Term and Stochasticity Risk Premia*

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Abstract

We compute the duration of stock indices in Eurozone, UK, and Japan using dividend futures. This enables us to decompose index excess returns into term, and stochasticity risk premia. The term risk premium is an expected excess return on a government bond which has its duration equal to the duration of the equity and compensates for risks related to shifting *fixed* amount of money in time. The stochasticity risk premium then compensates for the *randomness* in the size of the dividend, once the timing effect has been controlled for. The stochasticity risk premium is negative, highly volatile and is more predictable by dividend-price ratio than standard equity risk premium. This poses a major challenge to the current asset pricing theory. We also analyse the implications for time and risk preferences in the Bansal and Yaron [2004] model.

Extended Abstract

Present financial literature offers little guidance on how to compute excess returns. As discussed by Welch [2000]:

> ... the most common method to compute the equity premium — subtracting a short-term bond return from a long-term equity return — is neither parsimonious nor necessarily a fair investment holding-period comparison.

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We propose to benchmark equity returns to returns on a zero-coupon government bond with its maturity matched to the equity duration. This is a natural framework as it separates the compensation for risks related to shifting consumption in time from the compensation for risks an agent is exposed to when shifting consumption across states.

We use dividend futures on Euro Stoxx 50, Nikkei 225 and FTSE 100 to estimate the duration of a respective stock index in a novel way. We use the equity duration to decompose the equity expected excess return into two components: term and stochasticity risk premia. The term risk premium is an expected return on a long-term bond in excess of a short-term note. The long-term bond is chosen such that its duration is equal to the duration of the equity. This premium compensates for risks related to shifting fixed amount of money in time. The stochasticity risk premium then compensates for the stochasticity of equity payoff, once the timing effect has been controlled for. Thus, the stochasticity risk premium differs from the equity risk premium in that it does not contain the compensation for deferred consumption, it makes up for the stochasticity of the equity payoff only.

We find that the equity index duration is around 15 years. The duration is also remarkably stable over time. The maximum standard deviation is just around 3 months. These market-based results are close the regression-based estimates of Weber [2016] who finds an average duration of 19 years. This is slightly more than what we find in our sample that is based on different countries and that is shorter due to data-availability.

The stochasticity risk premium estimates are mostly negative: using monthly returns all estimates are negative and two out of three estimates are negative on yearly overlapping returns. To make sure the results are not driven by the financial crisis of 2008, we split the sample in half and drop the part containing the crisis. The negative stochasticity risk premium persists.

The negative stochasticity risk premium arises due to very good performance of long-term bonds in the sample. The good performance of bonds is *not* unique to the era of low interest rates and quantitative easing that coincides with the the majority of our sample. We find the negative stochasticity premium also in the 2000 till 2006 subsample.[1] The UK data which start in 1986 reveal positive stochasticity risk premium for the period preceeding 2000. Thus, the stochasticity risk premium has flipped the sign, but this change does not stem from the non-conventional monetary policies taken in response to the 2008 crisis. On the whole sample, the stochasticity risk premium estimate is negative. These results, however, depend on the assumption that the duration estimated on post-2007 data applies also to the early part of the sample.

The sign of the stochasticity risk premium reveals that risk premia on very long run dividends are negative. This is a valuable contribution especially due to the lack of long-maturity assets that would enable direct estimation of long-maturity dividend risk premia. van Binsbergen and Koijen [2015] decompose return on an equity index index into returns on a portfolio of dividend futures and bonds. The dividend futures give the buyer a claim on

[1] A related observation has been presented by Voss [2011] in the Financial Times: "... over the 130 years of equity risk premium data it [US equity return in excess of a yield on 10Y bond] has been negative roughly 25 per cent of the time. And since September 1965 "the equity risk premium was negative for 75 per cent of the time until December 2007."

dividend paid out by the underlying during a given year in the future. In return, the buyer agrees today to pay a fixed fee at the maturity. The fee is set that the expected dividend payment is discounted at a maturity-specific risk-premium that reflects the dividend risk at that maturity [van Binsbergen, Hueskes, Koijen, and Vrugt, 2013, see for details]. Our stochasticity risk premium is effectively an approximation of an expected return on the dividend futures portfolio. From this, we can derive implications for the term structure of the equity risk premium. The term structure starts at zero for very short-term maturities [Golez, 2014], then it increases sharply and peaks at the maturity of around 5 years. From that point it is downward-sloping [van Binsbergen, Brandt, and Koijen, 2012, van Binsbergen, Hueskes, Koijen, and Vrugt, 2013, van Binsbergen and Koijen, 2015, Weber, 2016]. These results imply that returns on the short-maturity elements of the dividend portfolio are positive. To make the whole sum negative, the long-maturity terms that follow must be negative, i.e., the long-term dividend risk premia are negative. This adds to Giglio, Maggiori, and Stroebel [2015] who find very low, but positive discount rates in the real-estate data. The discount rate is a sum of the long-term yield and additional risk premium that discounts for the cash flow uncertainty. Thus, under no market segmentation, our results imply a bound on long-run yields with the opposite sign than the dividend risk premium.

The negative stochasticity risk premium is difficult to reconcile with the most basic finance intuition of the risk-return relationship: exposure to risk commands a positive risk premium. A negative risk premium is only admissible if stocks are hedges for other risks the portfolio held by an investor is exposed to [Lintner, 1965]. This would be a case in a neoclassical model with constant real discount rates and perfectly rational agents. In this model stocks are real assets: they hedge against the inflation, rationalising the negative stochasticity risk premium. However, stocks are not good inflation hedges for the short investment horizons which we consider [Katz, Lustig, and Nielsen, 2016].

