What drives credit?

Understanding the cross section of expected corporate bond returns

Markets Division, Bocconi Students Investment Club

April 24, 2022 - Working Paper

Part II

BOCCONI STUDENTS INVESTMENT CLUB

Abstract

In this second part of our paper, we present results for the statistical estimation of factor premia through the Fama and MacBeth (1973) two-pass regression. Our main contribution is methodological. In part I, we defined new proxies for macro risk in the form of unanticipated shocks in inflation and interest rates. We find that the risk posed by possible unanticipated shocks in interest rates exerts an often statistically significant risk premium even when controlling for duration risk. This suggests that investors, at least in certain periods, may demand additional and separate compensation for *unexpected* interest rate risk. We further provide additional evidence for the presence of a credit risk premium. Finally, we discuss potential different frameworks that might help address some of the shortcomings of our analysis.

1 Introduction to Part II

In Part II of our paper on the cross section of corporate bond returns, we present some empirical results from our statistical estimation and discuss their meaning, while highlighting potential weaknesses in the analysis. We conclude by summarizing what can be learned form our estimates and what further research can be done with our research design to investigate the significance of the results.

As outlined in Part I of this paper, we apply the estimator in Fama and MacBeth 1973 to extract risk premia for the considered factors. Following the insights in Ambastha et al. 2010 and Chen et al. 2014, we decide to perform separate analyses for IG and HY bonds, as they represent two different segments of the corporate bond markets, and including them in a single analysis would introduce undesired heterogeneity.

Before we can delve into the empirical results, a few remarks are in order.

First, we build issuer-sorted portfolios to perform the first pass of the Fama and MacBeth two-pass regression. As we pointed out in Part I, we need to perform some form of portfolio sorting since, for some bonds, we do not have enough observations to perform factor loading estimation without running out of degrees of freedom (especially for high yield bonds). The sorting scheme we decide to adopt is by issuer, creating a bond portfolio for each firm for which we have securities in our databases. This has several advantages compared to other approaches: since we consider only issuers for which we have at least one observation in 180 of the 218 months in our sample, we obtain time series that are much longer than the average time series obtained with bond-level data. We have 150 such issuers in the Investment Grade universe and (only) 56 for High Yield, but we suspect they might be enough to obtain a large number of loading vectors such that there is enough variability in second-pass inputs.

Second, in preliminary analysis we find that the illiquidity proxy $ILLIQ_{it}$ constructed following Bao, Pan, and Wang 2011 is never statistically significant. We believe this was already explained by Bao, Pan, and Wang 2011 when they show that their measure of illiquidity loses significance when computed on monthly data points. We tried computing in on daily transaction data and then using the monthly median to compute the illiquidity loading, but it still lacked any statistical significance. Hence, we decided to use trading volume as a proxy for liquidity. An alternative would be to use bid-ask spread size, but in our database some observations were missing.

Third, our default factor proxy also came out as insignificant in preliminary analysis. Our solution is to use duration times spread (henceforth DxS) instead, as defined in Dor et al. 2007. DxS is a known measure of pure credit risk. Due to its statistical nature as an interaction term of the credit spread with duration, it ensures that when used to estimate the credit[1] risk premium, only the variability in excess return caused by cross-sectional differences in credit risk is captured. We remark that DxS is already a factor loading, thus it need not be included in the first pass of the two-pass Fama and MacBeth regression (see 2).

Fourth, differently form the model we specified in Part I, we do not include the downside risk factor. We decide to drop the factor because, despite there being some evidence in the literature for its significance (see Bai, Bali, and Wen 2019), the rolling window needed to construct the proxy with value-at-risk would require us to drop a large number of observations. As pointed out above, we can't afford the luxury of losing more data points than we already do due to our stringent rules to avoid selection bias and outlier-driven distortions (see Section 2 of Part I) and due to the presence of some missing values in the original data set. Hence, for the sake of estimation robustness, and assuming factor orthogonality, we decide to drop downside risk from our linear factor model.

[1] We use credit risk and default risk interchangeably in this paper.

