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Intertemporal risk–return relationships in bull and bear markets☆

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ABSTRACT

This paper examines whether the intertemporal risk–return relationship in the U.S. stock market varies with bull and bear markets. Based on the non-parametric Bry–Boschan approach for identifying bull and bear markets and the non-parametric Bartlett-kernel based realized variance as a proxy for the conditional variance, our empirical findings reveal that the risk–return relationship is significantly positive in bull markets, but significantly negative in bear markets. Even when the macroeconomic variables reflecting business cycle fluctuations are taken into account, these empirical results remain the same. The rolling regression results also reveal that our findings are quite robust over time; in particular, the range of the rolling estimates is much smaller, suggesting that the time-varying risk–return relationship can be appropriately explained by bull and bear markets.

1. Introduction

It is fundamental in finance that risk-averse investors would require a higher risk premium when the asset of interest becomes riskier. Such a risk–return tradeoff has underlain most of the asset pricing models; see e.g., the conventional capital asset pricing model (CAPM) of Sharpe (1964), Linter (1965) and Mossin (1966), the intertemporal CAPM of Merton (1973), the arbitrage pricing model of Ross (1976), and the consumption-based CAPM of Lucas (1978) and Breeden (1979). In view of this, many early empirical studies have examined the validity of asset pricing models by testing if the risk–return tradeoff holds cross-sectionally; see e.g., Fama and MacBeth (1973), Fabozzi and Francis (1977), Kim and Zumwalt (1979), Roll and Ross (1980), Chen (1982) and Breeden, Gibbons, and Litzenberger (1989). Since the work of Merton (1980) and French, Schwert, and Stambaugh (1987), the intertemporal risk–return relationship has also attracted much attention in empirical finance.

Although numerous empirical studies have examined the risk–return relationship using various non-parametric, semi-parametric, and parametric time-series models, the empirical results do not uniformly confirm the presence of risk–return tradeoff. For example, based on generalized autoregressive conditional heteroskedasticity in mean (GARCH-M) models, French et al. (1987) and Chou (1988) found that the risk–return relationship for the U.S. stock market is positive and significant, yet Baillie and DeGennaro (1990) found that when the distribution of standardized errors is specified as a *t* distribution (rather than normal distribution),

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which is more appropriate for explaining the fatter tail behavior of asset returns, the risk–return relationship remains positive but becomes insignificant. When asymmetric volatility is taken into account, Nelson (1991, p. 358) found that the U.S. risk–return relation is negative but insignificant; with a different specification for asymmetric volatility, Glosten, Jagannathan, and Runkle (1993) even documented a significantly negative relationship. These results reveal that the empirical risk–return relationship is quite sensitive to model specification.

As model misspecification may render the empirical results unreliable, French et al. (1987) employed a semi-parametric model (with a linear parametric model for the conditional mean and realized variance as a non-parametric measure of the conditional variance or risk) and found only indirect evidence supporting the risk–return tradeoff, yet some other related semi-parametric studies (that employ other non-parametric measures of risk and/or account for omitted variables in conditional mean) do provide evidence of risk–return tradeoff; see e.g., Ghysels, Santa-Clara, and Valkanov (2005), Guo and Whitelaw (2006) and Bali, Demirtas, and Levy (2009). However, based on a semi-parametric GARCH-M model, Li, Yang, Hsiao, and Chang (2005) found that the risk–return relationship is significantly negative for most of the major stock markets. On the other hand, by using non-parametric models for both conditional mean and conditional variance, Pagan and Hong (1991) and Harvey (2001) documented that the risk–return relationship is significantly negative (for the U.S. stock market), yet Harrison and Zhang (1999) reported that for longer holding horizons, it appears to be significantly positive. It follows that even model misspecification has been taken into account, whether there is a risk–return tradeoff remains a puzzle in empirical finance.

