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Stocks, Bonds and Causality

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The relationship between the returns of equities and government bonds seems to be perpetually on the minds of investors. This is understandable. U.S. government bonds have come to be viewed as a safe-haven asset, providing relative stability in times of economic uncertainty and an effective hedge to portfolios often dominated by explicit or implicit equity risk. Indeed, government bonds have been good performers in nearly all recessions over the past 60 years. Furthermore, since the late 1990s the statistical correlation between these two asset classes has become consistently negative, resulting in a generation of investors who have become accustomed to viewing U.S. government bonds not just as a safe asset in times of economic distress but as an asset class that can reliably reduce portfolio volatility in nearly all markets.

In this paper, we tackle the relationship between stocks and bonds along several fronts. First, we examine the historical track record, showing how the correlation between these asset classes has changed over time and describing their performance in distressed environments. Second, we estimate a formal econometric model that allows for both short- and long-run dynamics between stock and bond yields. Importantly, our model allows for the critical impact of valuation, which can materially affect the forward-looking relationship between the two asset classes. Last, we highlight several historical episodes in which bond and equity yields moved dramatically and connect them to the results of our econometric model.

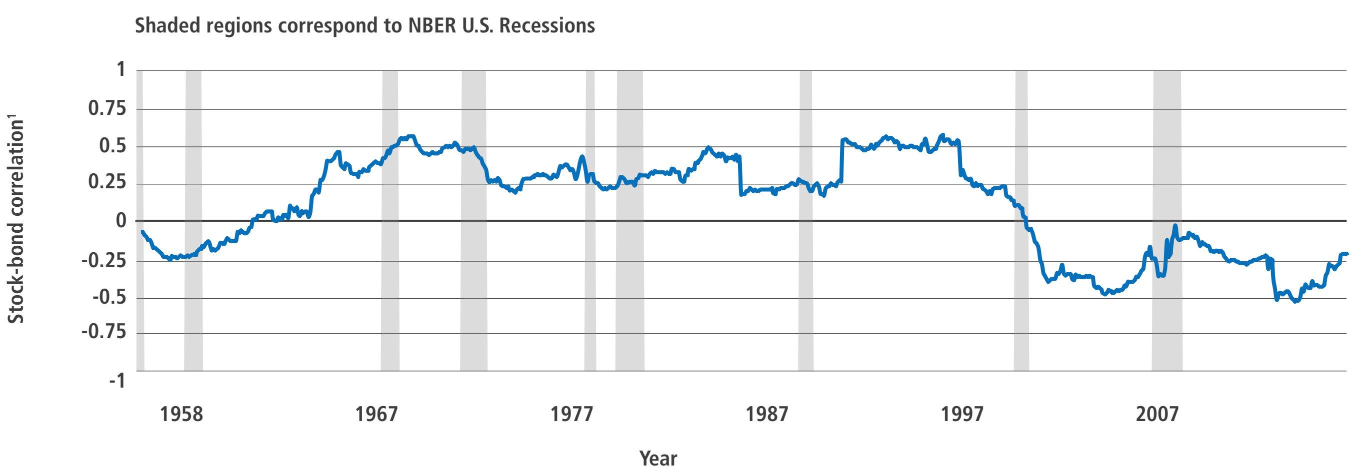
We find that while the correlation between stocks and bonds has changed over time, bonds have consistently performed in a countercyclical fashion, providing positive returns in all U.S. recessions since 1952. This was true whether the historical correlation between stocks and bonds was negative or positive at the time of the recession. Second, our results show that the relationship between stock and bond returns – whether they are positively or negatively related – depends largely on whether a shock emanates from the stock market or the bond market. Equity market shocks are associated with flight-to-quality (FTQ) effects and a negative relationship, whereas bond market shocks typically induce a positive stock-bond relationship, a finding consistent with Ilmanen (2003). We show that the relationship between these two asset classes depends critically on the level of market valuation. When markets are cheap or expensive, the effect of valuation can dominate the transitory impact of equity or bond market shocks. Therefore, investors who wish to form a forward-looking view on the stock-bond relation need to take current market valuation into account.

THE HISTORICAL RECORD

The statistical correlation between stock and bond returns changes over time. Exhibit 1 shows the historical five-year rolling correlation between U.S. equity returns and nominal bond returns from 1958 to 2017. Although today's investors have become accustomed to a negative correlation between stocks and bonds, the long history tells a different story: While the average correlation since 2000 has been -0.27, the full-sample historical average is 0.11. Furthermore, the correlation was positive in every five-year period from December 1964 through October 2001, averaging 0.33. As shown by National Bureau of Economic Research (NBER) recession highlights in Exhibit 1, the correlation does not appear to be related to periods of recession or overall economic distress. In fact, the average stock-bond correlation has been higher during recessions (+0.15) than during non-recessions (+0.10).

