Betting on Credit Betas *

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Abstract

Duration is an important driver of bond return volatility and, consequently, an important driver of market betas. In credit markets, we show that "betting against beta" (BAB) strategy closely resembles a betting against duration strategy. We introduce a new method to estimate conditional betas that more accurately capture the effect of time-varying duration. Our findings reveal that long-short portfolios sorted on duration produce negative alphas, consistent with Frazzini and Pedersen (2014) BAB. However, when controlling for duration, long-short portfolios sorted on beta generate positive alphas of a comparable magnitude. These results are robust to using Treasuries to hedge duration risk. A combined strategy of betting against duration and betting on betas yields a market-orthogonal Sharpe ratio of 1.1, which is almost four times the 0.31 duration hedged market Shape ratio. Leverage constraints alone cannot explain our results.

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1 Introduction

The corporate bond market has become increasingly significant in the U.S. financial landscape. According to the Securities Industry and Financial Markets Association (SIFMA), there were $10.4 trillion in outstanding corporate bonds in 2021, representing 45% of the total Treasury securities outstanding or 35% of the U.S. GDP. Corporate bonds account for approximately 13% of total assets traded in financial markets in the U.S. (Bekaert and Santis, 2021).

Despite their importance, surprisingly little is known about the drivers of risk and return of corporate bonds. Although new data has enabled a growing body of literature proposing various models and factors, replication challenges persist. As highlighted by Dickerson et al. (2023) and Dick-Nielsen et al. (2023), results often hinge on data cleaning methods and slight changes in empirical specifications. These discrepancies suggest that previous findings may be weak and highly dependent on methodological choices. Ultimately, the market portfolio remains a robust benchmark that is hard to outperform (Dickerson et al. (2023)).

We challenge this view by showing that a decomposition of market betas allows for a trading strategy that strongly outperforms the market returns. We decompose credit market betas into two components: one driven by duration and another that captures yield changes relative to the market, which we define as "beta." In our sample from 2000 to 2023, the betting-against-duration strategy delivers monthly alphas of 0.16% (t-stat: 2.14), while a betting-on-betas strategy delivers alpha of 0.26% (t-stat: 3.27). Combining both strategies yields an alpha of 0.21% (t-stat: 3.37), translating into a market-orthogonal Sharpe ratio of 0.72—53% higher than the market. When we combine this strategy with Treasury bonds to hedge for duration, the Sharpe ratio reaches 1.10, almost four times the duration-hedged credit market Sharpe ratio. These results highlight the economic relevance of separating duration-driven risks from other yield-based risks and underscore the value of refining how we measure and interpret credit market beta.

Our results suggest that leverage constraints alone cannot explain why the security market line is too flat to account for the cross-section of bond returns. Frazzini and Pedersen (2014), building on Black (1972), propose a model where leverage-constrained investors increase demand for high-beta assets, inflating their prices and reducing expected returns. As a result, riskier assets, as measured by their betas, exhibit lower alphas, while investors capable of allocating more to low-beta assets achieve higher risk-adjusted returns. Given the significant influence of duration on market betas, we demonstrate that a BAB (Betting Against Beta) trading strategy closely resembles betting against duration. However, after controlling for duration, portfolios sorted on betas produce opposite-signed alphas, suggesting that, if anything, the security market line may be too steep. This result underscores the existence of at least two distinct sources of risk in corporate bonds that are perceived differently by investors. The market alone cannot fully span these two sources of risk.

A fundamental building block of our paper is an accurate estimation of conditional market betas for corporate bonds. Rolling window estimates are inappropriate due to the time-varying distribution of returns, primarily influenced by duration. As bonds approach maturity, their duration decrease, affecting the distribution of returns. Previous literature attempted to address this by constructing portfolios based on characteristics. However, given that also the market's duration changes over time—from around five years in 2000 to eight years in 2023 in our sample—such approaches do not fully capture the dynamics at play.

We address this issue by disentangling beta from an asset's duration. Using a first order Taylor expansion of bond prices as a function of yields, it is well known that bond returns can be approximated as minus duration times changes in yields. Building on this approximation, we decompose market beta into two distinct components: (1) the asset's duration relative to the market's duration, and (2) the market beta of change in yields, which we define as beta. This definition of beta captures the asset's risk that is not mechanically driven by duration. Given the relative stability of yield changes over time, we employ the traditional rolling window method to estimate betas. Specifically, we adopt the methodology proposed by Frazzini and Pedersen (2014), estimating betas with a three-year rolling window for correlations (using three-day cumulative returns) and a one-year rolling window for standard deviations (using daily returns). However, when constructing portfolios, we deviate from their approach by calculating value-weighted portfolios, as we believe this yields more robust results[1]. In Figure 1, we provide an illustrative example that highlights the relationship between market beta and duration, demonstrating how our proposed measure isolates beta from duration effects.

[Figure 1 about here.]

[1] See Novy-Marx and Velikov (2020) for further discussion

Our decomposition reveals that betting against market betas closely resembles a strategy of betting against duration. Portfolios with lower duration (market beta) have higher alphas, while those with higher duration (market beta) have lower alphas relative to the market, consistent with leverage-constrained investors seeking beta exposure.

Conversely, our new beta measure alters previous findings. Portfolios with high betas exhibit positive alphas, whereas those with lower betas have lower alphas. Notably, this beta measure monotonically increases with credit ratings—AAA-rated bonds have the lowest betas, while C-rated bonds have the highest, suggesting it captures a dimension of credit risk. This suggests that investors view duration risk differently from beta risk.

This paper relates to the long literature assessing cross-section prices. Early work by Fama and French (1992) and Fama and French (1993) attempt to use a term and default risk factors, which links to our duration and beta-risk argument. Newer literature on corporate bonds such as Bekaert and Santis (2021), Dickerson et al. (2023) and Dick-Nielsen et al. (2023) provide evidences that factors are difficult to establish in this market, with some evidence towards country specific factors. In parallel, research by Kelly et al. (2023), Zhang and Zhang (2023), Ho and Wang (2018), Chung et al. (2018), Dor et al. (2007) propose different factor structures that are necessary to price the cross-section of bonds returns. Since Black (1972) we know that leverage constraints generate a betting against beta strategy. Our paper proposes a more robust way to think about CAPM that helps to reconcile the evidence of duration with credit factors.

A new literature is also uncovering the effects of duration on asset's returns. Binsbergen et al. (2024) shows how adjusting for the appropriate risk-free is important. By using duration matched treasuries, they explain practically all investment grade excess return, while some excess return is left for high-yield bonds. Gormsen and Lazarus (2022) and Gonçalves (2021) document the role of a duration factor in equity markets. We decompose market betas into duration risk and beta risk to show investors perceive these sources of risk differently.

The remainder of the paper is organized as follows: Section 2 presents the holding period return approximation and how market beta can be decomposed into two components. Section 3 describes the data and the empirical strategy for estimating beta, constructing portfolios, and conducting asset pricing tests. Section 4 discusses our findings. In Section 5, we present a discussion about our results and future research. Finally, Section 6 concludes.

2 Beta Methodology

In this section we decompose market beta into duration and a new beta that relates to yield movements. To do that, we introduce some information about corporate bonds assets.

A fixed-rate bond provides the holder with a series of cash flows CF_t consisting of periodic coupon payments and the face value repayment at maturity. The relationship between the bond's cash flow stream and its price $P_{n,t}$ is governed by the bond's yield to maturity $y_{n,t}$. For a bond maturing in n periods, the price is expressed as the present value of its future cash flows:

$$P_{n,t}(y_{n,t}) = \sum_{i=1}^{n} \frac{CF_i}{(1 + y_{n,t})^i} \tag{1}$$

This equation reflects the fundamental principle that the price of a bond equals the sum of its discounted future cash flows, where the discount rate is the yield to maturity. The yield to maturity is the internal rate of return that equates the present value of all future cash flows to the bond's current price.

