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Abhandlungen

Equity-Bond Returns Correlation and the Bond Yield: Evidence of Switching Behaviour from the G7 Markets

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Abstract

This paper examines the nature of the correlation between (real) equity and bond returns for the G7 markets. From the standpoint of established finance theory, we would expect a positive returns correlation, however, evidence has been presented to suggest that a negative correlation occurs over certain time periods. Using both panel and individual regression for the G7 markets we demonstrate that the correlation is itself positively correlated with the (real) bond yield. While a higher (lower) bond yield is generally associated with both falling (rising) equity and bond prices, a low and falling yield can cause bond prices to rise but equity prices to fall as it implies macroeconomic risk from potential deflation and economic stagnation. Furthermore, our results suggest that a real bond yield of less than 3 % is associated with a negative returns correlation. From an investor view point this suggests the potential for beneficial diversification, while also having implications for asset valuation.

Aktien-Anleihen Korrelation und Anleiherenditen: Nachweis von Wechselverhalten in den G7 Märkten

Zusammenfassung

In diesem Beitrag wird die Korrelation zwischen den realen Aktienrenditen und denjenigen von Staatsanleihen innerhalb der G7-Länder analysiert. Die etablierte Finanzmarkttheorie lässt eine positive Korrelation der Renditen erwarten. Allerdings zeigt die empirische Evidenz das Auftreten einer negativen Korrelation während bestimmter Zeitabschnitte. Die Korrelation selbst weist einen positiven Zusammenhang mit der (realen) Anleiherendite auf. Zu diesem Resultat führt die Anwendung von Panel- sowie individuellen Regressionen innerhalb der G7-Märkte. Für gewöhnlich wird eine höhere (niedrigere) Anleihenrendite mit sowohl fal-

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lenden (steigenden) Aktien- als auch Rentenkursen in Zusammenhang gebracht. Allerdings können niedrige respektive fallende Renditen dazu führen, dass die Anleihepreise steigen, während die Aktienkurse nachgeben. Grund hierfür ist, dass eine solche Konstellation makroökonomische Risiken in Form einer möglichen Deflation und/oder wirtschaftlichen Stagnation impliziert. Darüber hinaus sprechen die Ergebnisse dafür, dass eine reale Staatsanleihenrendite von weniger als 3 % mit negativen Korrelationen der Renditen einhergeht. Aus Sicht eines Investors stützt diese Erkenntnis das Auftreten positiver Diversifikationseffekte bei niedrigem Realzins. Darüber hinaus hat sie Auswirkungen auf Bewertungsmodelle für Aktien und Anleihen.

Keywords: Equity Returns; Bond Returns; Correlation; Bond Yield; Switching

JEL Classification: C22, C23, E44, G12, G15

I. Introduction

This paper examines the time-varying nature of the relationship between the equity returns and government bond returns.[1] In particular, an understanding of this relationship remains important for portfolio managers as it forms a key element in the asset allocation decision. Our standard view with regard to this relationship is that we would expect a positive correlation between the two sets of returns (for a discussion see inter alia *Barsky*, 1989 and *Shiller/Beltratti*, 1992). Although, asset pricing models for fixed-income securities and equities have traditionally been separated, more recently unifying pricing theories for equity and bond prices were proposed (for a discussion see inter alia *D'Addona* et al., 2006 and *Campbell* et al., 2013). For instance, *Mamaysky* (2002), *Bekaert* et al. (2010b), and *D'Addona* et al. (2006) specify an affine asset pricing model to price stocks and bonds. They assume that real interest rates, inflation and the dividend yield of stocks follow a mean reverting process. Furthermore, the model specifies a stochastic discount factor that prices all assets in the economy. Generally, the fair price of an asset is calculated by discounting expected future payoffs. For a default-free bond it is the discounted finite stream of known future cash flows, while for stocks it is the risk adjusted discounted infinite stream of expected future dividends (see *D'Addona* et al., 2006 and *Cochrane*, 2005). In the affine asset pricing model, the expected nominal return of a bond is a function of the real in-

[1] While studies of the comovement of bond and equity returns by *Shiller/Beltratti* (1992) and *Campbell/Ammer* (1993) imply a time invariant correlation between bond and equity returns, *Barsky* (1989) claims that the correlation should be state dependent and thus time-varying.

terest rate, expected inflation, the term premium, (unexpected) real interest rate shocks and (unexpected) inflation shocks. In contrast, the nominal return of stocks is a function of the real interest rate, expected inflation, the risk premium, (unexpected) real interest rate shocks, (unexpected) inflation shocks and (unexpected) dividend shocks. The model predicts that real interest rates and expected inflation move stock and bond returns generally in the same direction, while unexpected inflation and dividend shocks might reduce stock-bond comovement via the nominal channel (for a discussion see *Li*, 2002). Furthermore, unexpected inflation and dividend shocks should be reflected in risk aversion. As such, a rise in the yield on bonds leads naturally to a fall in bond prices due to an increase in the discount factor. That would also be accompanied by falling stock prices and a rising equity yield. This should occur where, according to the model, a rise in interest rates is associated with an increase in the discount rate and hence, falling prices. Moreover, an increase in rates may signal an increase in macroeconomic risk and a potential fall in future expected earnings, again causing current prices to fall.[2]

Notwithstanding this, evidence has been presented to suggest the potential for a negative correlation between equity and bond returns. Indeed, historically the stock-bond correlation has fluctuated heavily and been negative for prolonged periods of time. We find a statistically significant and robust positive relationship between real interest rates and stock-bond correlations that points to negative correlations at low and negative real interest rates, adding to the literature on stylized facts about historical stock-bond correlations. This finding is puzzling, because it cannot be explained by traditional asset pricing theory. As discussed earlier, asset pricing theories based on discounted payoffs or unifying affine pricing models for stocks and bonds predict, that real interest rates move stock and bond returns in the same direction – although not necessarily at the same magnitude. However, the switch from positive to negative stock-bond correlation at low real interest rates cannot be explained by traditional theory. The observation of negative correlation between equity and bond returns has been mainly explained by a flight to quality effect (see inter alia *Gulko*, 2002; *Connolly* et al., 2005; *Connolly* et al., 2007) or macroeconomic uncertainty (see inter alia *David/Veronesi*, 2004;

[2] A related line of research examines the potential for a positive relationship to exist between the bond and equity yields, known as the FED model (see, for example, *Estrada*, 2009; *Bekaert/Engstrom*, 2010a; *Maio*, 2013). This paper focusses exclusively on the relationship between returns.

