Quoniam

Quality as a factor in systematic corporate bond management

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Summary

Fixed income factor investing is becoming an increasingly popular investment approach among institutional investors. However, it is still less well known than its counterpart in the equity market. Many investors are keen to find out more about factor investing in corporate bonds. This white paper is part of our ongoing thought leadership series on this topic. It examines the quality factor and its interactions with the value and carry factors.

In the first section of the paper, we examine the role of quality alongside value and carry in a corporate bond factor portfolio. We conclude that 'three is a crowd' – one of these variables is redundant. We argue that the rationale for including a quality factor into a factor mix is to capture the low-risk premium that is present in the corporate bond market. In Part 2, we provide an expanded definition of quality, combining various aspects of a company's quality into a comprehensive measure.

In Part 3, the paper's empirical section, we provide evidence that in the factors value, carry, and quality there seem to be two premia present that we identify as the credit risk premium and the low risk premium. We also demonstrate that, even in a practical setting where the strict assumptions underlying our theoretical model no longer apply, any combination of two of the three variables (carry, quality, and value) shows a correlation pattern with various factor returns that aligns with our theoretical predictions. Therefore, we conclude that our theoretical considerations regarding the use of a quality factor are supported by our empirical analysis.

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We provide professional investors with smarter alpha and a more thoughtful way of investing, bringing clarity and precision to a complex world. Our approach involves harnessing the power of science-based research enhanced by AI to generate consistent, high-quality, risk-adjusted returns.

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Introduction

Credit factor investing – distinguishing features

Decades of academic research have shown that asset returns can be explained by an underlying factor structure. These factors are certain company or security characteristics that have consistently led to better risk-adjusted returns. Although factor investing in equities has been around for decades, it is a much newer phenomenon in corporate bonds. While there is less agreement on systematic factors in credit than in equities, certain factors such as value (identifying bonds that are undervalued relative to their risk) and momentum (examining trends in the company's equity, spreads, and economic variables that measure the firm's success) are widely considered as fundamental components of a credit factor mix. Additionally, the carry factor, defined as bonds with higher spreads delivering higher returns, is a foundational factor in credit portfolios.

In our white paper, 'Distinguishing Factor Strategies in Corporate Bonds and Equities', we examine in more depth how factor investing approaches for the two asset classes differ. Reasons include the multidimensionality of the market, the asymmetric return distribution of fixed income and how factors are defined. While the above-mentioned paper also explored the nature of the value and carry relationship in more detail, this discussion will focus on the quality factor. We have not included the momentum factor as it captures market information inefficiencies and has less interdependency with value and quality. Our findings shed light on why various practical approaches in the market differ in how they apply value and quality yet capture similar factor premia.

Part 1 – The purpose of quality in corporate bond factor investing

Quality is associated with safer, higher-rated issuers which means a high-quality bond would provide lower return relative to the universe. This is also known as a negative carry strategy. If high quality does not yield a return, what purpose does this factor play in a factor strategy? We will examine the evidence that risk-adjusted quality – quality with its correlation to spreads removed – captures the low-risk premium present in corporate bonds. Incorporating quality into a factor equation therefore aims to indirectly capture this premium.

We will also examine the theoretical notion that ‚three is a crowd – that is to say, credit investing need not include quality, value and carry in order to capture the core risk premia. Rather, the three factors have interdependencies that the asset manager must distil into a core essence in order to avoid spillover between the factors.

Part 2 – An extended definition of quality

While studies on quality in corporate bonds frequently use balance sheet variables to define the quality of a company, there is more to a company's quality than low leverage or strong cash flows. Other aspects of a company's quality are its risk management capabilities, its market position, and its management quality. In Part 2, we derive aspects of a company's quality theoretically, relate these to the existing credit spread research literature, and propose a selection of variables to combine into one broad-based measure of company quality.

Part 3 – Empirical deep-dive into the purpose and definition of quality

We test the theoretical assumptions made in Part 1 using the quality definition and resulting measures derived in Part 2. Our test is based on a realistic setup employed by practitioners. We demonstrate that, with our broader definition of quality, there is no return premium associated with holding high-quality issuers because this category strongly overlaps with low-carry issuers. However, when the carry effect is removed from quality, carry-adjusted quality exhibits the return properties of a low-risk factor.

We also demonstrate that, even in a practical setting where the strict assumptions underlying our theoretical model no longer apply, carry-adjusted quality and carry-adjusted value contain the same information and the correlation structure between the factors remains similar to the theoretical case. Therefore, our theoretical considerations regarding the use of a quality factor are confirmed by our empirical analysis.

Although quality is employed in various practical applications of factor investing in the corporate bond market, we demonstrate that approaches incorporating quality capture the same premia as those relying on value and carry.

Part 1: The purpose of quality in corporate bond factor investing

What is quality?

'Quality' in equity factor investing is usually defined as 'company characteristics that are believed to be predictors of business success and a rising stock price[1]. Characteristics that help a company to be successful also drive its stock price up and help investors in the company outperform the market.

While this is a sensible definition for equity investors, the concept of quality takes on a different character in corporate bonds, where the upside for a corporate bond is limited and the maximum terminal price is fixed. For corporate bonds, quality measures the likelihood that the company will pay its coupons on time and return the nominal value of its bonds upon maturity.

There may be a theoretical case to avoid the worst quality names, particularly in the high yield universe, as they may default before their bonds mature. However, if quality measures the inverse of the company's risk, the credit risk premium, i.e., the credit spread, should be negatively correlated with the bond's exposure to the quality factor. It is therefore unclear why higher quality bonds should outperform lower quality issuers in the longer term.

Moreover, some investors argue that quality helps to balance out the risk of the carry factor (or a value factor that is highly correlated with carry). During crises, when carry tends to strongly underperform, the quality factor is expected to cushion drawdowns. But it is an open question whether this achieves anything other than reducing the exposure to the carry factor in the portfolio.

Quality may capture the low-risk premium that is known to exist in corporate bonds[2]. This premium is typically achieved by going long low-risk assets and short high-risk assets in a way that balanced the long and short sides of the portfolio in their overall risk (not necessarily in invested dollars). If the average return of such a portfolio is positive indicating the outperformance of a risk-matched low-risk portfolio over a high-risk portfolio, a low-risk premium exists[3]. Therefore, including quality as a factor may be a way to incorporate this premium into the portfolio. That, however, would mean that incorporating quality as a factor would not increase returns, but risk-adjusted returns.

1 https://rpc.cfainstitute.org/en/research/financial-analysts-journal/2019/ip-what-is-quality
2 See, among many others, Frazzini and Pedersen (2014), Huang and Huang (2012), Asvanunt and Richardson (2017), and Friewald et al. (2014) for empirical evidence of the low-risk premium.
3 Leverage constraints are usually cited as the reason why the outperformance of such a leveraged long-short portfolio is not arbitraged away in the markets.

Why three is a crowd:
How quality relates to value and carry

To better understand how quality works as a credit factor, we will outline its relationship with two other systematic credit factors, carry and value.

Definition of carry:
Carry describes the return on holding an asset and earning its yield over time. In credit factor strategies, this usually refers to the difference in yield, i.e., the credit spread, of a corporate bond over a maturity-matched treasury bond. As a higher spread is, on average, associated with higher risk, a high carry portfolio earns this risk premium over time, unless there are any large-scale defaults in the portfolio. In this study, we use the expressions carry and spread synonymously and denote it with an S for spread.

