**AQR Systematic Investing in Credit Markets**

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3. 2 AQR’s Original Research on the Topic “Common Factors in Corporate Bond and Bond Fund Returns” AQR Working Paper 2016 Understanding Systematic Investing in Credit Markets Source: AQR. For illustrative purposes only. Please refer to Israel, Palhares, Richardson (2016) “Common Factors in Corporate Bond and Bond Fund Returns”. Ronen Israel AQR Capital Management LLC ronen.israel@aqr.com Diogo Palhares AQR Capital Management LLC diogo.palhares@aqr.com Scott Richardson AQR Capital Management LLC London Business School scott.richardson@aqr.com July 22, 2016 Abstract We identify four key characteristics (carry, defensive, momentum and value) that together explain nearly 15% of the cross-sectional variation in corporate bond excess returns. The positive risk-adjusted returns to these characteristics are diversifying with respect to both market risk premia and equity characteristic returns. We use portfolios based on these characteristics to explain both the returns and holdings of actively managed credit funds. Credit hedge funds have very significant positive exposures to credit markets (beta) and positive exposures to value. Credit mutual funds have the expected positive exposure to credit markets and, unlike hedge funds, no exposure to value but positive exposures to momentum, carry and defensive. JEL classification: G12; G14; M41 Key words: corporate bonds, credit mutual funds, credit hedge funds A previous version of this paper was titled “Investing with style in corporate bonds.” We thank Demir Bektic, Maria Correia, Wayne E. Ferson, Patrick Houweling, Antti Ilmanen, Sarah Jiang, Toby Moskowitz, Narayan Naik, Lasse Pedersen, Kari Sigurdsson and participants at the 4th Alliance Bernstein Quant Conference, 24th European Pensions Symposium, 7th Inquire UK Business School Meeting, Norwegian Ministry of Finance and University of Cambridge, 2016 SFS Finance Cavalcade, London Quant Group and UBS Quantitative Investment Conference 2016 for helpful discussion and comments. We acknowledge the outstanding research assistance of Peter Diep, Johnny Kang and Mason Liang. The views and opinions expressed herein are those of the authors and do not necessarily reflect the views of AQR Capital Management LLC (“AQR”), its affiliates or its employees. This information does not constitute an offer or solicitation of an offer, or any advice or recommendation, by AQR, to purchase any securities or other financial instruments and may not be construed as such.

4. Today’s Presenter 3 Scott Richardson, Ph.D. Managing Director Scott conducts research for AQR’s Global Alternative Premia group, focusing on strategies that contain credit risk, and he helps oversee equity research for the firm’s Global Stock Selection group. Prior to AQR, he was a professor at London Business School, where he still teaches M.B.A. and Ph.D. classes. He has held senior positions at BlackRock (Barclays Global Investors), including head of Europe equity research and head of global credit research, and began his career as an assistant professor at the University of Pennsylvania. He is an editor of the Review of Accounting Studies and has published extensively there and in other leading academic and practitioner journals. In 2009 he won the Notable Contribution to Accounting award for his work on accrual reliability. Scott earned a B.Ec. with first-class honors from the University of Sydney and a Ph.D. in business administration from the University of Michigan.

5. Fixed Income and Corporate Credit

6. The Fixed Income Universe: Core and Core Plus 5 The Global Fixed Income Market is $47.5 Trillion Corporate HY 1,787, 72% Emerging Sovereign 693, 28% Market Value ($2.5 Trillion) Corporate HY 3,092, 88% Emerging Sovereign 440, 12% Count (3,352 bonds) Core Core Plus Source: Barclays, AQR. Market values in USD. All data for month ending 3/31/2016. Core includes the Barclays Global Aggregate Index constituents. Core Plus includes Global Corporate High Yield and Emerging Market Hard Currency Sovereign. Please read important disclosure in the Appendix. Government 25,043, 56% Government- Related, 5,110, 11% Corporate IG 8,076, 18% Securitized 6,888, 15% Market Value ($45 Trillion) Government 1,356, 8% Government- Related 4,050, 24% Corporate IG 9,579, 57% Securitized 1,825, 11% Count (16,810 bonds)

