporate and government bonds) in panel C. The ARs and AARs for the effect of bond index deletions on stock returns that are reported in panel D are based on the Fama and French (1993) three-factor model. AAR [.,.] refers to the % AAR for the multi-month period beginning and ending with the first and second month in the brackets relative to the revision announcement month depicted as 0. The p-values for t- and Wilcoxon tests of whether the mean and median AAR, respectively, are significantly different from zero are reported in the table. The sample sizes are 59 bonds and 52 stocks for bond deletions. $^{a,\ b}$ and ^{c} indicate statistical significance at the 0.10, 0.05 and 0.01 levels, respectively.

Event Period	-1	0	1	[-1,1]	[-1,0]	[0, 1]	[0,2]	[0,3]	[1,2]	[1,3]	2	3
Panel A: Conditional one-factor bond model												
Mean	-1.693	-1.607	-0.021	-1.446	-1.872	-1.978	-1.094	-0.776	0.322	-1.693	-0.776	0.322
P-Val	0.012^{b}	0.785	0.887	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.126	0.012^{b}	0.000^{c}	0.126
Median	-0.009	-2.212	-0.055	-1.184	-1.447	-1.300	-0.862	-0.551	0.042	-0.009	-0.551	0.042
Wilcoxon	0.403	0.001^{c}	0.828	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.327	0.403	0.000^{c}	0.327
Panel B: Conditional two-factor bond model												
Mean	-1.659	-1.908	-0.057	-1.549	-1.997	-2.184	-1.192	-0.811	0.321	-1.659	-0.811	0.321
P-Val	0.021^{b}	0.666	0.707	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.134	0.021^{b}	0.000^{c}	0.134
Median	-0.170	-2.808	-0.151	-1.232	-1.776	-1.567	-0.939	-0.621	0.128	-0.170	-0.621	0.128
Wilcoxon	0.071^{a}	0.000^{c}	0.388	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.175	0.071^{a}	0.000^{c}	0.175
Panel C: Conditional three-factor bond model												
Mean	-1.851	-1.341	0.120	-1.251	-1.583	-1.808	-0.972	-0.740	0.357	-1.851	-0.740	0.357
P-Val	0.014^{b}	0.940	0.451	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.001^{c}	0.136	0.014^{b}	0.001^{c}	0.136
Median	-0.016	-2.264	0.215	-0.869	-1.351	-1.167	-0.624	-0.474	-0.063	-0.016	-0.475	-0.063
Wilcoxon	0.232	0.001^{c}	0.251	0.000^{c}	0.000^{c}	0.000^{c}	0.000^{c}	0.001^{c}	0.920	0.232	0.001^{c}	0.920
Panel D: Conditional three–factor stock model of Fama and French												
Mean	-3.688	-3.314	-0.211	-2.807	-4.320	-2.265	-2.346	-1.382	-1.583	-3.688	-1.382	-1.583
P-Val	0.426	0.779	0.954	0.285	0.181	0.372	0.300	0.412	0.542	0.426	0.412	0.542
Median	-3.869	-4.994	-0.459	-1.306	-5.808	-1.538	-3.384	-2.112	-2.998	-3.869	-2.112	-2.998
Wilcoxon	0.432	0.250	0.999	0.322	0.232	0.375	0.275	0.492	0.492	0.432	0.492	0.492

Appendix A

Comparison between Different Term Structure Models

Although many different methods are used in the literature to derive the term structure of interest rates, it is unclear which method is best. Hence, it is necessary to briefly explain each of these methods in order to indicate their strengths and weaknesses. In future work, one or more of these alternative methods can be used to test the robustness of the results reported herein that have been obtained using the standard Nelson and Siegel approach.

In general, two categories of models are used to derive the term structure of interest rates. The affine term-structure models are based on an appealing theoretical foundation. However, growing evidence indicates that these models do not effectively capture deviations from the expectations hypothesis. The second grouping of essentially empirical models tends to better capture the time-series behavior of the term structure of interest rates but lacks a strong theoretical grounding.

A1. Affine Term Structure Models

This category includes the models of Vasicek (1977), Cox, Ingersoll, and Ross (1985a,b), and Longstaff and Schwartz (1992a,b). These models assume that future changes in the term structure of interest rates depend on the behavior of certain (un)observable state variables. Using a non-arbitrage argument, a relationship between the term structure of interest rates and these state variables can be determined.

Although these models are grounded theoretically, they have many disadvantages when used empirically. First, rarely are these models able to adequately fit the current observed term structure of interest rates. Second, the incorporation of non-linearity into these essentially linear models greatly increases their complexity. [65]

A2. Empirical Models

This category of models essentially estimates the term structure by extracting the zero-coupon and forward interest rates from the prices of non-zero coupon-paying bonds. Recently, the initial Nelson and Siegel (1987) approach has been modified to enable the models to better describe the dynamics of the term structure of interest rates, and consequently to construct a time-series model for the evolution of interest rates. We now describe the Nelson and Siegel approach that has been used in this thesis, and the extended Nelson and Siegel approach as suggested by Diebold and Li (2006).