While several theoretical studies have argued that both positive and negative relationships between risk and return are consistent with general equilibrium asset pricing models (see e.g., Abel, 1988; Backus & Gregory, 1993; Gennotte & Marsh, 1993), they are unable to explain the puzzle above. As many empirical studies have pointed out that the risk–return relationship appears to be time-varying (see e.g., Campbell, 1987; Harvey, 1989; Chou, Engle, & Kane, 1992; Harvey, 2001; Lettau & Ludvigson, 2010), it follows that a time-varying relationship may explain why the empirical findings are mixed. In view of this, recent empirical studies have attempted to examine if the risk–return relation varies with the business cycle. In particular, Kim and Lee (2008) employed Markov-switching GARCH-M models and found that the risk–return relationship is significantly positive in expansion, but insignificantly negative in recession. By contrast, Nyberg (2012) employed QR-GARCH-M models (i.e., GARCH-M models with expansions and recessions determined by probit models) and found that the risk–return relationship is always significantly positive and countercyclical. However, it seems that such an empirical result is unable to explain the mixed findings of the existing studies.

In this paper, we revisit the U.S. intertemporal risk–return relationship by examining whether it varies with the financial cycle of bull and bear markets. Although several early empirical studies (see e.g., Kim & Zumwalt, 1979; Chen, 1982) have provided evidence that the cross-sectional relation between risk and return depends on bull and bear markets, most of the empirical studies on time-varying intertemporal risk–return relation focus only on the impact of business cycle. As Gordon and St-Amour (2000, p. 1028) clearly pointed out that the comovement of the financial and business cycles is weaker after mid-1970s, the representative investor's attitudes and preferences toward stock market risk should be more related to bull and bear markets. It is thus of interest to see whether the market conditions have an impact on the intertemporal risk–return relationship. To do this, we need to identify bulls and bears in the stock market and select a proper measure for the conditional variance. To avoid model misspecification, the econometric techniques employed for both of them are non-parametric.

For identifying bull and bear markets, we employ the non-parametric Bry–Boschan approach that has been widely employed in identifying the phases of business cycle (see e.g., Harding & Pagan, 2002) and financial cycle (see e.g., Pagan & Sossounov, 2003; Candelon, Piplack, & Straetmans, 2008). As for the conditional variance, many studies employ the realized variance of the sum of the squared or weighted squared excess stock returns; see e.g., Merton (1980), French et al. (1987) and Ghysels et al. (2005). However, such a non-parametric measure does not account for autocorrelations in excess stock returns. French et al. (1987) also proposed a realized variance that accounts for first-order autocorrelation. Unfortunately, the asset returns of interest are not necessarily only first-order autocorrelated so that it would still suffer from a bias problem arising from higher-order autocorrelations. More importantly, it may result in negative estimates for the conditional variance. In view of this, we employ the Bartlett kernel-based realized variance proposed by Hansen and Lunde (2005, 2006). Such a kernel-based measure is robust to serial correlations of unknown form and the resulting estimates are always non-negative.

Our main empirical findings are as follows. Consistent with the intertemporal CAPM of Merton (1973), the constant term in the conditional mean is insignificantly different from zero and the risk–return relationship is significantly positive in bull markets. Nonetheless, the risk–return relationship is significantly negative in bear markets, a sharp contrast with the findings in Kim and Lee (2008) and Nyberg (2012). While the negative relation is inconsistent with the intertemporal CAPM, it is still consistent with general equilibrium asset pricing models. In particular, it may still reflect that investors are more risk averse in bear markets. Such a negative relationship may also represent that the risk premium is negative (rather than positive) and the response to the leverage effect is stronger during bear market periods. These empirical results remain the same even when the October 1987 crash and the macroeconomic variables reflecting business cycle fluctuations are taken into account. Moreover, the rolling regression results also reveal that the positive relation in bull markets and negative relation in bear markets are quite robust over time. More importantly, after taking the market conditions into account, the range of the rolling estimates is much smaller than that reported in Chou et al. (1992), suggesting that the time-varying risk–return relationship can be appropriately explained by bull and bear markets.

The rest of this paper is organized as follows. In Section 2, we will introduce the realized variance for measuring risk, the definition of bull and bear markets, the empirical models that take bull and bear markets into account, as well as related econometric techniques. Section 3 provides a brief description of the data employed in our empirical study. The main empirical results are presented in Section 4. Section 5 further discusses the robustness of our main empirical findings. Finally, Section 6 concludes this paper.