Institute for Operations Research
and Computational Finance
University of St.Gallen

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Annual Report 2017

Institute for Operations Research and Computational Finance

Organization

The Institute for Operations Research und Computational Finance adjusts its structure to the requirements and opportunities in research, business, and teaching. The interdisciplinary development and application of mathematical optimization unites the team. The diverse backgrounds, on the other hand, enrich the perception of and approach to the tasks.

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[1] Principal Investigator of CREST

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[3] Core Member of CREST

1. The institute in 2017

Within the University of St. Gallen, ior/cf-HSG is part of the School of Finance and offers courses from the bachelor level to specialized lectures in various doctoral programs. Our teaching activities emphasize quantitative methods and models with focus on applications. One full and three assistant professors as well as several lecturers cover a diversity of topics and research questions. The courses in the HSG trading room, for which ior/cf-HSG has taken over the lead management, were substantially expanded in the previous year. In this way, the university's curriculum is enriched by innovative types of learning on the bachelor, master and doctorate level as well as in the executive education.

With its activities the Institute for Operations Research and Computational Finance (ior/cf-HSG) has supported project partners, clients and students likewise to achieve their aims or to take a big step forward in mastering the challenges of their professional daily business. Moreover, with a number of published scientific papers in top journals we demonstrate the quality and relevance of our research activities.

We share our knowledge in different forms of advanced education. The institute's Competence Center for Energy Management offers CAS programs ("Certificate of Advanced Studies") on the management of utility companies that has established itself in the corresponding fields. The center organizes also the annual conferences on electricity, gas and heat supply that continuously attract large attention among practitioners.

Additional spillover of ideas occurred due to our presence at seminars, congresses, and conferences. Several institute members presented their latest research results on international conferences and workshops. The institute is also strongly anchored in Switzerland's energy research by participation in the "Competence Center for Research in Energy, Society and Transition" (SCCER CREST) and a project within the National Research Program "Energy Turnaround" (NRP 70).

Ior/cf-HSG's technical expertise attracts also the attention of companies which allows us to share our competences in projects with the industry. The usefulness of our applied software finances the implementation of new ideas. Cooperations with the energy sector adapted the existing packages for power contracts to firm-specific requirements and inspired new applications. Software for algorithmic trading in the intraday market for electricity implement consistent and efficient orders within defined limits for the associated risks. Software tools and consultancy projects are also offered for the banking industry with applications in asset and liability management, risk management and forecasting.

The Institute for Operations Research and Computational Finance continues to concentrate on its core competences, stochastic optimization and the simulation of market dynamics. Based on accumulated experience and endorsed by our supporters, we tackle our ongoing and upcoming projects as a team.

For my part, I owe my thanks in turn to the people supporting me. The academic board members paved the way for promising business activities. My team members proved their willingness to perform and demonstrated flexibility whenever needed, and our project partners continued respectively started to trust our institute with their business decisions.

Prof. Dr. Karl Frauendorfer

Table of contents

2. Management summary of business activities

A result of ior/cf-HSG's activities in applied research are various software tools for market participants in the energy and financial industry. In addition, the institute estimates distributions of future spot prices and price forward curves for electricity and gas that are provided to subscribers. Details of the products and services that are offered, also in cooperation with partners, are described in section 4.

Algorithmic intraday trading for power traders

The institute developed an automatic trading algorithm that seamlessly integrates into trading system at energy exchanges and performs algorithmic intraday trading at electricity spot markets. Varying forecasts of electricity production by wind, photovoltaic and hydropower plants lead to open energetic net positions after the day-ahead market has been closed. The implemented algorithm calculates the optimal tranches of energy and the related prices that should be traded at a certain time – based on the observed current (and historical) market prices and the inherent forecast risks. It automatically places trade orders on the market to ensure a continuous cost effective closing of open positions, taking into account limits on maximum risk.