A2.1 The Nelson and Siegel Approach

The original motivation for this modeling method was to capture the range of shapes generally seen in yield curves; namely, monotonic and s-shapes. Nelson and Siegel assume that the instantaneous forward rate at any time *t* can be captured by a sequence of exponential terms that are represented by the following functional form:[66]

$$f(t) = \beta_0 + \beta_1 \exp(-t/\tau_1) + \beta_2 (t/\tau_1)\exp(-t/\tau_1) \qquad \text{(A1)}$$

Since spot rates can be represented as the average of the relevant instantaneous forward rates, Nelson and Siegel derive the spot rate function as:

$$r(t) = \beta_0 + \beta_1 \left[\frac{1-\exp(-t/\tau_1)}{t/\tau_1} \right] + \beta_2 \left[\frac{1-\exp(-t/\tau_1)}{t/\tau_1} - \exp(-t/\tau_1) \right] \qquad \text{(A2)}$$

This model has four parameters that must be estimated, β_0, β_1, β_2 and τ_1. The expected impact of these parameters on the shape of the spot rate function curve is now addressed. β_0 depicts the long-term component because it is the limiting value of r(t) as maturity gets

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[65] For a thorough study of affine term structure models refer to Bolder (2001).

[66] The instantaneous forward rate can be defined as the marginal cost of borrowing for an infinitely short period of time.

larger. The implied short-term rate of interest is $\beta_0 + \beta_1$ because this is the limiting value as maturity tends to zero. β_1 defines the basic speed with which the curve tends towards its long-term trend, and a positive [negative] sign for β_1 indicates a negative [positive] slope for the curve. τ_1 specifies the position of the hump or U-shape in the curve.

The Nelson and Siegel approach, as extended by Svensson (1994), makes the yield curve conditional on six parameters instead of four. The additional two parameters allow the term structure to have two instead of one hump.

Diebold and Li (2006) note that equation (A2) is a linear combination of three functions, f_0, f_1 and f_2, with coefficients β_0, β_1 and β_2, respectively. Since these three functions can be interpreted as level, slope, and curvature of the term structure, Diebold and Li (2006) propose a model where the coefficients β_0, β_1 and β_2 can be interpreted as the weights on the level, slope and curvature of the term structure over time. Forecasts of these weights are estimated as univariate AR(1) processes.

A2.2 Spline-based Models

These models tend to avoid specifying a single functional form over the entire maturity range. Instead, they fit the term structure by smoothly joining polynomial individual segments at the so-called knot points. However, higher-order polynomials usually are not smooth. As a result, the literature tends to use lower-order polynomials (mostly quadratic or cubic).

An extension of the traditional cubic splines method is the "smoothing splines" method of Fisher, Nychka and Zervos (1995). In their extension, the number of parameters needed to derive the entire term structure is not fixed in advance. Instead, the model is over-parameterized at the beginning and the parameters that do not contribute to the goodness of fit test are penalized. The optimal number of knot points is obtained by minimizing the ratio of a goodness-of-fit measure to the number of parameters. This approach allows for a large number of knot points in the model to provide sufficient flexibility for curvature throughout the spline.

A3. Discussion

In a recent paper, Bolder (2006) examines six term-structure models that belong to the theoretical and empirical categories. The empirical models include the extension of Diebold and Li (2006) of the Nelson and Siegel approach, an exponential spline model based on the work of Li et al. (2001), and the Fourier-series model proposed by Bolder and Gusba (2002). Each of these models has a different mathematical structure and leads to different factor loadings of the term structure.[67] The theoretical models include the three-factor Gaussian model of Dai and Singleton (2000), and more complex forms of affine term-structure models where the market price of risk is based on the work of Leippold and Wu (2000) and Duffee (2002). Bolder (2006) finds that the empirical models outperform the theoretical models. The extension by Diebold and Li (2006) of the Nelson and Siegel model has the most consistent in- and out-of-sample forecasting performance. Furthermore, only the Nelson-Siegel model is capable of reasonably describing the observed deviations from the expectations hypothesis. Bolder (2006) concludes that the extended Nelson and Siegel approach outperforms the other model.

Most central banks that report data have in recent years adopted the Nelson and Siegel or the Nelson-Siegel-Svensson approach, with the exception of central banks in Canada, Japan, UK, and USA, which all apply variants of the smoothing splines method.

[67] The Nelson-Siegel, exponential-spline, and Fourier-series models have Laguerre, orthogonalized-exponential, and trigonometric basis functions, respectively.

Appendix B

Measuring the Default Premium in a Risk-Neutral World without State Taxes

In a risk neutral world, the value of a corporate bond is the certainty equivalent cash flows discounted back to time zero at the government bond rate. Consequently, the value of a two-year corporate bond could be expressed as:

$$V_{12}=[C(1-P_2)+aP_2+1(1-P_2)]\,e^{-f_{12}^G} \qquad \text{(B1)}$$

where C is the coupon rate; P_t is the probability of bankruptcy in period t conditional on surviving an earlier period; a is the recovery rate assumed to be a constant percentage of the principal in each period; f_{tt+1}^G is the risk-free forward rate as of time 0 from t to t+1; and V_{tT} is the value of a T period bond at time conditional on surviving an earlier period.