Definition of value:
In fixed income, the value factor identifies bonds that offer more yield than expected based on their fundamentals or peers. It compares a bond's market spread to an estimated 'fair value' spread – either from a model or a peer group average. If the bond's spread is higher than what seems fair, it's considered undervalued or 'cheap.'

Thus, one can express the following equation:

$$S_{i,t} = FV_{i,t} + \varepsilon_{i,t} \; , \qquad (1\text{-}1)$$

with $S_{i,t}$ being the spread of bond i at time t, FV its fair value and ε the difference between the two. The fair value spread of a bond is the level of spread that compensates for the risk of holding the bond. This covers risks such as default, downgrade and spread volatility, which impact the prices at which investors can sell the bond in the future. For simplicity, assume that we determine the fair value by a linear regression, i.e., we express the fair value in (1-1) by a single quality characteristic, Q:

$$S_{i,t} = b_0 + b_1 Q^1_{i,t} + \varepsilon_{i,t}, \qquad (1\text{-}2)$$

where b_0 and b_1 are the regression coefficients.

As the credit spread represents the bond's carry, the residual from the regression represents the value factor, and the fair value estimate is negatively correlated with the bond quality, we can approximate

$$Carry_{i,t} = -r * Quality_{i,t} + Value_{i,t}, \qquad (1\text{-}3)$$

where r is a constant.

Equation (1-3) states a very important insight: The fair value expression in the value equation is inversely proportional to the quality of the respective bond.

Following the above definition of the quality of a corporate bond as a measure of the company's likelihood of paying its coupons and the nominal amount at maturity in full, it is clear that the fair value spread of a bond and its quality metric are negatively related. The lower the probability that the company will be able to meet all its obligations, the higher the fair value spread will be, to compensate for these risks. This means that the three factors carry, quality, and value are related as described in equation (1-3).

The value factor, which is based on a fair value regression, is thus a linear combination of the carry factor and quality characteristics. This means that only two of the three factors are needed to incorporate all relevant information into a linear factor model. Including all three factors – carry, quality, and value – adds redundant information to the linear pricing model[4].

> If we use two of the three factors carry, quality, and value in a factor model, the third one is redundant and can be ignored without loss of information.

4 Note that the value factor is theoretically only fully redundant if the factor premia and the value equation are estimated on the same dataset using exactly the same quality characteristics and the same methodology.

Proof of this statement can be found in the appendix[5]. This is important as it relates seemingly very different approaches to credit factor investing to a common underlying theory. While one approach may incorporate value and carry in their factor mix, the other may choose quality and value. Theoretically, under the assumptions above, each pair of chosen factors will capture the same information, irrespective of which factors are chosen.

Choosing either quality or value

In practice, there can be many reasons why these equations do not hold in a strict mathematical sense. For example, the quality characteristics used within the value estimation may differ from those used in the forecasting equation. Moreover, the value factor may be estimated using different data; for instance, it may be estimated monthly using only cross-sectional data, while the forecasting equation may be estimated using panel data.

However, in many cases, a factor model based on just two of the three factors carry, quality, and value will yield comparable results to a factor model based on all three. This is why many credit factor managers choose to work with only two out of these three factors.

The two main approaches in the market are to combine either carry and value or quality and value, but the choice of factors depends on preferences. For example, using carry and quality as factors has the advantage of simplicity. However, a large part of the quality factor returns can be explained by avoiding higher carry (riskier) bonds. This overlap makes it hard to tell which factor is really driving performance. This illustrates that there is a trade-off between the simplicity of the factor definitions and the ability to differentiate factor returns.

Neutralising quality for carry – carry-adjusted quality

If a low-risk premium exists in the corporate bond market, it should be present in its purest form in carry-adjusted quality. This is represented by quality that is neutralised with respect to carry. Defining quality (or value) in this way displays the pure quality (value) effect after correcting for carry. This factor can be interpreted as the quality exceeds what is expected for a given spread level. The key benefit here is that the factor returns on risk-adjusted quality will be driven much less by the carry factor.

For example, a simple way to neutralise quality, Q, versus the carry factor is by regressing it on the spread level[6]

$$Q_{i,t} = b * S_{i,t} + SQ_{i,t}, \tag{1-4}$$

where b is the regression coefficient. The residual SQ is then used as the *carry-adjusted quality* characteristic which by construction is uncorrelated with carry.

We next analyse the impact of adjusting quality for carry in our three-factor relationship and whether the third factor in the factor collection of carry, value and risk-adjusted quality is still redundant.

We compare value (V) and carry-adjusted quality (SQ) by looking at the following two regressions (assuming S and Q demeaned):

$$S = b^*Q + V \tag{1-5}$$

$$Q = c^*S + SQ \tag{1-6}$$

It is possible to prove that value (quality-adjusted carry – how much extra yield a bond offers given its level of quality) and carry-adjusted quality (how high a bond’s quality is *relative* to its level of carry) become more and more similar the better low quality explains high spreads (or, technically speaking, Correl (V, SQ) = -Correl (SQ)). The proof of this statement is in the appendix.

Risk-adjusted quality only becomes redundant, when the quality measure perfectly explains spreads. In that case, however, the market would be perfectly efficient, and no value factor would be needed.

5 The mathematical proofs to this and the following propositions can be skipped by readers not interested in the technical details.
6 Another well-established way to construct a carry-neutral portfolio is to estimate the carry-betas for each asset and then construct quality factor portfolios that are carry beta-neutral.

However, we can show that there is a linear relationship between carry-adjusted quality and carry-adjusted value. If we neutralise both variables with respect to the credit spread, then both variables again contain the same information and one of them can be dropped without loss of information.

In a linear factor model, carry-adjusted quality and carry-adjusted value contain exactly the same information.

Proof of this statement is again given in the appendix. This statement shows that adjusting for carry does not change the redundancy of the third variable in the trifecta of carry, value, and quality.

Using a carry-adjusted quality signal instead of an outright quality signal, generates no new information, and a two-factor model could theoretically use an outright quality instead[7]. However, in the practical application of managing and monitoring a factor-based portfolio, it is easier to understand what drives performance if one uses carry-adjusted factors.

Which premia are captured by systematic factors in different factor models?

Which premia are captured when incorporating two of the three factors of carry, quality, and value? Assuming the presence of a credit risk premium and a low risk premium in the bond market, incorporating two of the three variables will capture these premia. We show in the appendix that the following statement holds.

For any two-factor linear pricing model that is constructed with any two of the factors S (carry), Q (quality), and V (value), the factor premia associated with the two factors are linear combinations of the factor premia of the credit-risk and the low-risk premia.

That means that any combination of factor models using two of the three factors carry, quality, and value captures the same underlying premia – whether the model includes carry and value, value and quality, or quality and carry. The factor premia associated with the factors may capture these two premia to a varying degree and therefore may be difficult to compare between models. For example, value will contain more of the credit-risk and less of the low-risk premium when combined with quality compared to the combination of value with carry. But the overall effect of the factor model will be comparable across factor choices.

