BULLS, BEARS AND STRESS BETAS

by

Robert J. Bianchi
Griffith Business School, Griffith University

Michael E. Drew
Griffith Business School, Griffith University

Scott N. Pappas
Griffith Business School, Griffith University

and

Rene Tetteroo
Griffith Business School, Griffith University

Abstract

Diversified portfolios, those that invest beyond stock and bonds, may exhibit stress-betas. That is, they can experience periodic increases in beta, making them more sensitive to equity market moves. We find that stress-betas are not just a bear market phenomenon. Diversified portfolios have experienced increased betas during bull and bear markets. At a portfolio level, increases in correlation and the ratio of portfolio volatility to market volatility cause stress-betas.

Keywords: bull markets, bear markets, stress betas
JEL Codes: G11, G14, G23

1. Introduction

There is an old adage used by investors during periods of market turmoil that "*the only things that go up in a crisis are correlations*." This was particularly the case during the Global Financial Crisis (GFC) where growth-oriented asset classes exhibited a strong degree of correlation, particularly with U.S. equity.[1] It is against this backdrop that this study examines the relationship between portfolio sensitivity, or beta, and market conditions. At the heart of this relationship is correlation.

[1] For empirical evidence, see Leibowitz & Bova (2009).

This study examines the *stress-beta* hypothesis of Leibowitz & Bova (2009).[2] We compare the characteristics of different portfolio configurations - ranging from the *traditional,* 60/40 equity-bond portfolio, through various *diversified* portfolios comprised of multiple asset classes. Leibowitz & Bova (2009) find that, in *normal* market conditions, traditional and diversified portfolios are characterized by largely homogenous risk sensitivities - total portfolio volatility, the ratio of portfolio to U.S. equity volatility, portfolio correlation with US equities, and correlation-based betas are similar between diverse portfolios. During periods of stress, such as when equity markets fall, these portfolio sensitivities can change, and in some cases change dramatically. Leibowitz & Bova (2009) conjecture that diversified portfolios are more affected by stress-beta, that is, a sudden increase in equity market sensitivity, more so than their less diversified counterparts.

Building on the hypothesis of Leibowitz & Bova (2009), this paper examines the causes and behaviour of stress-beta in various market conditions, namely, extended periods of market rally (bull) and decline (bear) conditions.[3] It considers the beta of two policy portfolios - a traditional stock and bond portfolio, and a diversified multi-asset class portfolio. The stress-beta hypothesis proposes that while both traditional and diversified portfolios have largely homogenous risks during normal times, in severely declining markets the tightening of correlations has the potential to make diversified portfolios more vulnerable to stress-betas.

Using monthly real asset class returns for the period 1988 through 2011, we test the stress-beta hypothesis by comparing two representative policy portfolios in varying market conditions. We build on the work of Leibowitz & Bova (2009) by testing the stress-beta hypothesis in distinct market environments by formally identifying bull and bear markets.[4] We employ the Pagan & Sossounov (2003) ex-post dating algorithm, derived from the business cycle work of Bry & Boscham (1971), to identify distinct bull and bear markets.

2. Stress-Beta

Beta is the sensitivity of an investment's returns to the market's returns. For a given change in the market, an investment with a higher beta will change more than one with a lower beta. This paper examines portfolio beta during different market environments. We focus on identifying periods of stress-beta; episodes where portfolio beta increases dramatically, so that it is higher than the long-run beta.

---

[2] The topic of stress betas is part of a larger research theme on conditional betas, correlation convergence and dual betas. The non-stationarity of beta over varying market conditions is a well-known phenomenon (see Chen, 1982 among others) and we take one methodological approach (that of Leibowitz and Bova, 2009) to contribute to one specific area within the debate, namely, stress betas.

[3] This study builds on the work of Leibowitz and Bova (2009) by estimating stress betas by breaking up market history into bull and bear periods, such that the market is always either in one state or the other (bull or bear). A direction for future research may be to identify periods of unusual stress (for instance, a market can be declining but not under stress (say, the 2000-2002 bear market was orderly), and a market can be generally rising but under stress (the Asian contagion and LTCM episodes within the 1990s bull market are cases in point). We simply define 'stress' in this paper as a period of extended market decline. As discussed further in the paper, Leibowtiz & Bova (2009) considered the issue of stress betas during a single market condition (specified in their paper as the GFC period of calendar 2008).

