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Super-exponential growth expectations and the global financial crisis ☆

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ABSTRACT

We construct risk-neutral return probability distributions from S&P 500 options data over the decade 2003–2013, separable into pre-crisis, crisis and post-crisis regimes. The pre-crisis period is characterized by increasing realized and, especially, option-implied returns. This translates into transient unsustainable price growth that may be identified as a bubble. Granger tests detect causality running from option-implied returns to Treasury Bill yields in the pre-crisis regime with a lag of a few days, and the other way round during the post-crisis regime with much longer lags (50–200 days). This suggests a transition from an abnormal regime preceding the crisis to a "new normal" post-crisis. The difference between realized and option-implied returns remains roughly constant prior to the crisis but diverges in the post-crisis phase, which may be interpreted as an increase of the representative investor's risk aversion.

1. Introduction

The Global Financial Crisis of 2008 brought a sudden end to a widespread market exuberance in investors' expectations. A number of scholars and pundits had warned ex ante of the non-sustainability of certain pre-crisis economic developments, as documented by Bezemer (2011). Those who warned of the crisis identified as the common elements in their thinking the destabilizing role of uncontrolled expansion of financial assets and debt, the flow of funds, and the impact of behaviors resulting from uncertainty and bounded rationality. However, these analyses were strongly at variance with the widespread belief in the "Great Moderation" (Stock and Watson, 2003) and in the beneficial and stabilizing properties of financial derivatives markets by their supposed virtue of dispersing risk globally (Summers et al., 1999; Greenspan, 2005). In hindsight, it became clear to everyone that it was a grave mistake to ignore issues related to systemic coupling and resulting

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cascade risks (Bartram et al., 2009; Hellwig, 2009). But could we do better in the future and identify unsustainable market exuberance ex ante, to diagnose stress in the system in real time before a crisis starts?

The present paper offers a new perspective on identifying growing risk by focussing on growth expectations embodied in financial option markets. We analyze data from the decade around the Global Financial Crisis of 2008 over the period from 2003 to 2013.[1] We retrieve the full risk-neutral probability measure of implied returns and analyze its characteristics over the course of the last decade. Applying a change point detection method (Killick et al., 2012), we endogenously identify the beginning and end of the Global Financial Crisis as indicated by the options data. We consistently identify the beginning and end of the Crisis to be June 2007 and May 2009, which is in agreement with the timeline given by the Federal Reserve Bank of St. Louis (2009).[2]

The resulting pre-crisis, crisis and post-crisis regimes differ from each other in several important aspects. First, during the pre-crisis period, but not in the crisis and post-crisis periods, we identify a continuing increase of S&P 500 expected returns. This corresponds to super-exponential growth expectations of the price. By contrast, regular expectation regimes prevail in the crisis and post-crisis periods. Second, the difference between realized and option-implied returns remains roughly constant prior to the crisis but diverges in the post-crisis phase. This phenomenon may be interpreted as an increase of the representative investor's risk aversion. Third, Granger-causality tests show that changes of option-implied returns Granger-cause changes of Treasury Bill yields with a lag of few days in the pre-crisis period, while the reverse is true at lags of 50–200 days in the post-crisis period. This role reversal suggests that Fed policy was responding to, rather than leading, the financial market development during the pre-crisis period, but that the economy returned to a "new normal" regime post-crisis.

The majority of related option market studies have used option data for the evaluation of risk. An early contribution to this strand of work is Aïtsahalia and Lo (2000) who proposed a nonparametric risk management approach based on a value at risk computation with option-implied state-price densities. Another popular measure of option-implied volatility is the Volatility Index (VIX), which is constructed out of options on the S&P 500 stock index and is meant to represent the market's expectation of stock market volatility over the next 30 days (Chicago Board Options Exchange, 2009). Bollerslev and Todorov (2011) extended the VIX framework to an "investor fears index" by estimating jump tail risk for the left and right tail separately. Bali et al. (2011) define a general option-implied measure of riskiness taking into account an investor's utility and wealth leading to asset allocation implications. What sets our work apart is the focus on identifying the long and often slow build-up of risk during an irrationally exuberant market that typically precedes a crisis.

Inverting the same logic, scholars have used option price data to estimate the risk attitude of the representative investor as well as its changes. These studies, however, typically impose stationarity in one way or another. Jackwerth (2000), for example, empirically derives risk aversion functions from option prices and realized returns on the S&P 500 index around the crash of 1987 by assuming a constant return probability distribution. In a similar way, Rosenberg and Engle (2002) analyze the S&P 500 over four years in the early 1990s by fitting a stochastic volatility model with constant parameters. Bliss and Panigirtzoglou (2004), working with data for the FTSE 100 and S&P 500, propose another approach that assumes stationarity in the risk aversion functions. Whereas imposing stationarity is already questionable in "normal" times, it is certainly hard to justify for a time period covering markedly different regimes as around the Global Financial Crisis of 2008. We therefore proceed differently and merely relate return expectations implicit in option prices to market developments, in particular to the S&P 500 stock index and yields on Treasury Bills. We use the resulting data trends explicitly to identify the pre-crisis exuberance in the trends of market expectations and to make comparative statements about changing risk attitudes in the market.

The importance of market expectation trends has not escaped the attention of many researchers who focus on 'bubbles' (Galbraith, 2009; Sornette, 2003; Shiller, 2005; Soros, 2009; Kindleberger and Aliber, 2011). One of us summarizes their role as follows: "In a given financial bubble, it is the expectation of future earnings rather than present economic reality that motivates the average investor. History provides many examples of bubbles driven by unrealistic expectations of future earnings followed by crashes" (Sornette, 2014). While there is an enormous econometric literature on attempts to test whether a market is in a bubble or not, to our knowledge our approach is the first trying to do so by measuring and evaluating the market's expectations directly.[3]

This paper is structured as follows. Section 2 details the estimation of the risk-neutral return probability distributions, the identification of regime change points, and the causality tests regarding market returns and expectations. Section 3 summarizes our findings, in particular the evidence concerning pre-crisis growth of expected returns resulting in super-exponential price growth. Section 4 concludes with a discussion of our findings.

[1] Related existing work has considered data from pre-crisis (Figlewski et al., 2010) and crisis (Birru and Figlewski, 2012).

[2] See Section 3.2 for more details on market and policy events marking the Global Financial Crisis of 2008.

[3] For the econometric literature regarding assessments as to whether a market is in a bubble or not see Stiglitz (1990) (and the corresponding special issue of the Journal of Economic Perspectives), Bhattacharya and Yu (2008) (and the corresponding special issue of the Review of Financial Studies), as well as Camerer (1989), Scheinkman and Xing (2003), Jarrow et al. (2011), Evanoff et al. (2012), Lleo and Ziemba (2012), Phillips et al. (2013), and Hüsler et al. (2013).