2 Fama and MacBeth two-pass regression

We investigate the cross-sectional relation between corporate bond expected returns and a number of risk factors: credit risk, value, illiquidity, unexpected shocks in inflation and unexpected changes in interest rates. We perform our statistical analysis on excess returns $r_i^e = r_{i,t} - r_{f,t}$, namely bond returns less one-month risk-free rates.

For the sake of the reader, before we proceed to show and comment the empirical results, we revise the two passes involved in the derivation of the Fama and MacBeth estimates for the risk premium vector $\boldsymbol{\gamma}_{FM}$.

2.1 Estimation theory

The Fama and MacBeth two-pass estimator is derived through a time-series regression to estimate the factor loadings and a cross-sectional regression to estimate the factor premia. In the first pass, we regress the time series of excess returns r_i^e for each portfolio i (for the portfolio construction approach see 1) on the factor proxies defined in Section 3.1 of Part I:

$$\begin{aligned} r_i^e = \alpha_i + \hat{\beta}_{i,Value}\, Value_{i,t} + \hat{\beta}_{i,TVol}\, TVol_{i,t} + \\ + \hat{\beta}_{i,DxUI}\, DxUI_t + \hat{\beta}_{i,U\Delta IR}\, U\Delta IR_t + \hat{\varepsilon}_{i,t}, \end{aligned} \tag{1}$$

and we obtain the $N \times k$ matrix $\mathbf{B}_{FM}$ of factor loadings

$$\mathbf{B}_{FM} = \left[\, \hat{\boldsymbol{\alpha}} \;\; \hat{\boldsymbol{\beta}}_{Value} \;\; \hat{\boldsymbol{\beta}}_{TVol} \;\; \hat{\boldsymbol{\beta}}_{DxUI} \;\; \hat{\boldsymbol{\beta}}_{U\Delta IR} \,\right] \tag{2}$$

where each column k of the matrix $\mathbf{B}_{FM}$ is a vector $\hat{\boldsymbol{\beta}}_k$ of factor k loadings for each portfolio i, i.e.:

$$\hat{\boldsymbol{\beta}}_k' = [\beta_{1,k} \;\; \ldots \;\; \beta_{i,k} \;\; \ldots \beta_{N,k}] \tag{3}$$

where N is the total number of portfolios.

We then augment the $\mathbf{B}_{FM}$ matrix by a matrix $\mathbf{C}$ which includes the DxS loadings and duration, which we include as a control. More specifically, we include duration to see if the $U\Delta IR$ premium is robust to the inclusion of a duration premium. If that were the case, it would imply that there is a risk premium in the cross section of corporate bond returns on top of the premium that investors earn for bearing general interest rate risk as captured by duration. The resulting augmented matrix is

$$\mathbf{B}_{FM} \mid \mathbf{C} = \left[\; \hat{\boldsymbol{\alpha}} \;\; \hat{\boldsymbol{\beta}}_{Value} \;\; \hat{\boldsymbol{\beta}}_{TVol} \;\; \hat{\boldsymbol{\beta}}_{DxUI} \;\; \hat{\boldsymbol{\beta}}_{U\Delta IR} \;\mid\; \textbf{DxS} \;\; \textbf{Duration} \right] \tag{4}$$

In the second pass, we perform one cross-sectional regression for each time period t where we regress excess bond returns on the factor loadings[2] in matrix $\mathbf{B}_{FM} \mid \mathbf{C}$:

$$\begin{aligned} r^e_{i,t} = \hat{\gamma}_{t,const} + \hat{\gamma}_{t,\alpha}\, \hat{\alpha}_i + \hat{\gamma}_{t,DxS}\, DxS_{i,t} + \hat{\gamma}_{t,Value}\, \hat{\beta}_{i,Value} + \hat{\gamma}_{t,TVol}\, \hat{\beta}_{i,TVol} + \\ + \hat{\gamma}_{t,DxUI}\, \hat{\beta}_{i,DxUI} + \hat{\gamma}_{t,U\Delta IR}\, \hat{\beta}_{i,U\Delta IR} + \hat{\gamma}_{t,Duration}\, Duration_{i,t} + \hat{\nu}_{t,i} \end{aligned} \tag{5}$$