Besides prices and yields, duration is pivotal in fixed-income analysis as it measures the sensitivity of a bond's price to changes in interest rates. Duration is defined as the weighted average time to receive the bond's cash flows, where the weights are given by the present value of each cash flow divided by the bond's price. Intuitively, this measure allows investors to compare bonds with the same maturity but different cash-flow structures, such as varying coupon rates. Bonds that pay more cash flows earlier—typically through higher coupon payments—have a smaller duration because a larger portion of their value is recouped sooner, reducing their sensitivity to interest rate changes.

Algebraically, the Maucalay duration $D^*_{n,t}$ is:

$$D^*_{n,t} = \frac{\sum_{i=1}^{n} i \frac{CF_i}{(1+y)^i}}{P_{n,t}}$$

This formula computes the average time until cash flows are received, weighted by their present value proportions. However, for practical purposes, especially in measuring price sensitivity, the modified duration is more convenient. The modified duration $D_{n,t}$ adjusts the Macaulay duration for the bond's yield, providing a more direct measure of price elasticity with respect to yield changes[2]:

$$D_{n,t} = \frac{D^*_{n,t}}{1 + y_{n,t}} = -\frac{1}{P_{n,t}} \frac{dP_{n,t}}{dy_{n,t}}$$

This representation shows that the modified duration is the negative of the percentage change in the bond's price for a one-unit change in yield, emphasizing the inverse relationship between bond prices and yields.

Define the holding period return of a bond as:

$$r_{t+1} = \frac{P_{n-1,t+1} - P_{n,t} + CF_{t+1}}{P_{n,t}}$$

Here, $P_{n-1,t+1}$ is the bond's price at time $t+1$ with one less period to maturity, $P_{n,t}$ is the current bond price, and CF_{t+1} is the cash flow received at time $t+1$. This formula captures both the capital gain or loss from the price change and the income from the cash flow.

In Appendix A we show that a linear approximation of next period's price $P_{n-1,t+1}$ around previous period's yield $y_{n,t}$ gives a return approximation:

$$r_{t+1} \approx y_{n,t} - D_{n,t}\Delta y_{t+1} \tag{2}$$

This approximation highlights that the holding period return depends on known information at time t: the bond's yield $y_{n,t}$ and its modified duration $D_{n,t}$. The term Δy_{t+1} represents the unexpected change in the bond's yield between t and $t+1$.

Equation 2 decomposes the bond return into two components: the yield income and the capital gain or loss due to interest rate changes. The first term, $y_{n,t}$, is the expected return based on the bond's yield at time t. The second term, $-D_{n,t}\Delta y_{t+1}$, captures the sensitivity of the bond's price to changes in yield, scaled by modified duration [3].

This is a linear approximation, and therefore, we are abstracting away from higher-order terms such as convexity. While we recognize the important role convexity plays in accurately pricing bonds and computing holding period returns, omitting it here allows us to simplify the mathematical exposition without losing significant insights. In fact, focusing on the multiplication of modified duration and

[2]In continuous time Macaulay and modified duration are the same.

[3]Note that rearranging modified duration and considering discrete time: $\frac{\Delta P}{P} = -D \cdot \Delta y$

yield changes in the second term, $-D_{n,t}\Delta y_{t+1}$, greatly streamlines our analysis. This simplification enables us to reveal compelling results in subsequent sections that might be obscured by the added complexity of including convexity. By concentrating on this linear relationship, we can more effectively illustrate the key mechanisms driving bond returns.

So far, we have avoided cluttering the exposition with the bond's identifier i. However, we now turn to an equilibrium model of returns, which considers many assets and adding an identifier is necessary. Consider the holding period return of bond i as $r_{i,t+1}$. Under a conditional Capital Asset Pricing Model (CAPM), the expected excess return of the bond relates to the expected excess return of the market:

$$E_t(r_{i,t+1}) - r_t^f = \beta_{i,t}^m \left(E_t(r_{mt+1}) - r_t^f\right)$$

Where r_t^f is the risk-free rate, r_{mt+1} is the market return, and $\beta_{i,t}^m$ is the bond's market beta, defined as:

$$\beta_{i,t}^m = \frac{\text{cov}_t(r_{i,t+1}, r_{m,t+1})}{\text{var}_t(r_{m,t+1})}$$

This theoretical relationship implies that the expected excess return of bond i is proportional to its beta relative to the market. The beta measures the bond's systematic risk—the portion of risk that cannot be diversified away and is related to movements in the overall market.

However, this relationship does not provide guidance on how to estimate the covariance and variance empirically. Typically, rolling window regression estimate are employed, assuming that returns are drawn from the same distribution over time. However, as shown on equation 2, bond returns are related to duration, which decreases over time as the bond approaches maturity. This time-varying nature implies that returns are not identically distributed across time, violating the assumptions underlying traditional rolling regression methods.

This observation motivates us to adjust the beta estimation by incorporating the duration effect explicitly. Substituting the return approximation from 2 into the market beta expression, we obtain:

$$\beta_{i,t}^m = \frac{D_{i,t}}{D_{mt}} \underbrace{\frac{\text{cov}_t(\Delta y_{i,t+1}, \Delta y_{mt+1})}{\text{var}_t(\Delta y_{mt+1})}}_{\beta}$$

In this relationship, $D_{i,t}$ and $D_{i,t}$ are the modified durations of bond i and the market portfolio, respectively. These terms are known variables at time t and hence removed from the covariance and variance operators. The term β represents the beta computed on the changes in yields from the bond and the market. This formulation shows that market betas depend on the bond's duration relative to the market's duration and the covariance of yield changes.

Importantly, this adjustment accounts for the changing sensitivity of bond returns due to duration changes. By scaling the yield change beta by the ratio of durations, we recognize that bonds with longer durations are more sensitive to yield changes, influencing their systematic risk.

The change in yield of the market $\Delta y_{m,t+1}$ is also scaled by duration of the assets. It can be expressed in terms of changes in yields directly:

$$\Delta y_{m,t+1} = \sum_{i \in M} \frac{w_i D_{i,t} \Delta y_{i,t+1}}{D_{m,t}}$$

Where w_i is the weight of each asset on the corporate bond's market. This stems from the value-weighted market return r_{mt+1}:

$$r_{m,t+1} = \sum_{i \in M} w_i r_{i,t+1} = \sum_{i \in M} w_i y_{i,t} - \sum_{i \in M} w_i D_{i,t} \Delta y_{i,t+1} = y_{m,t} - D_{m,t} \Delta y_{m,t+1}$$

This expression shows that the market's yield change is influenced by the weighted yield changes of the constituent bonds, scaled by their durations. Understanding this relationship is crucial for accurate beta estimation.

In conclusion, adjusting the beta estimation to account for duration and yield level effects leads to a more precise assessment of a bond's systematic risk. This approach aligns the estimation process with the inherent properties of bond returns, which are influenced by changing durations and yield dynamics over time.

3 Data

In this paper we are using the data from IHS Markit[4] for the iBoxx indices. The iBoxx is a financial service division that designs, calculates and distributes fixed income indices. These are transparent, rules-based fixed income indices that are used by finance industry professionals.