Li, 2002). However, we suggest that the prolonged period of negative correlation is a result of economic stagnation. As bond yields are market based, expectations about future growth and economic risk are directly priced into the interest rate. For that reason, very low and negative interest rates occur during periods of economic stagnation and disinflation. In such an environment stocks tend to deliver negative or low returns while bond prices rise due to increased risk aversion and poor economic prospects. This paper also contributes to the literature, by modelling the correlation of real bond and real stock returns rather than using nominal returns. As a consequence, we do not incorporate inflation in the model and suggest that the real interest rate already carries the crucial information about risk aversion and the stochastic discount factor via its relationship to consumption growth. The Ramsey model of optimal growth in combination with the CES utility function for a representative household, is able to link real interest rates to consumption growth and risk aversion (for a discussion see *Laubach*, 2009). Hence, low real interest rates reflect lasting high risk aversion and low consumption growth, thus increasing the stochastic discount factor for risky assets such as equities.

Although stocks and bonds represent claims on future cash flows, *Shiller/Beltratti* (1992) argue that the dividend stream that is discounted for equities is very different from the coupons that are discounted for bonds. They point to the fact that dividend streams on stocks are fairly stable in real terms while coupons are stable in nominal terms. A negative relationship between bond and equity returns would imply that as bond yields fall, so do equity prices in contradiction of the dividend discount model. We argue that such a negative relationship may arise during periods of market stress and be an indication of weak economic growth even in a low interest rate period. Furthermore, it may point to the risk of deflation and economic stagnation. This may lead to a flight-to-safety effect such that during periods of high market uncertainty fund flows from equities towards bonds (see *Gulko*, 2002; *Connolly* et al., 2005; *Andersson* et al., 2008). Thus, bond yields fall due to higher demand for bonds while stock sales trigger declining share prices. The flight-to-safety effect is generally associated with a rare event such as the Russian bond default or the fall of Long Term Capital Management, that triggers a sudden drop in investors' risk appetite and increases risk aversion (for a discussion see *Beber* et al., 2009). As such, the phenomenon is a short-term event very concentrated in time. For instance, *Gubareva/Borges* (2016) define a maximum duration of flight-to-quality events to be 45 working days. Similarly, *Gulko* (2002) studies the decoupling effect between stocks and bonds during stock market crashes. The author finds that the flight-to-quality effect typically lasts two to three weeks with falling share prices and rising bonds. However, while this flight-to-safety effect is a rational argument for explaining temporary periods of a negative stock and bond correlation, it fails to explain prolonged periods of such a negative correlation. In contrast to the short term flight-to-quality event driven effect, a prolonged negative equity-bonds correlation might be rather rooted in a general change in the economic environment.

In this paper we contribute to the literature by linking the prolonged negative equity-bonds correlation in G7 markets over the last years to very low and partially negative real interest rates. As discussed before, the Ramsey model of optimal growth in combination with the CES utility function for a representative household, is able to link real interest rates to consumption growth and risk aversion (for a discussion see *Laubach*, 2009). Hence, low real interest rates might reflect lasting high risk aversion and low consumption growth, thus increasing the stochastic discount factor and pushing stock prices down while bond prices increase. We therefore argue that the prolonged negative equity-bonds correlation can be explained by economic stagnation in contrast to the flight-to-quality effect that is based on a short-term event triggering temporary negative correlations. Furthermore, the analysis reveals that negative real interest rates might drag stock-bond correlations into negative territory. This finding has major implications for the optimal asset allocation. As real interest rates are low or negative, the expected return for bonds might be low due to the marginal or negative carry. However, the analysis suggests that in such an environment the diversification effect between stocks and bonds might be particularly high.

Moreover, the negative correlation may point to a liquidity trap problem where falling interest rates cause equity prices to fall as they signal worsening economic conditions and imply future expected interest rate rises (for a discussion see, inter alia, *Keynes*, 1936; *Krugman* et al., 1998; *Krugman*, 2000; *Eggertsson* et al., 2012). In a liquidity trap, interest rates become so low that the opportunity cost of holding money is zero. In such a situation conventional monetary policy is unable to stimulate the economy through increasing the money supply or lowering interest rates, because excess funds are not necessarily channelled into new investments but rather hoarded in cash.

The most prominent example of prolonged deflation and economic stagnation has been Japan since the early 1990s (for a discussion see, *Turner*, 2003; *Goyal/McKinnon*, 2003). As a result, declining interest rates from already depressed levels might cause stock prices to fall due to worsening economic prospects while bond prices keep on rising. However, rising interest rates subsequently point to improving conditions inducing stock prices to advance. On this rationale, we hypothesize a negative correlation between bond and equity prices when interest rates are very low and during periods of economic stagflation. However, under normal economic conditions we would expect to observe a positive correlation with equity and bond prices moving in the same direction.

Furthermore, a negative correlation between equities and bonds can arise when real rates are positive but low because of nominal interest rates being close to zero with prevailing disinflation. For instance *Ilmanen* (2003) suggests that stock-bond correlations become negative during deflationary recessions. In a disinflationary world investors should prefer nominally fixed cash flows from bonds that might even increase slightly in real terms while corporate cash flows are most likely adversely affected by a loss of corporate pricing power and nominally fixed labour contracts. Furthermore, deflation makes hording cash very attractive due to increasing buying power over time while the opportunity costs of consumption and investments rise with falling prices for goods.

Therefore, an understanding of whether a negative correlation between equity and bonds exists is important for policy makers who may be concerned about the timing of interest rate changes, as well as for portfolio managers when confronted with market timing decisions. This paper seeks to establish a clear relationship between the equity and bond return correlation for the G7 markets. Moreover, to ensure there is no effect arising from inflation, we focus upon real returns. In particular, we use a 12 month rolling correlation coefficient to identify periods of negative equity-bonds correlation. Furthermore, we are interested in whether there is a threshold point about which the correlation turns negative in a systematic fashion or whether the correlation between equity and bond returns is irregular. Further still, we seek to understand the underlying causes of why a negative correlation between equity and bond returns can occur during low interest rate periods.