repeating for each $t = 1, \ldots, T$. Through this second step, we evaluate how return sensitivities to risk factors captured by factor loadings $\mathbf{B}_{FM}$ explain the variability in excess returns. We obtain the matrix $T \times p$ $\hat{\mathbf{\Gamma}}_{FM}$ of time-dependent risk premia

$$\hat{\mathbf{\Gamma}}_{FM} = [\; \hat{\boldsymbol{\gamma}}_0 \;\; \hat{\boldsymbol{\gamma}}_{DxS} \;\; \hat{\boldsymbol{\gamma}}_{Value} \;\; \hat{\boldsymbol{\gamma}}_{TVol} \;\; \hat{\boldsymbol{\gamma}}_{DxUI} \;\; \hat{\boldsymbol{\gamma}}_{U\Delta IR} \;] \tag{6}$$

where each column vector in $\hat{\mathbf{\Gamma}}_{FM}$ contains the estimated risk premium p in each time period $t = 1, \ldots, T$:

$$\hat{\boldsymbol{\gamma}}'_p = [\gamma_{1,p} \;\; \ldots \;\; \gamma_{t,p} \;\; \ldots \gamma_{T,p}] \tag{7}$$

[2]Notice that we include the intercept α because, even though it is supposed to be statistically insignificant in linear factor models that capture all systemic sources of risk, we might be operating under the presence of omitted factors, and data availability constrains our ability to address such issue.

Finally, we take the time-series average of each risk premium in $\hat{\mathbf{\Gamma}}_{FM}$, obtaining the average Fama-MacBeth risk premia for each risk factor.

The risk premia $\boldsymbol{\gamma}_{FM}$ have the interpretation of returns on corporate bond portfolios with a β equal to 1 for the factor corresponding to the risk premium and 0 for all other factors. This ease of interpretation is one of the several reasons why the approach in Fama and MacBeth 1973 is so popular in the literature.

2.2 Results for Investment Grade bonds

When performing the first pass as in 1, we apply `StandardScaling` to the factors so as to have coefficients of comparable magnitude. Moreover, we add a control for time to maturity to capture the component of returns that is sensitive to the remaining life of the bond.

The first-pass regression raises two red flags: the intercept α is often statistically significant (see the Introduction to Part I for a discussion of the implications of a statistically significant α), and the R^2 of the time series regressions are often quite low, ranging from 0.1915% to 16.3310%.

We report below the results for the second-pass regression, averaged over time[3].

	const	alpha	$\hat{\beta}_{Value}$	DxS	$\hat{\beta}_{TVol}$	$\hat{\beta}_{DxUI}$	$\hat{\beta}_{U\Delta IR}$	Duration
γ_{FM}	-0.51427	0.00078	0.01250	0.08290	-0.02841	-0.05228	0.04460	0.04146
t-stat	-0.3219	0.0008	0.0269	6.3920	-0.0469	-0.0428	0.0970	0.2441

As expected, we find that the default premium is statistically significant for any level of confidence. All the other factor premia are insignificant when testing their time-series average. Looking at p-values for individual time period cross-sectional regression, we find

[3] Note that the test statistics are computed as

$$t_{FM} = \frac{\overline{\gamma}_{FM}}{\sigma_{\gamma_{FM}}}. \tag{8}$$

When evaluating the significance of the risk premia, we use Newey-West standard errors, so as to control for heteroskedasticity and autocorrelation in the residuals.

that duration is highly significant for the overwhelming majority of the sample. Another interesting insight is that the factor capturing unanticipated shocks to interest rates is significant in 1/3 of the sample. In that portion of the time periods, duration is statistically significant for any confidence level. This seems to imply, if we accept that time-varying risk premia might play a role (and hence that the time-series average does not shed light on the full picture), that investors (at least in certain periods) require additional compensation for *unexpected* interest rate risk on top of the premium they earn for general interest rate risk quantified by duration.

2.3 Results for High Yield bonds

In the first pass, high yield bonds always present a statistically significant α. While this issue affects the IG model as well, the proportion of explained variance (R^2) is slightly higher, ranging between 0.3379% to 28.4516%.