We are specifically using the constituent corporate bonds of two indices: iBoxx USD Investment Grade (IG) and iBoxx USD High Yield (HY). These are daily

[4]IHS Markit merged with S&P Global in 2022.

information containing price, issuer, country of issuance, seniority and spreads. IG data starts in 1999 and HY data starts in 2013. We compute daily returns as:

$$r_{i,t+1} = \frac{\text{MarketValue}_{i,t+1} + \text{Cash}_{i,t+1}}{\text{MarketValue}_{i,t}} - 1$$

Where $\text{MarketValue}_{i,t}$ is the market value of asset i on time t and $\text{Cash}_{i,t}$ is any cash payment at time t. Following standard practices in the literature, we exclude bonds without rating, bonds issued with less than 18 months to maturity and bonds with less than 11 month until maturity. We also exclude 144a bonds (private placement), only keep fixed rate, i.e. exclude float, perpetual and fixed to float bonds; and require duration above 1 year. We remove extreme daily returns by dropping observations with return values below 0.01% and above 99.99% of the distribution. Finally, we exclude bonds that we are not able to compute betas due to small data availability (beta computation details are presented in section 3.1). The final sample contains 16,410 unique bonds.

Table 1 shows summary statistics per rating of our data. To construct this table, we first compute monthly statistics per rating and then we average across the months, this way we observe average cross-section information. We highlight that most of the market is concentrated in A and BBB bonds, in both number of securities and average monthly market value. The returns are increasing monotonically for Investment Grade (IG) bonds, which are bonds with ratings AAA up to BBB. However, as we move to the riskier High Yield bonds (rating BB or below), the monotonic pattern of returns disappear and the volatility increases drastically, yielding smaller Sharpe Ratios. Safer assets have lower yields and higher durations, with monotone pattern as assets get riskier. Our data is unbalanced, with HY starting in 2013. Since we are value-weighting portfolios in our analysis, the effects of HY coming later in the sample is reduced (HY assets are a much smaller market). Also, results hold if we use only the IG subsample.

[Table 1 about here.]

To compute excess returns, e use the short term risk-free rate from Fama and French data[5]. We also compute duration adjusted excess returns, as suggested by Binsbergen et al. (2024). To compute duration matched excess returns we use yields data from Discount Bond Data[6], computed by Filipovic et al. (2024). We use the

[5]Fama Website. We thank the authors for making the data public available.

[6]Discount Bond Data. We thank the authors for making the data public available.

yields data and compute treasury returns from yields as:

$$r_{n,t+1}^T = \frac{\exp(-y_{n,t+1}^T \cdot n)}{\exp(-y_{n+1,t}^T \cdot (n+1))} - 1$$

Where $r_{n,t+1}^T$ is the treasury return and $y_{n,t}^T$ is the treasury yield at time t with time to maturity n. The duration matched excess return is the return of the bond in excess of the return of a zero coupon treasury of the same duration. Because duration is the same as time to maturity for a zero coupon, the government return is matched to a bond with the same duration.

3.1 Beta Estimates

Empirically, we estimate betas at the daily level for each corporate bond in our sample. We closely follow the methodology of Frazzini and Pedersen (2014) to estimate betas, since we want to be able to compare results with theirs. To account for asynchronous trading and potential non-synchronous price movements—which can impact the correlation with the market—we estimate the correlations and standard deviations separately. This approach mitigates the biases that may arise from stale prices or infrequent trading of certain bonds. We use a three-year rolling window to compute the correlation and one-year rolling window for standard deviations.

To ensure robustness, we require that at least a 120 trading days are available within the rolling window for a beta to be computed in the analysis. Betas are estimated using the following formula:

$$\beta_{i,t} = \rho_{im,t} \frac{\sigma_{i,t}}{\sigma_{mt}}$$

Where $\rho_{im,t}$ is the correlation measure, $\sigma_{i,t}$ is the asset's standard deviation and σ_{mt} is the market standard deviation. We adjust the variables appropriately depending on the specific beta estimation approach—whether using returns, or yield changes—as discussed earlier.

In figure 2, we present density plots for the betas by breaking the sample based on duration—assets with modified duration below 5 versus assets with modified duration above 7. In this plot, modified duration and market betas are tightly related—bonds with duration below 5 have betas around 0.5 and assets with duration above 7 have market beta above 1. However, the new proposed betas and duration are independent with most betas around 1 for any given duration. This is compelling evidence that our new beta measure is cleansed from the effects of duration.

In the summary table 1 we also show the beta measure per rating. We observe that our new measure of beta increases monotonically with rating, indicative of capturing the risk of the portfolios. On the other hand, this pattern is not observed for market betas—as we discussed this measure of risk is entangled with duration effects. Since assets with safer ratings have longer durations, the market beta is entangling both dimensions.

[Figure 2 about here.]

3.2 Asset Pricing Tests

This section outlines the empirical methodology used to analyze the performance of bond portfolios based on specific characteristics. We constructed portfolios, performed sorting procedures, and evaluated their performance using the Capital Asset Pricing Model (CAPM). We choose the CAPM because there is no agreed-upon better alternative, and evidence suggests that the CAPM remains a robust benchmark that is difficult to outperform (Dickerson et al., 2023).

First, we compute monthly portfolio returns by accumulating daily returns for bonds, the short-term risk-free rate, and duration-matched Treasury securities. These portfolios are value-weighted. The characteristics used for portfolio formation are lagged by one period (from time $t-1$). The characteristics we use are: Duration, market beta and beta.

For the single sorted exercise, we formed quintile portfolios based on each characteristic, dividing the assets into five groups. Additionally, we constructed long-short portfolios by taking long positions in the top 20% of assets and short positions in the bottom 80%. This approach helps in isolating the effect of each characteristic on portfolio returns.

We also do double sorted exercises. We want to show that our results holds after controlling for duration. In this case, we separate assets in a grid of 9 portfolios, based on three duration buckets and three beta buckets. We conditionally sort, first on duration, then on betas. Finally, we compute a long-short portfolio of those portfolios (a total of 6 long-short portfolios).

We always construct value-weighted portfolios in our analysis. We do that because implementing a beta weighting procedure to enforce zero beta portfolios has generated criticisms of over-valuing small stocks and generating portfolios similar to equal-weighting (Novy-Marx and Velikov, 2020). For all portfolios described early, the performance is evaluated using the standard CAPM regression model:

$$r_{p,t+1} - r_t^f = \alpha_p + \beta_p \left(r_{m,t+1} - r_t^f \right) + \varepsilon_{p,t+1}$$

Where $r_{m,t+1}$ is a value weighted market return computed with our sample. We are interested in checking the post-formation β_i and Jensen's alphas α_i of these portfolios. On our analysis, we consider two types of excess return. In one case, we use the short term rate, in the other we use the duration matched government return—adjusting both the asset and the markets returns.

4 Results

In Table 4, we present the single-sorted portfolios. The left columns, labelled *unhedged*, present results for returns in excess of the short-term risk-free. The *hedged* columns on the right are for returns in excess of the duration-matched treasury.

Panel A shows portfolios sorted by market beta. These portfolios exhibit increasing excess returns and volatility across quintiles, accompanied by decreasing Sharpe ratios. We observe decreasing point estimates for the alphas, consistent with findings by Frazzini and Pedersen. However, in our sample and using our portfolio construction methodology, these results are statistically insignificant. The post-formation betas, durations, and yields increase across quintiles, indicating that higher quintiles correspond to riskier portfolios. These portfolios load more on market risk, have higher volatilities, and yield higher excess returns. While the risk-adjusted returns decrease across quintiles, they are not as significant as previously documented by the literature.

[Figure 3 about here.]

In Panel B, we perform a similar exercise but sort the portfolios based on duration. The portfolios sorted on duration closely resemble those sorted on market beta, displaying similar excess returns, volatility, durations, and yields. The post-formation betas are also very similar, and Jensen's alphas decrease across quintiles. The alphas are generally higher and exhibit more statistical significance; for example, the long-short portfolio has an alpha of -0.16% per month with a t-statistic of -2.14. Figure 3 illustrates that, over time, portfolios sorted on duration load very similarly to those sorted on market beta. The correlation of the market beta sorted long-short portfolio and the duration sorted long-short portfolio is 0.98, further evidence of the return correlation in both (Table 2).