An alternative explanation is provided by Lettau and Wachter [2007]. In their model, dividend growth and expected dividend growth are negatively correlated. Consequently, equities are dividend growth hedges. Since the expected dividend growth becomes more important for the price of the dividend strip as the maturity increases, this effect is more pronounced for equities with longer duration. However, Lettau and Wachter [2007] use duration to explain the value premium, providing a link from the term-structure properties to cross-sectional pricing, but Weber [2016] finds that duration factor is different from value.

Next, the duration-matched excess returns[2] are highly volatile. The high volatility of duration-matched excess returns arises due to the negative correlation of stocks and long-term bonds. This in contrast to the intuition of Campbell and Ammer [1993] that long-term assets should co-move in the same direction. However, this feature has been well documented by Baele, Bekaert, and Inghelbrecht [2010], Campbell, Sunderam, and Viceira

[2] We refer to returns in excess of a bond, which was chosen based on equity duration, as 'duration-matched'. The time-series average of the duration-matched returns is the estimate of the unconditional stochasticity risk premium.

[2013], Campbell, Pflueger, and Viceira [2015]. Theoretically was the negative correlation captured in the regime-switching model with learning of David and Veronesi [2013].

The duration-matched returns and their volatility are determined by performance of the equity and bond returns, and their correlation. The understanding of drivers common to stocks and bonds is therefore necessary. This literature dates back at least to Fama and French [1993]. Recent advances are Cejnek and Randl [2016], Koijen, Lustig, and Van Nieuwerburgh [2010], Brooks and Moskowitz [2017]. Koijen, Moskowitz, Pedersen, and Vrugt [2013] develop a framework connecting multiple asset classes.

We use the duration-based decomposition to predict duration-matched excess returns and long-term bond excess returns separately. This enables us to use a potentially different set of predictors for each of the components of the excess returns. To our best knowledge, we are the first to use the two excess return components in a regression analysis.[3] Economically, there is no reason why the realisations of the stochasticity risk premium should respond to the same sources of risk as the term premium. Our procedure enables us to identify coefficients with respect to each of the excess return components, whereas the current approach to excess returns allows to identify only the sum of coefficients. Indeed, we find that long-term bond excess returns are driven by different variables than duration-matched excess returns. We illustrate our finding on the example of Nikkei 225: the duration-matched excess return is predicted by the log-dividend-price ratio and the Cochrane and Piazzesi bond factor, the corresponding bond excess return is predicted by the Cochrane and Piazzesi bond factor only. Running regression of standard equity excess returns on the log-dividend-price ratio and the Cochrane and Piazzesi bond factor, we cannot reject the null of no predictability.[4] Thus, the duration-based decomposition enables us to show that term and stochasticity risk premium are driven by different economic variables, and that this predictability cannot be detected using standard equity excess returns.

Our contribution is threefold. First, we compute the equity duration using market data. Second, we argue that one can approximate return on the portfolio of dividend futures by *duration-matched* return of a stock index, that is, by the return of the stock index in excess of a bond that has the same duration as the stock index itself. We show that average duration-matched excess returns are negative and their volatility is high. We point towards the sources of these: the good performance of long-term bonds and the negative correlation of these bonds with equities. Also, duration-matched excess returns are predictable by different economic variables than corresponding bond excess returns. This predictability cannot be detected using standard equity excess returns. Third, we aim to link term and stochasticity risk premia to parameters of risk aversion and elasticity of intertemporal substitution. Intuitively, stochasticity risk premium should depend only

[3]The present literature focuses entirely on the choice of predictor where the dividend-price ratio is the most popular choice [Fama and French, 1988, Campbell and Thompson, 2007, Lettau and Wachter, 2007, Cochrane, 2008, van Binsbergen and Koijen, 2010] However, none of these papers analyses individual components of the excess returns.

[4]This result is based purely on regression analysis. In light of Cochrane [2008], more tests are necessary to show no return predictability.

on the parameter of risk aversion. The term risk premium can depend on both parameters. Model-implied term and stochasticity risk premia can then be compared to empirical quantities and used for testing models. For example, models would need to match substantial volatility of stochasticity risk premium which is in our data even higher than that of equity risk premium.

The closest papers are Weber [2016] and van Binsbergen and Koijen [2015]. The former paper differs from ours in that it focuses on the cross section rather than the time series of returns. Our papers share the use of duration. However, our focus on time series enables us to use market data to compute the duration. From the latter paper, we make use of the decomposition of an equity return into a portfolios of dividend futures and bonds. What we add is the approximation of the bond portfolio using a duration-matched bond and the result for the long-run discount rates. On top of both papers, we add the predictability analysis and the interpretation of the separation of time and risk effects. The idea of term and stochasticity risk premium goes back to Campbell [1986], Jermann [1994, 1998], Abel [1999]. However, we are the first to estimate it without a formal model.

This research leaves further questions for the future. The first one is how features of cash flow timing beyond duration affect pricing. In the current research, I match equity with bonds based on duration, but what is the effect of other timing aspects such as convexity? The second question regards equities and corporate bonds. Equity is a claim on a stochastic stream of cash flows, corporate bond has known payments, and both are exposed to the same source of risk. If equity could be matched with a corporate bond of the same duration, then the key difference between these claims should be variation of cash flows. Hence, the difference in returns on equity and corporate bond proxies for the reward for variation of cash flows.[5] This would give a direct measure of a portion of risk premium that investors require for being exposed to dividend growth variation.

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[5] One needs to control for effects that are not common to stocks and corporate bonds, especially liquidity.

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