Price prognoses and data analyses for electricity markets: BIT@EPI.Dynamics

The ior/cf-HSG offers an information service that includes long- and short-term prognoses as well as analyses of related volatilities. For the electricity markets Germany, Austria, Switzerland and France, hourly price forward curves (HPFCs) and corresponding confidence bands are generated for a long-term horizon of up to six years. This information is complemented by short-term spot price prognoses, analyses of volatility structures, spot and forward risk profiles as well as intraday price limits. The provided information is consistent with the respective market. Subscriptions are received by e-mail or may be downloaded from a special website or web service. On the sales level, this information service is supported by Powel AG, Basel.

Regime-dependent natural gas price forward curves: BIT@GAS.PFC

Supply contracts of natural gas mostly consist of longer delivery periods up to several years. Thus, a reliable valuation of such contracts requires price forward information for the respective market/hub and for the entire contract period under consideration. The institute offers such price forward information with daily granularity for the market area of the Dutch Title Transfer System (TTF) as well as for the two German market areas operated by Net-Connect Germany (NCG) and by Gaspool Balancing Services (GPL). Throughout all market areas, the provided information consists of two price forward curves (PFCs) representing two regimes: A cyclical and an anticyclical regime which influence the shape of the respective PFC. The first regime leads to a strong seasonal price pattern that stresses mainly the temperature dependency of natural gas spot prices. Such an expectation can be thought as the product of rather low future storage levels compared to the expected demand. The second regime, presumably a situation of high future storage levels, is characterized by a spot price expectation that shows almost no seasonality. A mechanism for generating these regime-dependent PFCs has been implemented in the software module BIT@GAS.PFC. For the above mentioned markets/hubs, a corresponding cyclical and anticyclical gas PFC is automatically generated on a daily basis. Subscriptions to the information service may be received by e-mail and are downloadable from a special website (www.iorcf.eu/dynamics).

Benchmarking of replication strategies for non-maturing assets and liabilities

The ior/cf-HSG has a vast experience in modeling non-maturing assets and liabilities (NoMALs) from research as well as practical projects with industry partners that go back to 1993. Activities in this field include the assessment of standard approaches for the construction of replicating portfolios, modeling the evolution of client rates and product volumes as well as the design of a dynamic replication model

based on multistage stochastic optimization methods. This experience is offered to banks for an assessment of their current approaches for managing NoMAL positions.

Margin Optimizer

Margin Optimizer is software for the control and quantification of the potential risk of non-maturing assets and liabilities in a bank's balance. By analyzing a large number of representative scenarios for the evolution of future interest rates and volumes, the tool calculates dynamic replicating portfolios that take into account the risk inherent to changes in these factors. Compared to static approaches that are currently still standard in the banking industry, the dynamic replication allows a substantial increase and stabilization of the margins of variable positions.

Modelling volumes and client rates of retail banking products

The volumes of retail banking products show significant variations over time that can be attributed to changes in clients' demand depending on the level of interest rates, offered product rates or other economic factors. The identification of the relations of product volumes on these factors provides valuable information for various applications like risk management, budget planning etc. The institute developed corresponding models, provides updated parameter estimates and consultancy services for partners in the financial industry.

3. Research program

Sophisticated solutions to practical problems embody ior/cf-HSG's device. Theoretical achievements lead to new algorithms whose implementation in turn may raise research questions. This chapter summarizes the institute's research activity and lists both projects and publications.

3.1 Research activities

According to ior/cf-HSG's affiliation to the University of St. Gallen, research is a commitment for the institute. Its activities promote applied research aiming at effective contributions for solving challenging and complex problems in the financial and energy industry. In addition, the problems often require preliminary conceptual and theoretical work attributed to basic research.

Many real problems are subject to dynamic decision processes whose handling depends decisively on uncertainties with respect to the development of relevant factors. The interaction of time and uncertainty in connection with regulatory and corporate requirements leads to complex decision problems that generally overstrain human intuition. Stochastic optimization concepts provide a systematic solution to such questions and constitute the methodic link among ior/cf-HSG's research activities. Theoretical insights allow the development of software solutions, corresponding training courses establish their application and knowledge about the inherent model risks.

