Intertrade times memory and autocorrelation of price changes absolute values

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Continuous-time random walk (CTRW) is a stochastic process with continuous and fluctuating waiting (interevent) time. It was firstly introduced to physics by Montroll and Weiss [1]. Since then it has been used to model anomalous transport and diffusion, hydrogen diffusion in nanostructure compounds, electron transfer, aging of glasses, transport in porous media, diffusion of epicenters of earthquakes aftershocks, cardiological rhythms, human travel and many more [2].

CTRW is also successfully applied in econophysics [3], for example it is used to describe stock price dynamics. We can consider the stock price as the price of the last transaction, so the value of a process represents the stock price and waiting times (WT) correspond to times between transactions. If we take into consideration only the memory between price changes it may describe empirical autocorrelation function (ACF) of price changes satisfactorily (one-step memory [4], two-step and infinite-step memory [5]). However, empirical ACF of price changes absolute values decays much slower than ACF of price changes and cannot be fully explained only by dependencies between price changes.

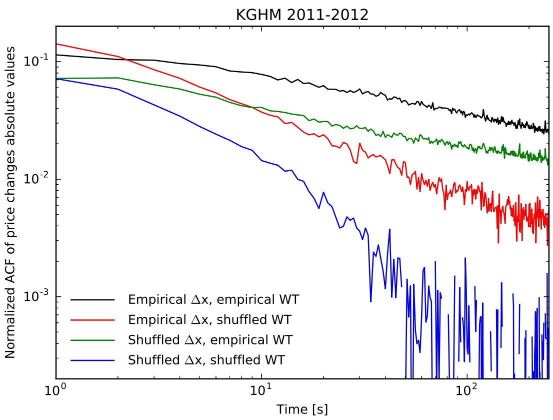

Figure 1: Normalized autocorrelation function (ACF) of price changes absolute values for KGHM (one of the most liquid polish stock) in years 2011-2012 for empirical data (black), empirical price changes and intra-daily shuffled waiting times (red), intra-daily shuffled price changes and empirical waiting times (green), and intra-daily independently shuffled price changes and waiting times (blue). Notice that considering real dependencies of waiting times reproduces ACF which decays like one for the empirical data. Considering only dependencies of price changes does not reproduce the original result.

By using empirical financial data we study the autocorrelations of the following quantities: price changes, their ab-

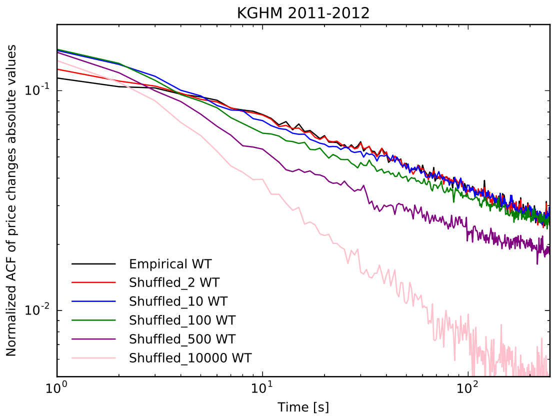

Figure 2: Normalized ACF of price changes absolute values for KGHM in years 2011-2012 for empirical data (black) and simulations. We intra-daily shuffle waiting times in non-intersecting windows of different sizes (in number of ticks): 2 (red), 10 (blue), 100 (green), 500 (purple), 10000 (pink). Notice that shuffling waiting times in windows does not significantly change pace of ACF decaying. Only taking a window bigger than the number of transactions per day (pink) accelerates decaying of ACF.

solute values and corresponding waiting times. We argue that the foundation of slowly decaying ACF of price changes absolute values are dependencies of waiting times (see Fig. 1). We show that those dependencies do not affect the ACF of price changes while they decisively influence the ACF of their absolute values. We present that considering only short-term dependencies is not enough to explain empirical ACF, we show the decisive role of long-term correlations (see Fig. 2).

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