Similarly, the time zero value could be expressed as:

$$V_{02}=[C(1-P_2)+aP_2+1(1-P_2)]\,e^{-f_{01}^G} \qquad \text{(B2)}$$

On the other hand, the same bond could be expressed in terms of promised cash flows and corporate forward rates at year *1* by:

$$V_{12}=(C+1)e^{-f_{12}^C} \qquad \text{(B3)}$$

where f_{tt+1}^C is the forward rate from t to t+1 for corporate bonds. Using the same logic, the time zero value could be expressed as:

$$V_{02}=(C+1)e^{-f_{01}^C} \qquad \text{(B4)}$$

Equating the two values of V_{12} and rearranging yields a forward spread of:

$$e^{-(f_{12}^C-f_{12}^G)}=(1-P_2)+[aP_2/(1+C)] \qquad \text{(B5)}$$

Equating these expressions for V_{02} yields a forward rate spread of:

$$e^{-(f_{01}^C-f_{01}^G)}=(1-P_2)+[aP_2/(V_{12}+C)] \qquad \text{(B6)}$$

Generalizing (B5) and (B6), the difference in forward rates at period t is:

$$e^{-(f_{tt+1}^{C}-f_{tt+1}^{G})} = (1-P_{t+1}) + [aP_{t+1}/(V_{t+1T}+C)] \tag{B7}$$

where $V_{TT} = 1$.

Appendix C

Measuring State Taxes

The same argument as in the previous appendix is used to reflect the tax spread effect but now the tax rates are included in the equations. Consequently, V_{01} is expressed in terms of risk neutrality as:

$$V_{01}=[C\,(1-P_1)\,(1-t_s\,(1-t_g)) + aP_1 + (1-a)\,P1\,t_s\,(1-t_g) + (1-P_1)]\,e^{-f_{01}^G} \quad \text{(C1)}$$

where the additional terms t_s and t_g are the state and federal tax rates, respectively, and all the other terms are defined as in appendix B.

Also, V_{01} can be expressed in terms of promised cash flows as:

$$V_{01}=(C+1)\,e^{-f_{01}^C} \quad \text{(C2)}$$

Equating the two expressions yields:

$$e^{-(f_{01}^C-f_{01}^G)} = (1-P_1) + \frac{aP_1}{1+C} + \frac{C(1-P_1)-(1-a)P_1}{1+C}(t_s)(1-t_g) \quad \text{(C3)}$$

In general, the forward rate spread becomes:

$$e^{-(f_{tt+1}^C-f_{tt+1}^G)} = (1-P_{t+1}) + \frac{aP_{t+1}}{V_{t+1T}+C} + \frac{C(1-P_{t+1})-(1-a)P_{t+1}}{V_{t+1T}+C}(t_s)(1-t_g) \quad \text{(C4)}$$

Appendix D

The Relationship Between Returns and Spreads

Let $r_{t,m}^{C}$ and $r_{t,m}^{G}$ be the spot rates on a corporate bond and a government bond, respectively, that mature at period m. Then the price of a corporate and a government zero-coupon bond with face value equal to one dollar respectively is:

$$P_{t,m}^{C} = e^{-r_{t,m}^{C} \cdot m} \text{ and } P_{t,m}^{G} = e^{-r_{t,m}^{G} \cdot m} \quad \text{(D1)}$$

One month later the prices for the corporate and government bond respectively become:

$$P_{t+1,m}^{C} = e^{-r_{t+1,m}^{C} \cdot m}, \text{ and } P_{t+1,m}^{G} = e^{-r_{t+1,m}^{G} \cdot m}$$

(D2)

The returns on the corporate and government bond are simply:

$$R_{t,t+1}^{C} = \ln \frac{e^{-r_{t+1,m}^{C} \cdot m}}{e^{-r_{t,m}^{C} \cdot m}} = m(r_{t,m}^{C} - r_{t+1,m}^{C}) \text{, and} \quad \text{(D3)}$$

$$R_{t,t+1}^{G} = \ln \frac{e^{-r_{t+1,m}^{G} \cdot m}}{e^{-r_{t,m}^{G} \cdot m}} = m(r_{t,m}^{G} - r_{t+1,m}^{G}) \quad \text{(D4)}$$

Rearranging the difference in return between the corporate and government bond yields:

$$R_{t,t+1}^{C} - R_{t,t+1}^{G} = -m[(r_{t+1,m}^{C} - r_{t+1,m}^{G}) - (r_{t,m}^{C} - r_{t,m}^{G})] = -m\Delta S_{t,m} \quad \text{(D5)}$$

where $\Delta S_{t,m}$ is the change in the spread from time t to t+1 on an m period bond. Consequently, using the unexplained credit spread $r_{t,m}^{uc} - r_{t,m}^{G}$ instead of the full credit spread $r_{t,m}^{C} - r_{t,m}^{G}$ in equation

(D5) and using equation (D3), which shows that $m(r_{t,m}^{uc} - r_{t+1,m}^{uc}) = R_{t,t+1}^{uc}$ (i.e., the unexplained bond return), equation (D5) can be rewritten as:

$$R_{t,t+1}^{uc} - R_{t,t+1}^{G} = -m[(r_{t+1,m}^{uc} - r_{t+1,m}^{G}) - (r_{t,m}^{uc} - r_{t,m}^{G})] = -m\Delta S_{t,m}^{uc} \quad \text{(D6)}$$

where superscript "uc" refers to the term "unexplained".

Appendix E

The After-default and After-tax Term Structures

In this section we illustrate the methodology used to compute the after-tax term structure of interest rate for corporate bonds. When assigning zero values to the tax rates, we obtain the after-default term structures that are used to compute the default spread.

