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Editorial: The 20th anniversary of econophysics: Where we are and where we are going

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1. Disciplinary rapprochement between physics and finance

Econophysics is an area of knowledge that deals with the application of physics to economic and financial issues. As the name suggests, econophysics is a hybrid discipline that can roughly be defined as "a quantitative approach using ideas, models, conceptual and computational methods of statistical physics" applied to economic and financial phenomena (Gopikrishnan, Plerou, Gabaix, & Stanley, 2002). Although the term "econophysics" was first coined twenty years ago by physicists (Stanley, Afanasyev, et al., 1996), the influence of physics on economics is an old story, and a number of writers have studied this "attraction" economists have to physics (Mirowski, 1989; Schabas, 1990). In this context, we may ask to what extent does econophysics differ from these previous interactions? Several authors (McCauley, 2006; Stanley et al., 2000; Stanley, Gabaix, & Vasiliki, 2008; Roehner, 2007) have explained how econophysics represents a fundamentally new approach. In contrast to previous links between economics and physics, econophysicists are not economists who take their inspiration from the work of physicists to develop their discipline but physicists who are moving beyond their disciplinary boundaries and using the lens of their models to study various problems raised by the social sciences.[1]

The hybrid nature of econophysics opens room for debate, as a quick look at the existing literature will show. While some authors (McCauley, 2006; Schinckus, 2010a,b; Stanley, Gabaix, & Plerou, 2008) emphasize the methodological dissimilarities between the two fields, others (Jovanovic & Schinckus, 2013, 2016; Walstad, 2010) explain that there exist a plethora of common conceptual features between these two areas of knowledge. Despite the existence of several conceptual and historical similarities[2] and some institutional bridges between econophysics and financial economics (e.g., conferences and special issues), the dialogue between the two communities remains difficult, and the communities seem to co-exist with no real interaction. Gingras and Schinckus (2012) even presented econophysics as an autonomous emerging field with its own annual conferences,[3] its own code (89.65Gh) in the "Physics and Astrophysics Classification Scheme" (PACS) and its own academic education and its own PhD programs.[4]

In this challenging context, this special issue is a new attempt to create a rapprochement between these two communities. The International Review of Financial Analysis is one of the rare journals listed in finance that regularly publishes papers related to econophysics, and the journal already published a special issue devoted to this topic in 2011. Maintaining an ongoing dialogue between econophysicists and financial economists is an explicit editorial goal of the IRFA since the journal has also a "topic editor" in charge of all papers related to econophysics. However, by organizing this new special issue led by

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[1] During past decades, many physics models have been used in economics but these were mainly used for their mathematical description of physical phenomena. Over time these imported models have become mainstream (see Black & Scholes model, for example). This trend is not seen in econophysics. From this perspective, econophysicists do not attempt to connect their work with pre-existing economic theory. For an epistemological analysis of this attitude, see Gingras and Schinckus (2012).

[2] We refer here to the works developed by Mandelbrot in the 1960s (see Mandelbrot & Hudson, 2004 or Jovanovic & Schinckus, 2013 for further details on this point).

[3] See <PhysicsWorld.com>.

[4] New Ph.D. programs in econophysics have recently appeared. See <phys.uh.edu/research/econophysics/index.php> and Kutner and Grech (2008).

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some fathers of econophysics (Professors Stanley, McCauley, and Roehner), the IRFA has gone a step further in the dialogue between the two disciplines and has given some of the fathers of econophysics the opportunity to be guest editors. Such a symbolic rapprochement will contribute to improving the dialogue between the two communities. This open-minded editorial policy is unique within our well-defined academic borders, and it may well be that economists and physicists, rather than dialogue, prefer instead to embrace what anthropologists call "scientific tribalism" (Bailey, 1977). However, as Bailey continues to point out, this does not make it impossible to have exchanges between communities within the context of an overarching culture. This special issue entitled "Econophysics: Where we are and where we are going" is a telling example of this perspective since it enlarges possibilities for scholars coming from different disciplinary cultures to interact and to contribute to the development of this new interdisciplinary field of "econophysics".

