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Macroeconomic factors and index option returns

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ABSTRACT

This study empirically investigates whether macroeconomic factors are priced in the cross-section of index option returns. Macroeconomic factors are extracted from a large panel of 132 economic activity indicators using dynamic factor analysis. The empirical analysis employs linear factor methodology with a factor structure including market return and macroeconomic factors. The results show that the risk premia on inflation, term spread, industrial production, and housing factors are significant. Further, business sales is a useful conditioning factor that drives variation in market betas. These extracted macroeconomic factors provide information that is not fully captured by Fama and French's (2015) investment and profitability factors.

1. Introduction

Macroeconomic activities are known to directly impact asset prices since firms' cash flow and risk-adjusted discount rates change with economic conditions. The extant literature has identified macroeconomic variables as essential state variables, that is, such variables should be priced as risk factors or at least, they carry common dynamic patterns in security returns (e.g., Chen, Roll & Ross, 1986; Ferson & Harvey, 1999).

Explaining puzzling stylized facts in option prices, such as asymmetric smiles and unstable volatility surfaces, has been a major issue in empirical option pricing. The reduced-form option pricing approach identifies and models stochastic volatility and jumps in underlying price/volatility as risk factors determining option prices. The risk premium on each factor is introduced as the difference between the parameters estimated under risk-neutral and objective probability measures. However, empirical results for the magnitude and significance of risk premia on these factors are mixed. Constantinides, Jackwerth, and Savov (2013), on the other hand, adopt the linear factor pricing model and confirm that crisis-related factors (price jumps, volatility jumps, and changes in liquidity, as defined in their paper) are priced in index option returns.

Another important strand of research emphasizes the role of economic mechanisms driving puzzling stylized fact in option prices. These studies develop an economy modeled using an unobservable state variable and conclude that uncertainty about the true value of the state variable generates asymmetric smiles and a risk premium on uncertainty (e.g., Buraschi & Jiltsov, 2006; David & Veronesi, 2002; Dubinsky & Johannes, 2005; Veronesi, 2000). In general, the candidate state variables include the output growth, inflation, interest rate, and corporate earnings. Economic state variables either have an effect on options' payoffs or signal a changing investment opportunity set. These studies confirm that an accurate update of the economy's current state can mitigate the mispricing of options. However, the influence of macroeconomic variables on option prices has rarely been discussed from a risk–return perspective; this is partially because of the lagged adjustment of the macroeconomic time series relative to finance time series. The advantage of adopting the risk–return perspective is that it allows us to evaluate the economic significance of pricing influence, particularly when assessing the extent to which potential returns outweigh risks.

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The risk–return relationship between macroeconomic variables and the stock or bond market has been extensively examined.[1] Theory, however, has been silent about which variables can influence all assets. Previous studies mostly rely on a small subset of selected macroeconomic variables; for example, term spread, default spread, dividend yield, and industrial production. Several studies[2] indicate that such reliance can suffer from drawbacks. First, certain economic variables are more likely to be imperfectly measured than financial time series, and thus, are less likely to precisely reflect the real economic concept. For example, the consumer price index (CPI) is one of the most popular measures of inflation; however, the fixed-weight nature of the CPI can cause an upward bias problem[3] compared with the personal consumption expenditure (PCE) price index, constructed on the basis of the changing composition of spending. Second, choosing a small number of economic variables could give rise to the problem of information omission, resulting in misleading model estimations. Third, the temporal instability in individual time series is less likely to be mitigated in a low-dimensional dataset. By contrast, instability in a high-dimensional dataset can be alleviated through statistical modeling, such as dynamic factor analysis, provided that the patterns of instability differ by series (e.g., Ludvigson & Ng, 2009; Stock & Watson, 2002). The abovementioned points prompt the current study to perform analyses using a large set of macroeconomic time series.

