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REPORT OF A THESIS ADVISOR

Title of Master's Thesis: "Physical aspects of financial markets"
Candidate: David Dobáš
Institution: Department of Physics, Czech Technical University in Prague, Faculty of Nuclear Science and Physical Engineering, Břehová 7, 115 19 Czech Republic
Assessment: A (výborně)

It is a pleasure to report on Bachelor's Thesis of David Dobáš. Mr. Dobáš worked under my supervision during the academic year 2021/2022. In the course of this time his scientific focus was on application of methods and techniques of statistical physics to financial markets and this line of research culminated in the present Bachelor's Thesis.

The use of physical concepts in physics (which goes under a broader name *Econophysics*) was originally introduced by H.E. Stanley, D. Sornette and L.P. Kadanoff in mid 1990's, even though the incentives can be traced back to seminal works of V. Pareto (in 1920') and of B.B. Mandelbrot (in early 1970's). Broadly speaking, Econophysics employes methods of statistical physics, information theory and quantum theory to financial markets. Typical playground is in financial systems with broad (or heavy-tail) distributions. The specificity of working with such systems lies in the fact that the conventional Central Limit Theorem alongside with the usual methods of equilibrium statistical physics cannot be applied. Theoretical qualification for such a "non-canonical" behavior is typically provided by theory of complex dynamical systems and, in particular, by the generalized Central Limit Theorem of P. Lévy and theory of critical phenomena.

In his work was Mr. Dobáš inspired not only by classical works of A. Mantegna, H.E. Stanley and P.W. Baschnagel (Econophysics and critical phenomena), T. Mikosch (stochastic calculus) and P. Wilmott (quantitative finance) but also by a number of original research papers. He approached the subject of his Thesis with a good knowledge of prerequisite mathematical and physical concepts.

Mr. Dobáš Thesis is well structured and basic concepts are easy to grasp. Chapters 1 and 2 are dedicated to selected background material on financial mathematics and theory of option pricing. Material presented is chosen so that it can be directly employed in Chapter 3 in connection with critical phenomena. I especially enjoyed the discussion on the analogy between Efficient market hypothesis and 2nd and 3rd laws of thermodynamics. Chapter 3 discusses the issue

of critical phenomena and its connection to financial markets. The issue is elaborated first from the point of view of critical exponents and related universality classes of statistical systems. With the help of scaling hypothesis Mr. Dobáš derives various relations between critical exponents. After this prelude Mr. Dobáš goes on to discuss the (position-space) renormalization. The issue of scaling and ensuing renormalization is further examined on three financial systems: crisis instigating microtrends model of Preis–Stanley and Cont–Bouchaud and Sornette–Johansen near-to-financial-crash models.

Finally, the thesis is supplemented with Bibliography. What I miss a bit in the work is a brief concluding section that would help the inquiring reader understand what are essential points of the Thesis.

The work is supplemented with three appendices that discuss some finer concepts from probability theory and theory of martingales that are employed in the main body of the text.

All in all, Bachelor's Thesis of Mr. Dobáš has in my view a very good quality. It offers an interesting and in many respects original overview of various Econophysical methods with ensuing applications in financial markets. I am sure that expertise gained by Mr. Dobáš during his work on the Thesis will be beneficial to him in the years to come.

Petr Jizba