7. Identification of ‘Styles’ for Corporate Credit

8. What Is Style Investing? Focusing on Four Intuitive Styles 7 Momentum Recent outperformers vs. recent underperformers Value Cheap vs. Expensive Carry High yield vs. low yield Defensive Safe/high quality vs. risky/low quality Source: AQR. Past performance is not a guarantee of future performance. Please read important disclosures in the Appendix. All Styles Must Be: • Persistent: Evidence of multidecade positive returns • Pervasive: Exist broadly across regions and assets • Transparent: Clearly defined investment process • Intuitive: Economic rationale for positive excess returns • Liquid: Can be captured by trading liquid instruments

9. Style Definitions 8 Summary Bond 6-month bond momentum Equity 6-month equity momentum MomentumValue Structural Regression of spread on structural model default probability Empirical Regression of spread on its widely available determinants: • rating, • duration, and • bond volatility Carry Option-adjusted spread Defensive Low Duration Low effective duration Low Leverage Low market leverage Profitability High gross profitability Source: AQR. Please read important disclosures in the Appendix.

10. 9 Valuation Source: Richardson, Scott A., and Lok, Stephen, “Credit Markets and Financial Information” (January 20, 2011). For illustrative purposes only. Please read important disclosures in the Appendix. • Distance to Default is an important fundamental measure, affecting both Credit and Equity prices • Calculating Distance to Default requires measures of leverage as well as asset volatility • Accurately measuring leverage and asset volatility are therefore important for correctly capturing the fundamental value of both Credit and Equity An Example of the Fundamental Drivers of Credit Spreads Value Asset Volatility (σA) Asset Value Drift (μ) (VA) Expected Default Frequency Today Maturity (T) TimeTime (t) Default Threshold (X)

11. Portfolio Details 10 Methodology (Table 1) Investment Universe - Select from universe of Investment Grade (60%) and High Yield Corporate (40%) bonds - Select one bond per issuer, aiming to select most liquid - Average of 1,200 bonds per cross-section Portfolio Construction - Rank and standardize measures - Demean within Duration Times Spread (DTS) buckets aiming to make portfolios closer to beta-neutral  Except Carry, Duration - Volatility-adjust based on past realized volatility - Form composites by placing equal risk on each factor - Form model by placing equal risk on each style Source: AQR. Past performance is not a guarantee of future performance. Investment process subject to change at any time without notice. Please read important disclosures in the Appendix.

12. Results

13. -2% 0% 2% 4% Losers 2 3 4 Winners Momentum -2% 0% 2% 4% Risky 2 3 4 Safe Defensive -2% 0% 2% 4% Low Yield 2 3 4 High Yield Carry -2% 0% 2% 4% Expensive 2 3 4 Cheap Value Long-Term Evidence of Excess Returns 12 Credit Excess Returns by Style (Table 4) Source: Israel, Palhares and Richardson (2016), AQR. Above analysis reflects a backtest of underlying theoretical long/short styles generated by AQR definitions and is for illustrative purposes only and not based on an actual portfolio AQR manages. The universe includes U.S. corporate bonds in the Bank of America Merrill Lynch investment-grade and high-yield corporate bond indices issued between January 1997 – April 2015. The sample analyzed are selected from this universe based on seniority, maturity, age and size. Performance statistics for value-weighted quintile portfolios formed on Value, Momentum, Carry and Defensive portfolios. Please read important disclosures in the Appendix. These charts relate to Table 4 in the Common Factors in Corporate Bond and Bond Fund Returns Paper. These are not the returns of an actual portfolio AQR manages and are for illustrative purposes only. Please read important disclosures in the Appendix. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix.