3.2 Research projects

The subsequent subsections report the institute's research projects. They cover topics which are either part of ior/cf-HSG's business activities or part of the research focus of the University of St. Gallen. Dissertation projects enhance the knowledge about specific topics, and collaborations with external researchers support the implementation.

3.2.1 Sustainability and Financial Markets

The awareness of the world's population towards the interdependence of the economy, financing and investment decisions, social cohesion, and our natural eco-system has significantly increased due to, for instance, the consequences of climate change and humanitarian disasters throughout the last decades. The integration of measures for environment, social, and governance (ESG) issues into financial decision-making concerns several major questions such as (1) the relationship between ESG performance and financial performance, (2) the risk mitigation effect of ESG criteria, (3) the measurement and the reliability of ESG assessments, and (4) the construction of appropriate models to integrate ESG measures into the decision-making process.

Since the sustainability of an investment concerns the long-term perspective, the implementation of a long-term trading strategy can benefit from the intangible nature and the heterogeneity of ESG activities. The obtained results for an US sample indicate that firms with strong ESG implementations significantly outperform firms with weak ESG standards in the mid and long run in certain thematic areas. Firm returns increase up to 3.8% with respect to an one-standard-deviation increase of the ESG rating. The main economic channel for the appreciation of strong ESG stocks is unexpected additional cash flows. The results are relevant for assessing the efficiency of ESG, and have broader implications for asset managers who can expect abnormal returns by investing in firms that exhibit a high CSR in the respective scores and holding the stocks for a longer period.
Furthermore, firms with a high level of ESG implementations generally exhibit superior stock price synchronicity in the markets of Europe, Japan, and the United States. Based on the findings, an optimal level of ESG exists to minimize idiosyncratic risk for each region. Moreover, ESG has a mitigating effect

on crash risk in Europe and the United States. In contrast, firms from the Asia-Pacific region display CSR over-investment followed by a higher crash risk.
Next, the reliability of ESG assessments is a central issue in empirical research. Reliable disclosures on ESG assessments may reduce information asymmetries when it comes to due diligence, for instance. Based on the press release of corporate scandals, an analysis of ESG assessments before, during, and after the event year indicates a significant decline in retrospective controversy indicators during the period in which the scandals are released. Subsequent to the scandals, ESG indicators experience a rebound. The assessments of forward-looking indicators indicate slightly significant increases during the scandal period. Moreover, the findings show that aggregated ESG assessments consisting of both retrospective and forward-looking indicators are useless when it comes to predicting corporate scandals. Therefore, the results recommend educating managers and investors upon how to obtain a comprehensive vision of the corporate social responsibility of a firm based on single ESG assessment indicators.
Finally, ESG integration – the integration of ESG assessments into the financial analysis – requires appropriate tools for decision-making. Computing the nondominated set (the set of all pareto optimal portfolios in investment decisions) of a sustainability portfolio decision situation with financial and extra-financial objectives has long been a topic in multiple criteria decision making. Starting with the desire to extend Markowitz portfolio selection to an additional linear criterion for sustainability, we demonstrate an exact method for computing the nondominated set of a tri-criterion program that is all linear except for the fact that one of its objectives is to minimize a convex quadratic function. With the nondominated set of the resulting quad-lin-lin program being a surface composed of curved platelets, a multiparametric algorithm is devised for computing the platelets so that they can be graphed precisely. In this way, graphs of the tri-criterion nondominated surface can be displayed so that, as in traditional portfolio selection, a most preferred portfolio can be selected while in full view of all other contenders for optimality. Finally, by giving an example for sustainable investors, we demonstrate that our algorithm can outperform standard portfolio strategies for multicriterial decision makers.