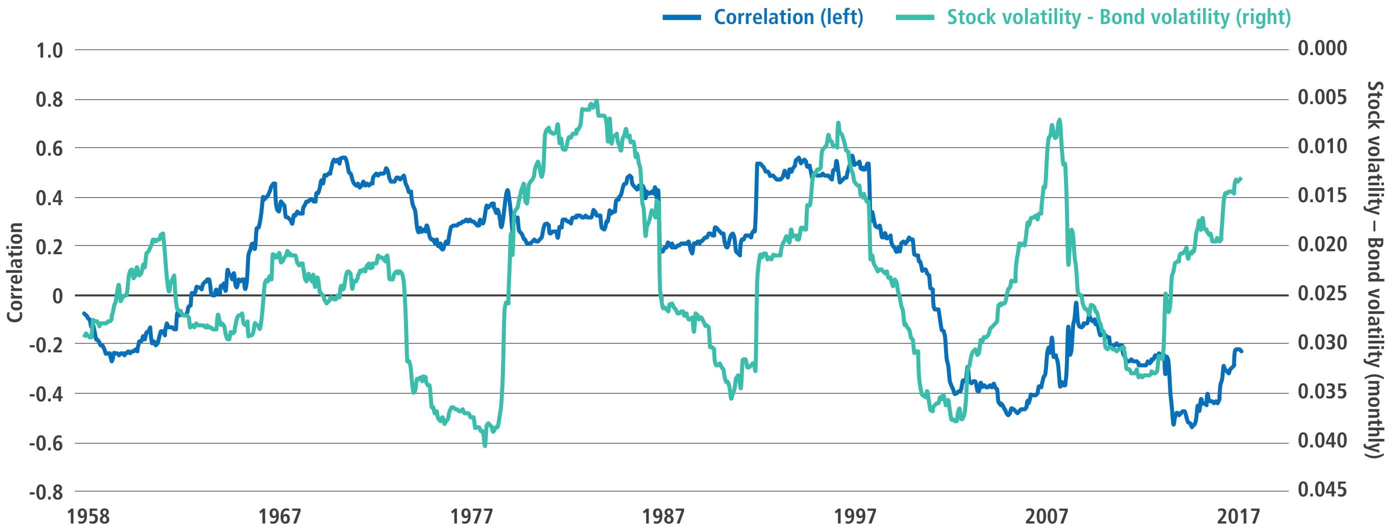
As described in Johnson et al. (2013) and shown in Exhibit 1, the stock-bond correlation shifted structurally in the late 1990s from positive to negative and has largely remained there. Asness (2000) shows that differences between equity volatility and bond volatility can explain stock yield levels relative to bond yield levels. We find an analogous relationship for the stock-bond correlation. Exhibit 2 shows the correlation (blue line, LHS) versus the difference between five-year realized stock and bond

Exhibit 1: Rolling 5-year correlation between equity and bond returns



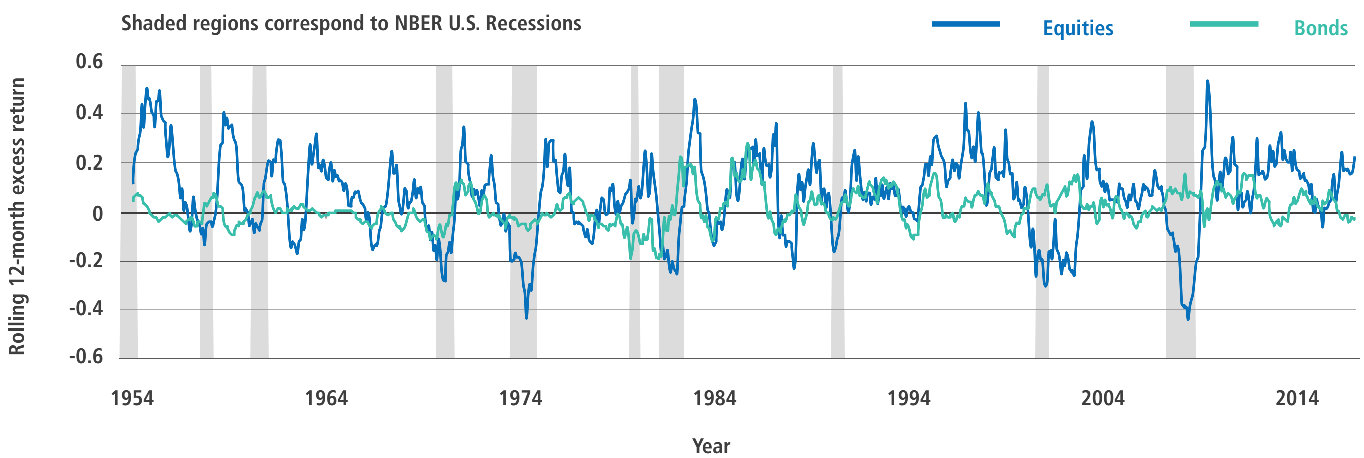
Sources: PIMCO, Bloomberg, FRED and ICE BofAML as of October 2017. Equity returns based on Bloomberg's SPX total return. Bond returns based on ICE BofAML 7-10 Year U.S. Treasury Index from 1976 to 2017. Missing bond returns are estimated from FRED's GS10 rates.

Exhibit 2: Stock-bond correlation versus equity-bond volatility



Sources: PIMCO, Bloomberg, FRED and ICE BofAML as of October 2017. Stock volatility and bond volatility are five-year realized volatilities of monthly returns.

Exhibit 3: Equity versus bond rolling 12-month excess performance



Sources: PIMCO, Bloomberg, FRED and ICE BofAML as of October 2017. Rolling returns are in excess of 3-month Treasury bills.

volatility (green line, RHS – inverted scale). Indeed, the dramatic fall in the correlation in the early 2000s coincided with a significant increase in equity volatility relative to bond volatility (a fall in the green line means that equity volatility is increasing relative to bond volatility). Conversely, the 1970s and 1980s were a period of relatively high bond volatility and a correspondingly positive correlation between stocks and bonds. Presumably, high equity volatility relative to rate volatility is indicative of an environment in which shocks to equity markets dominate shocks to the bond market, and vice versa. The results we derive from our econometric model in the next section are consistent with this anecdotal finding.

Although Exhibit 1 shows little to no relationship between the stock-bond correlation and recessions, U.S. government bonds have indeed historically acted in a countercyclical fashion, providing a reasonable hedge against equity risk in times of stress. This was true even in periods in which the correlation between equities and bonds was positive. Because correlations are measured over a long time window (five years in this case) they generally do not capture the shorter-term responses of equities and bonds to economic recessions and expansions. A better approach is simply to look at returns. Exhibit 3 shows the rolling 12-month excess returns for bonds and equities. Equities (blue) show a clear pattern of poor performance both heading into and during a recession. No such pattern is observed for bond returns.