If we ignore the effect of accrued interest and amortization, the price of a discount bond becomes:

$$\tilde{P}_t = \frac{\left\{C(1-\tau_i)\sum_{m=1}^{M} d_{t,m} + (1-\tau_g)d_{t,M}\right\}\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M}\left\{\left[C(1-\tau_i)\sum_{i=1}^{m-1} d_{t,i} + (1-\tau_g)\delta d_{t,m}\right]\lambda_m \prod_{i=1}^{m-1}(1-\lambda_i)\right\}}{1-\tau_g\left[d_{t,M}\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M} d_{t,m}\lambda_m \prod_{i=1}^{m-1}(1-\lambda_i)\right]} \quad \text{(E1)}$$

Adjusting for the accrued payments, the formula becomes:

$$\tilde{P}_t + A_t = \left\{(C(1-\tau_i) + A_t\tau_i)d_{t,1} + C(1-\tau_i)\sum_{m=2}^{M} d_{t,m} + [1-\tau_g(1-\tilde{P}_t)]d_{t,M}\right\}\prod_{m=1}^{M}(1-\lambda_m)$$
$$+\sum_{m=1}^{M}\left\{\left[(C(1-\tau_i) + A_t\tau_i)d_{t,1} + C(1-\tau_i)\sum_{i=2}^{m-1} d_{t,i} + (\delta + \tau_g(\tilde{P}_t - \delta))d_{t,m}\right]\lambda_m \prod_{i=1}^{m-1}(1-\lambda_i)\right\}$$

(E2)

This formula applies for corporate bonds issued before July 18, 1984. After this date many modifications to the tax regulations concerning the amortization of discounts over the life of the bond require that the pricing formula be modified as is now detailed.

If the bond is held until maturity, then the amortized discount 1- $\tilde{P}_t$ is taxed as ordinary income. If the bond is sold before maturity at PS, then a number of tax scenarios are possible. First, if PS- $\tilde{P}_t$ <0, then PS- $\tilde{P}_t$ is considered a capital loss. Second, if PS- $\tilde{P}_t$ >0 and is greater than the amortized portion of the discount, then the capital gain is taxed accordingly and the accrued amortized discount is taxed as ordinary income. If PS- $\tilde{P}_t$ >0 and is less than the amortized portion of the discount, then the entire capital gain is taxed as ordinary income. Finally, in the case of default, the same logic applies except that the recovery rate δ is used instead of PS in the previous three cases.

As a result, in the case of a discount bond issued after July 18, 1984, A2 becomes:

$$\begin{aligned}\tilde{P}_t + A_t = &\left\{(C(1-\tau_i)+A_t\tau_i)d_{t,1} + C(1-\tau_i)\sum_{m=2}^{M} d_{t,m} + [1-\tau_i(1-\tilde{P}_t)]d_{t,M}\right\}\prod_{m=1}^{M}(1-\lambda_m) \\ &+ \sum_{m=1}^{M}\left\{(C(1-\tau_i)+A_t\tau_i)d_{t,1} + C(1-\tau_i)\sum_{i=2}^{m-1} d_{t,i} + \left[(\delta+\tau_g(\tilde{P}_t-\delta))d_{t,m}\right]\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right\}\end{aligned} \qquad \text{(E3)}$$

Solving for $\tilde{P}_t$ in (E3) yields:

$$\begin{aligned}\tilde{P}_t = &\frac{1}{1-\tau_i d_{t,M}\prod_{m=1}^{M}(1-\lambda_m) - \tau_g\sum_{m=1}^{M} d_{t,m}\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)} \\ &\times\left\{-A_t + \left[(C(1-\tau_i)+A_t\tau_i)d_{t,1} + (1-\tau_i)d_{t,M} + C(1-\tau_i)\sum_{m=2}^{M} d_{t,m}\right]\prod_{m=1}^{M}(1-\lambda_m)\right. \\ &\left.+\sum_{m=1}^{M}\left[(C(1-\tau_i)+A_t\tau_i)d_{t,1} + C(1-\tau_i)\sum_{i=2}^{m-1} d_{t,i} + \delta(1-\tau_g)d_{t,m}\right]\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right\}\end{aligned}$$

(E4)

For premium bonds issued prior to September 27, 1985, the capital loss $\tilde{P}_t - 1$ can be recognized earlier using the linear amortization method. In this case, the equation for $\tilde{P}_t$ becomes:

$$\tilde{P}_t = \frac{\left[(C(1-\tau_i)-\frac{\tau_i}{t_M-t})\sum_{m=1}^{M} d_{t,m} + d_{t,M}\right]\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M}\left\{\left[(C(1-\tau_i)-\frac{\tau_i}{t_M-t})\sum_{i=1}^{m-1} d_{t,i} + \frac{\tau_g(t_{m-1}-t)}{t_M-t}d_{t,m} + (1-\tau_g)\delta d_{t,m}\right]\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right\}}{1-\frac{\tau_i}{t_M-t}\left\{\sum_{m=1}^{M} d_{t,m}\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M}\left[\sum_{i=1}^{m-1} d_{t,i}\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right]\right\} - \tau_g\sum_{m=1}^{M}(1-\frac{t_{m-1}-t}{t_M-t})d_{t,m}\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)}$$

(E5)