[4] The work of Leibowitz & Bova (2009) focusses on stress betas during the GFC period (specified as calendar year 2008).

Following Leibowtiz & Bova (2009), portfolio beta is implicitly derived from the variance-covariance matrix of portfolio assets. This implicit beta can be calculated as the product of the portfolio correlation with the market, and the ratio of the portfolio and market volatility. Using the S&P 500 as a proxy for the market we calculate portfolio beta as;

$$\beta_p = \rho_{p,M}\left(\frac{\sigma_p}{\sigma_M}\right). \quad \textbf{(1)}$$

From this equation we can see that portfolio beta β_p is a function of the portfolio's correlation with the market $\rho_{p,M}$, and the ratio of portfolio volatility σ_p and market volatility σ_M. The latter term is classified as the volatility ratio. From this definition we can see that stress-beta can be caused either by an increase in the correlation between the portfolio and the market, an increase in the volatility ratio, or a combination of these events.

3. Portfolios

Leibowitz & Bova (2009) demonstrated that correlation tightening and the resulting stress-beta has the potential to hurt diversified portfolios more than their less diversified alternatives. To examine their hypothesis further we employ two portfolio configurations. Our benchmark (and theirs) is the traditional 60/40 US stock-bond portfolio. We also construct a diversified portfolio consisting of US stocks and bonds, global stocks and bonds, emerging market stocks, real estate and commodities. Both of these portfolios are representative of portfolios employed in practice and have also featured prominently in the finance literature. Table 1 summarises the proxies employed to calculate investment returns for each portfolio. We convert asset returns to real rates of return using US CPI data as a proxy for the rate of inflation.[5]

Table 1 Asset Classes and Return Proxies

Investment	Proxy
US Stocks	S&P 500 (Total Return)
US Bonds	Barcap US Agg Bond (Total Return)
Global Stocks	MSCI EAFE (Gross)
EM Stocks	MSCI EM (Gross)
Global Bonds	Citigroup World Government Bond Index (Unhedged)
Real Estate	FTSI NAREIT (Equity REITS)
Commodities	S&P GSCI (Total Return)

Figure 1 illustrates the portfolios showing target portfolio weights for each investment.[6] Each portfolio is rebalanced to these weights at the end of each month.

Table 2 shows portfolio performance for each of the portfolios - the return, volatility and beta for each of the portfolios are similar. Digging deeper into the figures, we see that although portfolio beta is similar between funds, the diversified fund has a lower correlation

[5] Data is sourced using DataStream.

[6] The asset weights used for the diversified portfolio are based on the Vanguard Managed Payout Distribution Focus Fund Investor Shares.

with the market than the traditional fund. In theory, this implies the diversified portfolio is more susceptible to a sudden increase in beta from an increase in correlation.

