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Horizon effect in the term structure of long-run risk-return trade-offs

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ABSTRACT

The horizon effect in the long-run predictive relationship between market excess return and historical market variance is investigated. To this end, the asymptotic multivariate distribution of the term structure of risk-return trade-offs is derived, accounting for short- and long-memory in the market variance dynamics. A rescaled Wald statistic is used to test whether the term structure of risk-return trade-offs is flat, that is, the risk-return slope coefficients are equal across horizons. When the regression model includes an intercept, the premise of a flat term structure of risk-return relationships is rejected. In contrast, there is no significant statistical evidence against the equality of slope coefficients from constrained risk-return regressions estimated at different horizons. A smoothed cross-horizon estimate is then proposed for the trade-off intensity at the market level. The findings underscore the importance of economically motivated restrictions to improve the estimation of intertemporal asset pricing models.

1. Introduction

For decades now, several studies have proposed models to forecast stock market returns based on empirical evidence and theoretical arguments. In practice, many investors track the time variation in asset returns to try to take advantage of predictability patterns and mispricings. Fama and French (1988) report early evidence of stock returns predictability induced by dividend yields over various time horizons. Since then, many variables including macroeconomic indicators, financial ratios and risk factors have widened the set of predictors that can explain a substantial part of the time variation in stock returns. See for example Merton (1980), Campbell and Shiller (1988), Boudoukh et al. (2008).

In the return predictability framework, several models relate excess returns to risk measures. These models can be estimated at different horizons to yield a term structure of risk-return trade-offs. Variance measures emerge as good predictors of excess returns, delivering their full predictive power in the long-run as documented by Campbell and Viceira (2005), Bandi and Perron (hereafter BP) (2008), Bollerslev et al. (2009). At the market index level, a cursory look at the term structure of trade-offs between excess returns and historical variances, reveals a striking pattern. In general, the risk-return trade-off is hard to detect for short horizons but appears significant for longer horizons. The observed discrepancy between short versus long horizons trade-off estimates, illustrates the horizon effect. As pointed out by Camponovo et al. (2013), a few extreme observations might "hide" the evidence of short term return predictability. There is an ongoing debate on

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whether this empirical pattern is backed by an economic rationale or is just the result of a mere sampling artifact. Namely, the evidence of long horizon predictability in returns documented in Fama and French (1988), Valkanov (2003), Bandi and Perron (2008) has been challenged by Stambaugh (1999), Ang and Bekaert (2007), Boudoukh et al. (2008), Goyal and Welch (2008) who raise the possibility of spurious long horizon relations.

The main purpose of this paper is to propose a formal detection test for the horizon effect in the predictive long-run relation between the market excess return and its historical variance. To fulfill this objective, we employ a methodology which explicitly accounts for persistence in the predictor, that is, the variance process. In their multi-horizon analysis of the risk-return trade-off, Bandi and Perron (2008) accommodate the persistence in the variance process using a near-unit-root specification. However, the variance dynamics can exhibit long-range memory as pointed out by Comte and Renault (1998), Bandi and Perron (2006), Corsi (2009), Bollerslev et al. (2012), Sizova (2013) among others. Moreover, Bandi and Perron (2008) perform an individual treatment of the trade-off estimates while the inference on the term structure of predictive relationships should rely on joint test procedures to protect against spuriousness, as argued by Boudoukh et al. (2008). Because of the overlapping aggregation, there is a limited amount of independent information across horizons, and therefore, the estimated coefficients are strongly tied together. We propose a joint inference framework which is robust to the strong dependence among coefficients across horizons.

This article adds to the existing literature in two ways. First, we derive the joint asymptotic distribution of the term structure of risk-return trade-offs and the limiting approximation of its corresponding covariance matrix. We consider both local-to-unity (Bandi and Perron, 2008) and long-memory (Sizova, 2013) frameworks for the realized variance dynamics. Our results provide multivariate analytical tools to build appropriate Wald statistics and test some restrictions on the term structure of risk-return trade-offs. Thus, we generalize the analysis of Bandi and Perron (2008) and Sizova (2013) to the multivariate case and extend the results of Jacquier and Okou (2014) to long-memory predictors. Second, we exploit a standardized version of the classical Wald statistic, the *rescaled* Wald statistic, to assess the horizon effect. The proposed *rescaled* Wald statistic allows for multiple hypotheses testing while controlling for the level of type I error. In a multi-horizon context, this helps overcome the drawbacks of a "one-at-a-time" test strategy. We also provide simulated critical values for the *rescaled* Wald statistics.

Further, the inclusion of an intercept in the risk-return trade-off model plays a significant role. We find that the past market variance is positively related to the market excess return only at long horizons when an intercept is included in the model. By contrast, we cannot reject the assumption of no horizon effect for zero-intercept specifications as the estimated slope coefficients remain positive and have the same magnitude across all horizons. These results suggest a proportional risk-return trade-off relation consistent with Merton-type intertemporal capital asset pricing model (ICAPM). From the various horizon-specific estimates of the link between past variance and future excess return, we extract a smoothed proxy for the aggregate price of variance risk. We interpret this proxy as a "cross-horizon backward-looking" market price of risk. We obtain a reasonable value between 2 and 3.

The rest of this paper is structured as follows. We begin in Section 2 by introducing a simple risk-return model and discussing some estimation findings. Section 3 presents single inference results and simulated critical values for the *rescaled* t-statistics. In Section 4, we perform a joint test based on the *rescaled* Wald statistic to investigate the horizon effect in the term structure of risk-return trade-offs. Specifically, we study the statistical equality between slope coefficients from different horizons. Thus, we characterize the term structure of risk-return trade-offs and relate it to Merton's (1973) ICAPM framework. Then, we draw on model averaging techniques to compute a cross-horizon estimate of the strength of the trade-off, a proxy for the market price of risk. We conclude in Section 5.

2. Framework

2.1. Model specification

For the empirical work, we use NYSE/AMEX value-weighted index with dividends as the market proxy and 30-day T-bill rate as the risk-free rate. The data span the period from January 2, 1952 to December 31, 2009 and are retrieved from CRSP files. Bandi and Perron (2008) use the same dataset over a shorter period from January 2, 1952 through December 29, 2006. To begin our analysis, we specify the regressions

$$R_{t,t+h} = \alpha_h + \beta_h RV_{t-h,t} + \varepsilon_{t,t+h}, \quad (1)$$

where $R_{t,t+h}$ is the market log-excess return between t and $t+h$, $RV_{t-h,t}$ denotes the past market variance between $t-h$ and t, and $\varepsilon_{t,t+h}$ represents a prediction error. The subscript h stands for the horizon and takes value between 1 and 120 months. The parameters α_h and β_h are the intercept and the slope of the risk-return model. For a given horizon h, β_h captures the trade-off intensity.

The baseline data are daily. Thus, we aggregate the daily continuously compounded return (r) in excess of the risk-free rate (r^f), to obtain the monthly log-excess return

$$R_{t,t+1} = \sum_{j=1}^{n_t} \left(r_{t+j/n_t} - r^f_{t+j/n_t} \right), \quad (2)$$