MARIA GRITH - Research Statement

Financial markets have become increasingly complex and their functions go beyond supporting investment and trade. At the same time, their link to the real economy becomes apparent in situations of crisis, when they can generate significant risk for the economy as a whole. The functioning of the financial system has been traditionally studied using theoretical insights from economics. My work focuses on empirical research of financial markets. It relies on nonparametric methods and graphical interaction models to analyze functional and time series data that features complex temporal and spatial dependence structures. These statistical techniques allow empirical evaluation of state-of-the-art theories and reveal features in the data that are translated in formal models.

A central question in my work is how investors assess economic risk and uncertainty when pricing financial assets. My dissertation examines the conditional pricing kernel, which is used to valuate stochastic payoffs. Daily pricing kernel functions are estimated nonparametrically from option and stock index data. They are analyzed jointly using a shape-invariant model by considering pricing kernel estimates as a collection of curves that share common features. The pricing kernel depends on the risk preferences of the aggregate investor in the market. It is proportional to the marginal utility, which is supposed to be decreasing if a rational behavior is assumed. The nonparametric pricing kernel estimates have a nonmonotonic shape, for which I propose a behavioral rationale that links individual preferences to the average investment performance. This work provides evidence for benchmarking investment performance against the stock index, particularly when the uncertainty, generally associated with volatility risk premium, is low and when investors face low liquidity constraints. I have published three articles on these topics, coauthored with Wolfgang K. Härdle and Volker Krätschmer in the *Review of Finance*, with Wolfgang K. Härdle and Juhyun Park in the *Journal of Financial Econometrics*, and with Wolfgang K. Härdle and Melanie Schienle in the *Handbook of Computational Finance*.

The empirical analysis of asset pricing models requires the estimation of random functions which cannot be directly observed. One example is the risk neutral-density, which can be recovered empirically from large cross sections of observed option prices by taking the second derivative of the call pricing function with respect to the strike price. In my postdoctoral work, I apply functional principal component analysis to estimate derivatives of multivariate curves. This analysis relies on kernel smoothing methods and includes the choice of optimal bandwidth, derivation of asymptotic properties and efficiency comparison for two proposed estimation methods. An empirical analysis of DAX 30 index options reveals the main drivers for the dynamics of risk-neutral density of index returns, interpreted as volatility, skewness, tail and term structure factors. This work also provides evidence for time varying correlations between factor innovations, with possible implications for the estimation of leverage effect. This paper, coauthored with Wolfgang K. Härdle, Alois Kneip and Heiko Wagner has been submitted to *Statistica Sinica*.

The pricing kernel represents the natural link between the risk-neutral and the physical measure of the index returns. In an ongoing study, I address the nonparametric estimation of physical density through the maximum likelihood method, by exploring the predictive information in the risk-neutral distribution estimated from option prices. I propose a long-run identifying restriction used in asset pricing models to decompose the pricing kernel into permanent and transitory components. The aim of this research is to understand the sources of variation for equity and option prices and to formalize the link between the asset dynamics under the risk-neutral and physical measure.

My recent work analyzes the joint dependence in multivariate time series. For this, contemporaneous and lagged influences are represented using graphical interaction models. These models are well suited for analyzing such data because they provide descriptive measures that capture their local and systemic characteristics. A common assumption when analyzing multivariate time series data is stationarity, i.e. time invariance of the covariance function across time. Relaxing the stationarity assumption and under some additional smoothness conditions, dependence structures can be described through locally stationary graphs. I focus on partial correlation graphs, which are defined in time-frequency domain through the wavelet transform. Estimation of the graphs from noisy data is performed using semiparametric penalization techniques. This work is relevant for studying dependence in time-varying and nonlinear models and at different horizons. The methodology is applied to realized volatilities for the main equity indices worldwide. I plan to submit the paper, coauthored with Matthias Eckardt, next spring to the *Journal of the American Statistical Association.*

Another ongoing project addresses the mathematical structure of the networks encoded in the variance decomposition functions of vector autoregressive (VAR) models when the underlying time series processes have a dynamic factor structure. This project provides a formal treatment of the corresponding dependence measures and proposes new criteria that use low matrix rank and sparsity considerations to identify the factors from the data. This research is relevant for modelling dependence in high dimensions using factor structures.

In my future work, I will use graphical models to assess identification restrictions in structural vector autoregressive models using instrumental variables and conditional heteroskedasticity. At present, most of the theory and empirical methods for graphical models are developed for Gaussian processes. I will apply nonparametric and machine learning techniques to infer topological properties of the graphs for more general multivariate distribution functions. In addition, extending on my previous research experience in equity and derivative pricing, I will explore the econometric analysis of jump-diffusion models for asset pricing in high-frequency settings, i.e. the estimation of volatility, leverage effects and liquidity. Furthermore, I will research empirically network formation models to explain structural features in the dynamic dependence of asset prices.

There are two main themes which guide my work. Firstly, I apply a variety of flexible statistical techniques to study the factors and mechanisms that explain prices and risk premia. Secondly, I develop integrative frameworks to study joint dependence of economic time series in multivariate settings. Both are crucial to furthering our understanding of financial markets and fostering their efficiency.