Figure 1 Portfolio Asset Allocations

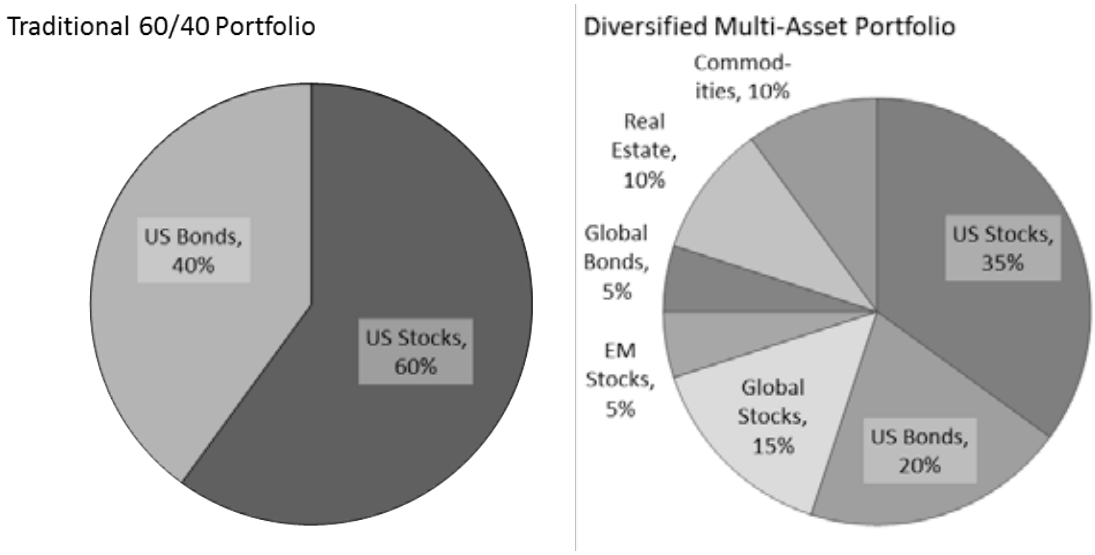


Table 2 Full-Sample Portfolio Performance

Descriptive Statistics	Traditional	Diversified
Return (% p.a.)	6.22%	6.35%
Volatility (% p.a.)	9.47%	10.39%
ρ(p,M)	0.98	0.92
Volatility Ratio	0.63	0.69
Portfolio Beta	0.62	0.64

4. Market Cycles

The work of Leibowtiz & Bova (2009) considered the issue of stress betas during a single market condition (specified in their paper as the GFC period of calendar 2008). We seek to add to the debate through an analysis of the performance of portfolios over different market conditions. To do so, we use the ex-post dating algorithm of Pagan & Sossounov (2003).[7],[8] The algorithm identifies bull and bear markets by finding the high and low points in a data series. These points are used to establish the start or end point of bull and bear market phases. Each phase must meet certain criteria to be identified as such. For example the total length of consecutive bull and bear market phases must be a minimum duration of sixteen months. Figure 2 illustrates the bull and bear markets identified by the

[7] We also employed the ex-post dating algorithm of Lunde & Timmermann (2004), but found it to produce almost identical results. The one difference was the short bear market in 1990 identified by the Pagan & Sossounov (2003) method which was not identified by the Lunde & Timmermann (2004) method.

[8] We note that there are a multitude of approaches to the identification of market cycles, of which we have used two (and reported one) of an ex-post nature in this study. For an alternative that considers a more dynamic estimation of bull and bear betas, see Woodward and Anderson (2009).

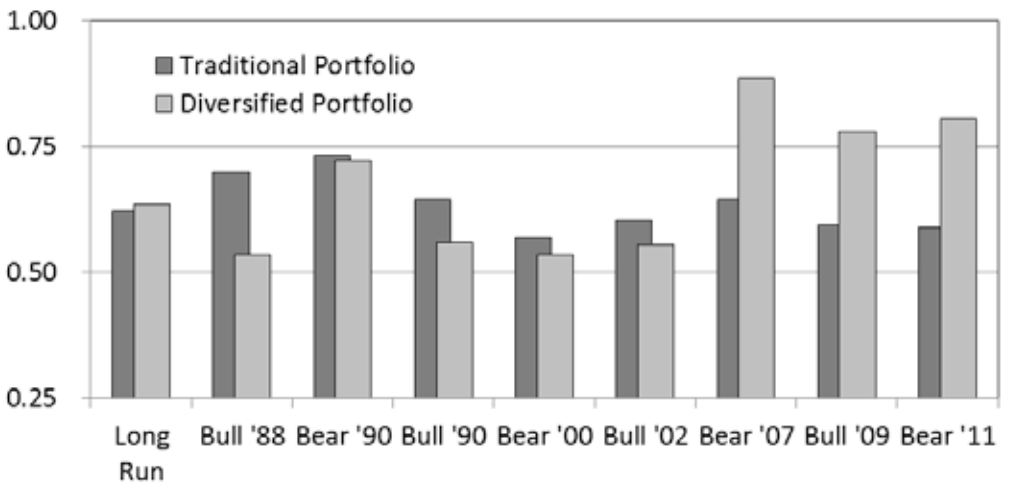
algorithm. Four bull and four bear markets are identified in the data. These eight phases will be employed to analyse the occurrence and characteristics of the portfolio stress-betas.

Figure 2 Bull and Bear Markets in US Equities (S&P 500)

5. Beta and Diversification

Figure 1 compares the portfolio beta of the traditional and diversified portfolios. The results, consistent with those of Leibowitz & Bova (2009), show an increase in beta for the diversified portfolio during, and subsequent to the GFC. The benefits of the diversified portfolio, that is, lower beta, are clear up until the bear phase in 2007 (the GFC). The diversified portfolio experiences stress-betas for the last three market phases of the study. Interestingly, the incidence of stress-betas appears to be a recent phenomenon, as the previous market cycles did not display significant increases in beta. In fact, *up until the GFC the diversified portfolio had portfolio betas consistently lower than the traditional portfolio*. While the diversified portfolio is susceptible to stress-betas, it is not always the case that they occur. Stress-betas appear to be period specific, implying that diversification works, just not all the time.

