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Market states and the risk-return tradeoff

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ABSTRACT

We re-examine the risk-return tradeoff in the U.S. equity market by allowing for time variation in the tradeoff and estimating conditional variance by the new mixed data sampling method. The main finding is that the risk-return tradeoff is strongly time-varying with the state of the market and the average of the time-varying tradeoff estimates is 1.43. The lagged market return is found to be the best indicator of market states. The empirical finding holds true for a battery of robustness checks during the post-Compustat sample period. The evidence from the international markets is similar to the U.S. one.

1. Introduction

There is mounting evidence that the market risk premium (defined as expected excess stock market returns) is time-varying. There is also convincing evidence that risk (measured by stock market volatility) changes over time. However, the nature of the risk-return tradeoff and the factors that drive the dynamics of the risk premium are more controversial. Because estimates of the market risk premium are frequently required for the solution of many investment and corporate finance problems, further research on time variation (or lack thereof) in the risk-return relationship is warranted.

In his influential study, Merton (1980) postulates a positive risk-return tradeoff:

$$E_t R_{t+1} = \gamma_{t+1} E_t \sigma^2_{M,t+1}, \quad (1)$$

where the conditional excess stock market return, $E_t(R_{t+1})$, is determined by its conditional variance, $E_t\sigma^2_{M,t+1}$ (which we later denote by σ_t^2 for ease of presentation), and $\gamma_{t+1} > 0$ measures the risk-return tradeoff. However, the empirical evidence of the risk-return tradeoff is ambiguous. Many studies, e.g., Brandt and Kang (2004), Campbell (1987), Glosten, Jagannathan, and Runkle (1993), Lettau and Ludvigson (2010), and Whitelaw (1994), document an insignificant or even negative (unconditional) risk-return tradeoff. In contrast, French, Schwert, and Stambaugh (1987), Ghysels, Santa-Clara, and Valkanov (2005), Harvey (1989), and Lundblad (2007) find a positive tradeoff between risk and return.

In this paper, we contribute to the literature by reexamining the issue in a simple linear framework that explicitly allows for time variation in risk aversion. Most of the recent empirical studies can be grouped into three categories. The first strand of literature considers the relationship between *expected* returns and *expected* volatility (or variance) which is literally stipulated by intertemporal CAPM (ICAPM). A partial list of this group includes Jiang and Lee (2009, 2014), Ludvigson and Ng (2007), and Pástor, Sinha, and Swaminathan (2008). The second line of research discovers a constant and significantly positive risk-return relation by including in Eq. (1) a second factor (hedge component). The contributions include Guo and Whitelaw (2006), Guo, Savickas, Wang, and Yang (2009), Rossi and Timmermann (2015), and Scruggs (1998). The third strand of the literature focuses on time variation in risk-return tradeoff, γ_t. The present paper falls in this category.

The state-dependent preferences (risk aversion) have a long history and have received increasing attention in financial economics (Gordon and St-Amour, 2000). However, relatively little is known about how the risk-return tradeoff varies empirically over the business cycle or with key macroeconomic indicators. For example, Harrison and Zhang (1999) report a strong nonlinear risk-return tradeoff. Nevertheless, constrained by the semi-nonparametric model form, the source of the time variation in the risk-return tradeoff is not explicitly explored. In Brandt and Kang's (2004)

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latent vector autoregression model, the cyclical properties of the risk-return tradeoff can only be indirectly studied from the (fitted) conditional mean and conditional volatility. Both Mayfield (2004) and Salvador, Floros, & Arago (2014) estimate regime-switching models and also find that the tradeoff varies with the market state, where the market state is represented by the high and low volatility regimes which must be estimated from the model. The link between time-varying risk aversion and underlying economic and financial conditions is again indirect. Finally, the loss aversion hypothesis proposed by Barberis, Huang, & Santos (2001) also predicts a time-varying risk-return tradeoff since how loss averse the investor is depends on his prior investment performance.[1]

Distinguishing from these studies, our paper focuses on empirical aspect of time variation in risk aversion itself without taking a stand on the nature of the underlying source of the variation. Briefly, we model the risk-return tradeoff γ_{t+1} as a simple linear function of the market state, $\gamma_{t+1} = \gamma_0 + \gamma_1{}^* Z_t$, where Z_t is a proxy for the market state.

Our second contribution is to use the relatively new mixed data sampling (MIDAS) method to estimate conditional market variance. It is well known that identifying the risk-return tradeoff critically depends on the estimates of conditional market variance. Following Baele, Bekaert, and Inghelbrecht (2010), Ghysels et al. (2005), Yu and Yuan (2011), and Salvador et al. (2014), we estimate conditional variance mainly using the MIDAS method (more on this in the next section).