Exhibit 4 shows detailed statistical data on excess equity and bond returns during recessions. Equities underperformed bonds considerably during the first half of recessions by an average 232 basis points (bps) per month; this difference is highly statistically significant, with a t-statistic of -3.82. During the second half of recessions, equities outperformed bonds by an average 90 bps a month, although the difference is not statistically significant (t = 1.01). Importantly, excess bond returns have been positive in both the first and second halves of recessions, generating Sharpe ratios of 0.34 and 1.03, respectively. Even during the turbulent, inflation-driven 1970s, bonds experienced positive nominal returns in each recession.[1] Hence, while equity returns are strongly related to the business cycle, U.S. government bonds have historically acted countercyclically, providing stable returns during recessions. This has been the case whether the stock-bond correlation was positive or negative. Last, the volatility profile of bonds has been significantly more stable during stress periods, showing a decline in realized volatility during the second half of recessions. Conversely, equity volatility has increased nearly 50% during the second half of recessions.

STOCKS, BONDS AND CAUSALITY

Although the correlation between stocks and bonds is an often-cited metric for investors wishing to understand the relationship between these asset classes, the correlation does not generally address the causal relationship between equity and bond yields, nor does it help assess magnitudes. A simple version of the Gordon dividend discount model can help motivate the discussion. The price of equity is given by

$$p = \frac{d}{r + ERP - g}, \tag{1}$$

where p is the price of an equity security, d is the dividend, r is the real interest rate, g is the real dividend growth rate, and ERP is the equity risk premium. It is then straightforward to show how equity prices covary with the real yield, the growth rate and the equity risk premium:

$$\frac{dp}{p} = -\frac{p}{d}(dr + dERP - dg). \tag{2}$$

Exhibit 4: Excess equity and bond performance during recessions

Recession	Mean (%/month)			Standard deviation (%/month)			T-stat			Sharpe ratio (annualized)		
	Equity	Bond	Equity-bond	Equity	Bond	Equity-bond	Equity	Bond	Equity-bond	Equity	Bond	Equity-bond
First half	-2.01	0.31	-2.32	4.39	2.97	4.54	-3.43	0.77	-3.82	-1.59	0.34	-1.77
Second half	1.60	0.70	0.90	6.37	2.25	6.59	1.86	2.32	1.01	0.87	1.03	0.47

Sources: PIMCO, Bloomberg, FRED and ICE BofAML. Based on monthly data from April 1953 to October 2017. Recessions correspond to NBER definition of business cycles. All returns shown are monthly in excess of the risk-free rate. Risk-free rate based on ICE BofAML three-month U.S. Treasury Index from 1978 to 2017. Missing returns are estimated from FRED GS3M rates.

In words, this formula says that the real duration of equity is the price-dividend ratio. Equity sensitivity to growth and the equity risk premium are also of the same order. In other words, all else equal, when the real yield moves up by 10 bps, with a price-dividend ratio of 40 (equivalent to a dividend yield of 2.5%), the expected equity return is -4%.

But evidently, all else is not equal. The dynamics between stock and bond returns are highly complex and growth, yields and premia are all correlated. For example, higher growth can lead to higher real rates as the demand for loanable funds increases. If the shock to growth turns out to be more positive than the shock in real rates, this should induce a stock market rally. If the shock in real yields prevails, an equity sell-off will ensue. Conversely, higher real rates can lead to lower real growth as the higher cost of capital starves demand for investment; this is unambiguously bad for equities. The equity valuation model is therefore fraught with feedback mechanisms that are hardly understood. How is one to make sense of such complexity?

In this section, we develop a more formal econometric model for examining the causal dynamics between stocks and bonds. Specifically, we calibrate a vector error correction model (VECM) (Granger and Engle 1987) on equity yields, real bond yields and inflation expectations. Our model is defined with the following three equations:

$$\Delta\left(\frac{E}{P}\right)_t = \phi_{11}\Delta\left(\frac{E}{P}\right)_{t-1} + \phi_{12}\Delta r_{t-1} + \phi_{13}\Delta\pi^e_{t-1} + \gamma_1\left[\left(\frac{E}{P}\right)_{t-1} - r_{t-1} - \hat{\mu}\right] + \varepsilon_{1,t}. \quad (3.1)$$

$$\Delta r_t = \phi_{21}\Delta\left(\frac{E}{P}\right)_{t-1} + \phi_{22}\Delta r_{t-1} + \phi_{23}\Delta\pi^e_{t-1} + \gamma_2\left[\left(\frac{E}{P}\right)_{t-1} - r_{t-1} - \hat{\mu}\right] + \varepsilon_{2,t}. \quad (3.2)$$

$$\Delta\pi^e_t = \phi_{31}\Delta\left(\frac{E}{P}\right)_{t-1} + \phi_{32}\Delta r_{t-1} + \phi_{33}\Delta\pi^e_{t-1} + \gamma_3\left[\left(\frac{E}{P}\right)_{t-1} - r_{t-1} - \hat{\mu}\right] + \varepsilon_{3,t}. \quad (3.3)$$

where E/P is the cyclically adjusted earnings yield, r is the 10-year real yield and π^e is expected long-term inflation.[2] Variables expressed as differences define the short-run relations, while the term $[(E/P_{t-1} - r_{t-1} - \hat{\mu}]$ dictates the long-run effects. The latter term is the "cointegration term" and is equal to the deviation of the equity risk premium *(ERP)* from its long-term mean, μ.[3,4] The intuition for our choice of the cointegration term is as follows: When the *ERP* is far from its average (i.e., stocks are "cheap" or "expensive"), it has a long-run impact on expected future changes in each variable. For example, if the cointegration term is positive (*ERP* is high), future changes in the earnings yield will likely be negative as stock prices slowly appreciate over time in response to favorable valuation. Similarly, if the *ERP* is low, this may have a negative influence on future real yields as investors sell equities and buy bonds.

