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A top-down approach to identifying bull and bear market states

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ABSTRACT

Bull and bear markets receive considerable media and academic attention. It is widely believed that such states are important determinants of wider market dynamics, yet no agreed definition exists. This paper investigates frameworks for ex post classification of asset prices in two-state (bull and bear) markets. An emphasis is placed on identifying state transition points that might achieve consensus. A number of potential difficulties with existing methodologies are highlighted. A principle-based approach is adopted from which a new, flexible, hierarchical methodology is proposed that addresses these issues and permits varying degrees of resolution allowing secondary trends such as bear rallies to be incorporated. The methodology is shown to be optimal under one measure of performance.

1. Introduction

The difficulties experienced by many major economies over the past decade have prompted renewed interest in economic cycles, financial cycles, and the global interactions between them. A particular focus is synchronization and the degree to which this magnifies outcomes. Such work is underpinned by the model used to identify the start and end of each cycle. Business cycles, comprising of expansion and recession phases, have widely accepted definitions and authorities to whom most observers are willing to defer. Equipped with a standard set of dates, economists can analyse relationships with economic activity. Economic phases are clearly influenced by the practical realities of companies operating in a market-based financial system (Woodford, 2010) yet, by contrast, the definition of a financial cycle is open to interpretation. Market prices should refect future profit expectations and economic forecasts but, unlike economic output, are immediately observable and continuously updated. In this paper we specifically consider the financial cycle, comprising of bull and bear phases, in relation to equity prices. A new approach is proposed that formalises the dating of these cycles in a manner that can attract broad support. The value of the proposed model lies in the importance of the systematic study of bull and bear markets as they relate to wider market and economic dynamics. To obtain reliable results, great care must be taken in defining and measuring the underlying cycles.

The terms 'bull' and 'bear' and their derivatives are frequently used during market commentary. When applied to entire markets, they are generally taken to mean extended intervals of time over which prices have broadly increased or broadly decreased respectively (Chauvet & Potter, 2000). Such intervals are bounded by peaks and troughs, and naturally form alternating phases. When applied to individual participants, bull and bear terminology reflects sentiment. A bullish investor has expectations of returns higher than some average value (Brown & Cliff, 2004). This expectation is potentially both influenced by, and an influence on, other investors (Shiller, 1995). Bull markets naturally arise when such investors dominate trading activity. Thus bull and bear labels characterise the prevailing sentiment in a market, a concept that is difficult to formalise. The Adaptive Markets Hypothesis posits that markets evolve and their participants adapt. On this basis, bear markets may impose natural selection. Lo (2004) notes that around the turn of the century, a significant group of investors had never experienced a bear market. If market dynamics do evolve then alternating bull and bear phases are part of this evolution.

Google's Ngram Viewer reveals that the terms 'bullish' and 'bearish' have been used for at least three centuries, and have been explicitly applied to markets since before 1900. While prevalent in the financial lexicon, these terms have no formally agreed definition. Commonly cited, but otherwise arbitrary, price change thresholds are 20% for bull/bear phases and 10% for corrections. They are also considered to have minimum durations spanning several months (Pagan & Sossounov, 2003). Despite this, these market states receive considerable attention from investors and researchers. Examples of such work include Kaminsky and Schmukler (2003) who analyse the impact of financial liberalization, Jansen and Tsai (2010) who examine the impact of surprise monetary policy, Candelon, Piplack, and Straetmans (2008) and Claessens, Kose, and Terrones (2010) who both investigate synchronization of markets across countries, Ntantamis and Zhou (2015)

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who look for relationships between commodity prices and commodity stocks, and Albuquerque, Eichenbaum, Papanikolaou, and Rebelo (2015) who examine the relationship between returns and fundamentals during bull and bear periods.

Given that much research is conducted on market dynamics during bull and bear states, there is a clear need for a more formal definition, and a means with which to determine the state of a market, at least on a historical ex post basis. By contract, economic cycles have attracted considerably more attention and there is now a widely accepted consensus on their definition. In the US, early attempts to address issues relating to the measurement of economic output, and timing of cycles, were led by the National Bureau of Economic Research (NBER). This work has clearly influenced the dating of financial cycles. In their book on 'Cyclical Analysis of Time Series' Bry and Boschan (1971) presented techniques adapted from NBER to identify such phases in economic data. A key motivation was to split cycles into homogeneous phases, yet the authors recognise the inherent difficulty in settling on a particular algorithm which 'cannot be regarded as objective in the sense that all reasonable and conscientious investigators would agree on the answers'.

The lack of an agreed definition means that some flexibility is desirable in any classification model. As market trends increase in magnitude or duration, one might expect greater consensus on applying a bull or bear label. A classification model that maximises the level of agreement between different observers, even if they differ in their definitions, is also appealing. Methodologies that lack broad consensus, are subject to future revision, or those which permit anomalies, have the potential to undermine the results of derivative work. A widely accepted ex post classification is also critical for the validation of future bull and bear predictions in such studies as Chen (2009) or Wu and Lee (2015). As with business cycles, a dating algorithm that is 'simple, robust, as transparent as possible and replicable' is desirable (Harding & Pagan, 2003).