That also means that factor approaches that seem different because of the use of different factors in their factor mix may be similar in terms of the underlying premia they aim to capture. Therefore, the perceived difference between credit factor approaches in the market could in practical terms be considerably smaller when assessed through the lens of the underlying risk premia.

Premia incorporated in the value factor

In the model framework that we use, we incorporate two factor premia: a credit risk premium, represented by the credit spread, and a low-risk premium, determined by risk-adjusted quality. In this framework, therefore, value represents a combination of these two premia depending on the composition of the factor equation.

In practice, more premia may be present that are captured by the value factor. As value reflects deviations in the credit spread from its fair value measure, not only the low risk premium, but other aspects such as an illiquidity premium, can be represented in the value factor. As the discussions about the composition of the value factor are outside the scope of this study, we will not discuss it in more detail.

7 This is the same argument as for the value characteristic.

Part 2: Definition and operationalisation of quality for practical application

Having considered the theoretical aspects of the quality factor, we will now turn to the practical task of defining and operationalising quality for empirical use.

A quality definition must include the probability of loss

The higher the quality of the company, i.e., the higher the probability of the company paying back its bonds in full and on time, the lower its credit spread will be. Therefore, a definition of quality should focus on variables relating to the specific company's probability of default and the loss given default.

Taking this idea into an equation: Corporate bonds usually offer a yield pick-up over maturity-matched government bonds, defined as the credit spread. This spread reflects the expected loss in terms of a default versus the default-free government bond plus a risk premium[8]:

$$S = EL + RP \qquad (2\text{-}1)$$

with S as the credit spread, EL as the expected loss and RP as the risk premium with the expected loss defined as the probability of default (PD) multiplied by the loss given default (LGD),

$$EL = PD * LGD. \qquad (2\text{-}2)$$

If we return to our definition of quality as a measure of business success and the likelihood of a company to pay back its bonds in full at time T, the expected loss of a company's bonds is highly negatively correlated with the quality of the issuing company.

A quality definition must be future looking

Sticking with the above definition of quality as "a factor that is a predictor of business success and the expected amount of the principal a lender can expect to receive at maturity T", any variables used to measure an issuer's quality must be correlated with the company's future developments. It is not sufficient to look at past success. A quality factor must assess the future success of the company, which is not perfectly correlated with how a company fared in the past.

Moreover, publications on credit factor investing frequently define quality as a combination of various balance sheet and income statement variables related to the respective company. Although a strong balance sheet and consistent, stable earnings reflect high quality, these factors alone are insufficient to capture all aspects that determine a company's quality. Consider, for example, creative accounting or a company's situation deteriorating at a faster pace than quarterly balance sheets can reflect. Moreover, balance sheet information is mainly backward looking, whereas in our definition above, quality is forward-looking.

8 Credit spreads are usually much larger than the realised losses stemming from defaults, a stylised fact known as the 'credit spread puzzle'. Usually, the difference is attributed to a risk premium as defaults are not equally distributed over time but tend to be concentrated in certain periods, usually economic downturns.

We therefore adopt a broader definition of quality and consider the following four aspects:

1. Financial performance and balance sheet strength
Balance sheet and income statement variables indicate the past and current quality of products and policies of a company. A high-quality company has favourable metrics indicating aspects such as consistent, sustainable revenue growth; high, stable profit margins; high returns on equity, assets and invested capital; strong free cash flow; healthy debt-to-equity and interest coverage ratios; and an adequate liquidity position.

2. Risk management
A high-quality company not only convinces with balance sheet strength but also with strong risk management that makes negative outcomes less likely and increases resilience to market shocks. Risk management captures the following three dimensions: operational risks (effective management of supply chain, regulatory, and other operational risks), financial risk (hedging or other strategies to manage currency, interest rate, and credit risks), and reputational risk (maintaining strong ethical standards and brand reputation).

3. Market position, growth potential and perception in the market
A company with a strong market position that is perceived as a leading company in the market is better positioned to capture market share and talent and is in a better position to overcome shocks to the industry.

A high-quality company is characterised by: competitive advantages through brand, technology, scale, or network effects; a leading or growing market share in key segments; alignment with favourable macro and industry-specific trends; favourable valuation metrics compared to peers; positive sentiment among analysts and rating agencies; and a stable investor base with a mix of institutional and retail investors who demonstrate confidence in the company.

Moreover, high-quality companies invest in research and development conducted by a world-class research team to drive new products and services; they can scale operations without a proportional increase in costs; and they develop and maintain diversified avenues for growth, including geographic expansion, new product lines, or acquisitions.

4. Management quality
Besides the quantifiable aspects of quality covered in points 1.-3., there are also qualitative factors, such as management quality and growth potential, that influence the quality of a company. A high-quality company has an experienced, visionary, and ethical management team with a strong track record, as well as clear strategic goals and a proven ability to execute plans effectively. The company will also ensure transparency and accountability, as well as aligning management incentives with the interests of shareholders.

Operationalisation of quality

These considerations show that the definition of a quality variable needs to account for multiple aspects of a company and should not be reduced to balance sheet metrics alone. For the empirical part of this study, we must define ‘quality’ in such a way that it can be calculated for each corporate bond in the sample, enabling us to assess its empirical properties. To operationalise quality, we use metrics that capture the four facets of quality discussed above. Specifically, we have chosen the following variables for the four quality categories:

Table 1: Operationalisation of quality

Category	Variables	Rationale
Balance sheet / income statement	Return on assets (net income / total assets)	Return on assets measures how effectively a company uses its asset to generate profit. It is an indicator of operational performance and includes all aspects of the business – revenues, costs, and asset management. All these aspects are related to a company's quality[9].
	Long-term debt to total assets	Long-term debt to total assets measures a company's debt burden to finance its assets indicating different levels of risk regarding interest rate increases, debt payments, as well as the propensity to borrow in the future if needed[10].
	Interest rate coverage (EBIT / interest expense)	The interest coverage ratio measures a company's ability to meet its interest payment obligations. This metric indicates a company's ability to service its debt, assesses its financial health and the likelihood of financial distress, and evaluates its operational efficiency in generating earnings relative to its debt burden and successful cash flow management. These aspects also point to the quality of the company[11].
Risk management	Option-implied equity volatility	Implied volatility, derived from equity options, is a forward-looking measure reflecting the market expectations about the company's prospects and risks and therefore the volatility of its equity. The larger the volatility, the more likely it is that a company may suffer a shock that makes it difficult to pay back its bonds. Higher-quality companies manage their operations in a way to lower this risk[12].
	250 day, 95% equity value-at-risk	As a robust business model and a strong organisational structure minimise potential losses, these will be reflected in the worst-case scenario equity losses over a certain period. We measure these losses using the 95% value-at-risk of a company's equity over 250 days to assess how strong the initial price reaction of a company's stock to a shock is. We use this as another indicator of a company's quality[13].
	5% expected shortfall of the stock of the company	The expected shortfall is defined as the expected loss in a company's market value when the stock return is below a certain level. Therefore, it can be considered a metric of the risk and vulnerability of the firm's equity to extreme losses in adverse market conditions. Companies with low expected shortfalls are less exposed to extreme downturns, indicating a higher stability. This is a quality characteristic of a company[14].