In accordance with the editorial policy of this journal (and the previous special issue devoted to this theme), we assume that participation in econophysics is not limited to the physics community. As Chen and Li (2012, p.8) stated, "The definition of econophysics is better regarded as intellectual rather than sociological". Here we consider econophysics to be a discipline that applies concepts and models from physics to finance and economics and not simply an addressing of economic and financial issues by physicists. This difference between these intellectual and sociological definitions is important because the latter refers to the physicists who developed this field while the former keeps the door open to non-physicists.

To appeal to a broad readership this special issue treats all aspects of econophysics, and the next section will emphasize the necessity of enlarging the scope of methodological approaches that deal with finance in a post-crisis context. The last section will present a synopsis of the articles presented in this special issue.

2. Post-crisis finance and the necessity of interdisciplinary

The last economic crisis generated much debate and many questions about the ability of financial economists to deal with financial reality. In a sense, that crisis was also a crisis for financial theory. In this challenging context, the time has come to reflect on the role of financial theory in our contemporary society. Although this issue is nothing new, it is often associated in the literature with restructuring the existing paradigm. However the recent crisis clearly exhibited how the functioning of financial systems and markets was far outside that predicted by standard models. Financial and economic systems are complex organizations of interacting adaptive agents whose interconnections with institutions can generate unexpected patterns, feedback loops, and diffusion processes.

Complexity science investigates the formation of structures and systems and how this formation influences the interacting elements that actually form it. Although complexity is difficult to model and measure, several frameworks inspired by biology, physics, and computer science have recently emerged to study this kind of environment. Can financial theory benefit from these new ways of studying complexity? Can financial theory be revisited in the light of complexity theories? How can the insights of the complexity approach assist economic and financial policy makers? The goal of this special issue is to offer examples of ways in which financial issues can be studied using the lens of one of the new conceptual frameworks that has emerged during this complex era: econophysics.

The influence of physics on the social sciences is not a new phenomenon, and there is a well-documented literature on the role played by classical mechanics in the history of economics. The influence of physics on social science goes beyond classical mechanics, however. In the 1950s physics Nobel Prize winner Wolfgang Pauli exchanged many letters with Carl Jung on how elementary quantum mechanical principles can have connections to psychology (Haven & Khrennikov, 2013; Jung, Pauli, & Hull, 1955; Khrennikov & Haven, 2013; Meier, 2001). Although there are multifaceted historical links between social science and physics, it is primarily in the last decade or so that we have witnessed the appearance of two new fields of research in this area of interdisciplinary collaboration. It is worth mentioning that econophysics is not simply a matter of finance. Although the vast majority of econophysics publications are dedicated to financial issues, some focus on macroeconomics, industrial economics, and international economics (Rosser, 2008).

Articles collected in this special issue primarily deal with broadly defined financial issues and use three major methodological lenses associated with econophysics. The first is based on statistical physics and its ability to deal with complex dynamic systems. The second is what we call agent-based econophysics. The literature associated with agent-based models comes from physics, is applied to economics, and can be grouped into two categories, (i) research that describes the emergence of specific macro-properties without drawing on a pre-defined macro-pattern, and (ii) work that reproduces existing macro-statistical patterns taken from empirical observations. The third methodological lens concerns a specific category of work that currently does not have a generic name that applies tools from quantum physics to social science. Although combining these research efforts with econophysics is still a new effort, some authors (Haven & Khrennikov, 2013; Schinckus, 2014) are emphasizing its potential contribution to a better understanding of financial and economic issues.

In this mixed context, the goal of this special issue is to promote works that bridge the efforts of physicists and financial economists. By taking into account the relevant disciplinary constraints, this special issue proposes contributions that will make sense to both physicists and economists. The next section provides a quick overview of these contributions.

3. Article synopsis

All of the articles were sent to two anonymous referees for two sets of reviews (the original and the revised versions). Nine papers have been accepted for this special issue and each of them contributes in at least one area of knowledge described above. A sample of the three methodological perspectives presented in the Section 2 demonstrates how this research directly contributes to a better understanding of financial issues.

