Journal of Banking & Finance 37 (2013) 2342–2353

Contents lists available at SciVerse ScienceDirect

Journal of Banking & Finance

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

Return sign forecasts based on conditional risk: Evidence from the UK stock market index

Thanaset Chevapatrakul

Nottingham University Business School, The University of Nottingham, UK

ARTICLE INFO

Article history:
Received 10 May 2012
Accepted 20 January 2013
Available online 8 February 2013

JEL classification:
C21
C32
C51
C53
G12
G17

Keywords:
Asset pricing
Asset price volatility
Multivariate GARCH
Limited-dependent variable approach

ABSTRACT

Recent theoretical works have found a link between return sign forecastability and conditional volatility. This paper compares the predictive performance of the conditional country risk and the conditional residual risk in forecasting the direction of change in the return on the UK stock market index. The conditional country risk and the conditional residual risk are estimated using the bivariate BEKK-GARCH technique and the direction of change in the UK stock market index is modelled using the binary logit approach. Both the in-sample and the out-of-sample predictions suggest that, as a predictor, the conditional residual risk is superior to the conditional country risk. Our findings support the residual risk model while contradicting the traditional capital asset pricing model (CAPM). Moreover, our tactical asset allocation simulations show that when the conditional residual risk is used in conjunction with multiple-threshold trading strategies to guide the investment decisions, the actively managed portfolio achieves greater returns than the return on a buy and hold portfolio.

1. Introduction

In their paper, Christoffersen and Diebold (2006) demonstrate a link between the forecastability of asset return sign and asset return volatility. Their findings suggest that information on conditional volatility can be used to produce direction-of-change forecasts of asset returns. Other authors, including Leung et al. (2000) and Nyberg (2011) for example, provide empirical evidence demonstrating that return sign forecasts are possible and are potentially useful for asset managers who actively allocate their assets between risky and risk-free investments.

Although research on asset return sign predictability is still in its infancy, several research papers in this area are worth mentioning. For example, Christoffersen and Diebold (2006) and Christoffersen et al. (2007) demonstrate a direct link between asset return volatility and asset return sign forecastability. The latter paper also provides empirical evidence suggesting that conditional variance, skewness and kurtosis are all capable of predicting the direction of change in the asset return. Leung et al. (2000) evaluate the efficacy of several multivariate classification techniques relative to a group of level estimation approaches. The classification techniques, which are employed in their work to estimate the probabilities of the direction of change of the return, include linear discriminant analysis, logit, probit and probabilistic neural networks. The authors find that the classification models outperform the level estimation models in terms of predicting the direction of stock market movement and maximising returns from investment trading. Another author who demonstrates that return signs are predictable is Nyberg (2011) who adopts the binary dynamic probit model to investigate the sign predictability of the US stock market. In his paper, the author includes a binary recession indicator, estimated in the first stage using the binary probit model, which is subsequently included in a set of regressors employed in the second stage of the estimation. His findings suggest that the direction of change in the US stock market is predictable with the binary recession indicator being the most useful predictor.

This paper takes the work of Christoffersen et al. (2007), which uses a univariate technique to model conditional volatility, one step further by modelling the conditional asset return volatility using the bivariate BEKK-GARCH technique to capture the impact of time-varying asset return correlation on conditional variance.

E-mail address: Thanaset.Chevapatrakul@nottingham.ac.uk

0378-4266/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jbankfin.2013.01.033

Specifically, we investigate the connection between asset return sign forecastability and conditional asset return volatility using data on the UK stock market index. Our technique also improves upon the work of Nyberg (2011) which calculates the volatility of stock returns as a 1-month rolling window of sum of squared daily stock returns.

The bivariate GARCH approach employed in this article has several attractive features that are worth mentioning. Firstly, it takes into account the impact of correlation between the UK stock market and the global stock market on the conditional return volatility thereby enabling us to capture the 'spill-over' effects between the two markets on the estimated conditional volatility. Secondly, the conditional return volatility and the conditional return correlation are jointly estimated using maximum likelihood estimation which permits asset return volatility to be a function of its own past values as well as its correlation with the other asset return volatility, thereby allowing correlation to change over time. The implication of time-varying correlation cannot be understated as a large body of research has shown that correlation is indeed unstable and changes over time (see Fabozzi and Francis (1978), Bos and Newbold (1984), Faff et al. (1992) and Brooks et al. (2002), for example). Thirdly, as the approach allows for time-varying correlation, it is possible for us to examine whether conditional country risk, which is a measure of time-varying co-movement between the return on a country's stock market and the return on the world stock market, can be used to forecast the direction of change in the asset return. In order words, we examine whether the main result of the Capital Asset Pricing Model (CAPM), which suggests that a return on the asset should reflect only the undiversifiable risk component (i.e., the systematic risk), is valid when the direction of change in the asset return instead of the level is modelled.

