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Fractal cycle turning points: A theory of human social progression

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ABSTRACT

Throughout history, rare, influential, unexpected, catastrophic events with widespread significant long-term effects such as societal collapse, wars, revolutions, natural disasters, disease pandemics, droughts, famines, and financial crises have impacted humanity at large. These events seem to occur infrequently in a random manner that makes their prediction difficult. I examined closely the seemingly "random" occurrence of these events and observed a peculiar pattern: they occur at Fibonacci intervals and exhibit the irregular regularity of fractal phenomena. I identify three unique sets of patterns, to which I refer as cycles: (1) the Kuwae Cycle, (2) the Tambora Cycle, and (3) the Deflationary Cycle. They closely align with significant historical events, disease pandemics, famines, revolutions and warfare in England and the United States, and link to anomalous weather patterns induced by volcanism, heat, cold, rain and drought, all of which influence harvests dating back to the 6th century. These patterns also correlate with commodity price changes for which we have good data to study their behavior. Using commodities data, I show that, not only are commodity price changes closely associated with large historical events, but that they also occur at Fibonacci intervals in a complex cyclical and fractal manner. Short-term price cycles are part of larger fractal price waves which are themselves part of higher order fractals that measure the rise and fall of civilizations. I develop an algorithm that defines the cyclical nature and importance of Fibonacci intervals and advance a "Fractal Cycle Turning Point Theory" that explains historical price patterns and makes predictions about future price cycles, disease pandemics, warfare, financial crises and other influential events.

1. Introduction

Price data of commodities people use and consume are perhaps the best quantitative indicator available to researchers for measuring historical change (Fischer, 1996). Price changes reflect shortage or abundance that results from environmental variability, the success of harvests, and the costs of extracting resources and refining products. They also measure monetary trends in which the purchasing power of money is debased by inflation or made more valuable through deflation. The combined effects of both mechanisms of price change contribute to social tranquility when prices are stable, but may lead to social and political stress when prices rise.

The economic history of Europe, for which good price data are available, reveals four major waves of inflation (Fischer, 1996): the medieval price revolution (approximately 1180–1350 A.D.), the 16th century price revolution (approximately 1480–1650 A. D.), the 18th century price revolution (approximately 1730–1815) and the 20th century price revolution (1896 to the present). Periods of price stability occurred between these waves during the Renaissance (1351–1479), the Enlightenment (1651–1729), and the Victorian Equilibrium (1816–1895) respectively. The first three waves occurred during the Little Ice Age (Fagan, 2000) which began in approximately 1300 and lasted until about 1850. The Little Ice Age was preceded by five centuries of mild weather in an era called the medieval warm period. Climate was generally temperate and conditions favorable for good harvests during the medieval warm period. Conditions changed abruptly during the Little Ice Age as Europe and North America experienced colder climate; the period was punctuated with anomalous weather patterns leading to serious crop failures, famines and disease pandemics. The final two waves described by Fischer (1996) also appear in American price data (Bezanson et al., 1935, 1951; Warren and Pearson, 1932; Laird, 2014). All four price waves involved significant social and political turmoil (Fischer, 1996). Crises, wars, famine, and disease pandemics during the 16th and 18th century price revolutions have been causally linked to climate change in Europe and the Northern Hemisphere (Zhang et al., 2011). The 18th century price revolution, for example, included social change in the form of revolution in France and the United States.

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Table 1
The Fibonacci (F) and Lucas (L) number series.

n:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
F(n)	0	1	1	2	3	5	8	13	21	34	55	89	144	233	377	610	987	1597
L(n)	2	1	3	4	7	11	18	29	47	76	123	199	322	521	843	1364	2207	3571

Fischer, 1996 clearly distinguishes between what he refers to as price waves and price cycles. He defines price cycles as having fixed durations and argues that price waves do not follow observable cycles and differ among one another in amplitude and periodicity. Kondratiev (1984) defined a price wave based on commodity prices that lasts approximately 50–55 years; however, recent attempts to forecast price turning points, or to define the structure of price waves with his model, have failed. In fact, there has been little success in defining the structure of price waves. Very few recognize the fractal nature of price waves, and knowledge about them is limited to knowing that they come and go. Benoit Mandelbrot, the father of fractal geometry, has also shown that virtually all price movements he studied: cotton, wheat, interest rates, railroad stocks, blue chip stocks, and many financial instruments, have fractal behavior since they follow a power law, as opposed to Bachelier's normality-based random walk[1] (Mandelbrot, 2006). Furthermore, Taleb (2007), has recently established that standard approaches using normality-based probability and statistical methods are not adequate for predicting or even describing the behavior of the rare and significant events of the nature discussed here. Rather, the fractal nature of these events is slowly being discovered and recognized, and that fractal mathematics is our best hope for understanding these rare but important events that characterize human social progression (Mandelbrot, 2006).