Exhibit 5 shows the estimation results for Equations 3.1–3.3.[5] The coefficients on the *ERP* deviation (cointegration term) show that future changes in the earnings yield are negatively correlated to the current equity risk premium, a finding consistent with Campbell and Shiller (1998). In other words, when the *ERP* is low (high), the earnings yield tends to rise (fall) in the future. Although the effect is statistically significant ($p = 0.01$), the convergence is by no means "fast"; our estimate of γ_1 implies a half-life on the earnings yield of approximately 5.5 years, meaning that deviations in the *ERP* are not easily arbitraged. γ_2 shows that the future real yield is positively related to the *ERP*. Hence, when stocks are expensive (cheap), the real yield is expected to decline (rise) in the future, although the coefficient is not statistically significant ($p = 0.33$). Our estimates γ_1 and γ_2 are consistent with Exhibit 6, which shows the forward five-year changes in the earnings yield and real yield versus the starting *ERP*. For example, when the *ERP* is in the top quintile (5%–9%), the earnings yield falls by 1.31% and the real yield rises by 1.11% over the next five years. Conversely, when the *ERP* is in the bottom quintile, the equity yield rises and the real yield falls by 62 bps and 103 bps, respectively. As expected, we find no meaningful relationship between the *ERP* and future inflation expectations.

Exhibit 5: VECM parameter estimates

		Coefficient	p_value
Earnings yield equation	γ_1 (ERP deviation)	**-0.012**	**0.004**
	$\phi_{1.1}$ (Earnings yield)	**0.216**	**0.000**
	$\phi_{1.2}$ (Real yield)	**0.180**	**0.000**
	$\phi_{1.3}$ (Inflation)	**0.708**	**0.001**
Real yield equation	γ_2 (ERP deviation)	0.004	0.333
	$\phi_{2.1}$ (Earnings yield)	**-0.179**	**0.000**
	$\phi_{2.2}$ (Real yield)	**0.314**	**0.000**
	$\phi_{2.3}$ (Inflation)	**0.533**	**0.019**
Inflation equation	γ_3 (ERP deviation)	0.000	0.986
	$\phi_{3.1}$ (Earnings yield)	-0.004	0.373
	$\phi_{3.2}$ (Real yield)	0.009	0.059
	$\phi_{3.3}$ (Inflation)	**0.558**	**0.000**

Sources: PIMCO and Robert Shiller's website. Monthly data from April 1953 to October 2017

Exhibit 6: Future 5-year changes in cyclically adjusted E/P and real yield versus starting ERP

Starting ERP	CAEP change (%)	Real yield change (%)
-2% to -1%	0.62	-1.03
-1% to 2%	0.50	-0.38
2% to 3%	0.11	-0.11
3% to 5%	-1.07	-0.20
5% to 9%	-1.31	1.11

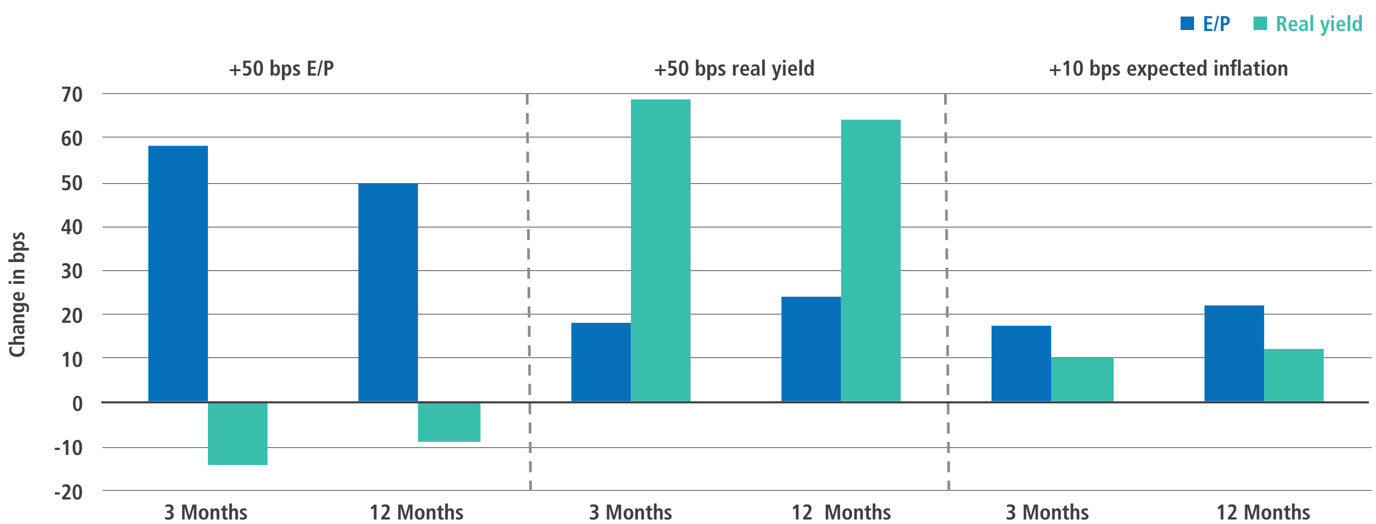
Sources: PIMCO and Robert Shiller's website. Monthly data from April 1953 to October 2017