[Table 2 about here.]

In Panel C, we examine portfolios sorted on the new beta measure, computed with yield changes. These portfolios differ notably from the previous ones. While we still observe increasing excess returns associated with higher quintile, i.e. higher beta; volatility decreases, resulting in increasing Sharpe ratios—contrary to the decreasing ratios seen in the previous portfolios. All portfolios have similar mean durations and yields. Figure 3 shows that these portfolios differ substantially from those sorted on duration or market beta. The durations of these portfolios vary over time; notably, the long-short portfolio has higher duration exposure in the first half of the sample (between five and ten), decreases to around three after 2013, and increases again after 2018.

The beta-sorted portfolios are also unique in their correlation with the market. They exhibit increasing alphas, with the long-short portfolio achieving a positive alpha of 0.26% per month and a t-statistic of 3.27, generating an information ratio of 0.70. These portfolios have similar market betas, around one, but the long-short portfolios have small post-formation betas (-0.11 for the short-term excess return and insignificant for duration-matched excess return). This indicates that the sorting generates a risk factor that appears uncorrelated with the market factor.

[Table 3 about here.]

Finally, we construct a combination portfolio that leverages both positive alpha strategies by betting against duration and betting on betas. Specifically, we go long on duration portfolio 1 and beta portfolio 5, and short duration portfolio 5 and beta portfolio 1. The results for this portfolio are presented in Table 4, showing an alpha of 0.21% per month with a t-statistic of 3.37 and information ratio of 0.72.

In figure 4 we show the cumulative return of strategies that bet against duration, bet on betas, and the combination of both. For each strategy, we first accumulate the returns of the long and short portfolios separately, ensuring their volatilities are scaled to match the market's volatility. The cumulative return is then computed by subtracting the accumulated short returns from the accumulated long returns.

[Table 4 about here.]

Table 5 presents the double-sorted portfolios, where assets are allocated into nine portfolios by first sorting on duration and then on yield beta. The patterns observed in earlier analyses persist even after controlling for the other characteristic. Specifically, within each duration bucket, portfolios sorted on beta generate positive alphas when constructed to bet on betas (i.e., long high betas, short low betas). Conversely, duration-sorted portfolios continue to exhibit negative alphas when designed to bet on duration. Both sorting methodologies yield statistically significant alphas in all but one case. These results are particularly noteworthy given the limitations of a 23-year data sample and the small cross-section of corporate bonds at the beginning of the sample period; nonetheless, we observe statistically significant results in most portfolios.

[Table 5 about here.]

The double-sorted portfolios also replicate the pattern observed in market betas, suggesting that duration is the primary driver of post-formation betas. Low-duration portfolios exhibit smaller post-formation betas, while high-duration portfolios have higher post-formation betas. In contrast, sorting on yield beta does not produce significant dispersion in post-formation betas. Indeed, the long-short portfolios based on yield beta demonstrate minimal loading on the market factor, with values ranging from statistically insignificant to 0.18. It is important to note that these portfolios are value-weighted, and no explicit strategy to mitigate market risk was employed in their initial construction.

[Figure 4 about here.]

5 Discussion

Our analysis proposes that there are two separate sources of risk in the corporate bond market. This is shown by disentangling the market beta into a duration, capturing interest rate risk, and beta risk, capturing yield risk.

First, traditional market beta in corporate bonds is closely tied to duration. Portfolios sorted on market beta and duration exhibit remarkably similar characteristics and return patterns. Specifically, both sorting methods result in portfolios where higher beta or longer duration corresponds to higher excess returns but lower risk-adjusted performance. This suggests that market beta, as commonly measured, may primarily capture duration risk rather than pure systematic risk associated with the bond market. The high correlation between the long-short portfolios sorted on market beta and duration (correlation coefficient of 0.98) further supports this conclusion.

Second, when we isolate beta from duration using our proposed measure—based on yield changes rather than returns—we uncover a different pattern. Portfolios sorted on the new beta exhibit increasing alphas and Sharpe ratios across quintiles, indicating that higher beta bonds, offer superior risk-adjusted returns. Notably, these portfolios do not have significantly different durations or yields, suggesting that the excess risk-adjusted returns are not compensation for traditional characteristics of bonds. Also, these portfolios load very similarly with the market, with a beta at around one, such that the long-short portfolio naturally diversifies from market risk. The disconnection from market risk is further evidenced by the negative correlation of this portfolio and duration or market-beta sorted portfolios.

In addition, double sorted portfolios provide further evidence that duration and betas are opposite sources of risk. By constructing portfolios with same duration and spreading on beta, we find evidence of a betting on betas. Also, for portfolios with similar betas but varying durations, we find evidence of betting against duration.

These results contribute to the academic literature on factor investing in corporate bonds. While previous studies have not agreed on a set of factor that explains the cross-section of returns, our approach provides a novel framework to think about that. By accounting for the time-varying nature of duration and its impacts on returns, we are able to have more robust estimates of beta risk.

Our findings propose possible avenues of future research to deepen our understanding of the corporate bond market. On one hand, we see promising effort to explaining these results in light of models with default risk such as Merton (1974) and Duffie and Singleton (1999).

On the other hand, frictions and market players can be driving the results. The results can be rationalized if long-term investors that demand high duration and safer assets make a big proportion of investors (i.e. pensions funds, life insurance companies) . These investors demand longer duration assets to match longer term liabilities—an immunization strategy to avoid interest rate risk (Redington, 1952). This high demand for high duration assets can explain the mispricing on duration. These investors are also subject to capital constraints that generates higher demand for lower risk assets, which explains the mispricing on beta. Of course, some kind of leverage constraint on arbitrageours as in Black (1972) and Frazzini and Pedersen (2014) is necessary to sustain the alphas we observe.

The practical implications of these findings are significant. Investors who are able to decouple beta from duration can construct portfolios that exploit this mispricing, achieving abnormal returns without taking on additional duration risk. The combination portfolio, which goes long on high-beta bonds and short on long-duration bonds, delivers a monthly alpha of 0.21% (t-statistic of 3.37) and an annualized information ratio of 0.72. This performance is not only statistically significant but also economically meaningful, offering a viable strategy for portfolio managers seeking to enhance returns.

However, our study is not without limitations. The sample period spans for just over two decades, including the introduction of high-yield bonds only from 2013 onward. Nevertheless, the statistical significance within this timeframe is meaningful. Additionally, our linear approximation of bond returns currently abstracts away from convexity effects, which could be significant for bonds with extreme durations or in volatile interest rate environments. Incorporating convexity into the analysis could refine our understanding of the return dynamics.

Furthermore, the practical implementation of the strategies we propose may face real-world constraints such as transaction costs, liquidity considerations, and regulatory requirements. While our portfolios are value-weighted to mitigate some of these concerns, particularly the criticisms highlighted by Novy-Marx and Velikov (2020) regarding beta weighting, further analysis is necessary to assess the net performance after accounting for such factors.

In conclusion, our study provides a novel perspective on the determinants of corporate bond returns by effectively separating beta from duration. This approach not only enhances our theoretical understanding of risk factors in the bond market but also offers actionable insights for constructing portfolios with superior risk-adjusted returns. Future research could build on our findings by exploring the implications in different market contexts, integrating additional risk factors, or examining the effects in international bond markets.

6 Conclusion

In this paper, we revisited the determinants of corporate bonds returns in the U.S. Corporate Bond market. By applying a linear approximation on bond prices, we were able to disentangle market beta into two components, one related to duration and another to yield risk. This allows us to compute more robust measures of beta, by computing rolling window on measures that are disentangled from duration effects.