In this paper I present evidence that multiple cycles of a fractal nature do exist in historical data. Three cycles occur in precise fashion based on Fibonacci intervals of time. Commodity prices make highs and lows, i.e., price reverses direction from the current trend and forms a turning point at these intervals. Two of the cycles are closely tied to climate behavior which, along with monetary inputs, appear to drive self-reinforcing price cycles. A third cycle interacts with the first two cycles and provides a framework for understanding inflationary and deflationary price waves.

One implication of the observed regularities reported here is that there is a defined order and timing to human social progression that can only be described with fractal mathematics. Scientists typically associate change to the most recent episodes and events, in essence ignoring the nonlinearity of systems and the fractal behavior of a complex system whereby change in the system at some higher level of organization at some distant past could cause huge changes. Current events leading up to major turning points can be viewed as a smaller component of a larger system in play.

In order to formalize a new theory on human social progression, I present here a Fibonacci cycle algorithm that quantifies the importance of Fibonacci intervals within each cycle and advance a "Fractal Cycle Turning Point Theory" that explains historical price cycles as well as predicts future turning points. I discuss how both disease pandemics and cycles of warfare occur at historical turning points in the context of the Fractal Cycle Turning Point Theory. Finally, I show that price cycles are a smaller fractal subunit of price waves which are, in turn, a smaller subunit of the rise and fall of Western civilizations.

2. Fibonacci and Lucas numbers

In this study, I investigated time sequences measured by Fibonacci and Lucas numbers (Fibonacci, 1202; Lucas, 1891; Hemenway, 2005; Hoggatt, 1969). Each number in the Fibonacci sequence is derived by summing the preceding two numbers starting from 0 and 1 (Table 1). Lucas numbers beginning with 1 can be derived from Fibonacci numbers. That is, a Lucas number L $(n-1) = \mathrm{Fib}(n) + \mathrm{Fib}(n-2)$. Values in the Fibonacci and Lucas sequences are fractal subunits of one another displaying the property of self-similarity (Livio, 2002).

3. Methods

3.1. Price Data

Yearly data for the prices of 10 commodities in England (summed values in Sterling for barley, oats, peas, wheat, firewood, linen, salt, suet, wine, and wool) are from Clark, 2004, 2005, 2007 and provided in downloadable digital format by Unger and Allen (2013). Data are presented as a percentage of prices in the year 1270. The 10 commodities chosen from a larger data set were ones that provided a nearly continuous data set over the period of focus with the fewest missing values. Missing values of one ($N = 35$) or two years ($N = 12$) were extrapolated by taking the average of the value in the year before and after the missing observation. None of these missing data points occurred at years defined here as turning points. Databases on English gold price (Officer and Williamson, 2013) and silver price (Unger and Allen, 2013) compiled from Feavearyear (1963) (Unger Personal Communication) provide yearly prices for each metal. United States commodity price data 1731–1800 (General price index, arithmetic version, 1731–1775 and 1784–1800; Bezanson et al., 1935) (Wholesale price index, 1776–1783, Appendix Table 3 unweighted average; Bezanson et al., 1951), and 1801–1932 (Warren and Pearson Wholesale Price Index, Table 1; Warren and Pearson, 1932) are compiled on a yearly basis from monthly data. There were 28 months, scattered through seven years, 1756, 1757, 1758, 1775, 1794, 1798 and 1799, in which price data were absent from the Bezanson data set. United States commodity data from 1933 to 2013 are compiled on a yearly basis from daily data from the Jeffries Reuters CRB commodity index (Laird, 2014). The values of the CRB data are weighted to equal 100 from 01/01/1932 to match the 1932 value of the Warren and Pearson data by multiplying CRB data by 3.64299. Therefore, the values for this index are higher than their true values.

Price lows or highs in England are considered turning points if price does not exceed the low or high of the year in question for the six years prior to the turning point and price moves in the opposite direction for a minimum of two years afterwards. Price lows or highs in the United States data are considered turning points if price rises or falls for a minimum of two years before the turning point and price moves in the opposite direction for a minimum of six years afterwards. One exception is the turning point of 1909 in which prices rose for more than 6 years before 1909 and fell for two years afterwards. Most turning points exceed these minimums by many years.

I segregated turning points into primary and secondary turning points, those which appeared to have the most important influence on prices, and those which occurred in conjunction with significant famines and/or disease pandemics. I identified 21 primary turning

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[1] "Random walk", developed by Louis Bachelier, a French mathematician in the 1900s, is a stochastic process that postulates prices go up or down with equal probability.