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Ups and downs of economics and econophysics — Facebook forecast

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ABSTRACT

What is econophysics and its relationship with economics? What is the state of economics after the global economic crisis, and is there a future for the paradigm of market equilibrium, with imaginary perfect competition and rational agents? Can the next paradigm of economics adopt important assumptions derived from econophysics models: that markets are chaotic systems, striving to extremes as bubbles and crashes show, with psychologically motivated, statistically predictable individual behaviors? Is the future of econophysics, as predicted here, to disappear and become a part of economics? A good test of the current state of econophysics and its methods is the valuation of Facebook immediately after the initial public offering — this forecast indicates that Facebook is highly overvalued, and its IPO valuation of 104 billion dollars is mostly the new financial bubble based on the expectations of unlimited growth, although it's easy to prove that Facebook is close to the upper limit of its users.

1. Introduction

Econophysics is a new paradigm [1], specialty, or even the youngest branch of modern science that economists are largely ignoring, but it is accepted by most physicists. It deals with solving problems in the economy, especially those related to financial markets and their behavior. The name was first used as a paper title in 1996 [2]. Econophysics is an interdisciplinary field of research, a branch of physics that attempts to describe the dynamics of financial markets [3] and other problems in the economy [4] and finds the universal laws for their description by applying ideas, concepts, techniques and methods of statistical physics. Illustrative examples of the breadth of topics range from the models of wealth distribution [5] and variations in the growth rate of companies [6] or the GDP of different countries [7], through the distribution of scientific discoveries [8], to modeling the winning strategies for web sites [9] or methods of their realistic valuations [10]. A review of methods can be found in the book by the author of the term "Econophysics" [11], and it is important to emphasize that econophysicists insist on developing models that are based on real data (*a posteriori*), in contrast to economists that usually interpret the data in accordance with prevailing theories (*a priori*), which led to the impossibility of identifying the major crises that are simply not consistent with the neoclassical theory of market equilibrium.

Each abstract model developed by neoclassical economists supports the equilibrium paradigm. Even the results of analysis are adjusted to these *a priori* models to identify the expected principles — for example, when Sharpe developed his known capital asset pricing model [12], he explained that this should be accepted although "there are highly and undoubtedly unrealistic assumptions… since the proper test of a theory is not the realism of its assumptions but the acceptability of its implications… these assumptions imply the equilibrium conditions which form a major part of classical financial doctrine". Models used in econophysics, by contrast, are primarily driven by data, not theories [13].

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Recent papers increasingly suggest that financial economics and econophysics are two disciplines that may be complementary [1], because the economy is a good example of a "complex system with a large ensemble of interacting units" [14], as studied by econophysicists in accordance with the development of so-called "complexity science" that emerged in the 1990s [15]. Physicists are trained to see connections between seemingly unrelated phenomena, to try to look at the big picture and present it with the simplest possible mathematical description which includes as many links as necessary, but no more than that [16].

However, communication between economists and econophysicists is difficult, as suggested by "Nature" back in 2006 [17]. Economists criticize (econo)physicists [18] especially on their contempt and ignorance towards historical achievements of economics, which is also true vice versa [19]. Ignorant relations contributed to the work of econophysicists being published mainly in mathematical and physical (rather than economic) journals, partly because of the complexity of the mathematics on which they are based. However, the current economic crisis reminds us of the old prophetic sentence by Friedrich Hayek, Nobel laureate: "An economist who is only an economist cannot be a good economist".

2. Theory and real-life application

The tools economists have today are not good enough to explain the current situation and enable the prediction and prevention of economic crises. The solution may be in sight, and the historical breakthrough in relations with econophysics started, quite unexpectedly, with the negative criticism [18] which made an example of one paper to show how: "'log-periodic' business had been exaggerated into doomsday speculations published in serious journals". The exemplified paper [20] explained historical anomalously large returns with the possibility that "a major still untriggered crash is looming over us". The same author soon published a book on stock market crashes [21] and a prediction that the US stock market would reach a lower turning point in early 2004 [22]. As this prophecy failed to come true two years after the publication, "the bubble of log-periodicity" [14] burst and put an end to numerous publications on the paradigm.

Developments continue, and the ScienceDaily article [23] from May 2010 claims that econophysics is good at predicting the economic crisis, because physicists have better tools than economists or financial experts. The same name is mentioned again in the story how already in 2005 Didier Sornette, a physicist, earthquake scientist, and financial expert at ETH Zurich (Swiss Federal Institute of Technology in Zurich, one of the most recognized technical and engineering universities in the world), predicted bubbles in the US real estate markets. His prediction turned out to be accurate, although it was criticized by many economists stating that such bubbles cannot exist or be predicted (such optimistic predictions about the future growth of the stock exchange happened also a few days before "Black Tuesday", as two main economic institutions failed to recognize the collapse in 1929 that marked the beginning of the "Great Depression"). The same physicist and his colleagues have since predicted the bursting of "many other bubbles", for example, in the oil market [24] and Asian financial markets.

The financial crisis was also commented on by Nobel laureates in economics, as Paul Krugman publicly asks: "How did economists get it so wrong?" [25]. Too few economists foresaw the coming crisis, and the profession itself was completely blind "to the very possibility of catastrophic failures in a market economy" due to a renewed romanticized belief that individual investors behave rationally in perfect markets that should be trusted (although the Nobel prize in economics for 2001 and 2002 was awarded for works that recognize the limitations of agents and markets, i.e. that conflict with the neoclassical idea of "market equilibrium"). Paul Krugman in his retrospective article repeatedly talks about "ketchup economists" to explain the state of mind in the economics profession immediately before the crisis – as "two-quart bottles of ketchup invariably sell for exactly twice as much as one-quart bottles of ketchup"; financial theorists conclude from this that the ketchup market is perfectly efficient, failing to observe the emergence of the biggest financial bubble in history – when the undiagnosed bubble burst, US households have seen $13 trillion in wealth evaporate and more than 6 million jobs have been lost!

Econophysicists repeatedly say that bubbles are created by unrealistic expectations for some growth to continue in the same (unsustainable) pace to infinity, and this psychological "pumping of valuation" by the expected (unrealistic) income at some point leads to a bursting of the overblown bubble — this happens while known economic signals are suggesting that all is well and never better (growth is faster than exponential), and that's why the consequences of such unexpected crashes are dramatic.

However, the emergence of bubbles, their growth and burst can be predicted, but only if we reject the idea of a market that seeks equilibrium. Is it possible to predict the behavior of chaotic systems? Models of such estimates have been used in econophysics, like the self-organized criticality models [26] and models that describe earthquakes [27]. These models were created to explain the phenomena that the "naked eye" can observe in nature. The most famous examples of self-organized criticality are visible on sand dunes in the desert, as seen in Fig. 1 — these regular forms unpredictably change under the onslaught of windy sand storms, and yet each period of rest after the storm is greeted with unexpected regularity. Models describing earthquakes can also be used to predict the stock market recovery after a crash, describing the chaos that is created and new small earthquakes that occur less frequently until the situation is completely stabilized.

Awareness of the relationship between the various research fields is gradually growing, and papers are more inclined to multi-disciplinarity to better clarify the achievements of different branches of the same field, such as the book "Classical Econophysics" written by economists, IT specialists and a physicist [28], or like a big pan-European research initiative FuturICT [29], which gathers scientists from physics, economics, social, engineering and computer science to jointly respond to major challenges of the future.