Establishing such a relationship, would have far reaching consequences for optimal asset allocation and monetary policy. In a low interest rate environment, investor fear that rising interest rates might cause bond and equity prices to fall simultaneously, assuming a positive correlation between stocks and bonds. Furthermore, central banks might hesitate to increase interest rates when moving back towards normal economic conditions due to the threat of negative wealth effects. However, these negative wealth effects might also be overestimated should there indeed be a negative correlation between stocks and bonds. Hence, monetary policy could be normalized earlier and thus avoiding the unnecessary risk of overheating at a later stage (for a discussion see *Hoffmann/Schnabl*, 2011).

The nature of the results here will be important for market participants concerned about market timing decisions and optimal asset allocation. For instance, *Wainscott* (1990) and *Dopfel* (2003) show the importance of the stock-bond correlation in the asset allocation process. In a *Markowitz* (1952) setting, everything else being equal, a fall in the correlation between equities and bonds increases the benefit of diversification and results in a lower standard deviation of the minimum variance portfolio and an improved Sharpe ratio (*Sharpe*, 1966) of the optimal risky portfolio. Also for policy makers in revealing the presence of a liquidity trap, which could result in central banks over-stating the negative effects of an interest rate rise from very low levels towards more normal levels. Finally, the results are of importance to academics in understanding asset price movements and particularly where the dividend discount model breaks down at very low interest rates levels (for a discussion see *Estrada*, 2009).

II. Establishing the Nature of the Correlation Between Stock Returns and Bond Returns

1. Data

In order to conduct the empirical analysis we use the real stock price index, the real government bond price index and real interest rates for the individual G7 countries on a monthly basis obtained from DataStream.[3] Real share prices and real bond prices are calculated by dividing the original nominal data by the consumer price index from the OECD databank. For real interest rates we subtract the YoY inflation rate from the nominal interest rate. Due to availability constraints for some G7 countries, we generate two samples. The first sample includes all G7 countries and runs from March 1993 until October 2014, while the second data set starts in January 1982 and only consists of the US, UK and Germany.

[3] For bond prices the clean price index is used and for stock prices the stock price index.

2. Methodology

In order to analyse the relationship between real interest rates and the equity/bond return correlation, we calculate the 12 month rolling Pearson correlation coefficient between real stock returns and real bond returns. The use of 12 month rolling correlations has the advantage of not smoothing the time series too much. A rolling window around one year has also been considered in earlier studies as a medium term correlation measure (see inter alia, *Kelly* et al., 1998; *Smith* et al., 2008; *Wainscott*, 1990; *Aste* et al., 2010).[4]

The Pearson correlation between two variables X and Y is defined by:

$$Cor(x,y) = \frac{\sum_{t=1}^{n}(x_t - \bar{x})(y_t - \bar{y})}{\sqrt{\sum_{t=1}^{n}(x_t - \bar{x})^2 * \sum_{t=1}^{n}(y_t - \bar{y})^2}} \tag{1}$$

with:

$$\bar{x} = \frac{1}{n}\sum_{t=1}^{n} x_t \text{ and } \bar{y} = \frac{1}{n}\sum_{t=1}^{n} y_t$$

As the stock-bond correlation is by definition bounded between –1 and 1, while the real bond yield on the right hand side of the regression is not, a generalized logit transformation is applied to transform the range of the correlations to –∞ and +∞. This transformation is common practice when regressing correlations on unrestricted variables and has been used by inter alia *Andersson* et al. (2008) for stock-bond correlations. The logit transformed correlations are obtained by:

$$\rho_t = log\left(\frac{1 + Cor(x,y)}{1 - Cor(x,y)}\right) \tag{2}$$

Having obtained the time-varying logit transformed correlation and in order to ensure the empirical validity of the results we obtain, we apply panel unit root tests to the two identified samples of data in order to verify the order of integration. While ultimately a sequence of Pearson correlations must be stationary as the series is bounded between –1 and 1, the logit transformed correlations are only bounded between –∞ and +∞. Furthermore, over any particular sample of data there is the potential for the series to exhibit non-stationarity.

[4] For robustness we also considered two year rolling correlations. The results are qualitatively the same and are available upon request.

We utilise the panel tests that allow for individual unit root processes, namely, the tests of *Im/Pesaran/Shin* (2003) and *Fisher* (1932). The panel unit root tests are based on the following ADF autoregression:

$$\Delta x_{i,t} = \alpha_i + \rho_i x_{i,t-1} + \sum_{j=1}^{ki} \beta_{ij} \Delta x_{i,t-j} + \eta_{i,t} \tag{3}$$

In general, we could also include a time trend. The heterogeneous panel unit root test developed by *Im/Pesaran/Shin* (2003) has a null hypothesis $H_0: \rho_i = 0$ for all i and is tested against the alternative $H_1: \rho_i < 0$ for some (but not necessarily all) i. In the *Im/Pesaran/Shin* test a separate ADF test is specified for each cross-section, where the test statistic is the arithmetic mean (across i) of the N individual ADF t-statistics on ρ_i. The test statistic follows a normal distribution. Numerical values for the mean and variance, conditional on $p_i = 1$, are generated by Monte Carlo simulation, and are tabulated by *Im/Pesaran/Shin*. The panel unit root tests based on *Fisher* (1932) are constructed in the same manner, but the tests are based on combining the p-values from the individual ADF tests, rather than the t-values, see *Maddala/Wu* (1999) and *Choi* (2001).

Having considered the stationary (or otherwise) behaviour of the series, we conduct both individual as well as panel regressions of the stock-bond correlation against the bond yield as such:

$$\rho_{i,t} = \alpha + \beta by_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t} \tag{4}$$

where $\rho_{i,t}$ represents the time-varying logit transformed correlation between equity and bond returns for market i, and $by_{i,t}$ represents the bond yield. The terms γ_i and δ_t refer to the cross-section and period-specific fixed effects, which effectively estimate the cross-sectional and period-specific means. In the individual country regressions these terms are not included. In order to account for heteroscedasticity and autocorrelation, we apply White period standard errors and covariance in the regressions (*White*, 1980).

