Report of an external referee

- Master thesis title: Relativistic stochastic processes, their description and use in financial markets

- Candidate: Bc. Rastislav Blaho

- Institution: Department of Physics, Czech Technical University in Prague,

- Faculty of Nuclear Sciences and Physical Engineering, Břehová 7, 115 19, CZ
  Assessment: A (výborně)

In his master thesis, the candidate Rastislav Blaho treated in an organic way the subject of relativistic stochastic processes with application to financial markets. The work presents a logically coherent framework, which also embeds various original contributions of the author.

The thesis deals on the relativistic description of stochastic processes, which seems to be currently quite popular, e.g., in a high-frequency trading or in a short-term option pricing (e.g., in barrier options). Stochastic processes and their various forms (Ito, Stratonovich, Lévy, etc.) are of a great interest, both from theoretical and phenomenological point of view. The thesis centers around the issue of relativistic generalization of stochastic processes. It is rater interesting that this issue is still not settled even almost 100 years after Wiener's formulation of stochastic processes. It is indeed true that the most rigorous treatment of relativistic stochastic process is due to Hänggi *et al.*, which he published in a series of papers at the beginning of this millennium. Hänggi's approache merely generalize 1-dimensional Ito–Wiener stochastic process associated with a scalar degree of freedom (e.g., scalar particle). This does not seems to be the most useful generalization in mathematical finance context.

The candidate explored in his thesis various relativistic generalizations of stochastic processes (including the Hänggi *et al.* canonical one) and in doing so he uncovered some interesting connections, such as connection between Dirac-type Fokker-Planck equation in 1+1 dimensions and telegrapher's equations. I also appreciate the discussion of the relativistic option pricing given in Chapter 3. As a matter of fact, in Chapter 3 are present few highlights on possible extensions and applications, e.g., relativistic generalizations of the celebrated Black-Scholes pricing equation. These results are interesting and it is only pity that the applicant has not published yet some of his findings.

I have no specific suggestions nor questions for the candidate. The work appears to be well motivated and quite lucidly written. I could not spot any serious conceptual, nor technical mistakes, though the Thesis is written in not perfect English with a number of typos. Some mathematical formulas (e.g.,3.54, 3.175, 3.187, etc.) overflow the line, would be better to split in two lines. Also use of brackets in some mathematical formulas is quite confusing (e.g., equations 1.106-108, 3.167, etc.) — too many nested round brackets.

Overall, the work is interesting and in many respects it provides an original approach to the subject of relativistic stochastic processes, which I have not seen before

discussed to such an extent. I think that this research can certainly provide in future numerous relevant contributions in econophysics and modern finance theory. In conclusion, my judgment on the master thesis of Rastislav Blaho is A (excellent).

Fisciano, 2.2.2022

Prof. Massimo Blasone