Project staff: *Prof. Dr. Sebastian Utz*

3.2.2 Swiss Competence Center for Research in Energy, Society and Transport

The Swiss Competence Centers for Energy Research (SCCERs) financed by the Federal Commission for Technology and Innovation bundle the national research efforts in the field of the energy transition. The Competence Center for Research in Energy, Society, and Transition (CREST) as one of those SCCERs and led by the University of Basel integrates five institutes from the University of St. Gallen consolidated in the Center for Energy Innovation, Governance, and Investment (EGI-HSG).

CREST as one of the eight SCCERs contributes to the energy transition in Switzerland by evidence-based recommendations on policies that reduce energy demand, foster innovation and increase the share of renewables efficiently. It covers economy, environment, law and behavior, and it develops concepts for energy policy, provides analyses of drivers and barriers to energy efficiency, produces strategies for firms and regions adjusting to the new energy system and develops assessment tools for policies and technological solutions. Work packages bundle these research efforts.

In 2017, the ior/cf-HSG developed a tool for the financial assessment of the energy composition and consumption according to scenarios compatible with the technical conditions in the city of St. Gallen. In a second project in cooperation with the city of St. Gallen, the ior/cf-HSG quantifies the financial potential of flexibility on the spot markets and, thus, estimates the volume the local utility would need in order to compensate the current shortfall in today's overly liquid markets. Finally, the ior/cf-HSG also contributed to the annual conference of SCCER CREST.

In the second phase of this research program, ior/cf-HSG focuses on the management of energetic portfolios in order to achieve adequate levels of risk and return, especially for flexibility. Price forward curves in quarter hour granularity, educational modules with specific use of the new trading room at

the University of St. Gallen and cooperation within the work package, across those of CREST and even with some other SCCERs improve the modeling and optimization of valuations and trading strategies.

Project staff: *Prof. Dr. Michael Gratwohl, Dr. Gido Haarbrücker, Dr. Michael Schürle*

3.2.3 Interval forecasts for electricity spot prices

Risk assessment relies on distributional assumptions. Flexible consumers and producers of electricity may earn flexibility premiums on intraday markets with the equivalent of the Delta hedge premium as the optimum, given the respective price dynamics. The allocation of rapid infeeds and flexibility may even exhibit positive effects on the overall efficiency, fluctuation and needs for investments into the transmission grid.

Spot markets move towards continuous exchanges for both day-ahead and intraday electric power. Price levels and fluctuations determine the operational optimum for the market participants and feed back into the availability and liquidity of those markets. Quarter hour resolution and quantiles for the spot price forecasts might improve the valuation and the risk management of electricity portfolios.

Project staff: *Prof. Dr. Michael Gratwohl*

3.2.4 Renewable methane for transport and mobility

The power-to-gas technology allows the use of excess electricity from renewable generation for the production of synthetic methane that can be fed in the natural gas grid. In this way, large amounts of electricity from seasons with a surplus of generation can be stored in existing infrastructure for use in periods where less renewable energy is available. The synthetic methane can either be converted back to electricity, or used for heating purposes and transportation. The SNF project “Renewable Methane for Transport and Mobility” focuses on the latter aspect. It results from a joint application of several research institutions under the lead management of the University of Applied Sciences Rapperswil.

The “Energy Strategy 2050” formulated by the Swiss Federal Council plans a substantial increase in the generation capacity of renewable electricity. Since the main contribution from renewable sources will come from photovoltaic generation, more “green” electricity will be produced in summer. According to some studies, production may temporarily exceed demand and, thus, storage technologies are required.

Beside hydropower pumped-storage plants that allow to store electrical energy also over seasons, the power-to-gas (P2G) technology could be used to convert excess electricity to hydrogen or methane. The former could be directly used as motor fuel, which would require the set-up of the complete corresponding distribution infrastructure, while the latter could be fed in the existing gas grid since the synthetically generated methane is chemically identical to natural gas. In this way, the existing infrastructure may be used for storage over long time intervals as well as for the distribution.