Although we expect a fixed effects model for our data, the Hausman test is applied to verify the null hypothesis of random effects against the alternative of fixed effects. The test is built upon the fact that under the hypothesis of uncorrelated individual errors with the regressors, the OLS and GLS estimates are consistent, but OLS is inefficient (*Hausman* 1978). In contrast, under the alternative, OLS is consistent while GLS is not.

Hence the null hypothesis of the Hausman test is no systematic difference between the OLS and GLS estimates.

3. Empirical Results on Bond/Equity Return Correlation and Bond Yield

Having obtained the 12 month rolling logit transformed correlations for each market across the different samples, we first conduct the panel unit root tests. In conducting the tests we consider both individual constant and trend effects, although our preference is for the individual constant only, as a long-term trend in correlations or yields is infeasible. Except for the US, UK and German real bond yields with individual effects, the hypothesis of non-stationarity of the variables can be rejected (as can be seen in Table 1). As a result, we will use the data series in level for the panel regression analysis.

We now analyse the relationship between the real equity/bond return correlation and the real bond yield by conducting a series of panel regressions with different assumptions regarding the nature of the cross section and period effects before concluding with individual regressions. Table 2 column (a) reports results of equation (4) for the G7 sample where the pooled regression includes cross section fixed effects. This regression yields a statistically significant positive relationship between real interest rates and the real equity/bond return correlation. Therefore, in support of the view outlined above a rising real bond yield is consistent with a strengthening positive correlation between real equity and bond returns. Thus, a rising interest rate is associated with both falling bond and equity prices. As discussed above, where a falling bond price falls automatically from a rising yield, for equity prices, a fall would be consistent with increasing macroeconomic risk. Equally, a falling bond yield is associated with a stock and bond return correlation that is declining in strength.

To assess the reliability of the model, we conduct the Hausman test for random effects in the cross section (country) series. Reported in the lower part of Table 2 (a), we can see that the Hausman test for random effects is not rejected. Therefore, we re-estimate the model with random instead of fixed effects, the results of which are reported in Table 2 column (b). Despite the change in model specification, the G7 pooled regression with cross section random effects confirms the statistically significant positive relationship between real interest rates and the real equity/bond return correlation with an almost identical (at three decimal places) coefficient value. Again, we report the results of the Hausman test, this time for the potential for period specific random effects, which is rejected, and for cross section and period random effects, which is equally rejected. Therefore, as a final model specification we include random cross section effects and period fixed effects, the results of which are reported in Table 2 column (c). The results of this model likewise support a statistically significant positive relationship between real interest rates and the real equity/bond return correlation, although the magnitude of the coefficient is noticeably smaller. To further support the robustness of the positive relationship between stock-bond correlations and real interest rates, we also estimate the model with lagged correlation on the right hand side of the equation to account for autocorrelation in the correlation directly. This methodology has been used by inter alia. *Li* (2002). Following the same procedure as before, the results reported in Table 2 columns (d and e) confirm the statistically significant positive relationship between stock-bond correlations and real interest rates. Only in the regression with cross section random effects and period fixed effects the positive relationship is not statistically significant anymore (see Table 2 column (f)). Of note, the included lagged correlation coefficient is highly significant and increases explanatory power substantially.

As an alternative method, we model the relationship between the correlation and the bond yield including a lagged AR(1) error term. This methodology has been implemented by inter alia *Andersson* et al. (2008). As can be seen in Table 3, the statistically significant positive relationship between real interest rates and stock-bond correlations is once again confirmed while the level of correlation is mainly picked up by the AR(1) term. We believe that these two alternative methodologies provide robust evidence for a positive relationship between the stock and bond returns correlation and the bond yield, suggest that negative real interest rates will push correlation down and eventually into negative territory over time.

To establish further evidence for this positive relationship, we now repeat the analysis utilising the smaller but longer time period sample for the US, UK and Germany.[5] We repeat the same procedure as above and report the results for the pooled regression with cross section fixed effects, cross section random effects and cross section random effects with

[5] Specifically, the G7 sample begins in 1993, while the sample for these three markets begins in 1982. Both samples end in 2014.

fixed time effects in Table 4 columns (a), (b), (c), (d), (e) and (f) respectively. As with the G7 results, to ensure robustness, we also provide the results when including an AR(1) term in the regression in Table 5. The results presented in these two tables are consistent with the results for the G7 markets, with evidence in favour of a positive and significant relationship between the real bond yield and the real equity/bond return correlation[6]. Again, the coefficient value is similar across columns (a) and (b), which include only cross section effects, and is smaller when we include period effects or lagged terms. In terms of the Hausman test, again the results are supportive of cross section random effects and period fixed effects. Generally, the US, UK and Germany are, together with Japan, the largest economies of the G7 countries and might have highly integrated capital markets. As interest rates and stock markets are quite synchronized, the time coefficients may well pick up a large part of the relationship between real bond yield and the correlation, which is likely to be the reason why the coefficient becomes much smaller.

To support this argument, we estimate the individual regressions for the US, UK and Germany separately over the same period (1982–2014). These results are reported in Table 6, where it can be seen that with the exception of the German regression that includes a time trend as well as the regressions with lagged correlation terms, all regressions yield a statistically significant positive relationship between the real bond yield and the real equity/bond returns correlations. To further illustrate these results, Figures 1 to 3 present the scatter plot between the real bond yield and real equity/bond return correlation together with the fitted line for the US, UK and Germany respectively. These figures show a strong positive relationship for each of the markets. These figures also reveal that at low levels of the real bond yield there exists a negative correlation between the real equity and bond returns. To complete this analysis we report in Table 7 the individual regressions for each of the G7 markets over the common sample period from March 1993 to October 2014. These results again are largely supportive of the positive relationship between the real bond yield and the real equity/bond return correlation. The only exceptions to this are the results of Japan, for Germany when we include a trend term as well as the regressions with

[6] As the result of the Hausman test in Table 4 column (f) supports cross-section and period random effects, we also estimated this model. The results are confirming the statistically significant positive relationship between bond-equity correlation with real bond yields and are available upon request.

lagged correlation terms.[7] For all the series that support a statistically significant real bond yield coefficient, a positive relationship is found. Overall, both the panel and individual regressions support a positive relationship between real interest rates and the real equity/bond return correlations in our data set.