Because all of the factors are interconnected in a VECM framework, it can be difficult to determine the effect of one variable on another simply by looking at the estimated coefficient. Therefore, to assess the impact of real yields on earnings yields, and vice versa, we shock a particular variable and then assess the responses of all variables over time. The *ERP* is set to its long-run mean of 3% at the beginning of each shock. Exhibit 7 shows the expected impact on the earnings yield and real bond yield when the initial shock occurs to the earnings yield, the real bond yield or expected inflation. We show results over both three-month and 12-month time periods.[6] The first panel shows the impact of a +50 bps shock to the earnings yield (an approximately 10% decline in equities). After three months, the earnings yield has increased by a total of 58 bps, while the real yield has fallen by 14 bps.[7] After 12 months, the changes are +49 bps and -9 bps, respectively. The second panel shows the effects of a +50 bps shock to the real yield (an approximately -4% return on a 10-year real government bond). After three months, the real yield has increased by 69 bps and the earnings yield has increased by 18 bps. After 12 months, these values are 64 bps and 24 bps, respectively. Last, the third panel shows the effect of an increase of 10 bps in long-term inflation expectations. The impact here is similar in sign to that of the real yield shock: After three months, the earnings yield increases by 18 bps, while the real yield increases by 10 bps. After 12 months, these values are about 22 bps and 12 bps, respectively. A key insight we can gather from these results is that the relationship between stock and bond yields changes based on the source of the shock; shocks to the equity market tend to be associated with a negative relationship, while shocks to the real bond yield and expected inflation are associated with a positive relation between stock and bond returns.

THE IMPACT OF VALUATION

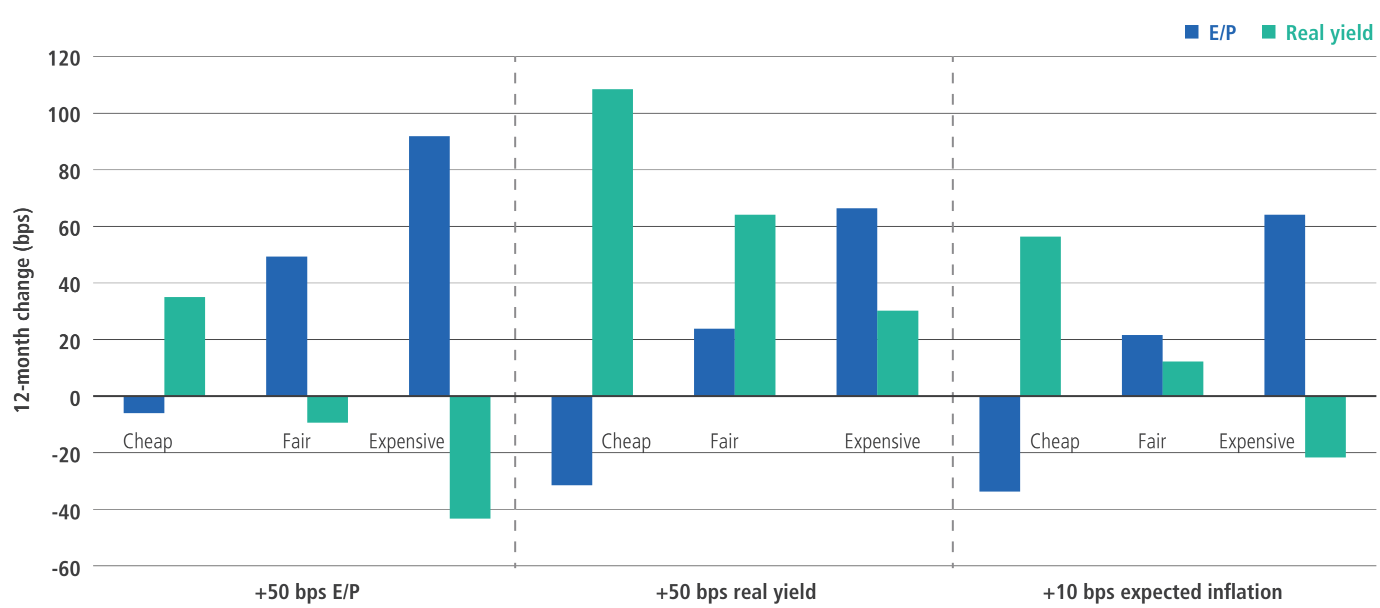
The results shown in the previous section were based on the assumption that the *ERP* is at its long-run equilibrium level. However, as shown in Exhibit 6, valuation has an impact on future equity and bond yield movements, acting as a gravitational force bringing equity and bond yields back to their equilibrium state over the long run. This effect is confirmed by the coefficients on the error correction term for the earnings yield and real yield in Exhibit 5. To test the extent to which equity market valuation matters, we shock the earnings yield, real yield and expected inflation by the same amounts as in the prior section, but we condition the shock on equities starting out cheap or expensive. We define cheap and expensive equity markets as markets in which the *ERP* is +7% and 0%, respectively. These values correspond to approximately the 95th and 5th percentiles of the historical *ERP* distribution. Examples of historical periods that correspond to our outlier values for the *ERP* would be the 2008 financial crisis (cheap) and the peak of the dot-com bubble in the late 1990s (expensive).[8] In Exhibit 8, we show the valuation-conditional impact on earnings yields and real yields based on shocks to each variable. The bars associated with "fair" correspond to the scenarios described in the previous section, in which the *ERP* is at its long-run value.

Exhibit 7: Expected earnings yield and real yield responses to shocks



Source: PIMCO. **Hypothetical example for illustrative purposes only.**

Exhibit 8: Earnings yield and real yield responses to shocks conditional on starting valuation, 12-month horizon



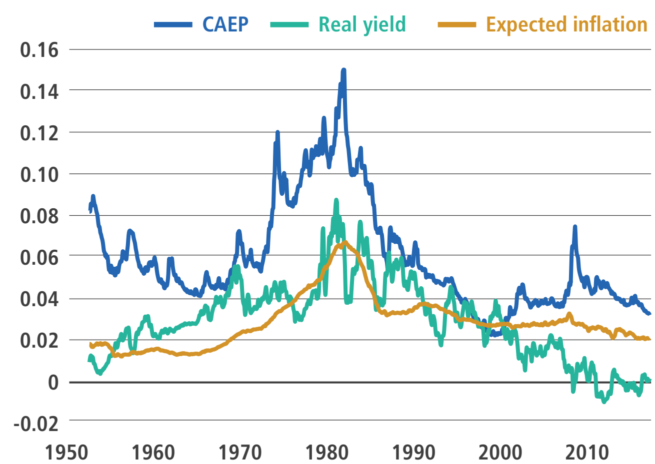
Source: PIMCO. **Hypothetical example for illustrative purposes only.**