Empirical results demonstrate that traditional market beta is closely linked to duration. Portfolios sorted on market beta or duration exhibit similar patterns: higher excess returns but lower risk-adjusted performance, suggesting that duration risk primarily drives market beta in corporate bonds. In contrast, our new beta measure, derived from yield changes, captures a different dimension of risk. Portfolios sorted on this beta show increasing alphas and Sharpe ratios across quintiles, indicating that higher beta bonds offer superior risk-adjusted returns independent of duration effects.

Our study contributes to the academic discourse by reconciling conflicting evidence on factor investing in corporate bonds. It revisits the "betting against beta" framework in the context of corporate bonds, highlighting how previous findings are due to a "betting against duration". Additionally, by effectively isolating the duration effect from the market beta, we document a new "betting on betas".

This work paves ideas for future research by understanding the validness of CAPM in this context. Models with default risks can rationalize the empirical results we have. Also, models with frictions based on what we know about insurance life companies and pensions funds can accommodate the kind of empirical result observed here.

Future research could also extend this analysis by exploring the effects of convexity and other higher-order risks on bond returns, as well as examining the applicability of our findings in different market environments or international contexts. Additionally, incorporating real-world constraints such as transaction costs and liquidity considerations would further validate the practical utility of the proposed strategies.

References

Bekaert, G. and Santis, R. A. D. (2021). Risk and return in international corporate bond markets. *Journal of International Financial Markets, Institutions and Money*, 72:101338.

Binsbergen, J. H. V., Nozawa, Y., and Schwert, M. (2024). Duration-based valuation of corporate bonds *.

Black, F. (1972). Capital market equilibrium with restricted borrowing. *The Journal of Business*, 45:444.

Chung, K. H., Wang, J., and Wu, C. (2018). Volatility and the cross-section of corporate bond returns.

Dick-Nielsen, J., Feldhütter, P., Pedersen, L. H., and Stolborg, C. (2023). Corporate bond factors: Replication failures and a new framework. *SSRN Electronic Journal*.

Dickerson, A., Julliard, C., and Mueller, P. (2023). The corporate bond factor zoo. *SSRN Electronic Journal*.

Dor, A. B., Desclée, A., Dynkin, L., Hyman, J., and Polbennikov, S. (2021). *Systematic Investing in Credit*. Wiley.

Dor, A. B., Dynkin, L., Hyman, J., Houweling, P., Leeuwen, E. V., and Penninga, O. (2007). Dts (duration times spread) - a new measure of spread exposure in credit portfolios.

Duffie, D. and Singleton, K. J. (1999). Modeling term structures of defaultable bonds. *The Review of Financial Studies*, 12(4):687–720.

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

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

Filipovic, D., Pelger, M., and Ye, Y. (2024). Stripping the discount curve - a robust machine learning approach.

Frazzini, A. and Pedersen, L. H. (2014). Betting against beta. *Journal of Financial Economics*, 111:1–25.

Gonçalves, A. S. (2021). The short duration premium. *Journal of Financial Economics*, 141:919–945.

Gormsen, N. J. and Lazarus, E. (2022). Duration-driven returns.

Ho, H. C. and Wang, H. C. (2018). Momentum lost and found in corporate bond returns. *Journal of Financial Markets*, 38:60–82.

Kelly, B., Palhares, D., and Pruitt, S. (2023). Modeling corporate bond returns. *The Journal of Finance*, 78:1967–2008.

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

Novy-Marx, R. and Velikov, M. (2020). Betting against betting against beta *.

Redington, F. M. (1952). Review of the principles of life-office valuations. *Journal of the Institute of Actuaries*, 78:286–340.

Zhang, X. and Zhang, Z. (2023). The cross-section of chinese corporate bond returns. *Journal of Finance and Data Science*, 9.

A Return Approximation

Start with equation 1, we can compute the price after one period:

$$P_{n-1,t+1}(y_{n-1,t+1}) = \sum_{i=1}^{n-1} \frac{CF_i}{(1+y_{n-1,t+1})^i}$$

We can write $\Delta y_{t+1} = y_{n-1,t+1} - y_{nt}$ and make a linear expansion of next period's price around previous period's yield y_{nt}

$$P_{n-1,t+1} \approx P_{n-1,t+1}(y_{nt}) + \left.\frac{\partial P_{n-1,t+1}}{\partial y}\right|_{y=y_{nt}} \cdot \Delta y_{t+1} \tag{3}$$

The duration of a bond is defined as:

$$D_{n,t}(y) = -\frac{1}{P_{n,t}(y)} \frac{\partial P_{n,t}}{\partial y}$$

Compute the derivative needed for equation 3:

$$\left.\frac{\partial P_{n-1,t+1}}{\partial y}\right|_{y=y_{nt}} = -P_{n-1,t+1}(y_{n,t}) D_{n-1,t+1}(y_{n,t})$$

Because of the Taylor expansion around known $y_{n,t}$, these $t+1$ terms can be computed using information available at time t. The holding period return of a bond is the coupon plus change in price divided by previous period price:

$$r_{t+1} = \frac{c_{t+1} + P_{n-1,t+1}(y_{n-1,t+1}) - P_{n,t}(y_{n,t})}{P_{n,t}(y_{n,t})}$$

Replacing with the linear approximation we obtain:

$$r_{t+1} \approx \frac{c_{t+1} + P_{n-1,t+1}(y_{n,t}) - P_{n-1,t+1}(y_{n,t}) D_{n-1,t+1}(y_{n,t}) \Delta y - P_{n,t}(y_{n,t})}{P_{n,t}(y_{n,t})}$$

Note that

$$c_{t+1} + P_{n-1,t+1}(y_{n,t}) = (1 + y_{n,t}) P_{n,t}(y_{n,t}) \tag{4}$$

$$(1 + y_{n,t}) P_{n,t}(y_{n,t}) = c_{t+1} + \sum_{i=1}^{n-1} \frac{CF_i}{(1+y_{n,t})^i} = c_{t+1} + P_{n-1,t+1}(y_{n,t})$$

Replace back

$$\begin{aligned}
r_{t+1} &\approx \frac{(1 + y_{n,t}) P_{n,t}(y_{n,t}) - P_{n-1,t+1}(y_{n,t}) D_{n-1,t+1}(y_{n,t}) \Delta y_{t+1} - P_{n,t}(y_{n,t})}{P_{n,t}(y_{n,t})} \\
&= \frac{y_{n,t} P_{n,t}(y_{n,t}) - P_{n-1,t+1}(y_{n,t}) D_{n-1,t+1}(y_{n,t}) \Delta y_{t+1}}{P_{n,t}(y_{n,t})} \\
&= y_{nt} - \frac{P_{n-1,t+1}(y_{nt})}{P_{nt}(y_{nt})} D_{n-1,t+1}(y_{nt}) \Delta y_{t+1}
\end{aligned}$$

The holding one period return depends on previous period's yield, the ratio of prices using $y_{n,t}$ to discount both cashflows, duration - also computed using $y_{n,t}$ and finally $\Delta y_{t+1} = y_{n-1,t+1} - y_{n,t}$ which is the only unknown information at time t (since $y_{n-1,t+1}$ is not know at t).