14. 13 Source: Israel, Palhares and Richardson (2016), AQR. Above analysis reflects a backtest of underlying theoretical long/short styles generated by AQR definitions and is for illustrative purposes only and not based on an actual portfolio AQR manages. The universe includes U.S. corporate bonds in the Bank of America Merrill Lynch investment-grade and high-yield corporate bond indices issued between January 1997 and April 2015. The sample analyzed are selected from this universe based on seniority, maturity, age and size. Sharpe ratios for each individual style and the composite portfolio are calculated targeting a volatility of 5% per annum. The composite portfolio combined the Value, Momentum, Carry and Defensive portfolios at equal weights. The results shown do not include advisory fees or transaction costs; if such fees and expenses were deducted the Sharpe ratios would be lower. The risk-free rate is the Merrill Lynch 3 Month T-Bill. Please read performance disclosures in the Appendix for a description of the investment universe and allocation methodology. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix. Hypothetical Gross Sharpe Ratios of Long/Short Credit Style Portfolios Corporate Bonds (January 1997 - April 2015) Single long/short strategies performed well… Composites may be even better Multi-Style Corporate Bond Portfolio Diversification: The Whole is Greater Than the Sum of the Parts (Table 4) 0.0 0.5 1.0 1.5 2.0 2.5 Value Momentum Carry Defensive Composite SharpeRatio

15. -4 -2 0 2 4 6 8 10 12 Alpha TSY CRP ERP SMB HML UMD QMJ t-stat Value -4 -2 0 2 4 6 8 10 12 Alpha TSY CRP ERP SMB HML UMD QMJ t-stat Carry -4 -2 0 2 4 6 8 10 12 Alpha TSY CRP ERP SMB HML UMD QMJ t-stat Defensive -4 -2 0 2 4 6 8 10 12 Alpha TSY CRP ERP SMB HML UMD QMJ t-stat Momentum Diversification Across Traditional Risk Premia and Equity Styles 14 Credit Styles are not Beta.. Or Equity Styles (Table 6) Source: Israel, Palhares and Richardson (2016), AQR. Credit Risk Premia (CRP) is measured as the value-weighted corporate bond excess returns of 1,300 bonds that comprise the Bank of America Merrill Lynch US Corporate Index (C0A0) and US High Yield Total ReturnIndex (H0A0) corporate bond indices. Equity risk premia (ERP) is measured as the difference between the total returns on the S&P500 index and 1-month U.S. Treasury Bills. TSY refers to the Treasury term premium, measured as the difference between total returns on the 10-year U.S. Treasury bonds and one-month U.S. Treasury bills. See the Appendix for definitions of SMB (size factor), HML (value factor), UMD (momentum factor) and QMJ (quality factor). Significance of Credit Style Factors January 1997 – April 2015

16. Credit Fund Indices Exposures to Market Beta 15 Source: AQR, Morningstar Direct and Hedge Fund Research Database. The table reports the fraction of the variance of fund returns’ explained by bond, equity, and credit markets in the case of hedge funds, and own benchmarks in the case of mutual funds. The mutual fund index is an equal-weighted portfolio of fixed income mutual funds whose holdings are at least 80% corporate bonds. The hedge fund index is an equal-weighted portfolio of US-centric, fixed income – corporate hedge funds. Active return is the difference between a fund return in excess of its benchmark. For hedge funds the benchmark is a portfolio of bond, equity and credit markets that most strongly correlates with its returns. The markets are defined as follows. For stocks the market is the return of the S&P500 in excess of the 1-Month T-bill. For bonds, it is the return of the Bank-of-America-Merrill-Lynch (BAML) U.S. Treasuries 7-10 Yrs Index in excess of the 1-Month US T-bill. For credit it is the return of a market-cap weighted portfolio comprised of all the bonds in the BAML High Yield and Investment Grade indexes in excess of the portfolio of maturity-matched treasuries. Please see appendix for description of the single-factor style components. Past performance is not a guarantee of future performance. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix. Regression of Credit Hedge Fund and High Yield Mutual Fund Returns on Market Beta January 1997 – April 2015 Significant Portion of Returns Attributable to Passive Exposures… (Table 8) • For hedge funds, we regress monthly excess returns over cash on equity, credit and treasury markets • For high yield mutual funds, we display the fraction of their returns explained by their benchmarks 0% 10% 20% 30% 40% 50% 60% 70% 80% Average Individual Hedge Fund HFRI Relative Value: Fixed Income Corporate Index Average Individual High Yield Mutual Fund R-Squared of Market Measures for Fund Returns.