Using the constant yield amortization for bonds issued after September 27, 1985, the pricing equation becomes:

$$\begin{aligned}\tilde{P}_t = &\frac{1}{1+\tau_i\left\{y\sum_{m=1}^{M}(1+y)^{m-1}d_{t,m}\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M}\left[\sum_{i=1}^{m-1}(y(1+y)^{i-1}d_{t,i})\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right]\right\} - \tau_g\sum_{m=1}^{M}(1+y)^{m-1}d_{t,m}\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)} \\ &\times\left\{\left[\sum_{m=1}^{M} C(1+\tau_i y\sum_{j=0}^{m-2}(1+y)^j\ )d_{t,m} + d_{t,M}\right]\prod_{m=1}^{M}(1-\lambda_m) + \sum_{m=1}^{M}\left\{\left[\sum_{n=1}^{m-1} C(1+\tau_i y\sum_{j=0}^{n-2}(1+y)^j)d_{t,n} + \left[(1-\tau_g)\delta - \tau_g C\sum_{j=0}^{m-2}(1+y)^i\right]d_{t,m}\right]\lambda_m\prod_{i=1}^{m-1}(1-\lambda_i)\right\}\right\}\end{aligned}$$

(E6)

All the equations for the premium bonds are then modified to account for the accrued interest rate in the same way as was done for the discount bonds earlier. For further details on these adjustments, please refer to Liu et al (2005).

Appendix F

Sample Sizes for the IO Sets Differentiated by Issuer Type and Credit Rating

Table F3.30. Sample sizes for the IO sets differentiated by issuer type and credit rating

This table summarizes the sample sizes in terms of unique bonds and the total number of bond prices in the IO sets investigated in this chapter. These IO sets are differentiated by issuer type and credit rating (panel A) and maturities (short maturities in panel B and long maturities in panel C). "Tr./Ag." refers to Treasury/Agency.

Panel A: Sample sizes for IO sets differentiated by issuer type and credit rating												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Unique bonds	27,497	9,113	7,511	4,453	4,991	1,429	30,758	10,206	3,714	7,442	4,722	4,674
Bond Prices	939,267	291,229	260,869	159,892	163,108	64,169	927,295	340,761	112,965	238,113	120,663	114,793
Panel B: Statistics for IO set differentiated by issuer type and credit rating and with maturities < 10 yrs												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Unique bonds	19,194	5,841	5,741	2,477	4145	990	21,355	7,195	2,233	5,016	3,083	3,828
Bond Prices	546,547	162,281	165,061	57,911	126,021	35,273	549,376	201,504	54,677	139,772	69,209	84,214
Panel C: Statistics for IO set differentiated by issuer type and credit rating and with maturities > 10 yrs												
	IOs differentiated by issuer type						IOs differentiated by credit rating					
IO	All	Tr./Ag.	Industrial	Utility	Financial	Foreign	All	Aaa	Aa	A	Baa	Spec.
Unique bonds	11,497	3,899	2,960	2,554	1,421	663	12,395	3,741	1,812	3,176	2,067	1,599
Bond Prices	392,702	128,939	95,806	101,979	37,085	28,893	377,902	139,247	58,285	98,340	51,451	30,579

* note that the sum of sample sizes for short maturities and long maturities does not add up to the size of the IO sets not differentiated by maturity because a unique bond could be listed both in short and long maturities when the time to maturity moves from more than 10 years to less than 10 years.

Appendix G

Time Series Plots for the Cross-sectional Metrics

Figure G.1 Potential diversification benefits for All IO set measured using MRD metric.

This figure shows the time series behavior of the potential diversification benefits for the "All" IO set for all maturities computed as the difference between the MRD metric for a PS of 2 and a Portfolio size of All. The Y axis shows the value of the potential diversification benefits while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.

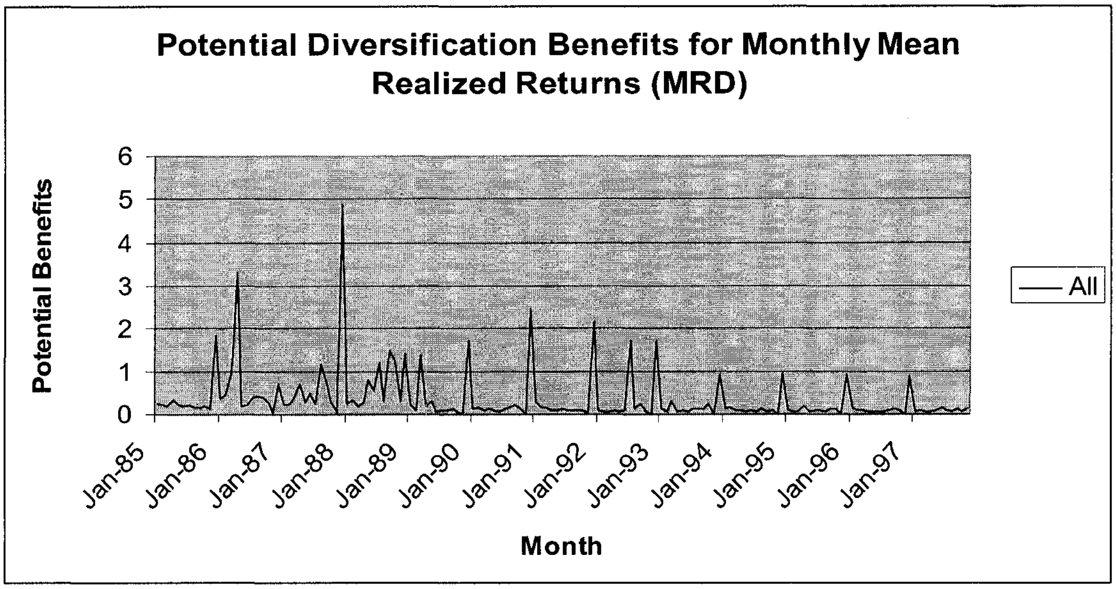


Figure G.2 Potential diversification benefits for Foreign IO set measured using MRD metric