As discussed in the Introduction there is evidence within the literature that the correlation between real equity and bond returns can become negative, contrary to expectation. The results reported above support a positive relationship between interest rates and the equity/bond correlation and thus the potential for a negative correlation at low values of interest rates. While Figures 1–3 provide graphical evidence of this with a negative correlation regime identified. Using the regression results therefore, we identify the level of real interest rates associated with a switch from a positive to a negative correlation between real equity and bond returns, for which Table 8 summarises this information. As can be observed in this table, based on the individual country model estimates the threshold is approximately a real rate of 2.7 %. For the three country panel (US, UK and Germany) the values are almost the same with approximately 2.8 %. Examining the G7 panel results, we can see that these are noticeably higher than for the longer sample. The values range between 1.8 % and 3.9 %, although for Canada the value is approximately 5.3 %. Overall, these results suggest that for a real bond yield of (approximately) below 2.7 % then the equity return and bond return correlation is expected to be negative. Under current market conditions, where all G7 countries currently have a real rate below noticeably this threshold, this implies the potential for diversification opportunities for investors that will remain even if interest rates begin to rise.

III. Explaining the Relationship

The above analysis has established a positive relationship between the real bond yield and the real bond/equity return correlation. This implies that as the real rate increases so the correlation strengthens, while equally it means that at low levels of the real rate then the correlation between bond and equity returns becomes negative. Understanding that

[7] Of note, if we estimate the model over the full sample of available data for Japan (1985–2014) then these results support a positive and significant relationship. Equally, Table 8 shows that the results for Germany over the longer sample are positive.

this relationship exists is important for market participants and portfolio managers in particular when making asset allocation decisions between bonds and equity. Notably, a negative correlation would imply diversification benefits, thus changes in the real rate can influence market timing activities. However, it is also important to understand why the relationship exists. Should the observed relationship be linked to explicit economic factors then it will provide an understanding of market behaviour that is likely to continue over time. In contrast, if the relationship is not linked to an economic variable then the observed relationship may provide a description of current market behaviour but is likely to break down at some point.

In examining the relationship between bond yields and bond returns there exists a relatively mechanical relationship. A rise in interest rates will lead to a fall in bond prices. This arises due to the fixed nature of the coupon payment. However, for equity the situation is different. Stock prices depend on expected discounted cash flow (dividends), however, dividends payments are not certain and thus contain additional risk compared to bonds. Under the tradition view of the dividend discount model, we would expect a rise in interest rates to lead to a fall in prices as the discount rate increases. Furthermore, dividend payments may become less certain as higher interest rates imply increased macroeconomic risk, i.e., the likelihood of a future economic downturn. Thus, both bond and equity prices move in the same direction with higher interest rates.

However, as observed in Figures 1 to 3, when real rates are low there is a negative correlation between bond and equity returns. Lower interest rates will imply rising bond prices, again as a result of the fixed coupon payment. Therefore, in order to generate a negative correlation equity prices must fall during periods of low real rates. This can occur where the low interest rate period is accompanied by an increase in macroeconomic risk, which may prompt a movement from equities to bonds. That is, where the low real rates accompany poor expected future economic growth prospects then equity prices may fall.

The existing literature has been mainly based on macroeconomic factors to explain the bond-equity correlation. For instance, *Barsky* (1989) shows that a negative bond-equity correlation might be caused by low productivity growth and high market risk, which will lower the real bond yield and depress earnings. Furthermore, *Li* (2002) and *D'Addona* et al. (2006) report that macroeconomic uncertainty weakens the bond-equity correlation, while *D'Arcy* et al. (2010) suggest that positive US employment data surprises increase earnings growth expectations more than they increase the discount rate and thus cause a negative bond-equity correlation. However, as a market rate, the interest rate not only carries information about the discount rate but also expected economic growth and risk aversion.

Laubach (2009) shows that under the Ramsey model of optimal growth in combination with the CES utility function for a representative household, the real interest rate is determined by:

$$r = \sigma g + \theta \tag{5}$$

where σ stands for the coefficient of relative risk aversion, g is real consumption growth and θ represents the household's rate of time preference (for a discussion see also *Poghosyan*, 2012). Hence, the model suggests that low real bond yields might reflect low consumption growth and high risk aversion.

In order to examine this issue we utilise private consumption growth data for each of the seven markets as a measure of economic performance. Following, for example, *Bansal/Yaron* (2004), we would expect a positive relationship between consumption growth and stock prices. Bansal and Yaron argue that higher (expected) consumption growth is consistent with improving economic conditions and rising stock prices. Equally, therefore, low consumption growth should be consistent with falling stock prices. To consider this, Table 9 presents the average level of consumption growth across different quintiles of real interest rate values.[8] As can be observed in this table, low real rates are associated with low consumption growth. Examining the average consumption growth values for the G7 markets both individually as well as across all markets, we can see that consumption growth is lower in the lowest interest rate quintile for all markets than the highest quintile. Furthermore, for the individual markets, with the obvious exception of Germany, average consumption growth typically increases with the real rate quintile, although not necessarily monotonically. Although, viewed as a group, average G7 consumption growth increases in a linear fashion with real rates.

[8] We re-sample the financial data at the quarterly frequency as that is the highest frequency that consumption data is available. The positive relationship between the real bond yield and the real equity/bond return correlation remains consistent at this frequency, with results available on request.

We also examine the results for just the US, UK and Germany using the longer available sample (1982–2014) for these three markets in Table 9. These results remain consistent with those reported for the full G7 markets. Consumption growth is lower with low real rates and increases with higher real rates. Again, this relationship is not always monotonic (although it is for the US) but in each case consumption growth is lower in the first quintile than for the highest two quintiles. Overall, the evidence presented here demonstrates that low real rates regimes are associated with low consumption growth and therefore periods of weak economic performance and high economic risk. This leads to lower stock prices and explains why stock prices and bond prices move in opposite directions when real rates are low. Arguably, the positive relationship between real interest rates and stock-bond correlation is caused by the reaction of investors and policy makers to changes in overall economic conditions.