Figure 3 Betas for the Traditional Stock-Bond and Diversified Multi-Asset Portfolios

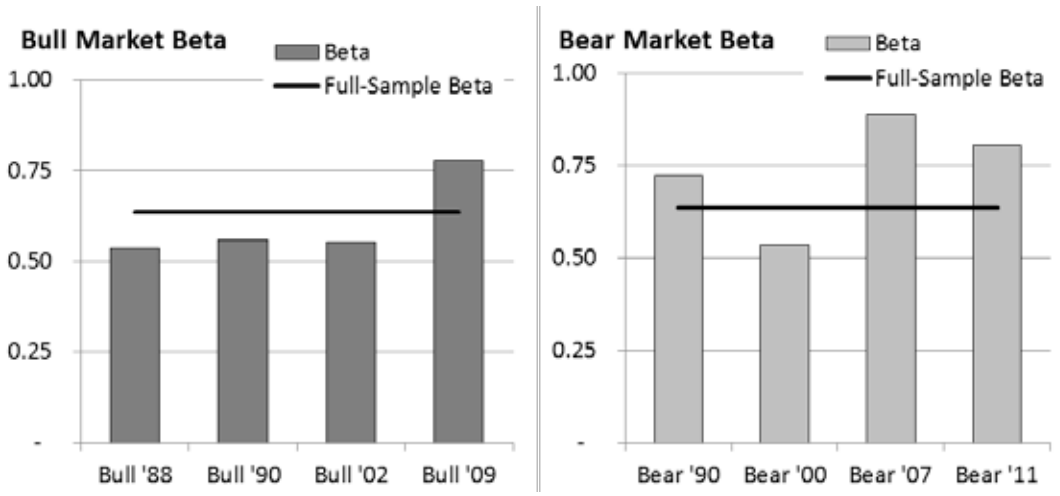


6. Bull and Bear Market Betas

Having explored the existence of stress-betas in the diversified portfolio, we now turn our attention to relationship between market phase and beta. Figure 4 examines the beta of the diversified portfolio during bull and bear market phases. Of the eight distinct market phases, four exhibit stress-betas. Interestingly, it appears that stress-betas can occur in both bull and bear markets. The most recent bull market, occurring after the GFC, saw portfolio beta increase markedly. The figure also shows that a bear market is not a sufficient condition for a stress-beta to occur. The 2000 bear market did not exhibit stress-beta. It appears that, at least according to our definitions, a bear market is not a necessary or sufficient condition for the occurrence of stress-beta.

The implication of this finding is important. While it is consistent with the findings of Leibowitz & Bova (2009), that is, diversified portfolios are at risk of stress-betas, we should not conclude that increases in beta will always occur. While the appearance of stress-betas during the most recent bear markets caused an increase in portfolio sensitivity, it was not just a bear market phenomenon. Stress-betas can work in favour of portfolio performance as well.