Exhibit 8 shows that when markets are expensive the negative stock-bond relation is even more pronounced after a positive shock to the earnings yield (an FTQ episode). Effectively, when equity markets are frothy, stocks have further to fall (the earnings yield rises) and bonds have more room to rise (real yields fall). Negative equity market shocks simply exacerbate the long-term valuation forces already in place when markets are expensive. On the other hand, when markets are cheap valuation acts as a buffer, resulting in little relationship between equity and bond returns. In fact, in the cheap scenario the earnings yield is lower and real yield higher 12 months after a negative equity shock – the exact opposite impact from when markets are expensive. Though real yield shocks result in a positive relationship in both fair and expensive markets, the relationship is negative when markets are cheap, again reflecting the long-run force of valuation on the yields of both asset classes. Last, shocks to expected inflation result in a negative relationship in both cheap and expensive markets. Hence, over a 12-month period the effect of valuation dominates transitory shocks to earnings and real yields after a shock to inflation expectations. We conclude that, unlike in the fair scenarios, in which the causal relations matter a great deal, valuation effects dominate when markets are far from their equilibrium values.

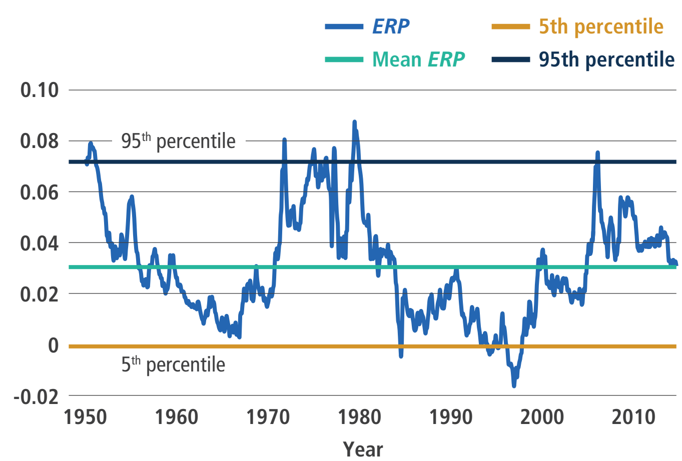
DISCUSSION

Exhibit 9 shows the historical cyclically adjusted earnings yield, real yield and *ERP*. The average *ERP* since 1953 has been 3.0% with an annualized standard deviation of 2.1%. We estimate the *ERP* today to be between 2.25% and 2.75%, or slightly expensive relative to the average.[9] As such, we would generally anticipate the ex-ante behavior of equity and bond yields to be roughly consistent with somewhere between a fair and expensive equity market, as described in the prior section. This would imply that FTQ shocks would be associated with a slightly more pronounced negative stock-bond relation and real yield and inflationary shocks resulting in a positive correlation. However, equities are more susceptible to negative bond market shocks (a rise in bond yields) when markets are expensive and, therefore, a rapid rise in real bond yields is a tangible risk that investors should be aware of. Of course, an inflationary surprise could lead to a significant structural shift to a positive stock-bond correlation. This would occur through two mechanisms: first, vis-à-vis the inflation surprise itself, which is likely to induce a positive correlation, and secondarily through the likelihood of Federal Reserve rate hikes. Finally, historically high global levels of household and government leverage could portend a simultaneous increase in bond yields and fall in corporate earnings, leading to a contemporaneous decline in equity and bond prices.

Exhibit 9: Cyclically adjusted earnings yield, real yield and ERP



Sources: PIMCO and Robert Shiller's website as of October 2017. **Hypothetical example for illustrative purposes only.**



Sources: PIMCO and Robert Shiller's website as of October 2017. **Hypothetical example for illustrative purposes only.**

Exhibit 9 can also shed light on the late 1990s structural shift in the stock-bond correlation. In the late 1990s, the equity risk premium was very low – about -1.6% in January 2000. As shown in the prior section, FTQ shocks result in a more negative relationship when the *ERP* is low. As such, the combination of a very expensive equity market, in conjunction with a significant equity shock resulting from the 2000 recession, may have been a key contributor to the structural shift in the stock-bond correlation during this period. Similarly, as shown in Exhibit 1, the correlation shifted upward in 2008–2009 (although it remained negative). This may have resulted in part from a significant increase in the *ERP* following the collapse of Lehman Brothers in September 2008.

To provide some historical context, Exhibit 10 shows starting and ending earnings yields and real yields over select periods, along with the start-of-period *ERP*. We characterize the market as expensive, cheap or fair depending on the starting value of the *ERP*. Our choice of the shock source is admittedly subjective, but we think it is useful for considering these periods within the context of the model results in the previous section.

The 1970s represent an interesting case study of the impact of a real yield shock. In both 1973 and 1978, bond yields increased as a result of supply-side disturbances to the oil market. However, the starting conditions in '73 and '78 were completely different: In February 1973, the *ERP* was 1.6%, compared with 7.6% in March 1978. Hence, the equity market was rich during the first oil embargo shock and favorably valued during the second. This resulted in different equity yield responses subsequent to the positive real yield shock, with the earnings yield increasing dramatically in 1973 but declining in 1978.