IV. Summary and Conclusion

This paper has sought to clarify the nature of the relationship between equity returns and bond returns. From the viewpoint of traditional finance theory on asset pricing, we would expect a positive correlation between the two return series. However, there exists evidence that the relationship can become negative and for a longer period of time than justified by a flight to quality argument. Instead, we hypothesise that the nature of the relationship varies with the bond yield. In particular, a rising bond yield leads to a fall in both stock and bond prices and equally, a falling bond yield leads to a rise in prices over a normal range of interest rates. However, when the interest rate is low, although further reductions continue to increase bond prices, they signal an increase in macroeconomic risk and so lower equity prices. That is, particularly low rates coincide with potential periods of deflation or economic stagnation and signal poor economic conditions. A rise in rates from a low level is often accompanied by rising equity prices as they signal a return to normal conditions.

In order to verify the relationship between real interest rates and the real equity/bond return correlation for the G7 countries, we apply both panel and individual country regression analysis. Taking the range of results provided as a whole, overall they support a statistically significant and positive relationship between real rates and the equity/bond correlation for our sample. Furthermore, the regressions also reveal that below a particular threshold level in real interest rates, the equity/bond correlation turns negative and that this rate appears to be below 3 %. Thus, at low real interest rates, the expected economic relationship between interest rates and stock prices changes and stocks tend to fall with interest rate decreases. An examination of consumption growth data over different quintiles of the real bond yield reveals that consumption growth is lowest when the real rate is lowest. This suggests that low real rates are associated with poor economic conditions and explains the fall in equity prices and the negative correlation between equity and bond returns.

From an investment point of view, these results suggest the potential for diversification benefits between stocks and bonds at low levels of the real rate. In addition, this will also have substantial consequences for relative valuation measures between stocks and bonds such as the FED model and is a likely source of further research.

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Appendix

Table 1

Panel Unit Root Tests

Variable	Individual effects and trends	Individual effects	None
ADF – Fisher Chi-square			
US, UK and GER correlations	16.2401***	11.8755*	24.2020***
G7 correlations	27.6433**	40.0952***	57.6396***
US, UK and GER real bond yields	21.4905***	4.07984	11.2546*
G7 real bond yields	70.8008***	22.0895*	35.3679***
PP – Fisher Chi-square			
US, UK and GER correlations	26.0071***	19.9980***	33.8710***
G7 correlations	35.5974***	45.7396***	64.5573***
US, UK and GER real bond yields	30.7097***	6.59634	10.8968*
G7 real bond yields	49.2621***	22.3856*	34.1092***
Im, Pesaran and Shin W-statistic			
US, UK and GER correlations	–2.46992***	–1.76016**	–
G7 correlations	–2.49693***	–3.83188***	–
US, UK and GER real bond yields	–3.2008***	–0.0832	–
G7 real bond yields	–6.2500***	–1.4859*	–

Notes: Entries are the panel unit root tests of equation (3), statistical significance is denoted at 10 % *, 5 % ** and 1 % ***

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Table 2

G7 Panel Regressions

	Pooled regression analysis for G7 (1993M3 – 2014M10): dependent variable correlations					
	(a)	(b)	(c)	(d)	(e)	(f)
Constant	–0.431747 (0.0000)	–0.431896 (0.0000)	–0.258487 (0.0147)	–0.019973 (0.0000)	–0.017807 (0.0000)	–0.021579 (0.0255)
Real bond yield	0.136276 (0.0000)	0.136331 (0.0000)	0.072218 (0.0722)	0.005521 (0.0001)	0.004896 (0.0037)	0.006244 (0.1525)
Correlation (t – 1)	–	–	–	0.942830 (0.0000)	0.950584 (0.0000)	0.948517 (0.0000)
Cross sec. fixed effect	yes	no	no	yes	no	no
Cross sec. random effect	no	yes	yes	no	yes	yes
Period fixed effect	no	no	yes	no	no	yes
R^2	0.391621	0.297907	0.612578	0.928253	0.928021	0.958207
	Hausman test Chi–Sq. Statistic					
Cross sec. Random	0.000000 (1.0000)			0.000000 (1.0000)		
Period random		1.090955 (0.2963)			0.034483 (0.9829)	
Cross sec. and period random			1.131226 (0.2875)			7.914664 (0.0191)

Notes: to account for heteroscedasticity and autocorrelation, we apply White period standard errors and covariance. The numbers in parentheses are p-values.

Table 3

G7 Panel Regressions – Cross Section Fixed Effects and AR(1)

G7 pooled regression analysis with cross section fixed effects and country specific AR(1) terms (1993M3 – 2014M10): Dependent variable: Equity/Bond Correlation

Variable	Coefficient	Standard Error	t-Statistic	Probability
Constant	–0.165359	0.016566	–9.981798	0.0000
Real bond yield	0.029350	0.007334	4.001769	0.0001
AR(1) Germany	0.964593	0.001426	676.2010	0.0000
AR(1) Canada	0.930014	0.001532	607.0746	0.0000
AR(1) France	0.953255	0.000947	1006.496	0.0000
AR(1) Italy	0.954920	0.000719	1328.156	0.0000
AR(1) Japan	0.927274	0.000132	7044.450	0.0000
AR(1) UK	0.948723	0.001408	673.8172	0.0000
AR(1) US	0.960098	0.000887	1081.990	0.0000
Fixed effects (cross):				
Germany	–0.121018	Japan	–0.155662	
Canada	–0.211882	UK	0.054270	
France	0.061918	US	–0.006441	
Italy	0.336362	R-squared	0.928253	

Notes: Entries are values from the panel regression given by equation (4), with fixed effects for the cross section only and country specific AR(1) terms.

