



Zurich, September 8, 2015

Research Proposal

Title

International Stock Portfolios
and the Role of Foreign Exchange Risks
*A Swiss Perspective on Advanced Time Series
Methods to Tackle Multi-Asset Class Problems*

Research Motivation

Swiss investors that allocate part of their wealth internationally, automatically create exposure to foreign exchange risks. While there are good documented reasons to diversify globally, the shift of exchange rates can not only – and most obviously – affect the return but also the variability of returns. Considering the current course of academic research, one can make two observations:

- Most time series literature focuses on single-asset class problems (and more recently approaches have been suggested that can address high dimensional problems), or examines multi-asset class problems but with only one representative asset for each asset-class.
- Those literature that investigates international stock portfolios commonly assumes that (a) returns are denominated in the currency of a fictitious investor (in fact, we know pretty much about international stock returns from a US investor’s perspective) or (b) the foreign exchange risk is fully hedged.

As for the former it appears that most time series models are not readily available for more general (and potentially more realistic) problem sets. In fact, based on the common perception of an asset class one would argue that the dependence within and among asset classes would differ — to account for this plurality is, however, not a trivial task. While the latter (a) may represent the more realistic case for private investors, it suffers from

spurious results as foreign exchange effects overlay the pure equity returns – ultimately the quantitative findings do not hold uniquely but differ from country to country. On the other hand, the latter (b) resolves the previous issue, but introduces several others. Neglecting the interdependence between foreign exchange rates and equity returns is less informative and may lead to suboptimal decisions. For instance, given that the *Capital Asset Pricing Model* holds, a full-hedge is inferior to other hedging strategies. Moreover, several authors have proven that foreign exchange risks can be significantly priced during some market phases, see De Santis and Gerard (1998) and De Santis, Gerard and Hillion (2003) among the first. As such, positions in currencies can meet a speculative purpose, beyond pure hedging needs.

Research Objective and Methodology

At first, this thesis aims to identify potential time series methods that can cope with dynamic dependencies among multiple asset classes. The limiting factor, however, will be that the proposed methods need to be feasible for practical purposes – by saying that, they have to be not only available for large scale problems but also parsimonious to be computational manageable. Moreover, while focusing on the interaction of foreign exchange rates and equity returns, the applied methods should be readily extendible to other applications of interest.

It lies out of the scope of this thesis to cover all potential time series methods comprehensively. Instead the work of Paoletta and Polak (2015) will serve as starting point. In general, univariate financial time series show some common and persistent patterns which are referred to as 'stylized facts'. Adequate *ARMA-GARCH* specifications can be motivated to account for this behaviour. The dependence among univariate time series data is commonly modelled via copulas that provide a flexible tool for multivariate time series analysis. Patton (2012) points out that an ideal copula model can accommodate dependence of either sign, can capture symmetric and asymmetric dependence as well as some degree of tail dependence. The methods entertained by Paoletta and Polak (2015) meet those requirements. The thesis will thus propose two main extensions of this model, and will thus contribute to the current course of research:

- It is well documented that correlations alter over time, and hence several authors question time-invariant dependence and propose dynamic copulas instead. The literature on this matter is numerous but once again, methods and their extensions have to be practical feasible – to the current state of research, most likely an adaptation of Engle's (2002, 2009) *Dynamic Conditional Correlation* steering the copula dynamics and some *Regime Switching* copula model will be entertained.

- To allow for multiple asset classes, an augmented copula structure will be proposed that initially goes back to the work of Daul, De Giorgi, Lindskog and McNeil (2003) and has more recently been used by Fantazzini (2009).

The proposed models will then be calibrated to weekly financial data of equity indices as well as their underlying currencies. Subsequently, one can employ multiple goodness-of-fit measures to evaluate the in- and out-of-sample fit of the model specifications. One of these methods involves a statistical comparison of expected and observed value at risk violations, following Engle and Manganelli (2004) – it thus opens the door for risk management applications.

Other practical fields, of which one will be discussed in the remainder of the thesis, may concern the conditional pricing of stock indices and currencies, the time-variant optimal hedge ratios or implications for international portfolio management.