Conversely, the years 2000 and 2008 are good examples of flight-to-quality effects. In both periods, equities sold off dramatically in response to declining economic activity, resulting in increases in the earnings yield of 202 bps and 230 bps, respectively. However, markets were overvalued in 2000 and roughly fairly valued in 2008. This resulted in a much larger fall in the real yield in 2000 versus 2008, with declines of 213 bps and 67 bps, respectively. The anecdotal episodes highlighted in Exhibit 10 confirm to a large degree our findings from the VECM in the prior section.

Last, our model results show a statistically significant positive relationship between equity yields and expected inflation. This is, perhaps, unexpected. Equities are *real assets,* in the sense that equity cash flows should ultimately move proportionally with the rate of inflation. Exhibit 5, however, shows that $\phi_{1,3}$=0.71 (p = 0.001) and $\phi_{2,3}$=0.53 (p = 0.02), meaning that both the earnings yield and the real yield are, indeed, strongly sensitive to changes in expected inflation. The positive relationship with respect to the real yield may be a function of the bond market's expectation of tighter future monetary policy. For the aforementioned reasons, the positive coefficient on the earnings yield is less obvious. Furthermore, the fact that the inflation coefficient on the earnings yield is larger than that on the real yield means that the *ERP* increases in the presence of inflationary shocks. This result is consistent across time. Exhibit 11 shows the *ERP* versus trailing five-year inflation by decade. While particularly strong in the 1970s, we observe a positive correlation between the *ERP* and inflation across every decade since the 1950s.

Exhibit 10: Earnings yield and bond yield responses in selected historical periods

			Start				End				
Dates		Shock	E/P	r	*ERP*	Valuation	E/P	r	*ERP*	Valuation	Relation
02/28/73	09/30/74	Real yield	5.6%	4.0%	1.6%	Fair	11.5%	4.8%	6.8%	Cheap	Positive
03/31/78	12/31/80	Real yield	11.2%	3.6%	7.6%	Cheap	10.6%	7.0%	3.6%	Fair	Negative
10/31/82	06/30/84	Real yield	12.5%	4.2%	8.4%	Cheap	11.1%	7.7%	3.4%	Fair	Negative
09/30/87	12/31/87	FTQ	5.7%	6.1%	-0.5%	Expensive	7.5%	5.7%	1.8%	Fair	Negative
03/31/00	12/31/02	FTQ	2.3%	3.5%	-1.1%	Expensive	4.3%	1.3%	3.0%	Fair	Negative
07/31/08	02/28/09	FTQ	4.8%	0.7%	4.1%	Fair	7.1%	0.0%	7.1%	Cheap	Negative
03/31/09	12/31/09	FTR	7.5%	0.0%	7.5%	Cheap	4.9%	0.8%	4.1%	Fair	Negative
12/31/12	12/31/13	Real yield	4.7%	-0.7%	5.4%	Cheap	4.0%	0.4%	3.7%	Fair	Negative

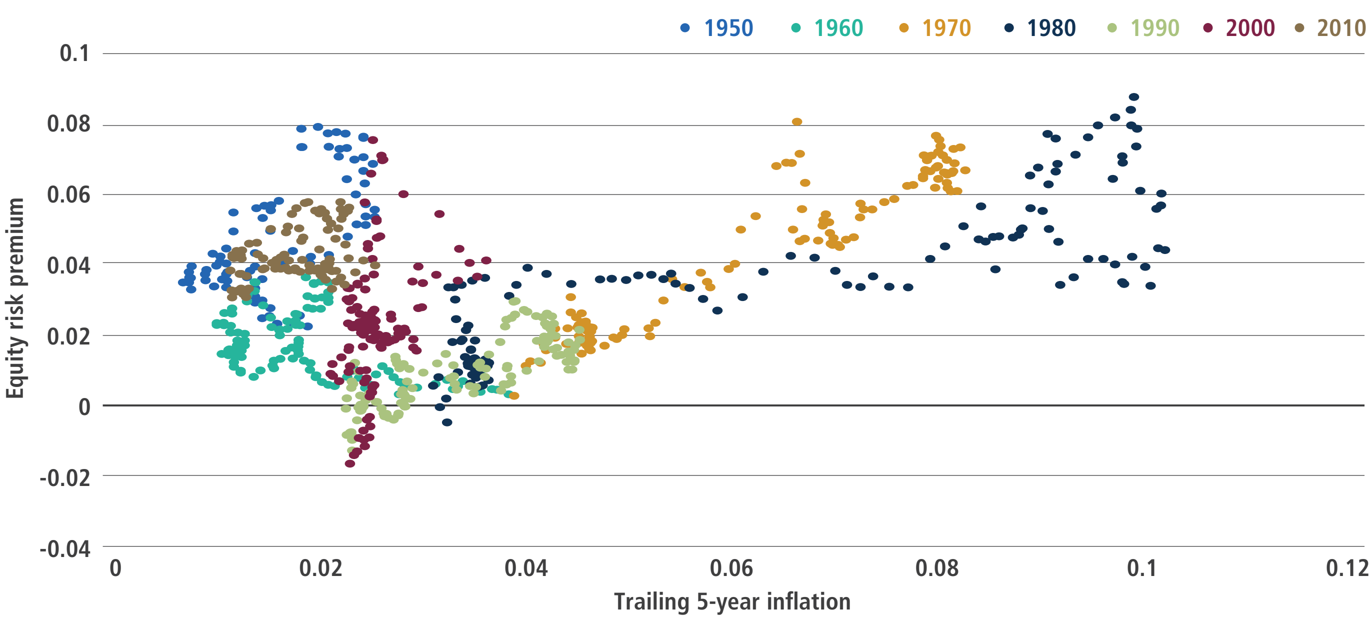
Sources: PIMCO and Robert Shiller's website. **Hypothetical example for illustrative purposes only.** A fair market is defined as one in which the *ERP* is +/- 1.5% from the historical mean of 3.0%. FTR refers to flight-to-risk.