9 Return on assets is widely used as a profitability measure and its relationship with credit spreads has been discussed, among others, by Chen et al. (2007) and Han et al. (2017).
10 Collin-Dufresne et al. (2001) discuss the relationship between credit spreads and leverage and show a robust positive relationship with changes in leverage and changes in spreads, arguing that higher leverage increases, all else equal, the probability of default.
11 Bai and Wu (2016) argue for a negative relationship between credit spreads and interest coverage as this metric measures how much a company is burdened by interest expenses. Their empirical analysis reveals a negative relationship.
12 Campbell and Taksler (2003) show that equity volatility is an important determinant of credit spreads arguing that higher volatility of a company increases the probability of default and therefore credit spreads.
13 Collin-Dufresne et al. (2001) look at probabilities for and actual realised downward jumps in a company's value and discuss their negative impact on credit spreads. We use the historical value-at-risk in a company's stock price as a measure of the probability of unexpected equity losses.
14 Collin-Dufresne et al. (2001) use option-derived measures to calculate jump probabilities. In this study, we focus on tail risk behaviour of the equity captured by the expected shortfall as liquid options are not available for all public companies.

Category	Variables	Rationale
Market position	Market capitalisation of the equity	The market capitalisation of a company reflects its size within the industry and the broader market. It also indicates how market participants perceive the company's future. A higher market capitalisation suggests that investors have confidence in the company's stability and growth potential. Hence, market capitalisation is also related to the quality of a company.
	Price-to-book ratio (market value of the equity/book value of the equity)	The price to book ratio reflects how much investors are willing to pay above (or below) the company's recorded equity value which relates to a company's perception in the market. A large premium in the equity value suggests that investors expect strong future growth, innovation, or competitive advantages. All this correlates positively with the quality of the company.
	Price/earnings ratio (market price per share/earnings per share)	The price/earnings ratio reflects how market participants value a company relative to its earnings. A high P/E ratio suggests a premium valuation due to expectations of growth or competitive advantages. It also indicates optimism about the company's future earnings potential. Likewise, a low P/E ratio can be an indicator of scepticism about of future earnings potential and limited growth prospects.
Management quality	MSCI G score	While there is no direct way of measuring the management quality of a company, we use the governance score (G score) of MSCI as a measure of how well-run a company is.

We focus on the selected variables, acknowledging that other metrics are possible to capture aspects like profitability or liquidity[15]. In this study, we do not attempt to discuss the optimal metric for certain aspects of quality. We rather want to show the properties of quality as it is defined here. However, we believe that the metrics chosen above are one sensible way of defining quality.

15 See, for example, the discussion in Bai and Wu (2016).

Part 3: Empirical results

Motivation

In the empirical Part 3 of this study, we apply the definition of quality from Part 2 to analyse the following questions:

- Does our quality definition lead to a quality factor with empirical properties in line with those expected from a quality variable?
- What are the performance and risk characteristics of the other factors used in Part 1? Which factors show comparable patterns? Which premia are present in the data?
- Does carry-adjusted quality represent the low-risk premium and what is its magnitude in a corporate bond portfolio?
- Given that our theoretical considerations hold under very specific assumptions, how do they hold in a practical application where some of the assumptions are weakened?

After describing data and methodology used in Part 3, we aim to answer these questions empirically.

Data and methodology

We use USD investment grade non-financial bonds that are included in either the Bloomberg USD Corporate or the ICE BofA Global Corporate benchmarks. We restrict ourselves to this sample for the purpose of this study to avoid potential problems from different definitions of quality for financials and non-financials. Moreover, to avoid biases from the combination of different currency samples, we focus on the largest currency area, the USD space.

We calculate a quality factor using the definition from Part 2 for all issuers in our universe. Balance sheet data is taken from Worldscope, implied volatility from Bloomberg, equity return data from Refinitiv, yields from IBES, and market capitalisation and the G score from MSCI. We obtain a quality measure by weighting the individual quality variables with their betas from the value regression. The betas are derived from expanding window time-series regressions. In practice, a time-series approach is frequently chosen due to the stability of the estimates. Moreover, an expanding window estimation ensures that at every point in time only information is used that was available at that date as it would be the case in a real-world portfolio.

Note that such a practical approach of defining the factors and calculating their returns deviates from the purely cross-sectional approach we used for the value regression. As discussed in Part 1, this means that the theoretical predictions do not hold anymore in a strict mathematical sense. If the assumed relationships are stable over time, however, results should be similar even with the relaxation of the strict assumptions underlying our theoretical considerations.

For the carry factor we coalesce benchmark spreads by ICE and Bloomberg into one spread measure. The value factor is obtained by regressing the spread on the quality variables in the cross-section of the sample per date using all variables as separate input factors in the regression,

$$S_{i,t} = b_{0,t} + \sum_{i=1}^{I} b_{i,t} Q_{i,t} + \varepsilon_{i,t}\,, \qquad (3\text{-}1)$$

where $Q_{i,t}$ are the individual quality variables defined in table 1.

Quintile portfolios are calculated monthly using end-of-month factor exposures. Returns reflect benchmark prices and do not account for transaction costs. We weight all bonds equally for the period 2007–2024. No minimum holding period for the bonds applies. Long-short portfolios are calculated for the same period using the bonds' Z score as a weighting factor. We use long-short portfolios in our study knowing that they are difficult to implement in real-world settings. We do not aim to create an implementable strategy but to show the magnitude and characteristics of the factor premia which can be seen cleanest in a long-short portfolio context.

