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Unfolded risk-return trade-offs and links to Macroeconomic Dynamics

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ABSTRACT

A general partial risk-return relation is derived based on return decomposition to allowing for the effect of time-varying skewness and kurtosis on the risk-return trade-off. Empirically estimated for 12 international financial markets, the proposed risk-return trade-off is significantly positive even after controlling for time-varying higher moments. Moreover, the stochastic dominance test reveals that modeling time-varying skewness significantly lowers the level of the risk-return trade-off. More importantly, the empirical evidence shows that the risk-return trade-off is countercyclical in the U.S. markets, consistent with the theoretical habit-formation model of Campbell and Cochrane (1999), whereas the risk-return trade-offs in European and emerging markets appear to be procyclical over a 12-month horizon, but countercyclical for a shorter horizon of 3 months. Finally, common macroeconomic variables can significantly explain risk-return trade-off dynamics.

1. Introduction

Since the seminal work of Merton (1973), the Intertemporal CAPM (ICAPM) that predicts a positive and time-invariant linear relationship between market risk premium and expected market volatility has been tested in numerous samples. Unfortunately, empirical evidence on this theoretical prediction is not only mixed and inconclusive (Rossi and Timmermann, 2015 and references therein), but strongly suggests that the risk-return relationship is unstable and varies through time.

Theoretically assuming a general equilibrium exchange economy, Whitelaw (2000) shows that the general equilibrium model generates a *complex, nonlinear* and *time-varying* relation between expected return and its volatility, duplicating the salient feature of the risk-return trade-off in the data. Brunnermeier and Nagel (2008) also show that persistent habits, consumption commitments, and subsistence levels can generate *time-varying* risk aversion with the consequence that when the level of liquid wealth changes, the proportion a household invests in risky assets should also change in the same direction. Empirically, Guo et al. (2013) uncover a strong comovement between stock market risk-return trade-off and the consumption-wealth ratio, and Lundblad (2007) has conducted exploratory analysis which suggests a role for a time-varying risk-return trade-off linked to the changing nature of the U.S. economy. In fact, these studies have emphasized the importance of time-varying investment opportunities, and thus bring into question the value of modeling expected returns as a linear and constant function of conditional volatility as in ICAPM.

To characterize the time-variation nature of the risk-return relationship, Campbell and Cochrane (1999) add a slow-moving habit or time-varying subsistence level into a consumption-based model, and show that, as consumption declines toward the habit in a business cycle trough, the relative risk aversion coefficient rises, so risky asset prices fall and expected returns rise. Eventually, their theoretical framework suggests that the risk-return relationship changes through time, for example, countercyclically varies with business cycles, and thus induces a countercyclical risk premium.[1]

However, the debate has recently emerged on whether risk-return relation is countercyclical or procyclical, although the studies have shown strong evidence of state-dependent risk-return trade-offs. On the countercyclical variation side,[2] Nyberg (2012) combines a probit model for a binary business cycle indicator and a regime-switching GARCH-in-mean model, and shows that risk aversion appears to be higher in the U.S. recession regime, indicating that investors are demanding a higher risk premium dur-

[1] A countercyclical variation in the risk-return trade-off presents if investors appear to be more risk-averse during economic recessions and/or financial crises than in normal economic times, and thus require higher risk premium. To the opposite, a procyclical pattern of the risk-return relationship shows a positively larger relationship in the normal economic times than in periods of recessions and crises.

[2] See, e.g. Brandt and Kang (2004), Kim et al. (2004), Bollerslev et al. (2011), Guo et al. (2013), Rossi and Timmermann (2015) and Chang (2016), among others.

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ing recessions. Smith and Whitelaw (2009) estimate time-varying risk aversion using market data that allows for feedback from both news about volatility and risk-aversion. Their results show that the price of risk varies countercyclically, with risk aversion increasing substantially over the course of economic contractions.

On the other hand, the procyclical variation with business cycles has also been found in recent studies.[3] Ghysels et al. (2014) use an MIDAS model for the conditional variance and allow for possible switches in the risk-return relation through a Markov-switching specification. They find that, in the first regime characterized by low ex-post returns and high volatility, the risk-return relation is reversed to be negative, whereas the intuitive positive risk-return trade-off holds in the second regime characterized by relatively high ex-post returns and low volatility. Particularly, the fist regime can be interpreted as a "flight-to-safety (quality)" regime (Adrian et al., 2016). This evidence corroborates the findings in Ghysels et al. (2013), who document that the Merton model holds over samples that exclude financial crises, such as the Great Depression and/or the subprime mortgage financial crisis and the resulting Great Recession. Kim and Lee (2008) also show that investors become more risk-averse during boom periods (i.e., procyclical risk aversion), which they confirm using a calibration of a simple equilibrium model.

Relying on the unfolded GARCH framework of Liu and Luger (2015), I address these inconclusive puzzles by proposing an innovative and general partial risk-return relation, which is time-varying and allows for a variety of possible shapes. The proposed risk-return relation unfolds potential nonlinearities inherent in the risk-return trade-off through the temporal interdependence between conditional volatility and market timing via return decomposition. Consequently, the time-variation nature of the risk-return trade-off can naturally be characterized by the expected interaction between the dynamic marginal components, namely conditional volatility and market timing, which are jointed by a copula function.

