Journal of Empirical Finance 28 (2014) 60–77

Contents lists available at ScienceDirect

Journal of Empirical Finance

journal homepage: www.elsevier.com/locate/jempfin

Re-examining the risk–return relationship in Europe: Linear or non-linear trade-off?

Enrique Salvador [a,c], Christos Floros [b,d], Vicent Arago [c]

[a] Financial Mathematics Computation Cluster, School of Business, University College Dublin, Blackrock, Co. Dublin, Ireland
[b] Department of Accounting and Finance, Technological Educational Institute of Crete, 71004 Crete, Greece
[c] Department of Finance & Accounting, Universitat Jaume I, Spain
[d] Hellenic Open University, Greece

ARTICLE INFO

Article history:
Received 26 July 2012
Received in revised form 24 May 2014
Accepted 26 May 2014
Available online 3 June 2014

Keywords:
Non-linear risk–return tradeoff
Pro-cyclical risk aversion
Regime-Switching GARCH
Regime-Switching MIDAS
Risk premium

ABSTRACT

This paper analyzes the risk–return trade-off in Europe using recent data from 11 European stock markets. After relaxing the linear assumptions in the risk–return relationship by introducing a new approach that considers the current state of the market, we obtain significant evidence for a positive risk–return trade-off for low volatility states. However, this finding is reduced or even non-significant during periods of high volatility. Maintaining the linear assumption over the risk–return trade-off leads to non-significant estimations for all cases. These results are robust across countries despite the conditional volatility model used. These results also demonstrate that the inconclusive results in previous studies may be due to strong linear assumptions when modeling the risk–return trade-off. This previous research fails to uncover the global behavior of the relationship between return and risk.

1. Introduction

One of the most discussed topics in financial economics is establishing a relationship between return and risk. Several theories have been suggested in an attempt to explain the dynamics and interactions between these two fundamental variables. From a theoretical framework, one of the most cited works analyzing this risk–return trade-off is Merton's (1973) intertemporal capital asset pricing model (ICAPM). Merton (1973) demonstrates that there is a linear relationship between the conditional excess market return and its conditional variance and its covariance with investment opportunities:

$$\mu_M - r_f = A\sigma_M^2 + BX_{M,S} \tag{1}$$

where $\mu_M - r_f$ is the excess return of the market portfolio over the risk-free asset, σ_M^2 is the conditional variance of excess market returns (known as the idiosyncratic portfolio risk), $X_{M,S}$ is the conditional covariance between excess market returns and the state variable that represents the investment opportunities (known as the hedge component), and A and B are the prices of these sources of risk. Assuming risk-averse investors, this model establishes a positive relationship between expected return and market variance (risk).

Despite the importance of this trade-off in the financial literature, there is no clear consensus about the empirical evidence. Campbell (1987), Glosten et al. (1993), Whitelaw (1994) and Brandt and Wang (2010) find a negative relationship between these variables, while other authors, such as Ghysels et al. (2005), León et al. (2007), Guo and Whitelaw (2006), Ludvigson and Ng (2007) and Lundblad (2007), find a positive trade-off.

E-mail address: cfloros@staff.teicrete.gr (C. Floros).

http://dx.doi.org/10.1016/j.jempfin.2014.05.004
0927-5398/

This paper analyzes the risk–return trade-off in 11 European countries (Germany, France, Spain, the United Kingdom, Switzerland, the Netherlands, Belgium, Denmark, Finland, Sweden and Greece) and elucidates the controversial results about its sign and magnitude. We use different assumptions when modeling conditional volatilities (GARCH and MIDAS approaches) and relax the strong linear assumption usually made in previous studies by introducing a Markov Regime-Switching process. This non-linear methodology helps us condition our estimates upon the current state of the market by obtaining different relationships between return and risk during periods of high and low volatility states. This paper is one of the first papers to use non-linear models, such as Regime-Switching MIDAS (RS-MIDAS), to analyze the risk–return relationship.[1]

In the theoretical framework, all of the parameters (the risk prices A and B in (1)) and the variables (the sources of risk σ_M^2 and $X_{M,S}$) are allowed to be time varying. However, to make the model empirically tractable, several assumptions need to be made, the most common being constant risk prices (Bali et al., 2005; Goyal and Santa-Clara, 2003). It is additionally necessary to assume specific dynamics for the conditional second moments representing the market risk. The most commonly used dynamics are the GARCH models (Bollerslev, 1986). Finally, the empirical model is established in a discrete time economy instead of the continuous time economy used in the equilibrium model of the theoretical approach. We additionally consider one set of investment opportunities constant over time, for example by retaining market risk as the only source of risk[2] (Glosten et al., 1993; Lundblad, 2007; Shin, 2005). In this paper, we follow these studies and analyze the effect of market returns given one risk factor defined by the conditional market volatility.

