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Predicting bear and bull stock markets with dynamic binary time series models

Henri Nyberg *

University of Helsinki, HECER, Finland

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ABSTRACT

Despite the voluminous empirical research on the potential predictability of stock returns, much less attention has been paid to the predictability of bear and bull stock markets. In this study, the aim is to predict U.S. bear and bull stock markets with dynamic binary time series models. Based on the analysis of the monthly U.S. data set, bear and bull markets are predictable in and out of sample. In particular, substantial additional predictive power can be obtained by allowing for a dynamic structure in the binary response model. Probability forecasts of the state of the stock market can also be utilized to obtain optimal asset allocation decisions between stocks and bonds. It turns out that the dynamic probit models yield much higher portfolio returns than the buy-and-hold trading strategy in a small-scale market timing experiment.

1. Introduction

A great deal of econometric research has been devoted to examining the behavior and potential predictability of stock prices. Various authors have suggested that there is some degree of out-of-sample predictability in the stock returns (see, e.g., Rapach et al., 2005; Guo, 2006; Campbell and Thompson, 2008; Cenesizoglu and Timmermann, 2012, and the references therein). Returns exhibit various typical features, such as volatility clustering and dependence on future investment opportunities, which can be used to predict the behavior of the stock market and potentially be utilized in market timing decisions in order to earn higher (risk-adjusted) returns than, for example, can be obtained with a passive buy-and-hold trading strategy.

Despite the large amount of previous research on stock return predictability, much less attention has been paid to the extensive periods of time when stock returns are rising or falling. These periods are often referred to as bull and bear markets. In this study, the main goal is to predict the state of the stock market (i.e., bear and bull markets) with dynamic binary time series models proposed in the recent econometric literature.

As bear and bull market states appear to imply very different investment opportunities, investors operating in financial markets are especially interested in predicting these periods when making their asset allocation decisions. A growing branch of finance research explores the optimal strategic asset allocation decisions among different asset classes. Guidolin and Timmermann (2005, 2007), Tu (2010) and Guidolin and Hyde (2012), among others, have recently considered asset allocation decisions in the presence of regime switches in asset returns. The existence of regimes such as bear and bull markets naturally requires evaluation of the risk of coming regime changes. As an example, during a bear market stocks are not very attractive as stock prices are generally falling. If the future market regime is predictable, an investor can do better by shifting her investments to risk-free assets when a bear market is predicted to occur, and vice versa with a bull market, making forecasts of the state of the stock market cycle of interest.

Another point of view on the potential predictability of bear and bull markets is obtained when considering, for example, the literature on momentum profits or firm size and value effects in stock returns and their relation to market conditions. Cooper et al. (2004) find that the momentum profits are confined to up (bull) market periods while Asem and Tian (2010) suggest the existence of

* Address: Department of Political and Economic Studies, P.O. Box 17, Arkadiankatu 7, FI-00014 University of Helsinki, Finland. Tel.: +358 9 191 28714; fax: +358 9 191 28736.
E-mail address: henri.nyberg@helsinki.fi

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momentum profits not only when the markets continue in an up state, but also when the markets continue in a down (bear) state (i.e., there are no momentum profits available around stock market turning points). Correspondingly, Perez-Quiros and Timmermann (2000) and Guidolin and Timmermann (2008), among others, have reported substantial asymmetry in the stock returns of firm size and value portfolios between regimes. Since the changes in the market regime are important determinants of the key asset pricing phenomena, it is also of interest in this respect to examine the potential predictability of the stock market turning points determining bear and bull markets.

In general, the idea of classifying the state of the stock market into bear and bull markets is similar to identifying recession and expansion periods of real economic activity (see, e.g., Hamilton, 2011). Measuring the state of the economy and understanding the transition between recessions and expansions has been a major topic in business cycle research for a long time. In principle, the methods that are used to determine the business cycle turning points can also be employed to find the stock market turning points. Maheu and McCurdy (2000), Pagan and Sossounov (2003) and Candelon et al. (2008) examine various turning point dating methods for the stock market. The methods can essentially be divided into two main classes. In the first, the turning points are obtained from a statistical model such as the Markov switching model, whereas in the second approach a non-parametric dating rule such as the well-known Bry and Boschan (1971) algorithm is employed. In this paper, we will follow the latter approach in determining the state of the U.S. stock market.

