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Toward an early warning system of financial crises: What can index futures and options tell us?

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ABSTRACT

This research develops an early warning system (EWS) for equity market crises based on multinomial logit models and variables relating to the information content of index futures and option markets. We show that the information impounded in S&P 500 futures and options is useful as leading indicators of financial crises. Results reveal that models estimated with futures and put options significantly improve the medium-term predictability of equity market crises. Variables that consistently provided information of an impending crisis include: the VIX, open interest, dollar volume, put option price, put option effective spread, and the Treasury term spread.

1. Introduction

Can the prediction of financial crises be improved? This question is addressed often in existing literature, particularly following the spike in currency crises in the late 1990s. Several authors have developed and modified 'early warning system' (EWS) models, and demonstrated success in the prediction of currency crises.[1] Surprisingly, a relatively sparse literature exists on forecasting equity market crises for the purpose of providing early signals of market declines. The current paper addresses this void in the literature. We accomplish this by exploring the information content of index futures and option markets, with the purpose of developing an EWS of financial crises.[2]

A considerable body of literature reports that option and/or futures markets tend to lead equity markets in terms of information arrival.[3] In addition, several researchers show that option/futures volumes, option/futures open interest, and implied volatility (VIX) exhibit predictive power on short-term equity price movement.[4] There are also theoretical reasons to believe that derivative markets may provide information in developing an EWS for equity markets. For example, Black (1975) argues that higher financial leverage offered by derivatives attracts greater participation by informed traders. Greater leverage implies greater risk and therefore increases the incentives for information dissemination and price discovery. Easley, O'Hara, and Srinivas (1998) and Pan and Poteshman (2006) present empirical evidence of information-based trading in option markets. The evidence in these studies indicates that derivative markets are more informative than equity markets. If an EWS model incorporates information revealed from derivative markets, it has potential to provide early signals of equity market crises.

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[1] For example, see Kaminsky et al. (1998), Berg and Pattillo (1999), Burkart and Coudert (2002), Kumar et al. (2003), and Bussiere and Fratzscher (2006).

[2] We note that the literature on the development of EWS is in contrast with the efficient market hypothesis, which says that prices follow a random walk.

[3] Please see, Manaster and Rendleman (1982), Diltz and Kim (1996), Kawaller et al. (1987), Stoll and Whaley (1990), Chan (1992), Fleming et al. (1996), Pizzi et al. (1998), and Kavussanos et al. (2008).

[4] See, Easley et al. (1998), Pan and Poteshman (2006), and Chung et al. (2011).

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The current research employs a multinomial logit model to test the forecasting power of several derivative market indicators on the probability of a financial crisis. We select variables from the two most active index derivatives in the U.S., the S&P 500 futures (SP) and the S&P 500 options (SPX), to test the predictability of financial crises from 1997 to 2009. In the multinomial logit model, we include the following variables as suggested by existing literature: open interest, dollar volume, option price, option effective spread, and the implied volatility of the S&P 500 options (VIX). This study tests several model specifications to understand the marginal contribution of each explanatory variable in the prediction of a financial crisis. Additionally, we re-estimate all models with the addition of Treasury term spread and test the robustness of the parameter estimates to an alternative definition of a financial crisis.

The empirical results support the notion that index futures and option markets lead equity markets. All models estimated successfully predict the majority of financial crisis months within the sample period.[5] Among the futures and option models, the best performing model, using put option variables, correctly identifies 85.8% of observations and 65.4% of crisis months. When the term spread is included within the model, the results improve with 94.8% of observations correctly identified and 92.3% of crisis months predicted correctly. The results of this paper demonstrate that information contained in index futures and option markets is useful as leading indicators of financial turmoil. By developing EWS models that utilize the information contained in S&P 500 futures and option markets to forecast equity market crises, this research contributes to the understanding and prediction of financial crises.

The remainder of the paper is organized as follows. Section 2 reviews literature, Section 3 describes data and methodologies, Section 4 discusses empirical results, and Section 5 concludes.