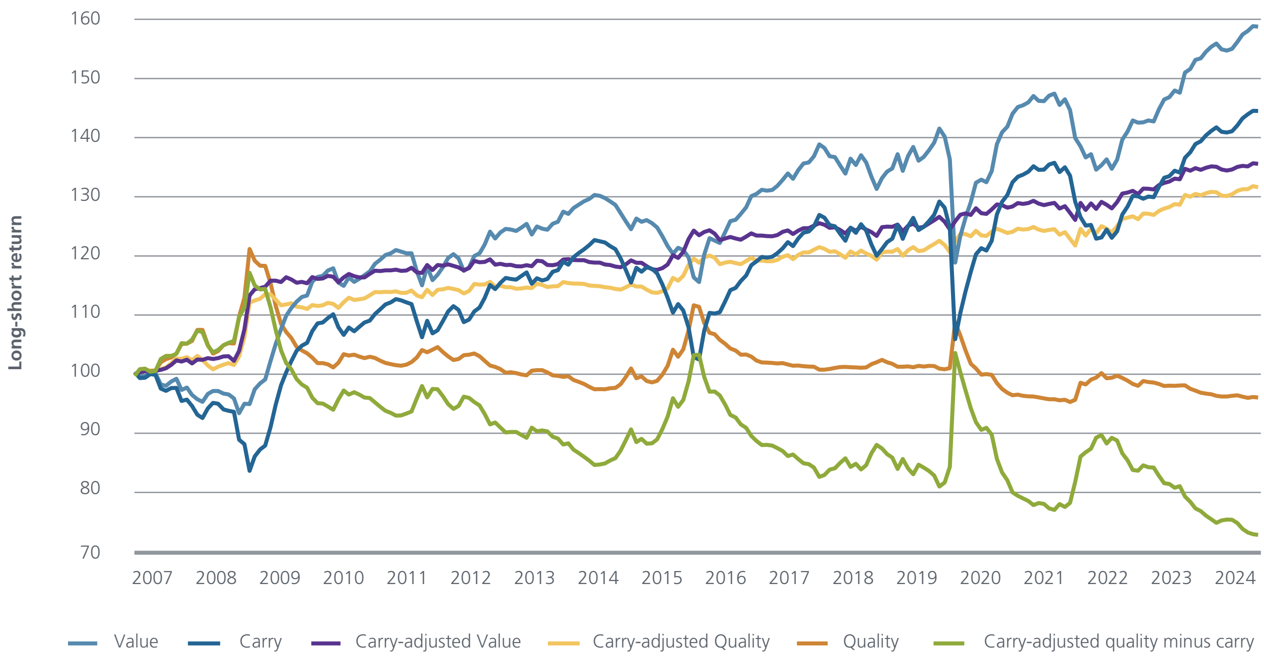
Factor returns

Firstly, we analyse the risk and return properties of our quality factor and all other factors used in the theoretical considerations in Part 1. The cumulative return of long-short portfolios of various factors is displayed in figure 1.

Over an 18-year period the average alpha of the quality factor is negative amounting to a loss of around two basis points per month. However, the factor shows a strong performance during the global financial crisis in late 2008/early 2009, the energy crisis in late 2015, and the Covid crisis in early 2020. These positive alphas, however, are quickly fading away in the subsequent market rallies. The annualised standard deviation of these long-short alphas is 4.1% which is considerably lower than the same metric for a long-short carry portfolio (6.2%). The correlation between the two is expectedly very negative at -85%. Overall, our quality factor has the properties one would expect from such a style.

The carry factor shows a significant positive return of 17 basis points per month and considerable drawdowns in crises periods indicating the higher-risk character of this factor. The value factor mirrors the performance of carry at a somewhat higher level but with similar drawdowns at the same time.

Figure 1: Cumulative returns of long-short factor portfolios: Presence of two premia



Source: Quoniam Asset Management GmbH

Carry-adjusted quality and carry-adjusted value, two factors covering essentially the same information according to our theoretical considerations, both show a very similar positive return pattern with very small drawdowns and a steady outperformance over time.

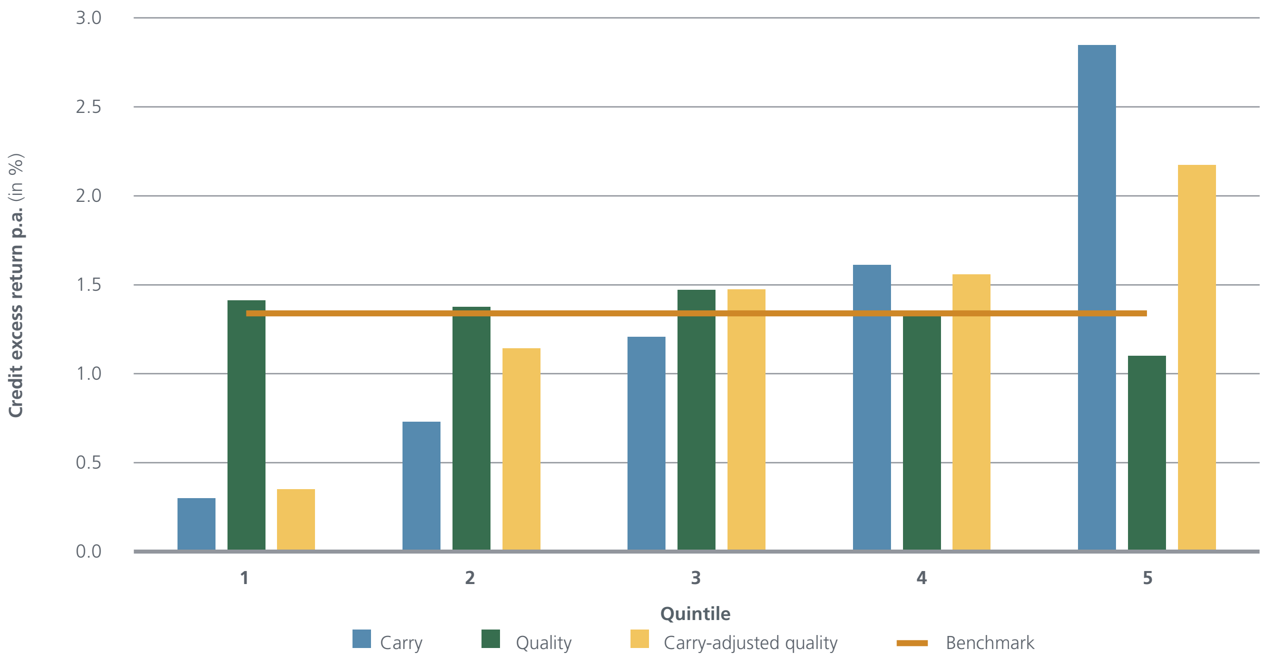
These results are consistent with the hypothesis that carry captures the credit risk premium that is prone to larger drawdowns in crisis, while carry-adjusted quality captures the smaller but also steadier low-risk premium as can be seen in the return patterns.

Quality shows different behaviour but, according to the theory, it should (positively) include the low-risk premium and (negatively) the credit risk premium. We therefore added the performance of a sixth factor constructed as carry-adjusted quality minus carry. As can be seen this factor, albeit at a somewhat lower level, mimics the performance pattern of the quality factor with a performance surge in crises and drawdowns in market rallies. We therefore suspect that in the six factors in figure 1 only two premia are present: a credit risk premium and a low-risk premium.

Secondly, we plot returns of quintile portfolios for the three factors carry, quality, and carry-adjusted quality. From the theoretical considerations, we expect a monotonous increase in return going from the first quintile (the bonds with the lowest factor exposure) to the fifth quintile (the bonds with the largest factor exposure) for carry reflecting the credit spread premium and for carry-adjusted quality representing the low-risk premium. As quality contains both the low-risk premium and the negative of the spread premium, the overall effect on the factor return is to be determined empirically.

Figure 2 shows that, as expected, both carry and carry-adjusted quality are associated with a return premium. Both factors increase monotonically from Q1 to Q5 and the long-short portfolios Q5–Q1 yield 2.55% for carry and 1.82% for carry-adjusted quality, respectively. The quality factor itself is not associated with a risk premium. Returns for Q1 to Q4 are very similar, and the high-quality portfolio Q5 has a lower return. The return of the long-short portfolio Q5–Q1 is -0.31% p.a.

Figure 2: Factor quintile returns



Source: Quoniam Asset Management GmbH

Carry-adjusted quality and the low-risk premium

We next look into evidence whether carry-adjusted quality really captures the low-risk premium. For that reason, we construct a risk-matched long-short quality portfolio and compare its performance pattern to the performance of the carry-adjusted quality factor [16].

