Statistical uncertainty of different markets[☆]

Koldanov A.P.[b], Kalyagin V.A.[a]

[a]*National Research University Higher School of Economics, Laboratory of Algorithms and Technologies for Network Analysis, 136 Rodionova street, 603093, Nizhny Novgorod, Russia*

[b]*National Research University Higher School of Economics, Department of Applied Mathematics and Informatics,25/12 Bolshaya Pecherskaya street, 603155, Nizhny Novgorod, Russia*

Network models of financial markets attract a growing attention in recent years [2, 1]. Usually in network representation of the stock market each stock corresponds to a vertex and a link between two vertices is estimated by sample Pearson correlation of returns of corresponding stocks. In order to simplify the network and preserve the key information various filtering techiques are used. Applications of such filtering procedures lead to different network structures, e.g. minimum spanning tree (MST), planar maximally filtered graph (PMFG), market graph (MG), maximum clique (MC), maximum independent set (MIS) in a market graph.

Estimations of Pearson correlations are constructed by financial time series. A stochastic nature of this data raises a question of statistical uncertainty of obtained results. Measures of statistical uncertainty were proposed in [3]. These measures were used for analyzing statistical uncertainty of network structures for a model of US stock market. In this model vector of stock returns had multivariate normal distribution with given correlation matrix. In [3] the correlation matrix was obtained from real observations on stock returns of US market (NYSE and NASDAQ). The motivation of this work is to check whether the results obtained in [3] are specific for US market or there is a common feature for different markets. For this purpose we compare statistical uncertainty of network structures for the above model of the following markets: France (Paris) , Germany (Frankfurt), Great

[☆]Research was partially supported by LATNA Laboratory, NRU HSE, RF government grant, ag. 11.G34.31.0057

Britain (London), Italy (Milan), Russia (Moscow), USA (NYSE, NASDAQ). We study statistical uncertainty of the following network structures:

MST is a spanning tree of a network which consists of important links associated with the highest degree of similarity.

PMFG is obtained from MST by iteratively connecting the most similar nodes until the resulting graph is planar.

MG is constructed from the original network by removing all edges with correlations less than given threshold $\theta \in [-1, 1]$.

MC is a maximum subset of pairwise adjacent vertices of MG.

MIS is a maximum subset of vertices no two of which are adjacent in MG.

For different markets we observe a dissimilarity of correlation matrices and diversity of levels of statistical uncertainty of above mentioned structures. Our main finding is that despite this fact the levels of statistical uncertainty of structures follow the same order for all considered markets. This gives rise to conjecture that there is some unknown common feature in different market networks. In other words there are common properties of correlation matrices associated with different stock markets which have specific impact on statistical uncertainty.

References.

[1] Boginski V., Butenko S., Pardalos P.M. Statistical analysis of financial networks *Computational Statistics & Data Analysis*. 48 (2) (2005) 431–443.

[2] Tumminello M., Aste T., Matteo T.D., Mantegna R.N. A tool for filtering information in complex systems *Proceedings of the National Academy of Sciences*. 102 (30) (2005), 10421–10426.

[3] Kalyagin V.A., Koldanov A.P., Koldanov P.A., Pardalos P.M., Zamaraev V.A. Measures of uncertainty in market network analysis *arXiv:1311.2273*