Table 4

Three Country Panel Regressions

	Pooled regression analysis for US, UK & Germany (1982M1 – 2014M10): dependent variable correlations					
	(a)	(b)	(c)	(d)	(e)	(f)
Constant	–0.356484 (0.0000)	–0.356571 (0.0000)	0.002648 (0.9518)	–0.014987 (0.0000)	–0.014615 (0.0000)	–0.004295 (0.5933)
Real bond yield	0.132330 (0.0000)	0.132356 (0.0000)	0.026358 (0.0591)	0.005479 (0.0000)	0.005328 (0.0000)	0.003311 (0.1977)
Correlation (t – 1)	–	–	–	0.949093 (0.0000)	0.950591 (0.0000)	0.913182 (0.0000)
Cross section fixed effect	yes	no	no	yes	no	no
Cross section random effect	no	yes	yes	no	yes	yes
Time period fixed effect	no	no	yes	no	no	yes
R^2	0.381793	0.368276	0.854193	0.936732	0.936702	0.973885
	Hausman test Chi–Sq. Statistic					
Cross sec. Random	0.000000 (1.0000)			0.000000 (1.0000)		
Period random		190.064821 (0.0000)			0.000000 (1.0000)	
Cross sec. and period random			190.366371 (0.0000)			0.000000 (1.0000)

Notes: to account for heteroscedasticity and autocorrelation, we apply White period standard errors and covariance. The numbers in parentheses are *p*-values.

Table 5

Three Country Panel Regression – Cross Fixed Effects and AR(1)

US, UK, Germany pooled regression analysis with cross section fixed effects and country specific AR(1) terms (1982M1 – 2014M10): dependent variable correlations

Variable	Coefficient	Standard Error	t-Statistic	Probability
Constant	–0.015874	0.012236	–1.297285	0.1948
Real bond yield	0.025934	0.003848	6.738738	0.0000
AR(1) Germany	0.975930	0.000451	2164.855	0.0000
AR(1) UK	0.953458	0.000528	1805.697	0.0000
AR(1) US	0.956622	0.000601	1592.685	0.0000
Fixed effects (cross):				
Germany	–0.129488	UK	0.064485	
US	0.038489	R-squared	0.932874	

Notes: Entries are values from the panel regression given by equation (4), with fixed effects for the cross section only and country specific AR(1) terms.

Table 6

Individual Country Regression: US, UK and Germany 1982:1 – 2014:10

	Individual regressions for US, UK and Germany (1982M1 – 2014M10) with and without trend				
Country	*Constant*	*Real bond yield*	*Correlation (t – 1)*	*Trend*	R^2
US	–0.332385 (0.0000)	0.138958 (0.0000)	–	–	0.383475
	–0.016149 (0.2334)	0.006443 (0.1025)	0.943372 (0.0000)	–	0.926731
	0.372168 (0.0011)	0.049301 (0.0025)	–	–0.002101 (0.0000)	0.443528
	0.043721 (0.2943)	–0.000341 (0.9543)	0.934837 (0.0000)	–0.000187 (0.1293)	0.927162
UK	–0.306634 (0.0000)	0.126580 (0.0000)	–	–	0.305472
	–0.015493 (0.2999)	0.006315 (0.1117)	0.943014 (0.0000)	–	0.919285
	0.078987 (0.5090)	0.080024 (0.0000)	–	–0.001107 (0.0007)	0.325733
	0.019394 (0.6395)	0.002340 (0.6928)	0.940392 (0.0000)	–0.000102 (0.3664)	0.919454
Germany	–0.442148 (0.0000)	0.130534 (0.0000)	–	–	0.411991
	–0.005545 (0.5407)	0.001322 (0.5997)	0.977527 (0.0000)	–	0.965354
	0.425249 (0.0000)	0.008444 (0.4543)		–0.002371 (0.0000)	0.595135
	0.034159 (0.1075)	–0.003090 (0.3480)	0.960558 (0.0000)	–0.000129 (0.0389)	0.965731

Notes: Entries are values from the individual version of the regression given by equation (4), the number in brackets is the p-value.

Table 7

Individual Country Regression: G7 1993:3 – 2014:10

	Individual regressions for G7 countries (1993M3–2014M10)				
Country	*Constant*	*Real bond yield*	*Correlation (t – 1)*	*Trend*	R^2
US	–0.503379 (0.0000)	0.202989 (0.0000)	–	–	0.434556
	–0.018862 (0.2751)	0.006640 (0.3201)	0.951117 (0.0000)	–	0.933640
	–0.212278 (0.0275)	0.154254 (0.0000)	–	–0.001437 (0.0011)	0.457696
	0.008513 (0.8019)	0.002545 (0.7497)	0.947093 (0.0000)	–0.000145 (0.3489)	0.933867
UK	–0.383016 (0.0000)	0.138926 (0.0000)	–	–	0.398247
	–0.020040 (0.2308)	0.006222 (0.2270)	0.935103 (0.0000)	–	0.917626
	–0.010921 (0.9470)	0.085373 (0.0009)	–	–0.001707 (0.0207)	0.410679
	0.026822 (0.6627)	–0.000306 (0.9749)	0.932588 (0.0000)	–0.000220 (0.4286)	0.917828
Canada	–0.533388 (0.0000)	0.076774 (0.0000)	–	–	0.194376
	–0.027857 (0.1474)	0.002808 (0.5099)	0.931943 (0.0000)	–	0.878558
	–0.392965 (0.0014)	0.057446 (0.0024)	–	–0.000642 (0.2276)	0.198936
	–0.001564 (0.9743)	–0.000806 (0.9139)	0.930982 (0.0000)	–0.000123 (0.5550)	0.878723
Japan	–0.287670 (0.0000)	0.006514 (0.6618)	–	–	0.000743
	–0.020426 (0.1347)	–0.001021 (0.8563)	0.923265 (0.0000)	–	0.857284
	–0.487412 (0.0000)	0.042264 (0.0183)	–	0.001094 (0.0006)	0.045919
	–0.049369 (0.0586)	0.003907 (0.5747)	0.917488 (0.0000)	0.000149 (0.2283)	0.858093