This figure shows the time series behavior of the potential diversification benefits for the "Foreign" IO set for all maturities computed as the difference between the MRD metric for a PS of 2 and a Portfolio size of All. The Y axis shows the value of the potential diversification benefits while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.

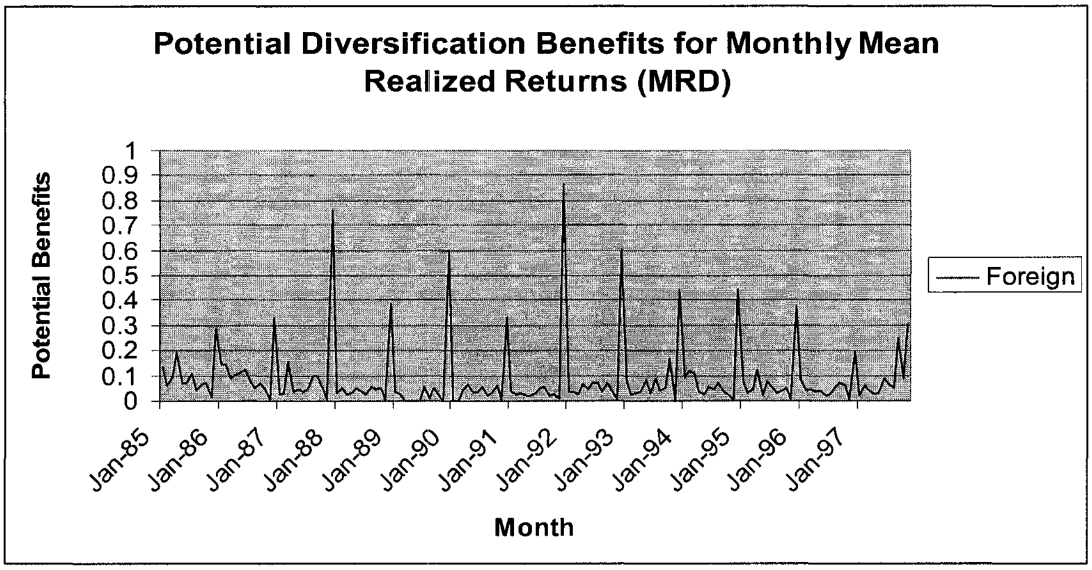


Figure G.3 Potential diversification benefits for Speculative IO set measured using MRD metric

This figure shows the time series behavior of the potential diversification benefits for the "Speculative" IO set for all maturities computed as the difference between the MRD metric for a PS of 2 and a Portfolio size of All. The Y axis shows the value of the potential diversification benefits while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.

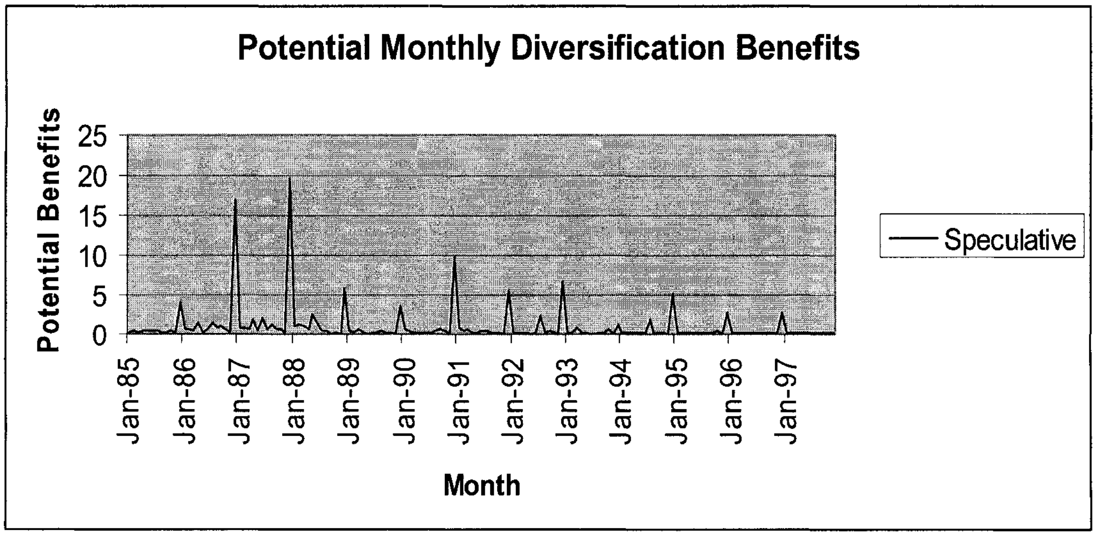


Figure G.4 Skewness of All IO set

This figure shows the time series behavior of the skewness metric for the "All" IO set for all maturities. The Y axis shows skewness while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.