Given these assumptions, many papers have introduced alternative empirical models to obtain evidence to support the theoretical intuition. The methodology most commonly used in the empirical analysis of the risk–return trade-off is the GARCH-M approach (Engle et al., 1987). This framework is simple to implement but leads to inconsistent results. Many studies fail to identify a statistically significant intertemporal relationship between the risk and return of the market portfolio (see Baillie and De Gennaro, 1990; Campbell and Hentschel, 1992). A few studies support a positive risk–return relationship (Bollerslev, 1986; Guo and Neely, 2008). Several studies even find that the intertemporal relation between risk and return is negative (examples include Nelson, 1991; Li et al., 2005). Therefore, alternative approaches to the simple GARCH-M methodology have been proposed when analyzing the risk–return trade-off. The most important frameworks developed as alternatives to GARCH models essentially obtain different estimates for conditional volatility. Whitelaw (1994) uses an instrumental variable specification for the conditional second moments. Harrison and Zhang (1999) use non-parametric techniques in their study in contrast to the more frequently used parametric approaches. Ghysels et al. (2005) propose the use of different data frequencies to estimate the mean (with lower data frequency) and the variance (with higher data frequency) equations. Despite the differences in the models, they share a strong linear (monotonic) assumption in the definition of the relationship between return and risk. In a recent paper, Muller et al. (2011) use the basic and asymmetric Cointegrated-GARCH (COGARCH) approach to test Merton's Hypothesis. They argue that the asymmetric COGARCH model is not supportive of Merton's Hypothesis, while the symmetric version of COGARCH shows a significant positive covariance between the market risk-premia of both the CRSP value weighted and equal-weighted excess market returns and volatilities over the period 1953–2007.

However, Merton's model is not the only theoretical approach to explain the risk–return relationship. Whitelaw (2000) proposes a non-linear relationship between return and risk based on an equilibrium framework. This theoretical framework is quite different from Merton's (1973) approach because it includes a complex, non-linear, and time-varying relationship between expected return and volatility. Similarly, Mayfield (2004) employs a methodology in which states of the market are defined by volatility regimes and condition the risk–return trade-off in these different states. Other authors also draw alternative frameworks where a monotonic risk–return relationship is not expected (Veronesi, 2000) and some (see Abel, 1998; Backus and Gregory, 1992) even develop theoretical models that support a negative risk–return relationship.

The main result of our paper is that a non-linear specification is necessary to reflect the positive and significant trade-off between return and risk. When several volatility states are considered, the risk–return relationship becomes significant, even ignoring possible changes in the set of investment opportunities. When linear patterns in the risk specification (GARCH and MIDAS) are considered, no significant relationship in any market is obtained. More specifically, a positive and significant trade-off between return and risk is obtained for low volatility states when non-linear patterns are considered (RS-GARCH and RS-MIDAS models). However, for high volatility states, the magnitude of this relationship is smaller or non-significant. These results are robust across the stock indexes analyzed and indicate that the lack of empirical evidence in previous studies may be due to the strong assumption of a linear risk–return relationship rather than a non-linear one, revealing the perils of using linear frameworks to analyze this trade-off empirically. These results explain the inconsistent results from previous studies using linear models about the sign and magnitude of this relationship. The results additionally may explain why results from linear models do not appear to be robust to the sample period used in the analysis. Studies using linear models analyzing a sample period corresponding to a low volatility state are more likely to find a positive risk–return tradeoff, while studies that include episodes of crisis or high volatility are more likely to find a negative or insignificant trade-off. In both cases, the conclusions can only be viewed as partial evidence because the omission of non-linearities may misrepresent the evidence.

[1] The first attempt to use these models is very recent (Guérin and Marcellino (2010)), but it is a specification with potential applications to a large class of empirical studies in applied economics and finance that have yet to be explored.

[2] A few papers, such as Scruggs (1998) and Scruggs and Glabadanidis (2003), show that the lack of empirical evidence of a risk-return trade-off is due to the omission of the hedge component. However, the evidence is inconclusive. Some alternative approaches use information not only about the market portfolio but also about additional risk factors, such as other asset portfolios or macroeconomic indicators, thereby extending their empirical models to a multidimensional framework (see Bali, 2008; Ludvigson and Ng, 2007).