In the empirical macroeconometric literature, Kauppi and Saikkonen (2008) and Nyberg (2010), among others, have recently shown that superior forecasts of the state of the business cycle can be obtained with dynamic binary time series models instead of using the conventional static model. To the best of my knowledge, Chen (2009) is the first study to consider the predictability of bear and bull stock markets with a static probit model and the main emphasis in his paper is also on Markov switching models. In the previous empirical finance research binary response models have been used to predict the signs of asset returns (see Leung et al., 2000; Rydberg and Shephard, 2003; Anatolyev and Gospodinov, 2010; Nyberg, 2011). As the binary time series showing the state of the U.S. stock market is much more persistent than the time series of the signs of monthly returns, the results concerning the usefulness of different model specifications and the best leading indicators of the stock market may differ from the evidence obtained in sign predictability research.

In this study, inspired by the findings obtained in the business cycle recession forecasting literature, the essential contribution is to generalize the conventional static probit model, also employed by Chen (2009), by allowing for dynamic structures in the predictive model for the U.S. bear and bull markets. In the static model, the bear market probability is determined solely by the past values of the predictive variables. A possible drawback of this approach is the lack of dynamics to capture how bear market probability may be influenced by the past state of the stock market cycle and the longer history of predictive variables. Thus, the main objective in this study is to compare the forecasting performance of the static model with more advanced dynamic probit models when using the predictive power of various financial and macroeconomic variables.

Following Pagan and Sossounov (2003) and Chen (2009), we concentrate on monthly U.S. data in which the bear and bull markets are based on the turning points of the S&P500 index identified by the Bry and Boschan (1971) algorithm. Making use of dynamic probit models with the dependence on the lagged state of the stock market, the fact that the stock market turning points are not necessarily known in real time should be taken into account when constructing a realistic forecasting model. In particular, since this means that the state of the stock market cycle is not necessarily known when forecasts are constructed, we pay special attention to the identification of the stock market turning points using the same information available to investors in real time in the past.

The results show that bear and bull market periods are predictable in and out of sample. In accordance with the findings obtained in the recession forecasting literature, the dynamic probit models consistently outperform the static model in terms of the statistical forecast accuracy measures, except the longest forecast horizons. This is also the case when comparing the returns obtained from simple market timing asset allocation strategies between stocks and the risk-free interest rate. In the dynamic models, the best predictive variables for the future market state are the term spread between the long-term and short-term interest rates and the dividend-price ratio. Furthermore, especially for the 1-month forecast horizon, the past stock returns and the past state of the stock market cycle have statistically significant out-of-sample predictive power for the future regime of the stock market.

The rest of the paper is organized as follows. In Section 2, the dating of the U.S. bear and bull stock markets and their effects in the usual regime switching modeling context are considered. The future bear and bull markets will be predicted using the static and dynamic probit models introduced in Section 3. Section 4 presents the in-sample and out-of-sample predictive performances of various probit models as well as results from the simple market timing experiment. Finally, Section 5 concludes the paper.

2. Bear and bull stock markets

2.1. Regime switching dynamics in stock returns

In stock market terminology, bear and bull markets are related to prolonged periods of decreasing and increasing market prices, respectively (see, e.g., Chauvet and Potter, 2000). In this sense, these two regimes correspond to the recession and expansion periods of real economic activity examined in the business cycle literature (see, e.g., Estrella and Mishkin, 1998; Hamilton, 2011). Recent surveys by Ang and Timmermann (2011) and Guidolin (2012) showed that econometric models allowing for regime switches can parsimoniously capture stylized behavior of financial returns, including persistently occurring periods of bull and bear markets, being thus useful in empirical finance research.

A large part of the previous literature on regime switching models in finance has concentrated on Markov switching models where the regime changes, such as bear and bull markets, have been modeled as unobserved regimes governed by a Markov chain with constant or time-varying transition probabilities (see, e.g., the survey by Guidolin (2012)). In addition to the ability to provide a good statistical description for the stock returns, Markov switching models have also been found useful in asset allocation and portfolio decisions (see, e.g., Guidolin and Timmermann, 2005, 2007; Tu, 2010). A general property of the Markov switching models is that the unobserved regimes are identified within the model. In this study, we follow a different approach in which binary response models are used to predict bear and bull markets determined by a mechanical dating rule and observed as the values of a binary time series.

Let us denote a 1-month stock return $r_t = \Delta \log P_t$ obtained as the log-difference of the level of the stock price index P_t, such as the S&P500 index employed in this study. Following Pagan and Sossounov (2003), we use a simple two-regime model (see also, e.g., Turner et al., 1989; Chen, 2009; Ang and Timmermann, 2011) as an illustration of the effects of bear and bull market regimes to justify the use of the binary time series models to predict these periods. The model is given as