MODELLING AND FORECASTING HIGH FREQUENCY FINANCIAL DATA WITH WAVELETS AND AN EVOLUTIONARY ARTIFICIAL NEURAL NETWORK

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ABSTRACT

In the environment with heterogeneous beliefs, where prices are driven by prevailing expectations of market participants, one must form expectations of others forecasts, predicting future prices. Evolution of agents' expectations largely governs the adaptive nature of market prices. Overlapping beliefs of heterogeneous agents prevent the effective examination of expectation formation and price forecasting by traditional methods.

In the approach proposed in this paper, high frequency transaction data from a financial market is decomposed into a combination of underlying series, representing beliefs of major clusters of agents. The data generating mechanism of a financial time series is considered as a complex multi-structured system, with individual layers corresponding to particular frequencies. Reflecting the time preferences of agents, trading strategies being homogeneous intra-type are heterogeneous inter-type for agents with distinct time preferences. Overall market activity at each moment, providing the dynamic feedback across agents' types, generates market prices. The frequency decomposition of a time series identifies the local and global structures and separates short and long time dynamics.

This paper considers a scaling law, a rule relating price movements and time intervals, in the spectral analysis settings. The fractal behaviour of stock index returns, occurrence of similar patterns at different scales, is examined in a diffuse two-dimensional time-frequency domain, rather than in a one-dimensional time domain. The novelty of the approach is to investigate the probability distribution of the data-generating mechanism over frequencies localised in time, as an alternative to sampling intervals.

Utilising the signal processing methodology that develop real-time signal modification, a heterogeneous beliefs model with expectations differentiated according to their time dimension is proposed. Decomposing a high frequency time series data into a combination of the underlying series, representing beliefs of major clusters of market participants, a fractal structure of the agents' time preferences (memory and trading horizons) is identified. In adaptive analysis of local behaviour of heterogeneous agents the high, medium and low frequencies signals are distinguished to represent the short, medium and long term traders. By separately investigating different frequencies frames, we identify the dominant cluster of traders on the market considered and the adaptive nature of such market prices. The information about dominant agents' reaction time to the market news and the dealing frequencies permits to select an appropriate for this particular market sampling interval. Further potential application of the model presented is for the user to tune into the cycle best suited to an individual trading style.

Computational intelligence is employed in simulations. Wavelet transforms are used for adaptive analysis of the local behaviour of heterogeneous agents. The genetic algorithm is applied to determine the optimal decomposition of the signal and representation of heterogeneous traders. The artificial neural network is trained to learn information at the scale level that is hidden in the aggregate.

In designing computer simulations, a non-linear optimisation problem of a computationally intensive 'black-box' function was addressed. In such optimisation problem, the simulation inputs and outputs are related by complicated surfaces, there is a tight limit on the simulation runs, as well as an objective function cannot be commonly expressed in an analytical form. Utilising computational intelligence in modeling and forecasting high frequency financial data, providing rapid analysis, improves the stability of the whole system.

JEL classification: D4; D84; G1; G12;

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