We can further simplify the expression by considering that:

$$\frac{P_{n-1,t+1}}{P_{n,t}} D_{n-1,t+1} = \frac{P_{n-1,t+1}}{P_{n,t}} \frac{1}{(1+y_{n,t})P_{n-1,t+1}} \left(\frac{1 \cdot CF_2}{(1+y_{n,t})} + ... + \frac{(n-1) \cdot CF_n}{(1+y_{n,t})^{n-1}} \right)$$

Where we add and subtract some terms to obtain:

$$\begin{aligned}
\frac{P_{n-1,t+1}}{P_{n,t}} D_{n-1,t+1} &= \frac{1}{(1+y_{n,t})P_{n,t}} (\frac{1 \cdot CF_2}{(1+y_{n,t})} + ... + \frac{(n-1) \cdot CF_n}{(1+y_{n,t})^{n-1}} + \\
& [CF_1 + \frac{CF_2}{(1+y_{n,t})} + ... + \frac{CF_n}{(1+y_{n,t})} - CF_1 - \frac{CF_2}{(1+y_{n,t})} - ... - \frac{CF_n}{(1+y_{n,t})}]) \\
&= \frac{1}{(1+y_{n,t})P_{n,t}} \left(\sum_{i=1}^{n} \frac{CF_i}{(1+y_{n,t})^{i-1}} - \sum_{i=1}^{n} \frac{CF_i}{(1+y)^{i-1}} \right) \\
&= \frac{1}{(1+y_{n,t})P_{n,t}} \sum_{i=1}^{n} \frac{CF_i}{(1+y_{n,t})^{i-1}} - \frac{1}{(1+y_{n,t})P_{n,t}} \sum_{i=1}^{n} \frac{CF_i}{(1+y)^{i-1}}
\end{aligned}$$

Now the first term can be simplified:

$$\frac{1}{(1+y_{n,t})P_{n,t}} \sum_{i=1}^{n} \frac{CF_i}{(1+y_{n,t})^{i-1}} = D_{n,t}(1+y_{n,t})$$

And the second term:

$$\frac{1}{(1+y_{n,t})P_{n,t}} \sum_{i=1}^{n} \frac{CF_i}{(1+y)^{i-1}} = \frac{1}{P_{n,t}} \sum_{i=1}^{n} \frac{CF_i}{(1+y)^{i}} = 1$$

Therefore

$$\frac{P_{n-1,t+1}}{P_{n,t}} D_{n-1,t+1} = D_{n,t}(1+y_{n,t}) - 1$$

Now I need to show that $D_{n,t}(1+y_{n,t}) - 1 \approx D_{n,t}$.

We can further simplify the expression by considering that $c_{t+1} + P_{n-1,t+1}(y_{n,t}) = (1+y_{n,t})P_{n,t}(y_{n,t})$ implies that:

$$\frac{P_{n-1,t+1}}{P_{n,t}} = 1 + y_{nt} - \frac{c_{t+1}}{P_{n,t}}$$

Which, if we assume that yield to maturity and current yield, on a daily basis, are insignificant values. For example YTM of 8% is 0.03% daily. The difference between daily YTM and current yield must be significant for this value to be meaningful. We assume that changes in price computed with the same yield are negligible such that $\frac{P_{n-1,t+1}(y_{nt})}{P_{nt}(y_{nt})} = 1$.

We assume also the change in duration is negligible at the daily level, $D_{n-1,t+1}(y_{nt}) = D_{n,t}(y_{nt})$.

We further simplify this in the context of the daily data we use to compute the risk-factor. We assume that changes in price computed with the same yield are negligible such that $\frac{P_{n-1,t+1}(y_{nt})}{P_{nt}(y_{nt})} = 1$ and the change in duration is negligible at the daily level, $D_{n-1,t+1}(y_{nt}) = D_{n,t}(y_{nt})$.

Figures

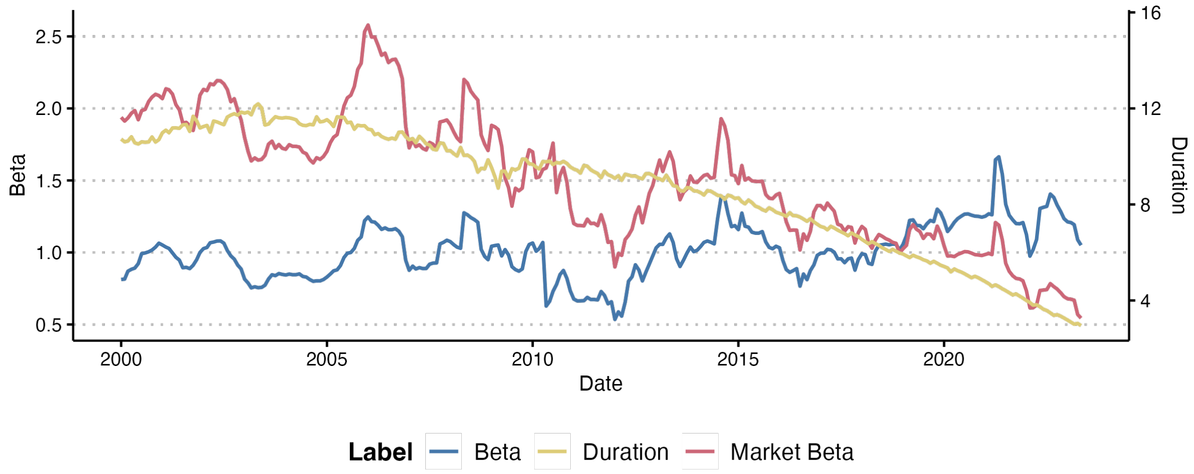

Figure 1: **Illustrative Asset: Betas and Duration.** This plot shows the duration, market beta and our proposed beta for one specific corporate bond maturing in 2026.

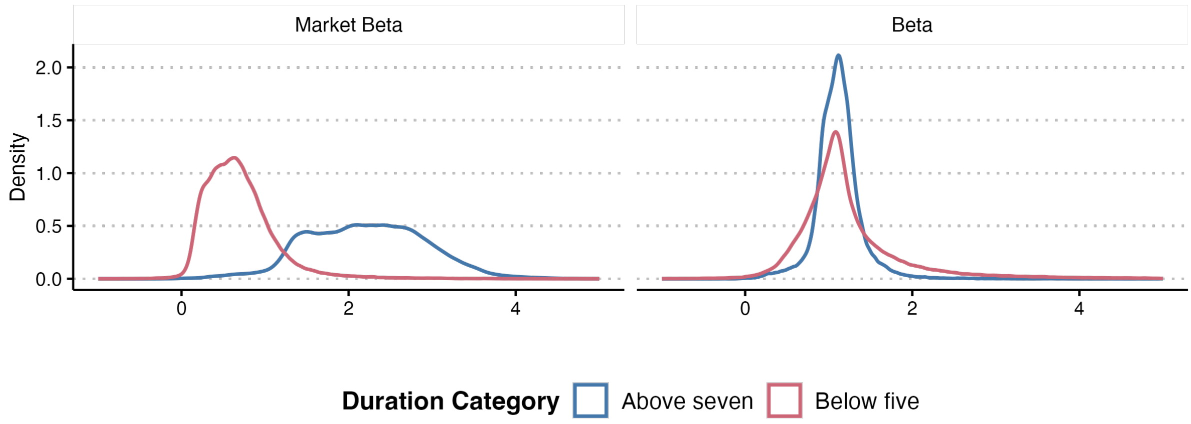

Figure 2: **Density of Betas.** This plot shows the density of our measures of beta for two subsamples: assets with modified duration below five and assets with modified duration above seven.