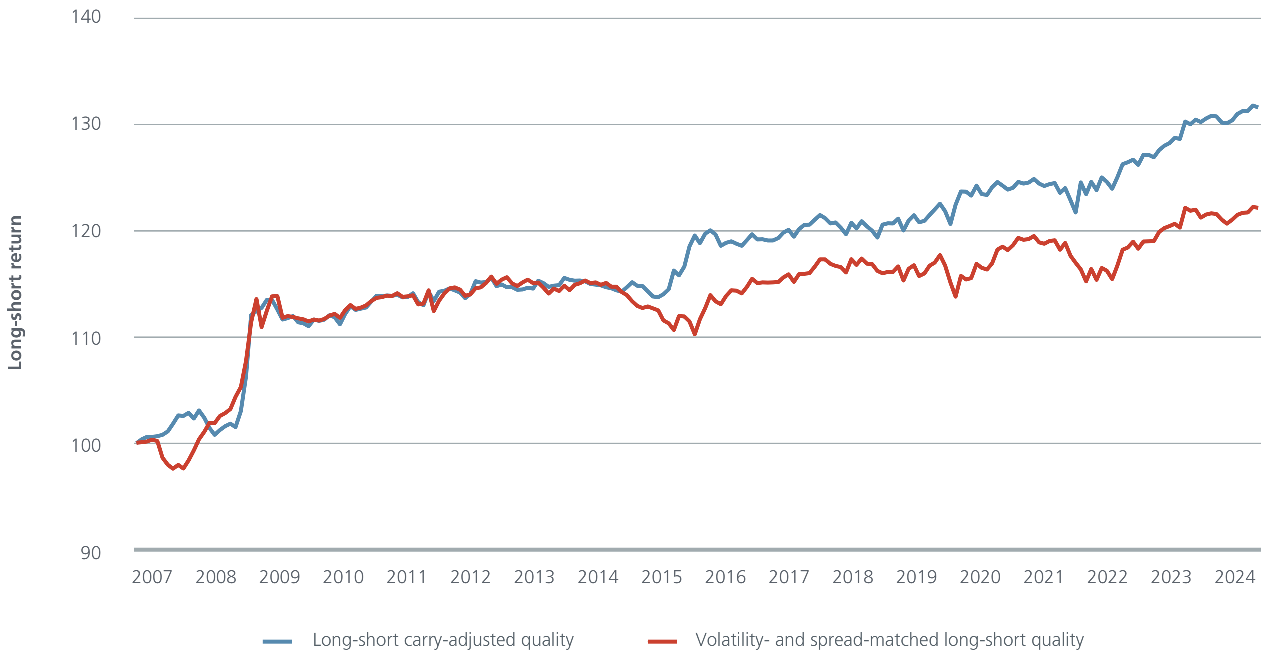
Following this methodology, the low-risk premium emerges when one goes long a low-risk portfolio and, at the same time, shortens a high-risk portfolio with the same overall risk. That means that the high-risk part that is shorted will have a lower volume in invested dollars so that the overall risk level of the long and short parts is equal.

We use the one half of the portfolio with quality above median as the long portfolio weighting every bond with its Z score. Likewise, the short portfolio consists of the lower quality half of the bond universe. As a risk-matching criterion we use the average option-adjusted spread of the portfolio and determine the weight of the short leg every month in a way that the spreads of both portfolio legs are equal.

To make the long-short, carry-adjusted quality portfolio comparable to the spread-matched, long-short quality portfolio, we scale the latter so that both strategies have the same ex-post volatility. This makes the return levels more comparable. The results are presented in figure 3.

Figure 3 shows that both return time series are similar. The correlation of monthly returns is 57%. There is a period between mid-2014 and mid-2016 where the returns behave differently, but afterwards both time-series look very close to each other in the return behaviour. The high correlation and the visual similarity suggest that both approaches capture a similar effect in credit returns. This adds evidence to our suggestion that carry-adjusted quality represents the low-risk premium.

Figure 3: Similarity of two low-risk measures



Source: Quoniam Asset Management GmbH

16 We follow the standard approach to measuring low-risk outlined in Frazzini and Pedersen (2014).

Do our theoretical considerations still hold in practice?

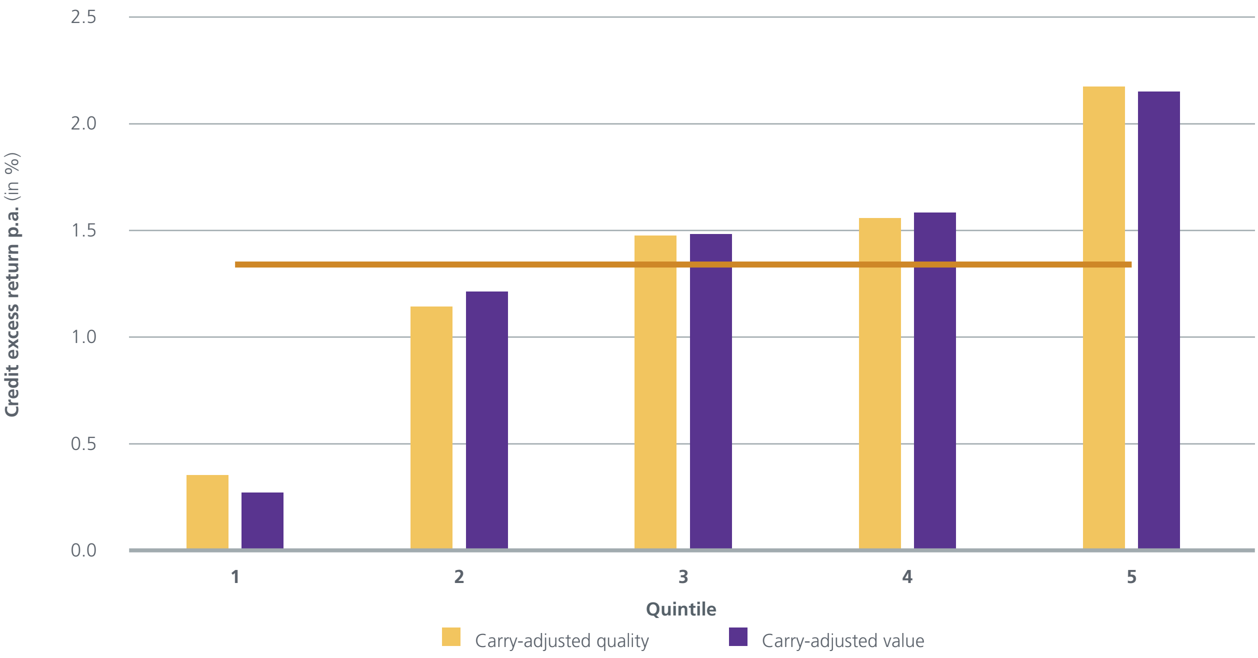
As outlined above, the theoretical relationships from Part 1 above only hold in a strict mathematical sense if the factors are calculated on the same data with the same methodology. As in practice this is an unrealistic setting, we now analyse whether our theoretical relationships still hold when value is estimated in the cross-section per date, but quality is calculated using time series elements.

We compare carry-adjusted quality and carry-adjusted value. From our theoretical considerations, these two variables capture the same effect (the low-risk premium). Consequently, we expect the return profile of both variables to be interchangeable.

As can be seen from figure 4, the return profiles of the two variables are virtually identical despite the assumptions underlying our theory no longer in place. The long-short returns are 1.82% for carry-adjusted quality and 1.87% for carry-adjusted value, providing strong empirical support that the relationship between the two variables is very stable beyond the set of strict assumptions in our prediction.