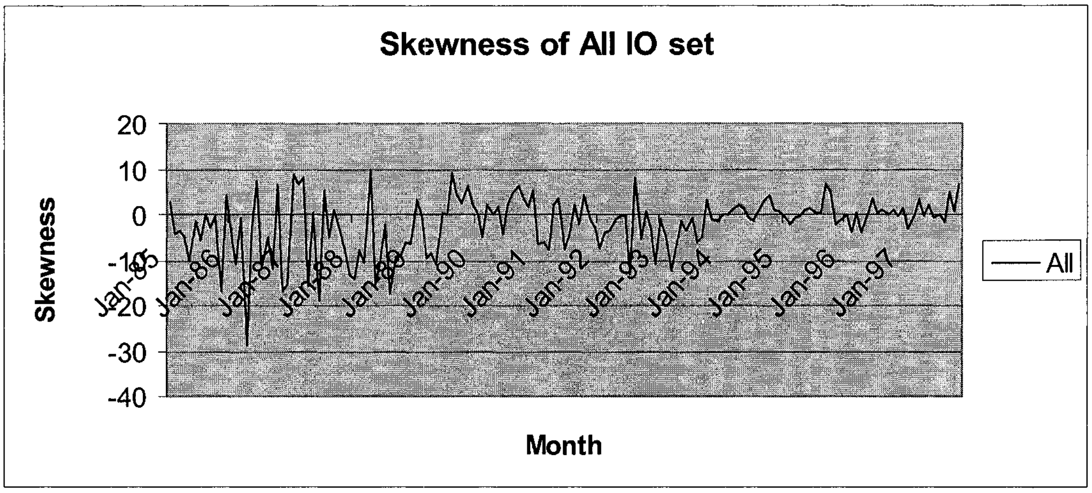


Figure G.5 Kurtosis for All IO set

This figure shows the time series behavior of the kurtosis metric for the "All" IO set for all maturities. The Y axis shows kurtosis while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.

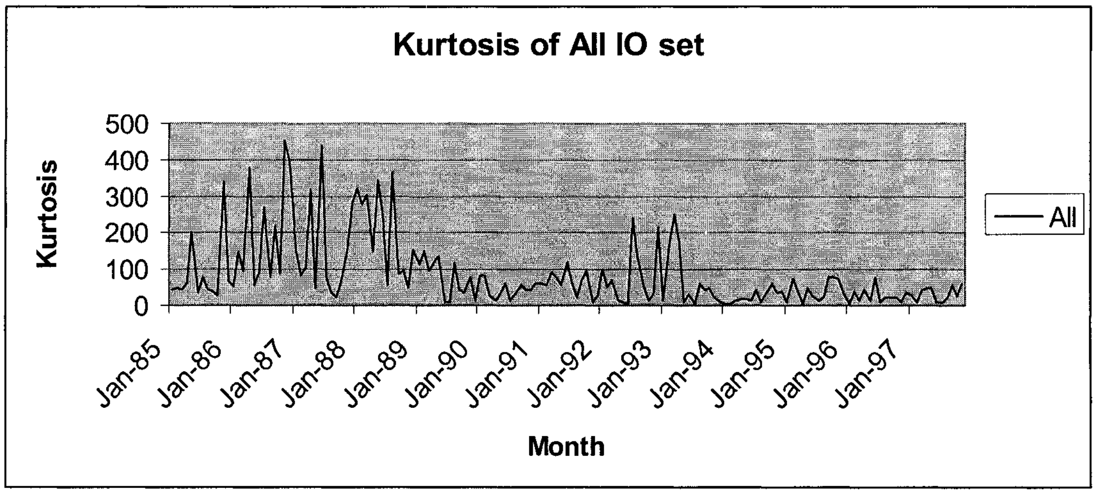
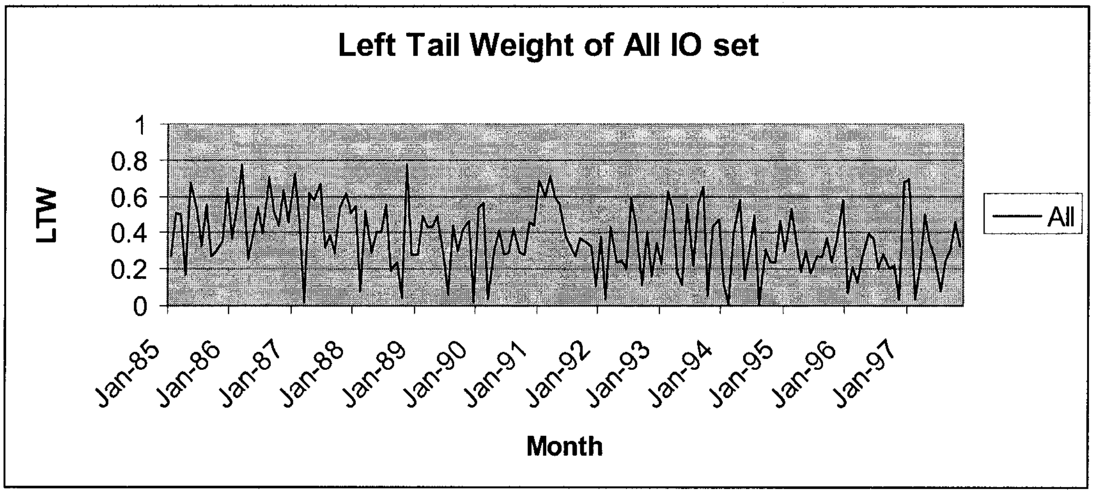


Figure G.6 Left tail weight for the All IO set

This figure shows the time series behavior of the left tail weight metric for the "All" IO set for all maturities. The Y axis shows the value of the left tail weight while the X axis shows the dates. The sample starts in January 1985 and ends in December 1997.