Figure 4 Diversified Portfolio Beta in Bull and Bear Markets



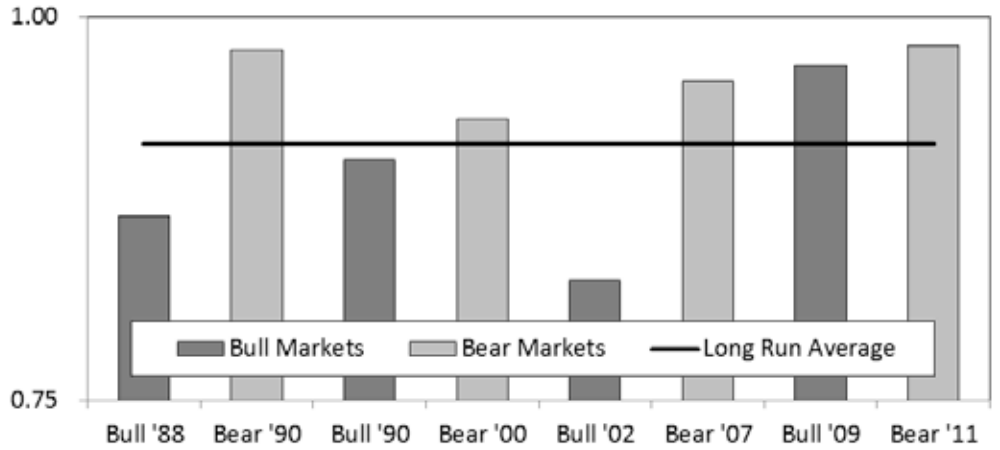
7. The Causes of Stress-Beta

Examining the data further we can attempt to identify what drives stress-beta. Recall from formula (1)

that portfolio beta is a function of the volatility ratio, and the correlation, between the portfolio and the market. Figure 5 below shows the correlation between the diversified portfolio and the market over the various market phases. Correlations vary widely between periods and it appears that they are generally higher during bear markets. All four stress-beta periods exhibit a high level of correlation. As suggested by Leibowitz & Bova (2009), the diversified portfolios are effected by correlation tightening. The bear market in 2000 also has an elevated correlation, however this period did not experience an increase in beta. While all

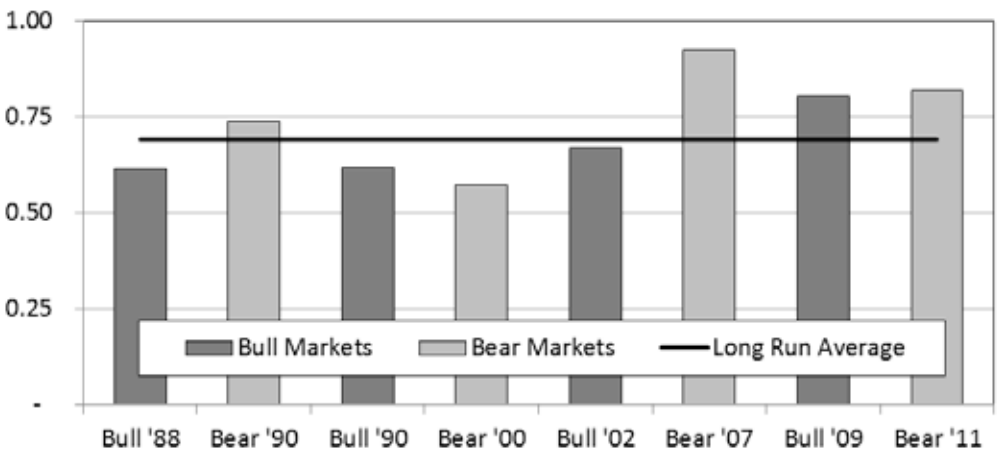
stress-betas can be characterized by elevated correlations this does not by itself result in a stress-beta.

Figure 5 Diversified Portfolio and Market Correlation during Bull and Bear Phases



The volatility ratio is the other component that completes the beta equation. Figure 6 examines the volatility ratio of the diversified portfolio for the identified bull and bear markets. The four periods with the highest volatility ratio coincide with periods of stress-betas. The increase in volatility ratio *combined* with the increase in correlation during these periods caused the occurrence of stress-betas. The results indicate that for stress-betas to appear, both a tightening in correlation and an increase in volatility ratios are required.