Next, we analyse whether different combinations of carry, quality, and value capture the risk premia in a way predicted by theory in practice. We do this by comparing the empirical correlation between factor risk premia and portfolio returns with their theoretical predictions. The theoretical predictions are given by the coefficients in equations (A4-12) to (A4-14), while empirical correlations are obtained by calculating the Spearman rank correlation between the monthly coefficients (which can be interpreted as factor risk premia) and long–short portfolio returns for the individual factors. If the respective factors in the three return equations (carry and value, carry and quality, quality and value) are correlated with the low risk and credit spread premia, respectively, these correlation should on average be reflected in the factor returns of the respective factors.

Figure 4: Carry-adjusted quality and carry-adjusted value



Source: Quoniam Asset Management GmbH

To calculate the expected relationship, we first need to determine the correlation ρ between quality and carry in our sample. This number is -0.77 and expectedly strongly negative. If we enter this value into equations (A4-13) and (A4-14), we obtain the following predictions, which we compare to the empirical correlation in table 2.

These empirical results show that the theoretical considerations regarding which risk premia are captured by different combinations of factors also hold in a more realistic setting, even when the methodology for estimating factors is not perfectly identical across factors. We therefore conclude that using the definition of quality in Part 2, the theoretical properties of quality and its interactions with other factors are present in the data.

Table 2: Comparison between factor risk premia and factor returns

Factor equation	Correlated factors	Predicted sign	Empirical correlation	Correct sign
Spread + value	Spread and carry	+	81%	✓
	Value and carry	+	32%	✓
	Value and carry-adjusted quality	+	94%	✓
Quality + value	Value and spread	+	96%	✓
	Value and carry-adjusted quality	+	44%	✓
	Quality and spread	–	-77%	✓
	Quality and carry-adjusted spread	+	26%	✓
Spread + quality	Spread and carry	+	97%	✓
	Spread and carry-adjusted quality	+	44%	✓
	Quality and carry-adjusted quality	+	99%	✓

"Spread" refers to the credit spread as a factor in the three return equations with spread and value, spread and quality, and quality and value, respectively. "Carry" refers to the spread in the original factor equation with carry and carry-adjusted quality. Source: Quoniam Asset Management GmbH

Conclusion

Quality is negatively correlated with the credit risk premium and for that reason is not associated with a return premium. Quality may capture the low-risk premium existent in corporate bonds and therefore does not increase returns, but risk-adjusted returns in a factor mix. However, we show that the credit risk and low risk premia can be captured by two of the three factors carry, quality, and value. Therefore, while many approaches combine quality and value without carry in a factor mix, we show that the same effect can be achieved by combining carry and value or carry and quality.

In this study, we restrict ourselves to the variable set of carry, quality, and value. In practice, other systematic factors like equity momentum enter a factor mix and their interaction with the three factors would be interesting to analyse. Another direction of future analysis is the extension from a company-specific quality factor to a bond specific low-risk factor where besides the company's credit risk the bond's interest risk is incorporated. We leave these questions for future studies.

We have shed light on the role quality plays in a factor mix and bridged the apparent differences between several approaches in the market. We hope that this result fosters a more coherent perception of credit factor approaches in the market and helps increase the popularity of the factor strategies in credit.

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Appendix

PROPOSITION 1:
If we use two of the three factors carry, quality, and value in a factor model, the third one is redundant and can be ignored without loss of information.

PROOF:
Let V be defined as the residual from the value regression:

$$S_{i,t} = \beta_0 + \beta_1 Q_{i,t} + V_{i,t}. \tag{A1-1}$$

We compare the case where we use only carry and quality characteristics to explain future bond returns via a linear regression

$$r_{i,t+1} = b_0 + b_1 S_{i,t} + b_2 Q_{i,t} + \varepsilon_{i,t} \tag{A1-2}$$

with the case that includes the value factor V in the equation. Substituting it with its equivalent expression from equation (A1-1) yields

$$\begin{aligned} r_{i,t+1} &= \hat{b}_0 + \hat{b}_1 S_{i,t} + \hat{b}_2 Q_{i,t} + \hat{b}_3 V_{i,t} + \hat{\varepsilon}_{i,t} \\ &= \hat{b}_0 + \hat{b}_1 S_{i,t} + \hat{b}_2 Q_{i,t} + \hat{b}_3 (S_{i,t} - \beta_0 - \beta_1 Q_{i,t}) + \hat{\varepsilon}_{i,t} \\ &= (\hat{b}_0 - \hat{b}_3 \beta_0) + (\hat{b}_1 + \hat{b}_3) S_{i,t} + (\hat{b}_2 - \hat{b}_3 \beta_1) Q_{i,t} + \hat{\varepsilon}_{i,t}. \end{aligned} \tag{A1-3}$$

There is no new independent variation coming from $V_{i,t}$ because it is exactly spanned by the variables already incorporated in the factor equation ($S_{i,t}$ and $Q_{i,t}$). Consequently, adding $V_{i,t}$ in this form cannot improve the fit or explanatory power of the regression. Any change is fully absorbed by re-defining the intercept and the coefficients on the same two variables, $S_{i,t}$ and $Q_{i,t}$. The same logic applies to any other combination of the variables.

Note that the differences in the sample including time can play a role here. If the value regression (A1-1) is purely cross-sectional, i.e., the value factor at time t is the residual of a regression using only characteristics observed at time t and the return regressions (A1-2, A1-3) are also purely cross-sectional, then the proof holds exactly. The same applies when all equations are estimated across the same asset-date panel data.

If the data is different, for example if value is estimated monthly, but the return regression is a panel regression then it is mathematically no longer equivalent. Still, if S and Q are strongly related in the same way at all dates (same slope for each date), then the cross-sectional value might still behave as if it had been estimated on the panel, giving little extra information. However, if the relationship between S and Q (the slope r_t) shifts over time, then the 'orthogonal component' $V_{i,t}$ is no longer a single global linear combination of the two variables. In that scenario, $V_{i,t}$ could have extra predictive power.

PROPOSITION 2:
Given two inverse linear regressions

$$Y = b_0 + b_1 X + \varepsilon \quad \text{(A2-1)}$$

$$X = c_0 + c_1 Y + \xi \quad \text{(A2-2)}$$

the correlation between the residuals is the negative of the correlation between the two variables:

$$\boldsymbol{Corr(\varepsilon, \xi) = -Corr(X, Y)} \quad \text{(A2-3)}$$

PROOF:
Let

$$\rho \coloneqq Corr(X, Y), \sigma_X \coloneqq \sqrt{Var(X)}, \sigma_Y \coloneqq \sqrt{Var(Y)} \quad \text{(A2-4)}$$

We can express the regression betas as the product of the correlation between X and Y and the ratio of their volatilities:

$$b_1 = \rho \frac{\sigma_Y}{\sigma_X}, c_1 = \rho \frac{\sigma_X}{\sigma_Y} \quad \text{(A2-5)}$$