17. 0.1 2.5 5.5 2.0 -4.7 2.2 1.1 3.7 2.3 -1.6 -6 -4 -2 0 2 4 6 8 Value Momentum Carry Defensive Intercept T-stat Mutual Funds (R-Squared: 15%) HFRI RV (R-Squared: 11%) Credit Fund Indices Exposures to Styles 16 Source: AQR. The table reports t-statistics of regressions of mutual and hedge fund indexes active returns on value, momentum, carry and defensive long-and-short, single-factor style portfolio returns. The mutual fund index is an equal-weighted portfolio of fixed income mutual funds whose holdings are at least 80% corporate bonds. The hedge fund index is an equal-weighted portfolio of US-centric, fixed income – corporate hedge funds. Active return is the difference between a fund return in excess of its benchmark. For hedge funds the benchmark is a portfolio of bond, equity and credit markets that most strongly correlates with its returns. The markets are defined as follows. For stocks the market is the return of the S&P500 in excess of the 1-Month T-bill. For bonds, it is the return of the Bank-of-America-Merrill-Lynch (BAML) U.S. Treasuries 7-10 Yrs Index in excess of the 1-Month US T-bill. For credit it is the return of a market-cap weighted portfolio comprised of all the bonds in the BAML High Yield and Investment Grade indexes in excess of the portfolio of maturity-matched treasuries. Please see p.7 for description of the single-factor style components. Data for actively managed credit mutual and hedge funds are sourced from Morningstar Direct and Hedge Fund Research Database respectively. The intercept is defined as the proportion of returns not explained by Value, Momentum, Carry and Defensive. Past performance is not a guarantee of future performance. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix. Significance of Credit Hedge Fund and Mutual Fund Returns Loadings on Hypothetical Style Portfolio Returns January 1997 – April 2015 …Especially to Carry (Table 9)

18. Conclusion

19. Conclusion 18 Style Investing in Corporate Bonds We believe it has worked • Carry, Defensive, Momentum and Value measures explain up to 15% of cross-sectional variation of corporate bond excess returns Actively managed credit funds have significant exposure to ‘beta’ and minimal exposure to well compensated styles • But, evidence of ‘reaching for yield’ Styles in credit markets are different to styles in equity markets

20. Appendix

21. Diversification across traditional Risk Premia and Equity Styles 20 Terms and Definitions Credit Risk Premium (CRP) Equity Risk Premium (ERP) Treasury Term Premium (TSY) SMB HML UMD QMJ Excess returns to corporate bonds, measured as the difference between value-weighted monthly total returns of corporate bonds included in the BAML dataset and a portfolio of duration-matched U.S. Treasury bonds. Excess returns to the S&P 500 Index, measured as the difference between monthly total returns to the S&P 500 and one-month US Treasury Bills. Treasury term premium, measured as the difference between total returns on the 10-year U.S. Treasury bonds and one-month U.S. Treasury bills Monthly mimicking-factor portfolio return to the size factor, obtained from Ken French’s website. Monthly mimicking-factor portfolio return to the value factor, obtained from Ken French’s website. Monthly mimicking-factor portfolio return to the momentum factor, obtained from Ken French’s website. Monthly mimicking-factor portfolio return to the quality factor, obtained from the AQR website. Regression Analysis 𝐑 𝐢,𝐭 = 𝛼 + ߚ𝟏 𝐓𝐒𝐘𝐢,𝐭 + ߚ𝟐 𝐂𝐑𝐏𝐢,𝐭 + ߚ𝟑 𝐄𝐑𝐏𝐢,𝐭 + ߚ𝟒 𝐒𝐌𝐁𝐢,𝐭 + ߚ𝟓 𝐇𝐌𝐋𝐢,𝐭 + ߚ𝟔 𝐔𝐌𝐃𝐢,𝐭+ ߚ𝟕 𝐐𝐌𝐉𝐢,𝐭 + ߝ𝐢,𝐭 Source: AQR. 𝑅𝑖, denotes the duration-hedged excess return of bond i over month t. See Israel, Palhares and Richardson (2016) for more detail. Please read important disclosures in the Appendix