The agent-based methodology is presented in the article by Jackson and Ladley entitled "Market Ecologies: The Effect of Information on the Interaction and Profitability of Technical Trading Strategies," which demonstrates how agent-based modeling is useful in better understanding the complexity of financial markets. They show that the presence of technical traders (i.e., chartists) reduces market volatility or increases the accuracy with which the market price tracks the underlying fundamental value. This paper paves the way to further research since this analysis of the dynamics of agent strategy can allow the identification of group strategies that lead to a fixed population and those that lead to mixes and chaos. In relation to this idea to use the agent-based modeling to study financial reality, Viktor Manahov investigates in his "Latency arbitrage and market efficiency: why is high frequency trading so difficult to regulate?", how high frequency trading can improve the market efficiency. In this perspective, the author developed three artificial markets populated with aggressive high frequency traders. While market regulators are still debating about the legitimacy of the implementation of high frequency trading algorithms, this article emphasizes interesting points about the way to improve the market quality.

Three papers show how to use the fundamentals of physics to model behavioral aspects of agents (which we called the "physics-social science interface" in Section 2). The paper by Haven and Sozzo, "A Generalized Probability Framework to Model Economic Agents' Under Uncertainty"proposes a further step in the rapprochement of finance and physics by applying the mathematical formalism of quantum mechanics to model human decision-making under conditions of uncertainty in behavioral economics and finance. In so doing, the author extends the current econophysics literature to quantum considerations in accordance with a methodological call suggested by Schinckus in 2014. Along the same lines, Pineiro-Chousa and Vizcaino-Gonzalez in "Quantum derivation of a reputational risk premium" also propose such an extension, explaining that corporate reputation, which involves managing relations with corporate stakeholders, can be treated as a coalition strategy framed in a quantum game theory schema.

Five papers focus on the classical interaction between thermodynamics or statistical physics and finance. "A Thermodynamical View on Asset Pricing" by Gunduz and Gunduz offers an interesting rapprochement between thermodynamics and financial economics by describing the dynamics of stock markets in terms of viscoelasticity, i.e., conservative and non-conservative forces. They study asset values in a "cause-effect" framework by associating the market values to vectorial forms that can be split into its conservative and non-conservative components. The conservative component refers to a work-like term, but the non-conservative one uses a heat-like term that treats asset prices in terms of thermodynamics. Lavicka, Linchard, and Novotny in "Sands in the Wheels or Wheels in the Sand? Tobin Taxes and Markets Crashes" show how econophysics enables a better understanding of fat-tailed distributions in finance, and how the non-normality of the return distribution caused by price jumps influences the performance of risk-hedging algorithms and also the frequency of catastrophic market events. The authors discuss how an optimal level of taxation regulation could provide balance. Fry and Cheah in "Antibubbles and Shocks in Cryptocurrency Markets" propose translate a financial issue—the evolution of cryptocurrencies—into econophysics terms. They provide an original econophysics-based discussion on "cryptocurrencies," a currently emerging financial issue, and they draw a relationship between statistical physics and mathematical finance. Olkhov in "On Economic Space Notion" introduces the concept of economic space to express a particular financial formalism as a mathematical physics equation, and presents specific examples of the modeling of economic space, including option pricing, the derivation of Black and Scholes models, and Markov processes to show how using this concept enables the expression of financial and economic processes in terms of physical kinetics, hydrodynamics and wave equations. Proposing a physics-based formulation of particular financial processes is a telling example of a potential rapprochement between physics and economics. In line with hydrodynamics evoked above, Sensoy and Tabak use the Hurst exponent in their "Dynamic efficiency of stock markets and exchange rates" to investigate long-range dependence in countries that adopted a floating currency system and an inflation targeting monetary regime. The presence of long-range dependences in financial events challenges the financial mainstream inviting the authors to use conceptual tools coming from hydrodynamics.

4. Concluding remarks

The main goal of this special issue is to support the growing rapprochement between econophysics and finance. Thus several papers open conceptual doors to aid this rapprochement. The literature of econophysics is scattered, and selecting literature that provides a good overview of this diversified area of research and providing articles that will elicit future potential links between the two fields is difficult. In addition to this main goal, we have also including some papers that are not strictly econophysics with the hope that this will open a door for a rapprochement between econophysics and finance.

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