Our research method involves two stages. In the first stage, the bivariate BEKK-GARCH is fitted to the data to estimate the conditional variance–covariance matrices. The conditional country risk (also called the conditional beta or the time-varying beta) and the conditional volatility (also called the conditional residual risk or the conditional idiosyncratic risk) are computed using the information obtained from the conditional variance–covariance matrices. The two measures of risk are subsequently used as explanatory variables in the second-stage estimation. In the second stage, we employ the binary logit model to predict the direction of change in the UK stock market return. In our model, only two possible states for the change in the return are possible: 'upwards' and 'downwards'. A set of diagnostic tests are performed to select a benchmark model whose predictive performance serves as a yardstick to which the predictive performance—both in-sample and out-of-sample—of the other models may be compared. In addition, using the out-of-sample return sign forecasts, we simulate investment returns generated by different trading strategies: the passive 'buy and hold' strategy and the active asset allocation strategies guided by the benchmark model, the conditional country risk model and the conditional residual risk model. This type of return simulation is potentially beneficial to asset managers whose job is to allocate their managed assets between risky and risk-free rate investments. Incorporated into our simulations are transaction costs and threshold trading rules employed by Leung et al. (2000). These rules are designed to better utilise the probability forecasts, generated by the binary logit estimations, by taking into account 'degrees of confidence' in the forecasting models' predictive strength.

Our results suggest that both the conditional country risk and the conditional volatility are capable of predicting directional changes in returns on the UK stock market. Specifically, the conditional residual risk possesses statistically significant predictive power, generating superior return sign forecasts both in-sample and out-of-sample. Diagnostic tests based on log-likelihood functions and outcome-based predictive performance evaluation both confirm the usefulness of the conditional residual risk in predicting the direction of change in the return on the UK stock market index. Our findings add to the growing literature on the relevance of residual risk to asset pricing. Furthermore, our investment return simulation results suggest that the return on a portfolio managed actively using the probability forecasts obtained from the conditional residual risk model exceeds the return on a passive 'buy and hold' portfolio provided that multiple threshold trading rules are employed.

The article proceeds as follows. We briefly present the theoretical relationship between asset return volatility and return sign forecastability as well as relevant literature on usefulness of residual risk in Section 2. We then outline our methodology—the BEKK-GARCH technique and the binary logit model—in Section 3. While Section 4 explains the data, we present both the BEKK-GARCH and the binary logit estimation results in Section 5. The in-sample and out-of-sample results, as well as forecast evaluations, are discussed in Section 6. Section 7 deals with trading simulations. Finally, Section 8 concludes the paper.

2. Volatility dynamics and direction-of-change forecasts

The ability of volatility to predict asset return signs is derived from the interaction between a nonzero mean return and nonconstant volatility and is independent of the shape of the return distribution. However, when the distribution of asset returns is symmetric, either a zero mean or constant volatility would render the sign unforecastable as pointed out by Christoffersen and Diebold (2006). For the same reason, when volatility is large relative to the mean return, the return sign also becomes nearly unpredictable: in a highly volatile market, forecasting where the market will go next is difficult. Christoffersen and Diebold (2006) also indicate that sign forecastability is often disguised by a practice of removing unconditional means and working with zero-mean series in traditional financial econometrics.

In this section, we explain in more detail the concepts of conditional mean dependence, sign dependence and volatility dependence. We then review and discuss in the following subsection relevant literature that focuses on investigating the extent to which estimated conditional volatility can be used to explain asset returns.

2.1. Conditional mean dependence, sign dependence and volatility dependence

According to Christoffersen and Diebold (2006), approximate conditional mean independence in asset returns, asset return sign dependence and asset return volatility dependence are interrelated. To explore this idea further, let X_t be the information set available to the investor at time t. Conditional mean return independence implies that $E(R_{t+1}|X_t)$ does not vary with X_t. Furthermore, when R_{t+1} displays sign forecastability (sign dependence), the expected return sign indicator series $E(I(R_{t+1} > 0)|X_t)$ varies with X_t; and when R_{t+1} displays conditional variance dependence (also referred to as conditional variance dynamics), $\sigma^2_{t+1|t} = \mathrm{Var}(R_{t+1}|X_t)$ varies with X_t.

The link between conditional return volatility and return sign forecastability can be demonstrated as follows. Consider the return on a risky asset at time $t+1$ conditional upon the information set X_t:

$$R_{t+1}|X_t \sim N\left(\mu, \sigma^2_{t+1|t}\right) \quad (1)$$

where $\mu = E(R_t) = E(R) > 0$ and $\sigma^2_{t+1|t} = \mathrm{Var}(R_{t+1}|X_t)$. While the return is assumed to be conditional mean independent (i.e., not