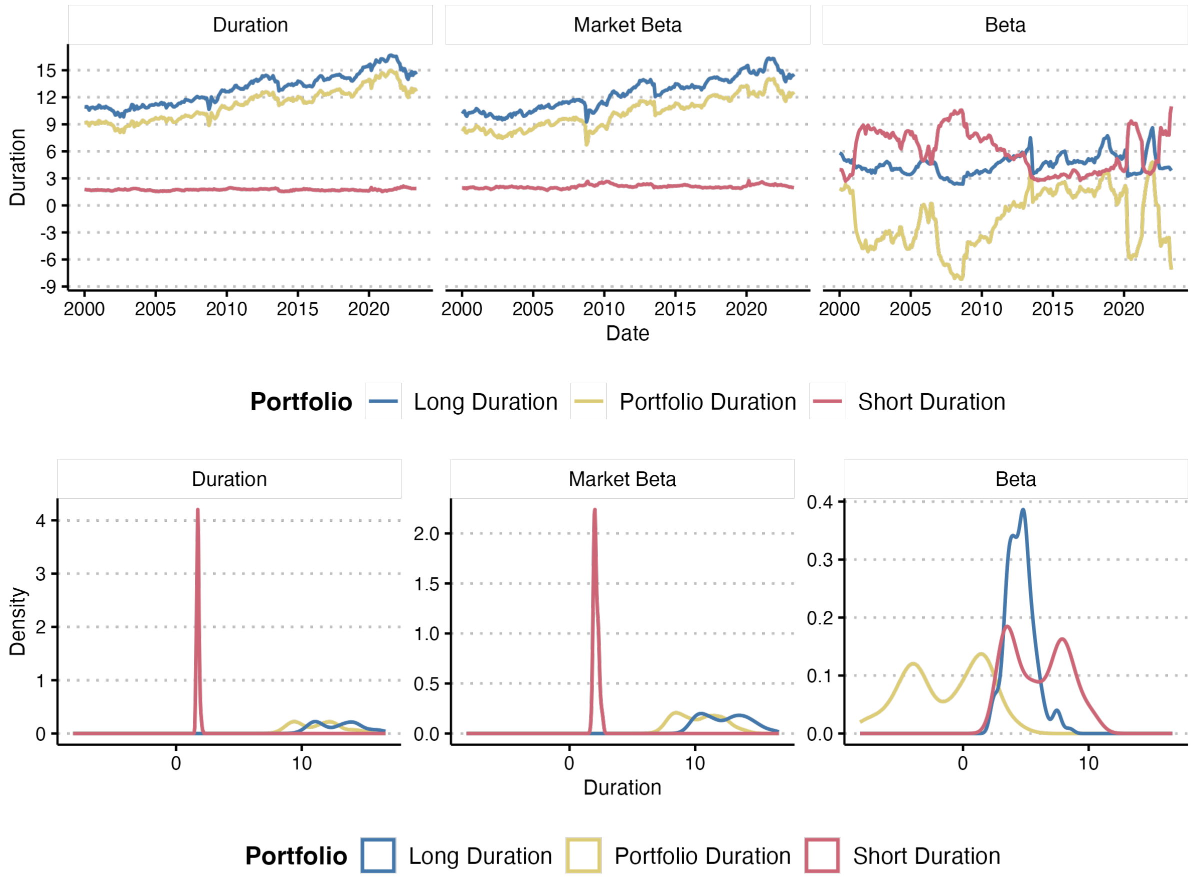

Figure 3: **Portfolios Duration.** This plot shows the duration of portfolios constructed with single sorted methodology. The long portfolio corresponds to the fifth quintiles (characteristic's top 20%), the short portfolio corresponds to the first quintile (characteristic's bottom 20%) and the portfolio represents the long short portfolio which goes long in the fifth portfolio and shorts the first quintile.

Figure 4: **Cumulative return of long-short portfolios.** In this plot the return of the long and the short portfolios are accumulated and the cumulative returns are subtracted from each other. In Panel A, the excess returns are calculated with respect to a short-term risk-free rate. In Panel B, excess returns are calculated with respect to the return of a duration matched treasury bond. Each portfolio is a dollar neutral strategy: duration goes long in bottom 20% duration and short top 20%, beta goes long in top 20% and short bottom 20%. The combination equal weights the long and short portfolios.

Tables

Table 1: **Data summary.** Table monthly summary statistics per rating, the aggregate across all months. The number of assets N is a count of unique bonds per month. The market value is measured in billions of dollars and is the sum of market value of all bonds in that rating. All other characteristics are measured as value-weighted mean, the variables are: return, unhedged excess return (in excess of short-term risk-free) and hedged excess return (in excess of a duration matched treasury), modified duration, yield, market beta, beta, relative yield beta. Betas are computed at last day of month with daily data, using 3 years for correlation and 1 year for standard deviations. In parenthesis standard-deviations.

Rating	N	Mkt Value	Ret	Unhed-ged	Hed-ged	Dur	Yield	Mkt Beta	Beta	Start
AAA	48.8	56.9	3.8	2.3	0.7	7.3	3.6	1.36	1.06	2000-1
	(19.4)	(30.1)	(6.0)	(6.0)	(3.2)	(2.5)	(1.4)	(0.36)	(0.15)	
AA	187.5	237.0	4.2	2.7	1.2	6.2	3.7	1.24	1.15	2000-1
	(75.6)	(104.7)	(5.2)	(5.1)	(3.4)	(1.5)	(1.4)	(0.23)	(0.16)	
A	816.1	876.4	4.3	2.8	1.1	6.3	4.1	1.29	1.15	2000-1
	(425.9)	(470.6)	(5.6)	(5.6)	(4.3)	(1.0)	(1.6)	(0.18)	(0.17)	
BBB	932.3	908.2	5.2	3.6	1.6	6.7	4.8	1.39	1.18	2000-1
	(694.0)	(721.1)	(6.3)	(6.3)	(5.9)	(0.8)	(1.7)	(0.21)	(0.17)	
BB	544.8	396.8	5.0	4.1	4.6	4.4	4.9	0.99	1.44	2013-2
	(154.6)	(117.0)	(7.4)	(7.5)	(7.2)	(0.4)	(1.0)	(0.35)	(0.42)	
B	447.2	293.1	3.2	2.3	2.7	3.5	6.6	0.91	1.63	2013-8
	(65.6)	(37.4)	(7.2)	(7.2)	(7.4)	(0.4)	(1.4)	(0.29)	(0.48)	
CCC	183.4	98.8	3.5	2.6	3.0	3.1	11.3	0.94	1.93	2013-8
	(34.0)	(13.1)	(9.9)	(9.9)	(10.2)	(0.3)	(2.9)	(0.36)	(0.76)	
CC	9.3	3.8	4.2	3.3	3.9	2.6	30.5	1.40	4.00	2013-8
	(5.1)	(1.9)	(22.4)	(22.4)	(22.6)	(0.6)	(17.1)	(0.56)	(2.88)	
C	2.7	0.8	5.5	4.6	4.7	2.1	51.3	1.55	5.73	2014-5
	(1.7)	(0.8)	(36.6)	(36.6)	(36.8)	(0.7)	(29.4)	(0.72)	(7.46)	

Table 2: **Long-short Portfolio Correlations**. This table contains the correlation of long-short portfolios sorted on duration, market beta and beta. Betas are computed with daily data using 3 years for correlation and 1 year for standard deviations. Characteristics from the previous month are used to compute monthly value-weighted portfolios. The portfolios goes long in the top 20% of the characteristic and shorts the bottom 80%.

Unhedged

Duration	Market Beta	Beta
1.00	0.98	-0.26
0.98	1.00	-0.11
-0.26	-0.11	1.00

Hedged

Duration	Market Beta	Beta
1.00	0.97	-0.09
0.97	1.00	0.10
-0.09	0.10	1.00

Table 3: **Single Sorted Quantile Portfolios**. This table contains quintile portfolios sorted on characteristics market beta, duration, and beta. Market betas and betas are computed with daily data using 3 years for correlation and 1 year for standard deviations. Characteristics from the previous month are used to compute monthly value-weighted portfolios. The portfolios are benchmarked with a market index, a value-weighted return of the market.