Several theories have been put forth as to why such a strong empirical negative relation between equity returns and inflation exists. One prominent thesis is the notion of "inflation illusion," in which investors mistakenly apply nominal discount rates to real (equity) cash flows (Modigliani and Cohn 1979, Ritter and Warr 2002). One needs to look only as far as the well-known "Fed model," which compares stock yields with nominal (as opposed to real) bond yields, for evidence of the prevalence of this behavioral error (Asness 2003).[10] Additionally, recent empirical research supports the notion that investors make systematic pricing errors consistent with the inflation illusion hypothesis (Cohen, Polk and Vuolteenaho 2005).We interpret the econometric results in Exhibit 5 as part rational, part behavioral, with the coefficient on the real yield reflecting a rational market response to tighter monetary conditions and the coefficient on the earnings yield more reflective of the inflation illusion phenomenon. Additionally, Exhibit 8 lends some credence to this behavioral hypothesis: Valuation effects dominate positive shocks to inflation expectations at the 12-month horizon, meaning that potentially irrational transitory shocks to the earnings yield from an inflationary spike may be reversed in fairly short order.

CONCLUSION

The correlation between the returns of government bonds and equities is one of the most important metrics in asset allocation. To the extent that the experience of the past generation holds true in the future, government bonds may not simply act as a flight-to-safety asset class but also may provide investors with reduced overall portfolio volatility, particularly for equity beta-heavy portfolios. We have shown, however, that this critical relationship depends on whether shocks occur in the equity or bond market. When shocks emanate from the equity market, the correlation is typically negative, but shocks to the bond market correspond to a positive relationship between stock and bond returns. Additionally, valuation matters: When the equity risk premium is far from its long-run average, valuation is the main effect and can dominate any transitory shocks to bond yields or earnings yields. Hence, investors must consider current valuation in assessing their forward-looking view of the stock-bond correlation. We have provided examples of historical periods that coincided with large moves in equity and bond yields. We found that many of these historical episodes produced movements in yields consistent with the predictions from our model.

Exhibit 11: Equity risk premium versus inflation, by decade



Sources: PIMCO and Robert Shiller's website. Monthly data from April 1953 to October 2017

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TECHNICAL APPENDIX

Gordon growth model and a negative stock-bond relation

The standard model of Gordon (1959) is

$$p = \frac{d}{r+ERP-g}, \tag{A1}$$

where p is the price of an equity security, d is the dividend, r is the real interest rate, g is the real dividend growth rate and *ERP* is the equity risk premium. Letting γ represent the payout ratio of earnings, e, and rearranging yields

$$\frac{e}{p} = \frac{r+ERP-g}{\gamma}. \tag{A2}$$

Letting the *ERP* and g be a function of r and differentiating with respect to the earnings yield, real yield and equity risk premium, we have

$$\frac{d\left({}^{e}/_{p}\right)}{d(r)} = \frac{1}{\gamma}\left(1 + \frac{\partial ERP}{\partial r} - \frac{\partial g}{\partial r}\right). \tag{A3}$$

Equation A3 shows that a negative relationship between the earnings yield and real yield can be obtained if $(\partial ERP/\partial r - \partial g/\partial r) < -1$. In other words, if the equity risk premium is strongly negatively related to the real rate of interest, or if the growth rate is strongly positively correlated to the real interest rate, one can obtain flight-to-quality effects under the Gordon model. Typically, one would assume $\partial g/\partial r \approx 1$, implying that the real interest rate and *ERP* only need to be moderately negatively correlated to induce a negative stock-bond relation. Without the assumption of a negative relationship between the *ERP* and r, the Gordon model predicts a positive relationship between the earnings yield and the real rate of interest.

Derivation of the equity risk premium

Solving A2 for *ERP* yields

$$ERP = \gamma\frac{e}{p} + g - r. \tag{A4}$$

Letting $g = (1-\gamma)\frac{e}{p}$ yields

$$ERP = \frac{e}{p} - r. \tag{A5}$$

In other words, when the dividend growth rate is proportional to one minus the payout ratio, the equity risk premium is equal to the difference between the earnings yield and the real yield.

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[1] We estimate total nominal bond returns to have been 13.4%, 2.3% and 18%, respectively, in the 1970, 1974–1975 and 1980 recessions.

[2] To compute inflation expectations, we regress realized future five-year inflation on past five-year inflation and use the predicted values from the regression as a proxy for inflation expectations. A similar methodology was used in Arnott and Bernstein (2002). The real yield is equal to the difference between the 10-year nominal bond yield and our estimate of inflation expectations.

[3] E/P-r is equal to the equity risk premium under the assumption that the dividend growth rate is proportional to the earnings retention rate. We show the proof of this in the Technical Appendix.

[4] E/P, r and π^e are confirmed to be nonstationary. P-values from an augmented Dickey-Fuller test are 0.42, 0.31 and 0.13, respectively, for the earnings yield, real yield and expected inflation. However, the first difference of each variable is stationary with p-values 0.00, 0.00 and 0.03. The equity risk premium is stationary with p-value 0.02.

[5] The adjusted R-squared for the earnings yield, real yield and expected inflation equations are 0.13, 0.11 and 0.31, respectively.

[6] Initial shocks are based on two-standard deviation monthly changes. These values are 0.50%, 0.50% and 0.10%, respectively, for the earnings yield, real yield and expected inflation.

[7] In the Technical Appendix, we show how one can obtain a negative relationship between the earnings yield and real yield under the model of Gordon (1959).

[8] We estimate the equity risk premium to have been -1.3% and +7.1% in December 1999 and February 2009, respectively.

[9] As of 28 February 2018, the cyclically adjusted earnings yield was about 3% using average trailing earnings and 3.5% using median trailing earnings. The 10-year real rate was 0.75%, implying an *ERP* between 2.25% and 2.75%.

[10] Despite its name, the Fed model is not officially endorsed by the Federal Reserve.

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