This paper highlights potential deficiencies in existing ex post rule-based methodologies and proposes adjustments to address such issues. While early work was inspired by the treatment of business cycles, here a principle-based approach is adopted specifically for the treatment of bull and bear market phases. Through this, an alternative approach is developed, free from such deficiencies, while retaining the flexibility to adopt elements from earlier models. It can be applied to any time series regardless of frequency or prior filtering. The approach is top-down in nature and begins by first identifying low-frequency, long-term trends where wide agreement between market observers would be expected. The different approaches are applied to various time series and the results compared. The top-down methodology is shown to be optimal under one measure of performance, and therefore has the potential to act as a benchmark against which actual performance could be compared. In contrast to other studies, daily rather than monthly price series are considered. Examples are provided to show that filtering of the data may lead to anomalies. This paper proceeds as follows. In Section 2 existing ex post classification models are reviewed. Section 3 outlines the new top-down approach which is then applied in Section 4 and contrasted with existing models. Section 5 concludes the paper.

2. Review of existing methodologies

Any methodology $\mathscr{M}$ for identifying market phases within a discrete time series $P = (t_i, P(t_i))$ for $i = 0,\ldots,n$ can be thought of as an operator $\mathscr{M}(P,\theta)$ which identifies a subset of P that partitions the series into distinct phases for a given parameterization θ. The partitioning subset is defined by the set of points which mark the transition between phases. This creates a partial ordering for phase classifications based on set inclusion where . This provides a convenient framework in which to compare the partitions generated by different parameterizations and to formalise their behaviour.

Assuming the methodology respects the accepted bull/bear essence, the fewer points that occur in $\mathscr{M}(P,\theta)$, the more we would expect market participants to agree on the trend exhibited between points, and the selection of points themselves. While one market participant may have *stricter* criteria for defining a bull market than another, if the parameters themselves can be compared in these terms then a 'well behaved' methodology would be monotonically decreasing in the sense that $\theta \preccurlyeq \theta^* \Leftrightarrow \mathscr{M}(P, \theta^*) \preccurlyeq \mathscr{M}(P, \theta)$.

To determine bull and bear cycles, one must depart from traditional economic approaches which typically use (monthly) smoothed data series, often without a long term trend. Ex post methodologies for identifying such cycles are largely based on the identification of turning points (i.e. peaks and troughs). Such local extrema are candidates for the start and end of phases within the cycle. In determining which of these candidates to retain in the final classification, one must impose further rules based on considerations such as the length of the phase or magnitude of change. The following principles are adopted for guidance:

P1. Bull and bear phases alternate.
P2. Bull (bear) markets exhibit a significant rise (fall) in prices between the start and end.
P3. The prices over each phase should be bounded by the values achieved at the phase end points.

Principle P1 follows logically in a two-state model where we insist every point must be classified as belonging to either a bull or bear phase. Principle P2 is necessary to align with common usage of the terms. This allows short-term reversals (secondary trends) to occur mid-phase, but insists each phase exhibit a clear primary trend distinct from irregular fluctuations. Principle P3 means that the maximum and minimum values achieved over any phase coincide precisely with the phase start and end dates. We will refer to phases satisfying this property as being *end-bounded*. This prohibits bulls (bears) reaching new phase lows (highs) or ending at a price lower (higher) than an earlier phase high (low). A violation of this principle implies the presence of an intermediate point representing a phase maximum or minimum value. This raises the question why the prior phase was not extended to this point.

In what follows, unless stated otherwise, we incorporate this into our definition of bull and bear. The use of daily price series reduces the risk of this principle being violated. Conversely, the use of monthly data increases the risk of anomalies[1]. The principles require phase end dates to be turning points. To these we add:

P4. A small change in parameterization should not fundamentally alter the phase dates.
P5. Extending the time series should not fundamentally alter the phase dates.

Principle P4 seeks to impose a form of stability so that methodologies are well behaved in the sense that a small change in the model parameterization θ to θ^* should have a small, incremental and order-preserving change in the model outputs. Such a change might add or remove phase partitioning points, but would be expected to leave $\mathscr{M}(P, \theta) \subseteq \mathscr{M}(P, \theta^*)$ or $\mathscr{M}(P, \theta^*) \subseteq \mathscr{M}(P, \theta)$.

Principle P5 requires that model results should not be subject to continuous revision. Thus, extending the time series should not lead to a reevaluation of historical partition points (Claessens et al., 2010). Clearly this would not be acceptable in the analogous case of business cycles.

Akin to Kole and van Dijk (2016), the principles are inspired by a trader who is required to be fully invested (long or short) at all times

[1] Of course it would be possible to claim that an intraday high, occurring on some otherwise unremarkable day, marked the true market peak.

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