Importantly, theory predicts that expected returns should also be linked with variations in higher order risks, such as asymmetry and tail thickness (Rubinstein, 1973; Kraus and Litzenberger, 1976). More recently, the studies by Feunou et al. (2012); 2014), Jahan-Parvar and Mohammadi (2013) and Cheng and Jahan-Parvar (2014) have shown that the market price of risk is a nonlinear function of conditional Pearson mode skewness. The shape of this nonlinear function depends on parameters of higher order risks. To this end, the general risk-return relation derived in this paper has clearly been advantaged by the unfolded GARCH framework in which time-varying skewness and kurtosis are specified with separate dynamic processes but simultaneously estimated. Consequently, the effect of dynamic higher moments on the risk-return relation can explicitly be incorporated and statistically tested in this paper.

Empirically, I examine the proposed general partial risk-return trade-off in 7 major developed and 5 largest emerging markets. Consistent with the prediction of asset pricing theory, the proposed general risk-return trade-off has found significantly positive, even after controlling for time-varying higher moments. This significant and positive result, nonetheless, sometimes turns to be significantly negative due to extreme economic/market changes. The stochastic significance and dominance tests of Bernal et al. (2014) applied in this paper show that modeling time-varying skewness significantly lowers the level of the risk-return trade-off. This empirical finding is reproduced by a simulation experiment in this paper, so that the mixed sign and inconclusive significance of risk-return trade-offs found by previous studies, may to some extent be explained as an incomplete description of investors' attitude toward risk in response to complicated and varying economic/market conditions and/or due to unmodeled effects of dynamic higher moments.

Applying the panel predictive regression for an in-depth analysis in the risk-return dynamics linking to macroeconomic activities, I find that the empirical results from the U.S. markets statistically support countercyclical risk-return trade-offs, which are negatively related to the growth rate of industrial production and the price-dividend ratio of the U.S. markets. This finding also supports the theoretical prediction of Campbell and Cochrane (1999)'s habit-formation model discussed early. Nonetheless, the results obtained from European and emerging markets are to some extent mixed. The cyclical variation in European and emerging markets, evolves over a longer horizon (i.e., 12 months) to become significantly procyclical, although the cyclicality in these markets appears to be significantly countercyclical within a relatively short horizon, i.e., 3 months.[4]

The reminder of this paper is organized as follows. Section 2 proposes the general partial risk-return relation, and derives its solution using the unfolded GARCH framework of Liu and Luger (2015). Section 3 describes data. Section 4 reports the model estimation results, moment specification tests and the estimates of the unfolded risk-return trade-off. In this section, using the stochastic significance and dominance tests of Bernal et al. (2014), I test the effect of return asymmetry on the unfolded risk-return trade-off. Section 5 conducts the predictive panel data analysis to explore potential economic sources that link to the time-variation of the risk-return trade-off. The cyclical variation with business cycles is also statistically tested using the stochastic tests. Section 6 concludes this paper.

2. The methodology

To fix ideas, I decompose the excess return, r_t, into the product of absolute value and sign

$$r_t = |r_t| sign(r_t) \tag{2.1}$$

which is called "an intriguing decomposition" in Christoffersen and Diebold (2006). From (2.1), the conditional mean of r_t can be expressed in terms of an indicator function, $s_t = \mathbb{I}(r_t > 0)$, as

$$\mu_t = E_{t-1}(r_t) = 2E_{t-1}(|r_t|s_t) - E_{t-1}(|r_t|) \tag{2.2}$$

in which the potential nonlinearity inherent in excess return dynamics can be modeled by the temporal interdependence between the two components, $|r_t|$ and s_t (Anatolyev and Gospodinov, 2010; Liu and Luger, 2015).

2.1. Definition and motivation

In this paper, the risk-return relation is defined and developed in a general and partial form to allowing for a variety of possible shapes and time-varying, as $\partial E_{t-1}(r_t)/\partial \sigma_t^2$, where σ_t^2 is conditional variance of r_t. By applying this definition to (2.2), the risk-return relationship can be expressed in a general decomposition form as

$$\beta_t = 2\frac{\partial E_{t-1}(|r_t|s_t)}{\partial \sigma_t^2} - \frac{\partial E_{t-1}(|r_t|)}{\partial \sigma_t^2} \tag{2.3}$$

Christoffersen and Diebold (2006) document a direct connection between return volatility dependence and return sign dependence.

[3] See, e.g., Whitelaw (2000), Mayfield (2004), Lundblad (2007), Kim and Lee (2008), Salvador (2012), Salvador et al. (2014) and Wu and Lee (2015), among others.

[4] It is interesting for future research to understand why the procyclical pattern of risk-return trade-offs, somehow counterintuitive, occur. Some discussions in e.g., Kim and Lee (2008) and Rossi and Timmermann (2015), among others, might be useful in pursuing the research in this direction.