2. Literature review

The current state of predicting financial crises is much better than a 'random guess'. A number of studies have developed EWS models based on data from a variety of countries. Examples of this research include: Kaminsky, Lizondo, and Reinhart (1998), Kumar, Moorthy, and Perraudin (2003), Distinguin, Rous, and Tarazi (2006), Bussiere and Fratzscher (2006), and Coudert and Gex (2008). Kaminsky et al. (1998) propose and test a 'signals' approach which combines several macroeconomic variables as leading indicators to predict currency crises. They show that EWS models based on leading macroeconomic indicators crossing a pre-specified threshold level are useful in the prediction of currency crises.[6] Kumar et al. (2003) and Distinguin et al. (2006) employ binomial logit models to predict currency crashes and banking crises, respectively. The results of both papers argue for the use of a binomial discrete dependent variable approach to forecast financial crises. However, Bussiere and Fratzscher (2006) argue that an EWS model based on a binomial discrete dependent variable is subject to a post-crisis bias, because it does not distinguish crisis and post-crisis periods. Applying a multinomial logit model, Bussiere and Fratzscher (2006) show a significant improvement of forecasting currency crises. In a recent paper related to the current research, Coudert and Gex (2008) employ multinomial logit models using well-known risk aversion indicators. They document that the majority of these risk aversion indicators are good leading indicators of currency crises, and all have predictive power of equity market crises.

Most EWS models use macroeconomic or monetary variables as leading indicators to predict currency crises. In contrast to the majority of existing literature, the current research utilizes the information revealed in derivative markets to predict equity market crises within a multinomial logit model over a one-year forecasting horizon. To motivate our variable selection, we now briefly summarize the literature on the linkages between equity and derivative markets.

Voluminous literature examines the lead–lag relationships between option/futures prices and the underlying equity prices (returns). The preponderance of the empirical evidence demonstrates that option/futures prices (returns) lead cash index prices (returns). For example, in a comprehensive analysis of the S&P 100 and 500 futures, options, and spot markets, Fleming, Ostdiek, and Whaley (1996) find that index futures and option returns lead equity index returns. Their empirical evidence is consistent with the trading cost hypothesis that price discovery occurs first in the lowest-cost markets.[7]

The informational role of option/futures volume and open interest is also researched extensively in literature. For example, volumes and open interest are used to examine information arrival in option/futures and equity markets, to predict equity/option price movements, to predict future price volatility, and to investigate the existence of informed trading regarding corporate events. Most related to the current research are studies that use volume or order flow to examine the informativeness of options/futures relative to equity markets. A good example of this type of study is Chakravarty, Gulen, and Mayhew (2004). They document that option markets are more informative when the option volume is higher and effective spread is narrower relative to those of the stock markets. Bessembinder, Chan, and Seguin (1996) examine the relations between information, divergence of opinions, and trading activity of S&P 500 futures. They confirm a positive relationship between information flow and trading volume in the spot and futures markets.

Additional literature relevant to the current research explores the information role of option implied volatility and examines its relationship with equity returns, future realized volatility, and stock market crashes. The evidence of a positive relationship between implied volatility and equity returns is presented in Giot (2005) and Banerjee, Doran, and Peterson (2007). In an analysis of VIX and S&P 100 index, Giot (2005) documents a positive relationship between VIX and future market index returns. In a similar study, Banerjee et al. (2007) find that future portfolio returns are positively significantly related to both VIX levels and innovations for portfolios sorted by beta, size, and book-to-market equity.

Recent research has demonstrated the superior predictive power of implied volatility on future realized volatility and returns as well. In a study of the 1997 Hong Kong stock market crash, Fung (2007) finds that implied volatility performs better than volume, open interest, and arbitrage basis of index futures in forecasting the future realized volatility. Chung, Tsai, Wang, and Wang (2011) show that the information embedded in VIX options significantly improves the predictive power on the returns, volatility, and density of the S&P 500 index.

Limited research examines index derivatives market variables to predict an equity market crisis. Early research by Bates (1991) and Rappoport and White (1994) document that the equity

[5] Models estimated with index futures market variables display similar conditional probabilities to models estimated with index put option variables.

[6] Examples of leading indicators include: international reserves, the real exchange rate, domestic credit, public sector credit, domestic inflation, trade balance, exports, money growth, real GDP growth, the fiscal deficit, and equity prices.

[7] International evidence confirms that futures prices (returns) lead equity prices (returns) [e.g., Abhyankar, 1998; Kavussanos, Visvikis, & Alexakis, 2008; Ryoo & Smith, 2004; Tang, Mark, & Choi, 1992].