	Individual regressions for G7 countries (1993M3–2014M10)				
Country	*Constant*	*Real bond yield*	*Correlation (t – 1)*	*Trend*	R^2
Germany	–0.496166 (0.0000)	0.132088 (0.0000)	–	–	0.405018
	–0.006664 (0.5663)	0.000359 (0.9188)	0.973548 (0.0000)	–	0.957281
	0.250711 (0.0006)	0.002863 (0.8425)	–	–0.003256 (0.0000)	0.594409
	0.021122 (0.3791)	–0.003706 (0.4278)	0.958186 (0.0000)	–0.000155 (0.1866)	0.957571
France	–0.605235 (0.0000)	0.207114 (0.0000)	–	–	0.442236
	–0.034878 (0.1357)	0.011275 (0.1338)	0.932156 (0.0000)	–	0.918652
	–0.698900 (0.0000)	0.222827 (0.0000)	–	0.000373 (0.5156)	0.443155
	–0.025546 (0.6734)	0.009688 (0.4243)	0.932350 (0.0000)	–0.000004 (0.8675)	0.918661
Italy	–0.323769 (0.0000)	0.161372 (0.0000)	–	–	0.406809
	–0.007558 (0.6908)	0.006004 (0.3318)	0.935342 (0.0000)	–	0.912322
	–0.826972 (0.0000)	0.224847 (0.0000)	–	0.002302 (0.0000)	0.501545
	–0.084538 (0.0377)	0.018359 (0.0298)	0.913925 (0.0000)	0.000319 (0.0325)	0.913876

Notes: Entries are values from the individual version of the regression given by equation (4), the number in brackets is the p-value.

Table 8

Estimated Threshold Values for Switch in Sign of Equity/Bond Return Correlation

Individual regressions 1982–2014				
Country	*Constant*	*Coefficient*	*Threshold*	
US	–0.332385	0.138958	2.391982	
UK	–0.306634	0.126580	2.422452	
Germany	–0.442148	0.130534	3.387225	
Average			2.733886	
Panel regression (cross section random effects only) 1982–2014				
Country	*Common constant*	*Individual constant*	*Coefficient*	*Threshold*
US	–0.356223	–0.080655	0.129416	3.375665
UK	–0.356223	0.025993	0.129416	2.551694
Germany	–0.356223	0.054661	0.129416	2.330176
Average				2.752512
G7 Panel regression (cross section random effects only) 1993–2014				
Country	*Common constant*	*Individual constant*	*Coefficient*	*Threshold*
US	–0.416062	0.087282	0.125427	2.621286
UK	–0.416062	0.065165	0.125427	3.836710
Germany	–0.416062	–0.069545	0.125427	3.871631
Canada	–0.416062	–0.248229	0.125427	5.296236
France	–0.416062	0.038560	0.125427	3.009735
Italy	–0.416062	0.193765	0.125427	1.772321
Japan	–0.416062	–0.066997	0.125427	3.851316
Average				3.465605

Table 9

Average Consumption Growth by Real Bond Yield Quintile

	Real Bond Yield Quintiles				
	Q1	*Q2*	*Q3*	*Q4*	*Q5*
	G7 Markets – Consumption Growth				
US	1.27	2.06	3.01	3.41	3.18
UK	0.60	0.39	2.31	4.28	3.67
Canada	2.72	3.13	3.36	2.23	2.89
Germany	1.06	0.86	0.74	0.92	1.73
France	0.70	1.81	2.45	1.56	1.93
Italy	0.43	0.49	0.69	0.45	1.05
Japan	–2.84	0.41	0.78	1.37	2.33
Average	0.56	1.31	1.90	2.03	2.40
	UK, US and Germany – Consumption Growth				
US	0.68	1.67	2.95	3.27	4.35
UK	0.62	–0.05	0.38	2.49	4.57
Germany	1.06	0.76	0.78	2.08	3.49
Average	0.79	0.54	1.37	2.61	4.13

Notes: entries are the values for average consumption growth across the different quintiles of the real bond yield.

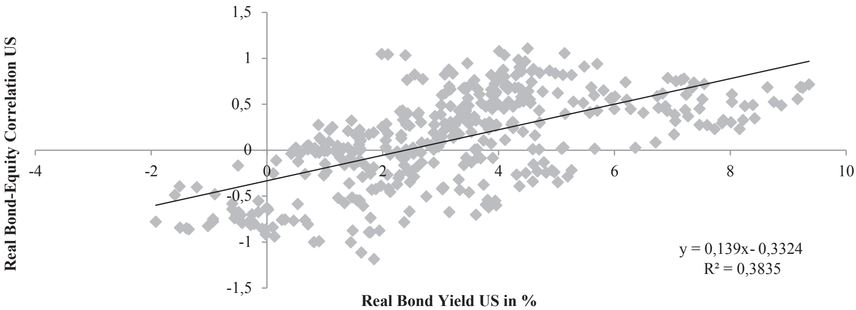

Figure 1: Logit Transformed Real Bond/Equity Correlation vs. US 10 Year Yield Since 1982

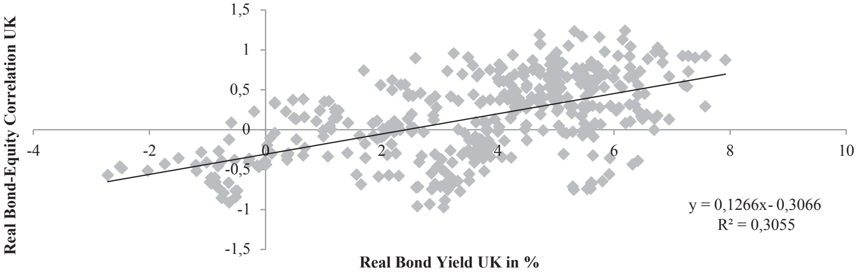

Figure 2: Logit Transformed Real Bond/Equity Correlation vs. UK 10 Year Yield Since 1982

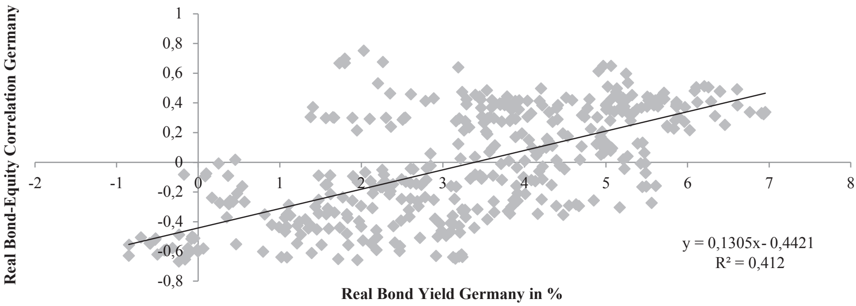

Figure 3: Logit Transformed Real Bond/Equity Correlation vs. German 10 Year Yield Since 1982