Our third contribution is to provide two types of robustness checks on the basic findings, which are not done in this line of research. First, we conduct out-of-sample forecast comparison between the model allowing for time variation in the risk-return tradeoff and other popular models with a constant tradeoff. Second, we examine the performance of our model in the international markets.

Within the above simple and tractable linear framework, we are able to find that there is a significant risk-return tradeoff and the tradeoff varies with the state of the market. In particular, among a wide range of financial and macroeconomic variables, the one-month lagged market return appears to be the best real time indicator of market states at the monthly frequency, followed by the wealth-consumption ratio of Lettau and Ludvigson (2001). Based on our benchmark model estimated using the post-Compustat sample, a one-standard-deviation increase in the current month market return is expected to increase the risk-return tradeoff by 1.00 in the next month, whereas the average value of the time-varying estimates of the tradeoff (mostly positive) is 1.43 during the sample period. The 25th and 75th percentiles of the time-varying tradeoff estimates are 0.85 and 2.10, respectively. Furthermore, the time-varying tradeoff remains significant after we control for a wide range of commonly used economic and financial variables (including lagged returns) which have predictive power for stock returns. This last result implies that the two-factor ICAPM with constant risk aversion may be insufficient to model the relationship between risk and returns.

The basic finding that the risk-return relationship is not constant but changes across market states does not depend on the use of the MIDAS estimator. It remains true for other popular conditional variance estimators including the rolling window estimator and the GARCH estimator. By contrast, the use of these competing estimators often yields different conclusions about the risk-return tradeoff in previous studies. The results from other robustness checks also show that the model allowing for time variation in the risk-return tradeoff outperforms the model with a constant tradeoff in the out-of-sample forecast comparison. The evidence of time-varying tradeoff is even stronger in the world market as well as in aggregate markets such as the world market excluding the U.S., developed economies, and developed economies excluding the U.S. Nevertheless, evidence from other individual G7 countries is weaker although it is qualitatively similar to our basic results.

It is worth noting that (lagged) market return has been used in the literature on the risk-return relationship although for different purposes. For example, both Lettau and Ludvigson (2010) and Theodossiou and Savva (2016) include the lagged return as a control variable in estimating the relationship between risk and returns. In modeling upside uncertainty and downside risk, Feunou, Jahan-Parvar, and Tedongap (2012) use market return as the market state indicator for their bi-normal GARCH model. Pettengill, Sundaram, and Mathur (1995) adopt a similar strategy when examining beta and return relationship using cross-sectional regressions. None of these studies has considered market return as an indicator for time variation in risk aversion.

The remainder of the paper is organized as follows. We describe the data and research methodology in Sections 2 and 3, respectively. The empirical results for the U.S. market are presented in Section 4 while those for the international markets are given in Section 5. Section 6 provides a summary of the major findings.

2. Research methodology

In this section, we first introduce the specifications of the theoretical Model (1) given earlier to estimate the risk-return tradeoff. We then briefly describe the four methods used to estimate the conditional variance, namely, the one- and three-month rolling window realized variance estimators, the mixed data sampling (MIDAS) estimator, and the generalized autoregressive conditional heteroskedasticity (GARCH) regressions method.

2.1. Mean equation with constant- and time-varying risk-return tradeoff

We start with the following market return model with a constant risk-return tradeoff ($\gamma_{t+1} = \gamma$):

$$R_{t+1} = \mu + \gamma * \sigma_t^2 + \varepsilon_{t+1}, \quad (2)$$

where, μ is a constant, and as before, σ_t^2 is the conditional variance of monthly excess market returns using information up to time t, which will be specified shortly.

To determine time variation in the risk-return tradeoff, we estimate the following more general model:

$$R_{t+1} = \mu + (\gamma_0 + \gamma_1 * Z_t) * \sigma_t^2 + \varepsilon_{t+1}, \quad (3)$$

where the tradeoff measure γ_{t+1} is assumed to be a linear function of state variable Z_t, $\gamma_{t+1} = \gamma_0 + \gamma_1 * Z_t$.[2] Model (3) can also be understood as a variant of the conditional CAPM with one factor (σ_t^2). In the benchmark analysis we consider the lagged market return R_t as the state variable. For the purpose of comparison, we also consider nine other economic and financial variables as candidates of Z_t (to be defined in the next section).

From the statistical viewpoint, γ_{t+1} may be varying with R_t simply because we fail to include all variables which have predictive power for stock returns. This could happen when R_t and the conditioning variables are closely correlated. To address this issue, we extend Eq. (3) to include a linear term of X_t:

$$R_{t+1} = \mu + (\gamma_0 + \gamma_1 * Z_t) * \sigma_t^2 + \lambda X_t + \varepsilon_{t+1}, \quad (4)$$

[1] Recent contributions from behavioral finance include Zheng (2015), Aissia (2016), and Liston (2016).

[2] Others, e.g., Brandt and Wang (2010), also use the same linear approximation.

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