Figure 6 Diversified Portfolio Volatility Ratio in Bull and Bear Markets



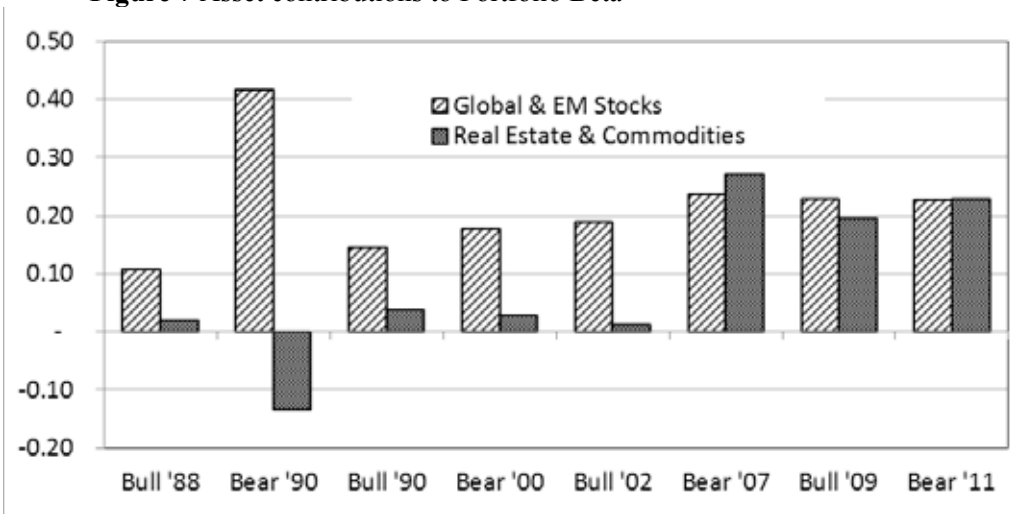
8. Asset Beta Behaviour

Another way to examine the causes of stress-betas is to examine the individual asset class betas. By examining individual betas we can determine how effective diversification is. As the US Equity beta is constant and the beta of the two bond assets is very low we will ignore them in the analysis. Figure 7 compares the beta of the remaining assets. The figure

contrasts the combined beta of global and emerging market stocks with the combined beta of commodities and real estate. Aside from the 1990 bear market, the beta of global and emerging market stocks maintains a modest range. Excluding the 1990 bear market, the variation in beta is not enough to cause the stress-betas exhibited by the portfolio.

The combined beta of real estate and commodities however, is more interesting. Rather than differing between bull and bear market phases as one might expect, these assets seem to vary between cycles. The distinction can be seen before and after the GFC, which ended the 2002 bull market and started the 2007 bear market. Prior to the GFC, real estate and commodities contributed very little to portfolio beta. In fact on average they had a beta of zero for the period. After the GFC however, these two asset classes had a significant impact on portfolio beta as can be seen in Figure 7. During the last three market phases real estate and commodities contributed as much to portfolio beta as the global and emerging market stocks. The most recent incidence of stress-beta appears to be largely due to the increase in real estate and commodity beta.

Figure 7 Asset contributions to Portfolio Beta



9. Conclusion

Diversified portfolios exhibit stress-betas, that is, episodes where portfolio beta is higher than the long-run average. We find that these episodes are not unique to bear markets, and moreover, stress-betas are not guaranteed to occur during bear markets. Stress-betas, in our study, appeared only when both correlation between, and volatility ratio of, portfolio and market returns increased. Our findings suggest that three recent occurrences of stress-beta were largely caused by an increase in real estate and commodity beta. Our results suggest that multi-asset diversification is susceptible to increased betas from time to time, decreasing the impact of portfolio diversification. Despite this, there have been periods where diversification has functioned as expected. Diversification may be capricious but it is not kaput. The work of, Leibowtiz & Bova (2009) considered the issue of stress betas during a single market condition (specified in their paper as the GFC period of calendar 2008), we build on this work by defining 'stress' in this paper as a period of extended market decline. A potential area for research consideration would be to identify very specific, shorter periods when the market was under stress, measure the betas during those periods, and make recommendations to investors based on the findings.

Reference

Bry, G & Boscham, C (1971), "Cyclical Analysis of Time Series: Selected Procedures and Computer Programs", *NBER: New York*.

Chen, S (1982), "An Examination of Risk Return Relationship in Bull and Bear Markets using Time Varying Betas", *Journal of Financial and Quantitative Analysis*, vol. 17, no. 2, pp. 265-285.

Leibowitz, ML & Bova, A (2009), "Diversification Performance and Stress-Betas", *The Journal of Portfolio Management*, vol. 35, no. 3, pp. 41-47.

Lunde, A & Timmermann, A (2004), "Duration Dependence in Stock Prices: An Analysis of Bull and Bear Markets", *Journal of Business & Economic Statistics*, vol. 22, no.3, pp.253-273.

Pagan, AR & Sossounov, KA (2003), "A simple framework for analysing bull and bear markets", *Journal of Applied Econometrics*, vol. 18, no. 1, pp. 23-46.

Woodward, G & and Anderson, H (2009), "Does Beta React to Market Conditions? Estimates of Bull and Bear Betas using a Nonlinear Market Model with Endogenous Threshold Parameter", *Quantitative Finance*, vol. 9, no. 8, pp. 913-924.