Using this, we can express the covariance between ε and ξ in terms of just ρ, σ_x, and σ_y:

$$\begin{aligned} Cov(\varepsilon, \xi) &= Cov(Y - b_1 X, X - c_1 Y) \\ &= Cov(X, Y) - c_1 Cov(Y, Y) - b_1 Cov(X, X) + b_1 c_1 Cov(X, Y) \\ &= \rho\sigma_X\sigma_Y - c_1\sigma_Y^2 - b_1\sigma_X^2 + b_1 c_1 \rho\sigma_X\sigma_Y \\ &= \rho\sigma_X\sigma_Y - \rho\sigma_X\sigma_Y - \rho\sigma_X\sigma_Y + \rho^3\sigma_X\sigma_Y \\ &= \rho(\rho^2 - 1)\sigma_X\sigma_Y \end{aligned} \quad \text{(A2-6)}$$

Similarly, we can derive:

$$\sigma_\varepsilon^2 = \sigma_Y^2(1 - \rho^2) \quad \text{(A2-7)}$$

$$\sigma_\xi^2 = \sigma_X^2(1 - \rho^2) \quad \text{(A2-8)}$$

Now we can solve for the correlation between ε and ξ

$$Corr(\varepsilon, \xi) = \frac{Cov(\varepsilon, \xi)}{\sigma_\varepsilon \sigma_\xi} = \frac{\rho(\rho^2 - 1)\sigma_X\sigma_Y}{\sigma_Y\sqrt{1-\rho^2}\sigma_X\sqrt{1-\rho^2}} = -\rho \quad \text{(A2-9)}$$

PROPOSITION 3:

In a linear factor model, risk-adjusted quality and risk-adjusted value contain exactly the same information.

PROOF:

Assume that both the spread S and the quality variable Q are demeaned. Define value V via a regression:

$$S = bQ + V \tag{A3-1}$$

Define risk-adjusted value SV via a regression:

$$V = cS + SV, \tag{A3-2}$$

and risk-adjusted quality SQ via a regression:

$$Q = dS + SQ. \tag{A3-3}$$

Inserting A3-3 into A3-1, we get

$$S = bQ + V = b(dS + SQ) + V \tag{A3-4}$$

Rearranging for V to express value in terms of spread and risk-adjusted quality, we obtain

$$V = (1 - bd)S - bSQ \tag{A3-5}$$

Because c is the beta in the linear regression A3-2, we can express it as follows

$$c = \frac{Cov(V,S)}{Var(S)} \tag{A3-6}$$

Inserting A3-5 into A3-6 and using the bilinear form property of the covariance, we get

$$c = \frac{Cov((1-bd)S-bSQ,S)}{Var(S)} = \frac{(1-bd)Cov(S,S)-bCov(SQ,S)}{Var(S)} \tag{A3-7}$$

From A3-3 we know that SQ is the residual of a linear regression of Q on S, therefore the covariance between SQ and S is 0. Furthermore, we can write $Cov(S,S)$ as $Var(S)$ and end up with

$$c = (1 - bd) \tag{A3-8}$$

Comparing A3-2 and A3-5, we get

$$cS + SV = (1 - bd)S - bSQ \tag{A3-9}$$

Using A3-8, we see that both terms including S are equal and, thus, we end up with

$$SV = -bSQ \tag{A3-10}$$

Risk-adjusted value SV is just a scaled version of risk-adjusted quality SQ.
And the scaling parameter is the negative of the beta of the original value regression.

PROPOSITION 4:
Assume that the R^2s of the value regression and the risk-adjusted quality regression are strictly between 0 and 1 (i.e., carry and quality neither contain exactly the same information nor are they completely uncorrelated).

For any two-factor linear pricing model that is constructed with any two of the factors S (carry), Q (quality), and V (value), and the factor premia (α_1, α_2) taken from the regression

$$r = \alpha_0 + \alpha_1 F_1 + \alpha_2 F_2 + \eta, \quad \text{(A4-1)}$$

there exists a unique, non-singular 2x2 matrix A such that

$$(\alpha_1, \alpha_2) = A(c_1, c_2) \quad \text{(A4-2)}$$

where c_1 is the carry premium and c_2 is the low-risk premium from the regression

$$r = c_0 + c_1 S + c_2 SQ + \varepsilon \quad \text{(A4-3)}$$

Interpretation: All factor premia observed in any of the popular two-dimensional factor models (S,Q), (S,V), and (Q,V) are just (linear) combinations of the carry premium and the low-risk premium.

PROOF:
From the definitions of value and risk-adjusted quality, we have:

$$S = \beta_0 + \beta_1 Q + V \quad \text{(A4-4)}$$
$$Q = f_0 + f_1 S + SQ \quad \text{(A4-5)}$$

Case: two-factor equation with carry and quality

For the return equation

$$\mathrm{r} = \alpha_0 + \alpha_1 \mathrm{S} + \alpha_2 \mathrm{Q} + \eta \quad \text{(A4-6)}$$

we substitute: $\mathrm{Q} = \mathrm{f}_0 + \mathrm{f}_1 \mathrm{S} + \mathrm{SQ}$:

$$\mathrm{r} = \alpha_0 + \alpha_1 \mathrm{S} + \alpha_2 (\mathrm{f}_0 + \mathrm{f}_1 \mathrm{S} + \mathrm{SQ}) + \eta, \text{ or} \quad \text{(A4-7)}$$
$$\mathrm{r} = (\alpha_0 + \alpha_2 \mathrm{f}_0) + (\alpha_1 + \alpha_2 \mathrm{f}_1)\mathrm{S} + \alpha_2 \mathrm{SQ} + \eta \quad \text{(A4-8)}$$

Comparing (A4-8) with $\mathrm{r} = \mathrm{c}_0 + \mathrm{c}_1 \mathrm{S} + \mathrm{c}_2 \mathrm{X}$

$$\mathrm{c}_1 = \alpha_1 + \alpha_2 \mathrm{f}_1 \quad \text{(A4-9)}$$
$$\mathrm{c}_2 = \alpha_2 \quad \text{(A4-10)}$$

Therefore,

$$(\alpha_1, \alpha_2) = (\mathrm{c}_1 - \mathrm{f}_1 \mathrm{c}_2, \mathrm{c}_2), \quad \text{(A4-11)}$$

i.e.,

$$A = \begin{pmatrix} 1 & -f_1 \\ 0 & 1 \end{pmatrix} \quad \text{(A4-12)}$$

with $\det(\mathrm{A}) = 1 \neq 0$.

The derivations for the models with S and V as factors and with Q and V are similar.
For the case of S and V, the matrix A is given by

$$A = \begin{pmatrix} 1 & \frac{1-\rho}{\beta_1} \\ 0 & -\frac{1}{\beta_1} \end{pmatrix}, \quad \text{(A4-13)}$$

where ρ is the correlation between carry and quality.

In the case of a factor model with Q and V, the matrix A is given by

$$A = \begin{pmatrix} \beta_1 & 1-\rho \\ 1 & -f_1 \end{pmatrix} \quad \text{(A4-14)}$$

with f_1 and ρ as defined above.

If $1 - \beta_1 f_1 = 0$, then the residual V would be perfectly determined by SQ, the residual of the inverse regression, which would contradict our assumption that $0 < R^2 < 1$ holds for both the value and the risk-adjusted quality regressions. Thus, $1 - \beta_1 f_1 \neq 0$. Furthermore, from the same assumption $f_1 \neq 0 \neq \beta_1$.

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