This study draws on Constantinides et al. (2013), who construct the leverage-adjusted index option portfolio returns and conduct a horse race test on various sets of factors, including a set of selected macroeconomic variables commonly used in the literature. They conclude that crises-related factors work well in the cross-section of options; however, macroeconomic factors fail to do this job. By contrast, the present study focuses on the role of macroeconomic factors and adopts an asset pricing framework to examine whether macroeconomic factors are priced in S & P 500 index option returns. In particular, it performs dynamic factor analysis to extract common macroeconomic factors from the broad categories of economic activity indicators. In this way, a large set of macroeconomic variables can be summarized into a handy set of common factors that are possibly less noisy measures for economic state variables. Note that characterizing a set of macroeconomic factors that outperform crisis-related factors is not the primary purpose of this study. Instead, this study aims to identify relevant macroeconomic forces that drive the co-movement of index option prices across moneyness and maturity.

This study makes the following contributions. First, rather than exhaustively characterizing a set of influential macroeconomic variables, this study develops a connection between Merton's (1973) intertemporal capital asset pricing model and option returns by determining a set of common factors that summarizes a large fraction of the variation in 132 macroeconomic time series. Second, it finds that the estimated risk premia on factors related to inflation, term spread, industrial production, and housing are significant. Linear two-factor models with any of these factors (along with the S & P 500 index return) outperform the single factor model, that is, the pricing errors of index option returns are substantially reduced. Third, conditioning the CAPM on factors related to business sales, the model best explains the cross-section of index option returns. Finally, the significance of these macroeconomic factors is robust even when imposing a restriction on the market risk premium or using 10 momentum equity portfolios. These extracted macroeconomic factors also provide information that is not fully captured by Fama and French's (2015) investment and profitability factors.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 outlines the empirical method. Section 4 describes the data construction. Section 5 presents the empirical results. Section 6 provides several robustness checks. Section 7 concludes the paper.

2. Related literature

Analyses on option returns have recently received increasing attention. Diressen and Maenhout (2007) use S & P 500 OTM put returns and ATM straddle returns to examine the economic benefits of holding option positions from the perspective of asset allocation. Rosenberg and Engle (2002) estimate a time-varying pricing kernel using S & P 500 option returns and a stochastic volatility model for the S & P 500 index returns and conclude that the empirical pricing kernel exhibits counter-cyclical investor risk aversion in the S & P 500 return states. Cao and Huang (2007) examine the common factors that affect S & P 500 index option returns and conclude that 93% of the variation in option returns can be explained by three factors determined using principal component analysis.

Adopting the risk–return perspective, Broadie, Chernov, and Johannes (2009) find that put options are not mispriced by comparing historical returns on S & P 500 futures options with those generated using common option pricing models. Using linear multifactor and stochastic discount factor (SDF) models, Bondarenko (2003), Santa-Clara and Saretto (2009), and Coval and Shumway (2001) conclude that returns on options or option strategies are not in line with their risks. Coval and Shumway (2001) find that zero-beta straddle returns cannot be justified by the asset pricing model and suggest that stochastic volatility should be considered as a risk factor in securities returns. Echoing this result, Arisoy, Salih, and Akdeniz (2007) use zero-beta straddle returns

[1] Studies analyzing the risk–return relationship include Chen et al. (1986) (term spread, default spread, dividend yield, and industrial production), Ferson and Harvey (1999) (term spread, default spread, and dividend yield), Hahn and Lee (2006) (term spread and default spread), Jensen and Mercer (2002) (proxies for monetary stringency), Liu and Zhang (2008) (industrial production), Peiro (2016) (industrial production and interest rate), Santos and Veronesi (2006) (labor income) Much research focuses on the reaction of asset returns and volatility to scheduled macroeconomic news announcements. For example, see Becker, Finnerty, and Friedmam (1995), Flannery and Protopapadakis (2002), McQueen and Roley (1993), and Veronesi (1999) for the stock market and Balduzzi, Elton, and Green (2001), Bollerslev, Cai, and Song (2000), Ederington and Lee (1993), and Fleming and Remolona (1999) for the bond market.

[2] See Ludvigson and Ng (2007, 2009) for a more detailed discussion.

[3] See the Monetary Policy Report to the Congress, Federal Reserve Board of Governors, February 17, 2000.