Appendix H

Summary Statistics on the Distribution of the Credit Spread Changes

Table H5.5 Summary statistics on the distribution of the credit spread changes

This table provide the mean, median, standard deviation, skewness, kurtosis, and range of maximum-minimum values of the credit spread changes for the one to ten year maturity credit spreads. "F" refers to the financial sector whereas "I " refers to the industrial sector. Aa, A, and Baa are the rating categories. The mean, median, standard deviation and range values are multiplied by 100.

FAa/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	-0.002	-0.002	-0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001
Median	0.003	0.008	0.007	0.007	0.009	0.004	-0.002	-0.005	-0.005	-0.006
Std Dev.	0.218	0.180	0.147	0.125	0.114	0.113	0.115	0.116	0.116	0.113
Kurtosis	2.490	3.691	3.400	2.957	3.114	3.773	5.103	6.590	7.648	8.203
Skewness	-0.479	-1.115	-0.857	-0.417	-0.131	0.164	0.487	0.759	0.998	1.144
Range	1.390	1.060	0.920	0.800	0.730	0.770	0.860	0.890	0.900	0.890
FA/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	-0.003	-0.004	-0.004	-0.004	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
Median	-0.008	-0.013	-0.013	-0.015	-0.010	-0.007	-0.005	-0.007	-0.008	-0.012
Std Dev.	0.248	0.215	0.179	0.151	0.132	0.125	0.122	0.122	0.122	0.119
Kurtosis	7.160	6.389	5.708	4.750	4.033	3.765	4.541	5.504	6.309	6.451
Skewness	-0.221	-0.153	0.144	0.356	0.301	0.133	0.061	0.112	0.189	0.223
Range	2.060	1.700	1.390	1.160	0.970	0.860	0.870	0.870	0.870	0.860
FBaa/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	-0.003	-0.003	-0.003	-0.001	-0.002	-0.002	-0.001	-0.003	-0.004	-0.005
Median	-0.023	-0.033	-0.024	-0.015	-0.009	-0.001	0.002	-0.002	-0.012	-0.009
Std Dev.	0.423	0.373	0.328	0.311	0.309	0.310	0.311	0.310	0.306	0.300
Kurtosis	11.138	14.386	19.426	24.011	27.038	29.375	31.589	33.814	35.745	37.379
Skewness	-1.053	-1.904	-1.893	-1.079	0.136	1.278	2.133	2.868	3.376	3.749
Range	3.770	3.290	3.410	3.610	3.710	3.740	3.730	3.670	3.590	3.480
IAa/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	0.003	0.000	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002	-0.002	-0.003
Median	-0.001	0.000	0.004	-0.006	-0.003	0.000	-0.001	-0.004	-0.005	-0.005
Std Dev.	0.000	0.000	0.000	-0.005	0.000	0.000	0.000	0.000	-0.005	-0.005
Kurtosis	3.107	4.755	9.680	9.213	6.221	5.236	7.128	10.337	12.202	12.151
Skewness	0.317	-0.135	-0.515	-0.551	-0.363	-0.124	0.118	0.170	0.233	0.277
Range	3.130	2.000	1.640	1.310	1.020	0.840	0.910	0.960	0.940	0.860
IA/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	-0.006	-0.006	-0.006	-0.005	-0.004	-0.003	-0.004	-0.003	-0.003	-0.003
Median	-0.002	0.005	0.003	-0.007	-0.010	-0.010	-0.003	-0.003	-0.003	-0.001
Std Dev.	0.224	0.191	0.152	0.123	0.104	0.098	0.097	0.098	0.097	0.094
Kurtosis	2.454	3.330	3.265	3.623	4.442	5.546	7.351	9.465	10.580	10.987
Skewness	-0.526	-0.603	-0.363	-0.275	-0.532	-0.743	-0.571	-0.197	0.290	0.528
Range	1.450	1.290	1.060	0.910	0.760	0.720	0.790	0.880	0.910	0.890
IBaa/Maturity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Mean	0.001	0.001	0.001	0.001	0.000	-0.001	0.000	0.000	0.000	-0.001
Median	-0.007	0.004	0.002	-0.002	-0.005	0.000	-0.001	0.004	0.006	0.003
Std Dev.	0.263	0.268	0.265	0.277	0.285	0.285	0.277	0.262	0.241	0.219
Kurtosis	3.911	10.344	18.007	24.111	26.553	28.101	29.607	31.458	33.150	34.363
Skewness	0.750	0.689	0.625	0.288	-0.091	-0.472	-0.771	-1.068	-1.323	-1.376
Range	1.780	2.300	2.820	3.200	3.390	3.440	3.380	3.240	3.020	2.760