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Price trends and patterns in technical analysis: A theoretical and empirical examination

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ABSTRACT

While many technical trading rules are based upon patterns in asset prices, we lack convincing explanations of how and why these patterns arise, and why trading rules based on technical analysis are profitable. This paper provides a model that explains the success of certain trading rules that are based on patterns in past prices. We point to the importance of confirmation bias, which has been shown to play a key role in other types of decision making. Traders who acquire information and trade on the basis of that information tend to bias their interpretation of subsequent information in the direction of their original view. This produces autocorrelations and patterns of price movement that can predict future prices, such as the "head-and-shoulders" and "double-top" patterns. The model also predicts that sequential price jumps for a particular stock will be positively autocorrelated. We test this prediction and find that jumps exhibit statistically and economically significant positive autocorrelations.

1. Introduction

There is now convincing evidence that stock prices display short-term momentum over periods of six months to a year and longer-term mean reversion (De Bondt and Thaler, 1985; Chopra et al., 1992; Jegadeesh and Titman, 1993). There is also evidence of economically significant price reversals over short time horizons of a week to a month (Jegadeesh, 1990; Lehmann, 1990; Jegadeesh and Titman, 1995; Gutierrez and Kelley, 2008).[1] This evidence provides support for trading rules designed to detect persistent *trends* in asset prices. Research has shown that such rules have predictive power in equity markets (Brock et al., 1992) and in foreign exchange markets (Dooley and Schafer, 1983; Sweeney, 1986; Levich and Thomas, 1993; Neely et al., 1997; Dueker and Neely, 2007).

The use of technical signals based on *price patterns* has received less academic attention, despite the fact that these signals are widely used by practitioners (Taylor and Allen, 1992; Lui and Mole, 1998; Cheung and Chinn, 2001). At present, we lack theoretical models that can explain the presence of *pattern-based* trading rules, though several empirical studies suggest that such rules may be profitable. Chang and Osler (1999) examine the profitability of using the "head-and-shoulders" pattern in the foreign exchange market to predict changes of trend, and find evidence of excess returns for some currencies but not others. Lo et al. (2000) develop a pattern detection algorithm based on kernel regression. They apply this methodology to identify a variety of technical price patterns including "head-and-shoulders" in the US stock market over the period 1962–1996. They find statistical evidence that there is potentially useful information contained in most of the patterns they consider. Savin et al. (2007) show that a modified version of the algorithm of Lo et al. applied to the

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[1] Conrad et al. (1991) demonstrate that bid-ask bounce explains some of this return reversal. Cooper (1999) and Subrahmanyam (2005) find that microstructure issues cannot fully explain the documented return reversal.

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"head-and-shoulders" pattern has substantial predictive power for US stock returns over periods of one to three months.[2]

The objective of this paper is to present a theoretical model that provides an explanation for the observed autocorrelation patterns in asset returns and for the documented success of both *trend-following* and *pattern-based* technical trading rules. We do this by introducing a single cognitive bias into the model, that of confirmation bias. The bias is a phenomenon that has been extensively documented in experimental studies. It refers to the search for, or the interpretation of evidence in ways that favor existing beliefs or expectations. It has been described as "perhaps the best known and most widely accepted notion of inferential error to come out of the literature on human reasoning" (Evans, 1989, p. 41 quoted in Nickerson, 1998).

In our model, information arrival is modeled with signals of various magnitudes, arriving at differing frequencies. Large, infrequently observed signals are interpreted rationally by investors. However, investors' interpretation of less informative signals (which arrive more frequently) is biased by the recently observed large signals. The model generates price patterns, most notably the "head-and-shoulders" pattern, that have the predictive power for future stock returns claimed by technical analysts. The model thus provides a theoretical foundation for several price patterns commonly used by technical analysts. The model also produces the well-documented pattern of price momentum which can be exploited by trend-following technical rules such as those based on the comparison of short- and long-run moving averages.

In addition, our model makes several predictions. First, return autocorrelations are negative over very short horizons, positive over intermediate horizons, and become negative again over long horizons. This feature of the model conforms to the empirical properties of US equity prices described above. To our knowledge, our model is the first to simultaneously capture all three of these patterns in return autocorrelations, and provides a simple alternative to the microstructure-based explanation for negative short-horizon autocorrelations. Our model also produces a sharp prediction that the time-series of jumps in the price series should be positively autocorrelated. So far as we know, this is a new and untested empirical prediction.