The focus of the thesis is of rather quantitative and theoretical nature. Accordingly, there will be no questionnaire among practitioners. The required data is accessible via Bloomberg and FRED, of which the latter is an open database that is published by the Federal Reserve Bank of St. Louis. To implement and test the time series models, the software package MATLAB and some of its extensions will be used.

Academic Context and Existing Literature

Following the previous two sections, noteworthy literature for the course of the thesis can be listed as follows:

- Daul, Stéphane, et al. "The grouped t-copula with an application to credit risk." Available at SSRN 1358956 (2003).
- De Santis, Giorgio, and Bruno Gerard. "How big is the premium for currency risk?." *Journal of Financial Economics* 49.3 (1998): 375-412.
- De Santis, Giorgio, Bruno Gerard, and Pierre Hillion. "The relevance of currency risk in the EMU." *Journal of Economics and Business* 55.5 (2003): 427-462.
- Engle, Robert. "Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models." *Journal of Business & Economic Statistics* 20.3 (2002): 339-350.
- Engle, Robert. *Anticipating Correlations: A New Paradigm for Risk Management: A New Paradigm for Risk Management*. Princeton University Press, 2009.
- Engle, Robert F., and Simone Manganelli. "CAViaR: Conditional autoregressive value at risk by regression quantiles." *Journal of Business & Economic Statistics* 22.4 (2004): 367-381.

- Fantazzini, Dean. "Value at risk for high-dimensional portfolios: a dynamic grouped-T copula approach." *The VAR IMPLEMENTATION HANDBOOK*, McGraw-Hill (2009): 253-282.
- Paolella, Marc S., and Paweł Polak. "ALRIGHT: Asymmetric Large-Scale (I) GARCH with hetero-tails." *International Review of Economics & Finance* (2015).
- Patton, Andrew. "Copula methods for forecasting multivariate time series." *Handbook of economic forecasting 2* (2012): 899-960.

It is fair to say that the literature about copulas, *GARCH* models and their combinations ranks among the fastest growing fields of financial and econometric research and many more sources could have been listed here.

Preliminary Schedule

Since modelling the dependence between international stock returns and foreign exchange rates is far from trivial, describing the current status of research and formulating its potential extensions will account for most of the work. When also considering the coding of those models, the expected time needed for those tasks is estimated with 10 to 12 weeks. For the remainder of the thesis that discusses the empirical findings and looks at one of the practical applications, an amount of 3 to 4 weeks each is assumed realistic and allows for sufficient time for formatting and proof reading at the end of the working process.

Preliminary Outline of the Thesis

1. Introduction
2. Financial Time Series Analysis
 - 2.1. GARCH Processes
 - 2.2. Multivariate GARCH Models
 - 2.2.1. Constant Conditional Correlation (CCC)
 - 2.2.2. Dynamic Conditional Correlation (DCC)
3. Modelling Dependencies
 - 3.1. A Glimpse on Copula Theory
 - 3.2. Normal Mixture Copulas
 - 3.2.1. The Concept of Normal Mixture Distributions
 - 3.2.2. Tail Dependence – the Case Against Gaussian Copula
 - 3.2.3. Paoletta and Polak (2015) – Meta-elliptical t Copula
 - 3.2.4. Augmented Structure – Grouped Normal Mixture Copulas
 - 3.3. Time-Varying Copulas
 - 3.3.1. Review of Literature
 - 3.3.2. Altering the Copula Function – Regime Switching
 - 3.3.3. Time-Varying Copula Parameters – DCC
4. An International Stock Portfolio
 - 4.1. Data Descriptives
 - 4.2. Review of Goodness of Fit Measures
 - 4.3. Calibrating the Proposed Models
 - 4.3.1. Marginal Models
 - 4.3.2. Static Copula Specification
 - 4.3.3. Dynamic Copula Specification
 - 4.4. The Accuracy of Out-of-Sample Forecasts
5. Conditional Asset Pricing (?) Optimal Hedge Ratios (?) Portfolio Optimization (?)
6. Conclusion