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The hypothetical performance results contained herein represent the application of the quantitative models as currently in effect on the date first written above and there can be no assurance that the models will remain the same in the future or that an application of the current models in the future will produce similar results because the relevant market and economic conditions that prevailed during the hypothetical performance period will not necessarily recur. There are numerous other factors related to the markets in general or to the implementation of any specific trading program which cannot be fully accounted for in the preparation of hypothetical performance results, all of which can adversely affect actual trading results. Discounting factors may be applied to reduce suspected anomalies. This backtest’s return, for this period, may vary depending on the date it is run. Hypothetical performance results are presented for illustrative purposes only. In addition, our transaction cost assumptions utilized in backtests, where noted, are based on AQR's historical realized transaction costs and market data. Certain of the assumptions have been made for modeling purposes and are unlikely to be realized. No representation or warranty is made as to the reasonableness of the assumptions made or that all assumptions used in achieving the returns have been stated or fully considered. Changes in the assumptions may have a material impact on the hypothetical returns presented. Hypothetical performance is gross of advisory fees, net of transaction costs, and includes the reinvestment of dividends. If the expenses were reflected, the performance shown would be lower. Styles backtests herein are of underlying theoretical long/short styles generated by AQR definitions and are for illustrative purposes only and not based on an actual portfolio AQR manages. The universe includes U.S. corporate bonds in the Bank of America Merrill Lynch investment-grade and high-yield corporate bond indices issued between January 1997 and April 2015. The sample analyzed are selected from this universe based on seniority, maturity, age and size. Sharpe ratios for each individual style and the composite portfolio are calculated targeting a volatility of 5% per annum. The composite portfolio combines the Value, Momentum, Carry and Defensive portfolios at equal weights. The results shown do not include advisory fees or transaction costs; if such fees and expenses were deducted the Sharpe ratios would be lower. The risk-free rate is the Merrill Lynch 3 Month T-Bill. AQR High Yield backtest refers to the positions of a theoretical long-only portfolio based on the combination of four style components: Value, Momentum, Carry and Defensive. Each strategy is designed to take long positions in the assets with the strongest style attributes. The universe is based on the constituents of the Bank of America Merrill Lynch High Yield index (BAML H0A0). There is a risk of substantial loss associated with trading commodities, futures, options, derivatives and other financial instruments. Before trading, investors should carefully consider their financial position and risk tolerance to determine if the proposed trading style is appropriate. Investors should realize that when trading futures, commodities, options, derivatives and other financial instruments one could lose the full balance of their account. It is also possible to lose more than the initial deposit when trading derivatives or using leverage. All funds committed to such a trading strategy should be purely risk capital. Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index. The Standard & Poor‘s 500, abbreviated as the S&P 500 Index , is an American stock market index based on the market capitalizations of 500 large companies having common stock listed on the NYSE or NASDAQ. The Barclays US Treasury Index measures US dollar-denominated, fixed-rate, nominal debt issued by the US Treasury. Treasury bills are excluded by the maturity constraint, but are part of a separate Short Treasury Index. STRIPS are excluded from the index because their inclusion would result in double-counting. CDX.NA.HY Index is composed of one hundred liquid constituents with high yield credit rating. HFRI Fund Weighted Composite Index is an equal-weighted index that includes over 2100 constituent funds, both domestic and offshore. All funds report assets in USD, report Net of All Fees returns on a monthly basis, and have at least $50 million under management or have been actively trading for at least twelve (12) months. No Fund of Funds included in Index. HFRI RV: Fixed Income – Corporate Index includes strategies in which the investment thesis is predicated on realization of a spread between related instruments in which one or multiple components of the spread is a corporate fixed income instrument. Strategies employ an investment process designed to isolate attractive opportunities between a variety of fixed income instruments, typically realizing an attractive spread between multiple corporate bonds or between a corporate and risk free government bonds. (c) Morningstar 2016. All rights reserved. Use of this content requires expert knowledge. It is to be used by specialist institutions only. The information contained herein: (1) is proprietary to Morningstar and/or its content providers; (2) may not be copied, adapted or distributed; and (3) is not warranted to be accurate, complete or timely. 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