Panel A: Market Beta

	Unhedged						Hedged					
	1	2	3	4	5	(5-1)	1	2	3	4	5	(5-1)
Alpha	0.00	0.03	0.02	0.02	-0.06	-0.06	0.01	0.04	0.03	0.02	-0.10	-0.11
	(0.09)	(1.38)	(0.82)	(1.20)	(-1.06)	(-0.79)	(0.62)	(2.15)	(1.32)	(1.32)	(-2.15)	(-1.80)
Beta	0.37	0.61	0.89	1.21	1.74	1.36	0.49	0.65	0.88	1.17	1.64	1.15
	(23.91)	(46.39)	(65.09)	(140.06)	(52.30)	(29.72)	(31.71)	(51.05)	(65.10)	(114.85)	(50.50)	(26.11)
Excess Returns	1.21	2.31	3.07	4.08	4.86	3.61	0.88	1.41	1.60	1.95	1.22	0.34
Volatility	2.59	3.70	5.23	6.91	10.34	8.86	2.68	3.31	4.42	5.74	8.39	6.64
Sharpe Ratio	0.47	0.62	0.59	0.59	0.47	0.41	0.33	0.43	0.36	0.34	0.15	0.05
Info. Ratio	0.02	0.29	0.17	0.25	-0.22	-0.17	0.13	0.45	0.28	0.27	-0.45	-0.37
R^2	0.67	0.89	0.94	0.99	0.91	0.76	0.78	0.90	0.94	0.98	0.90	0.71
Duration	2.10	3.40	4.89	7.07	12.38	10.28	2.10	3.40	4.89	7.07	12.38	10.28
Yield	3.56	4.05	4.63	5.03	5.53	1.97	3.56	4.05	4.63	5.03	5.53	1.97

Panel B: Duration

	Unhedged						Hedged					
	1	2	3	4	5	(5-1)	1	2	3	4	5	(5-1)
Alpha	0.04	0.05	0.06	0.01	-0.12	-0.16	0.07	0.06	0.06	0.01	-0.17	-0.23
	(2.07)	(1.85)	(2.18)	(0.62)	(-2.04)	(-2.14)	(4.34)	(3.03)	(2.91)	(0.61)	(-3.61)	(-4.01)
Beta	0.32	0.62	0.92	1.21	1.77	1.44	0.39	0.69	0.98	1.15	1.63	1.24
	(26.71)	(39.39)	(55.60)	(122.63)	(49.43)	(31.52)	(35.67)	(49.74)	(68.39)	(108.28)	(49.40)	(29.91)
Excess Returns	1.52	2.54	3.66	4.00	4.18	2.62	1.37	1.72	2.15	1.81	0.37	-0.99
Volatility	2.16	3.80	5.44	6.94	10.58	9.27	2.08	3.51	4.90	5.66	8.35	6.90
Sharpe Ratio	0.70	0.67	0.67	0.58	0.39	0.28	0.66	0.49	0.44	0.32	0.04	-0.14
Info. Ratio	0.43	0.39	0.46	0.13	-0.42	-0.44	0.91	0.63	0.61	0.13	-0.74	-0.82
R^2	0.72	0.85	0.92	0.98	0.90	0.78	0.82	0.90	0.94	0.98	0.90	0.76
Duration	1.74	3.18	4.81	7.18	12.94	11.20	1.74	3.18	4.81	7.18	12.94	11.20
Yield	3.65	4.15	4.69	4.86	5.47	1.83	3.65	4.15	4.69	4.86	5.47	1.83

Panel C: Beta

	Unhedged						Hedged					
	1	2	3	4	5	(5-1)	1	2	3	4	5	(5-1)
Alpha	-0.13	-0.06	0.00	0.03	0.13	0.26	-0.12	-0.04	-0.01	0.03	0.14	0.26
	(-2.74)	(-1.86)	(0.01)	(1.17)	(2.58)	(3.27)	(-3.73)	(-1.66)	(-0.70)	(1.79)	(3.25)	(3.98)
Beta	1.01	1.06	1.01	0.94	0.90	-0.11	1.07	0.94	0.96	0.94	1.06	-0.01
	(36.58)	(58.60)	(69.97)	(66.24)	(29.00)	(-2.38)	(46.28)	(57.28)	(80.50)	(83.70)	(34.75)	(-0.16)
Excess Returns	1.68	2.69	3.22	3.33	4.51	2.78	0.11	0.92	1.26	1.72	3.26	3.15
Volatility	6.32	6.25	5.89	5.49	5.90	4.56	5.51	4.76	4.75	4.66	5.71	3.77
Sharpe Ratio	0.27	0.43	0.55	0.61	0.77	0.61	0.02	0.19	0.27	0.37	0.57	0.84
Info. Ratio	-0.57	-0.39	0.00	0.25	0.55	0.70	-0.77	-0.34	-0.15	0.37	0.68	0.84
R^2	0.83	0.92	0.95	0.94	0.75	0.02	0.88	0.92	0.96	0.96	0.81	0.00
Duration	6.02	6.72	6.85	6.13	4.57	-1.44	6.02	6.72	6.85	6.13	4.57	-1.44
Yield	4.63	4.35	4.38	4.40	5.22	0.59	4.63	4.35	4.38	4.40	5.22	0.59

Table 4: **Single Sorted Quantile Portfolios**. This table contains long-short portfolios sorted on characteristics duration, beta and a final combination of both. Betas are computed with daily data using 3 years for correlation and 1 year for standard deviations. Characteristics from the previous month are used to compute monthly value-weighted portfolios. The portfolios are benchmarked with a market index, a value-weighted return of the market. The combination portfolio goes long in the beta long-short portfolio and shorts the duration long-short portfolio.

	Unhedged			Hedged		
	Duration (5-1)	Beta (5-1)	Combination (Beta - Duration)	Duration (5-1)	Beta (5-1)	Combination (Beta - Duration)
Alpha	-0.16	0.26	0.21	-0.23	0.26	0.25
	(-2.14)	(3.27)	(3.37)	(-4.01)	(3.98)	(5.23)
Beta	1.44	-0.11	-0.78	1.24	-0.01	-0.62
	(31.52)	(-2.38)	(-20.69)	(29.91)	(-0.16)	(-18.57)
Excess Returns	2.62	2.78	0.08	-0.99	3.15	2.07
Volatility	9.27	4.56	5.67	6.90	3.77	4.08
Sharpe Ratio	0.28	0.61	0.01	-0.14	0.84	0.51
Info. Ratio	-0.44	0.70	0.72	-0.82	0.84	1.10
R^2	0.78	0.02	0.61	0.76	0.00	0.55
Duration	11.20	-1.44	-6.32	11.20	-1.44	-6.32
Yield	1.83	0.59	-0.62	1.83	0.59	-0.62

Table 5: **Double Sorted Duration and Beta Portfolios**. This tables contains terciles portfolios conditionally double sorted, first on duration and then on yield beta. Yield betas are computed with daily data using 3 years for correlation and 1 year for standard deviations. Characteristics from previous month are use to compute monthly value-weighted portfolios. The portfolios are benchmarked with a market index, a value-weighted return of the market.

	Yield Beta							
	1	2	3	(3-1)	1	2	3	(3-1)
Duration	Alpha				t(Alpha)			
1	-0.03	0.03	0.11	0.13	-0.95	1.74	2.47	2.75
2	-0.05	0.04	0.15	0.2	-1.4	1.96	2.99	3.26
3	-0.13	-0.11	0.02	0.16	-2.41	-1.92	0.55	2.54
(3-1)	-0.1	-0.14	-0.08		-1.41	-2.05	-1.28	
	Beta				t(Beta)			
1	0.33	0.36	0.53	0.2	18	31.21	20.61	6.65
2	0.89	0.86	0.98	0.08	38.33	69.63	33.35	2.29
3	1.6	1.64	1.58	-0.02	48.12	49.62	61.45	-0.57
(3-1)	1.26	1.28	1.05		28.61	31.26	27.11	