We provide empirical evidence that confirms the prediction of our model that sequential price jumps in equity prices are positively autocorrelated. Specifically, we utilize the statistical bi-power variation estimation technique to identify all statistically significant jumps in the daily price series of the individual component stocks of the S&P 100 Index over the sample period 1999–2005. We find that sequential price jumps exhibit statistically and economically significant positive autocorrelations, and that these autocorrelations decay at a rate that is also consistent with the model.

[2] The value of using technical trading rules based upon past prices is still an open empirical question. Jegadeesh (2000), in his discussion of Lo et al. (2000) points out that there is no evidence of significant one-day returns after the identification of technical indicators. This finding is confirmed for the UK stock market in Dawson and Steeley (2003), while Marshall et al. (2006) find that candlestick trading strategies do not have value for Dow Jones Industrial Average Stocks. However, Savin et al. (2007) find that with longer holding periods evidence of substantial predictive power emerges. Bessembinder and Chan (1998) and Allen and Karjalainen (1999) suggest that gross profits are available from technical trading but are insufficient to cover transactions costs. Osler (2003) documents that order clustering of stop-loss and take-profit orders at round numbers provides a justification for intraday technical analysis in the currency markets. Kavajecz and Odders-White (2004) conclude that intraday technical analysis captures changes in the state of the limit order book and may add value by locating liquidity in the limit order book that allows traders to place strategic limit orders with better execution and lower transaction costs. In contrast, Marshall et al. (2008) investigate the profitability of over 5000 technical trading rules using intraday data on Standard and Poor's Depository Receipts (SPDRs) and conclude that technical analysis is not profitable after data snooping bias is taken into account.

Our model presents an alternative momentum explanation to the gradual information diffusion hypothesis of Hong and Stein (1999). In their model, newswatchers trade on fundamental information while momentum traders make trades based on past price movements. Fundamental information diffuses gradually across the newswatchers and this causes prices to underreact and display positive autocorrelation. The autocorrelation provides incentives for momentum traders whose simple trading strategies based on past prices eventually drive prices above fundamental value, leading to negative autocorrelations over longer horizons. The agents in their model are boundedly rational in that their decisions do not make use of all relevant information. Our approach is closer in spirit to that of Daniel et al. (1998) in that we assume that decisions are affected by a psychological bias. Our model setup is different and begins with the arrival of a large piece of information that is immediately and rationally impounded into prices. This news biases investors' interpretation of later information, and so in a sense is 'diffusive' in that it continues to affect future price changes. Like Hong and Stein (1999) our model predicts that certain trading strategies based on past prices can be profitable. Two notable differences are that our model predicts negative autocorrelation in the very short-run, and also explains why certain technical price patterns forecast future returns.

Our model and empirical tests also complement the recent empirical work of Gutierrez and Kelley (2008). They document negative weekly autocorrelations immediately after extreme information events, but find that momentum profits emerge several weeks after an extreme return and persist over the remainder of the year. Moreover, this momentum easily offsets the brief and initial return reversal. Our model produces predictions consistent with this finding. They also find that markets react similarly to explicit (public) and implicit (private) news, and note that many behavioral models require investors to react differently to different types of news. In contrast, our model makes no distinction between public and private news.

Zhu and Zhou (in press) offer a rather different perspective on the advantages of using technical analysis. They find that when there is uncertainty about the degree of predictability of the stock price, adding a technical Moving-Average (MA) component to the strategy that invests a fixed percentage of wealth in stocks may increase investor utility. This is because optimal dynamic strategies depend upon investors' prior beliefs and learning about unknown model-specific parameters, while MA strategies are more robust to model and parameter misspecification.[3] While Zhu and Zhou focus on the effects of technical strategies on investor utility, one of our main objectives is to develop a model that captures the underlying phenomena that give rise to specific price patterns such as the head-and-shoulders or double-top patterns.

The rest of the paper is organized as follows: Sections 2 and 3 present the model. Section 4 describes various trading rules and relates them to the model. In Section 5 we describe our jump-detection methodology and present empirical results. Section 6 concludes.

2. The confirmation bias

2.1. Existing literature on the confirmation bias

As noted above, the confirmation bias refers to the search for, or the interpretation of evidence in ways that favor existing beliefs or expectations. A related phenomenon has been extensively investigated in the management literature under the heading of "escala-

[3] For a similar argument, see Blanchet-Scalliet et al. (2007).