In the second pass, the time-series regressions show that, on the average level, the intercept $\hat{\gamma}_{t,const}$ is statistically significant for all the time periods. For the other factor loadings, we observe that most of them retain their statistical significance in the considered data set, $\hat{\boldsymbol{\gamma}}_{DxS}$ being the most significance. We find that all the other factors loadings, on average, are statistically significant in at least half of the time frames considered. This piece of evidence will yield some insight when we discuss the validity of the Fama-MacBeth t-test for the final (time-series average) risk premia, which are display below.

	const	alpha	$\hat{\beta}_{Value}$	DxS	$\hat{\beta}_{TVol}$	$\hat{\beta}_{DxUI}$	$\hat{\beta}_{U\Delta IR}$	Duration
γ_{FM}	-0.5505	-0.0009	0.0145	-0.0001	-0.0002	-0.0176	0.0101	0.0012
t-stat	-0.6986	-0.0560	0.3064	-0.1441	-0.0059	-0.1684	0.1575	0.1607

As shown, $\hat{\beta}_{\text{Value}}$ and $\hat{\beta}_{U\Delta IR}$ exhibit meaningful positive (if insignificant) risk premia – with the first one overwhelmingly supported by the existing literature.

3 Conclusion and areas of further development

In this two-part paper on the cross section of corporate bond returns we attempted to price the factor risk that investors take when holding company-issued debt securities.

We applied the most popular risk premium estimator in the literature, namely the two-pass regression of Fama and MacBeth 1973. Our first-pass results are often affected by low values for R^2, indicating that our linear factor model captures a limited amount of variability in bond returns (especially in investment grade securities, while the picture is somewhat more positive in the high yield space). Additionally, the model (thoroughly discussed in Part I of this paper) contains statistically significant intercepts. This implies that we fall short of describing the complete systematic risk entailed in corporate bonds. This is party due to limited data access. It may be pointed out, however, that when the R^2 are contextualized in the literature on the cross section of corporate bond returns, they do not necessarily fare worse than most of the published studies.

Our main contribution, in this two-part paper, is methodological. We defined new proxies for macro risk in the form of unanticipated shocks in inflation and interest rates. An interesting insight, which surely begs to be further investigated, is that the risk posed by possible unanticipated shocks in interest rates exerts a risk premium that is very often statistically significant together with the duration risk premium. Such a finding can hardly be ignored. If further analysis yields more robust results, it will be possible to assert that investors (at least in certain periods) require additional compensation for *unexpected* interest rate risk on top of the premium they earn for general interest rate risk quantified by duration.

We believe our contribution is significant in that it problematizes this component of interest rate risk and it provides a measure for it in the form of a proxy via residualization that (to our knowledge) was not explored in previous research.

Finally, we find that despite not having statistically significant time-series-average premia (when computed as in 8), many of the premia are highly significant in several time periods.

We believe this could indicate that test statistics in 8 do not provide a full-picture view on what is priced in the cross section of corporate bond returns. Perhaps, models that can capture time-varying or regime-dependent risk premia might be shed more light on the matter.

References

Ambastha, Madhur et al. (2010). "Empirical Duration of Corporate Bonds and Credit Market Segmentation". In: *The Journal of Fixed Income* 20.1, pp. 5–27.

Bai, Jennie, Turan G. Bali, and Quan Wen (2019). "Common risk factors in the cross-section of corporate bond returns". In: *Journal of Financial Economics* 131.3, pp. 619–642.

Bao, Jack, Jun Pan, and Jiang Wang (June 2011). "The Illiquidity of Corporate Bonds". In: *Journal of Finance* 66, pp. 911–946.

Chen, Zhihua et al. (2014). "Rating-Based Investment Practices and Bond Market Segmentation". In: *Review of Asset Pricing Studies* 4.2, pp. 162–205.

Dor, Arik Ben et al. (2007). "Duration Times Spread". In: *Journal of Portfolio Management*.

Fama, Eugene F. and James D. MacBeth (May 1973). "Risk, Return, and Equilibrium: Empirical Tests". In: *Journal of Political Economy* 81.3, pp. 607–636.