Since the last conversion step to methane requires also carbon dioxide, as an additional advantage emissions from sewage plants, cement mills or other sources can be exploited that would otherwise be released to the atmosphere. However, the degree of efficiency of synthetic methane generation is about 50 per cent, i.e., 2 MWh of electrical power are required to generate 1 MWh of “renewable” gas. Therefore, the practical application is economically only beneficial if electricity is sufficiently cheap or can otherwise not be used, which might be the case when production from renewable sources is significantly extended in the future. A conversion of gas back to electricity would reduce the overall energy efficiency further. Thus, it seems economically and ecologically more reasonable to use “renewable” gas directly for heating or transportation.

The project "Renewable Methane for Transport and Mobility" (RMTM) focuses on the latter aspect. It is conducted in collaboration with several research institutions under the lead management of the University of Applied Sciences Rapperswil (HSR) with financial support of the Swiss National Funds (SNF) within the National Research Programme "Energy Turnaround" (NRP 70). The contribution of ior/cf-HSG is the analysis of economic aspects of P2G with focus on transportation.

Within the project, a real option model was developed for an assessment of business models and the profitability of investments in P2G facilities. This approach models the uncertainties of the relevant risk factors (power prices on spot markets, investment costs etc.) and takes into account an investor's flexibility to start, extend or abandon a project also at later time points, e.g., when the costs for a new technology have decreased sufficiently. Real option analysis usually leads to higher project values than the classical (static and deterministic) net present value calculation due to the value of flexible investment timing when revenues and costs are uncertain.

In the previous year, the real option model was refined and tested for various settings for realistic input values. It turned out that currently the investment costs for P2G plants are too high to make investments in P2G plants profitable under the given regulatory and market conditions. Moreover, P2G plants are subject to grid fees if power is purchased from the grid, which makes the costs for electricity prohibitively high. However, if electricity is obtained from own production and grid fees are avoided then investments in P2G plants may become profitable in the medium term since investment costs are expected to decrease with a higher penetration of P2G infrastructure. Moreover, car manufacturers may avoid penalties for exceeding the 95 g/km limit for CO2 emissions if they increase their sales in natural gas vehicles, which run on synthetically generated gas from renewable sources. This is a strong motivation for the automobile industry to invest in P2G facilities.

The results of the analyses are not only important from the perspective of an individual plant operator. Flexible consumers like P2G plants may also contribute to a stabilization of the power grid. This aspect will become more important in the future, as the increasing share of variable production from renewable sources can only be handled if consumption can be shifted at least partially. This might be taken into account by policy makers by promoting the technology in form of subsidies, exclusion from grid fees or other measures.

Project staff: *Dr. Michael Schürle*

3.3 Publications

This section lists selected basic and applied research work of the past three years and supervised theses of the previous two years, respectively. Readers interested in other publications, presentations, or working papers are welcome to contact the institute or to visit *www.iorcf.unisg.ch*.

Basic research

- Aepli Matthias, Roland Füss, Tom-Erik Sønsteng-Henriksen and Florentina Paraschiv (2017). *Modeling the multivariate dynamic dependence structure of commodity futures portfolios.* Journal of Commodity Markets, 6, 66-87.
- Jaimovich Gregorio, Juliana Martinez Rolon, Helen Baldomero, María Rivas, Ignacio Hanesman, Luis Bouzas, Julia Palma, Amado Kardus-Urueta, Diana Almeida Ubidia, Willem Bujan-Boza, Oscar Gonzalez-Ramella, Guillermo Ruiz-Arguelles, David Gomez-Almaguer, German Espino, Ernesto Fanilla, Derlis Gonzalez, Antonio Carrasco, Sebastián Galeano, Gabriel Borelli, Marcos Hernandez-Gimenez, Marcelo Pasquini, Yoshihisa Kodera, Alois Gratwohl, Michael Gratwohl, José Nuñez, Jeff Szer, Robert Gale, Dietger Niederwieser and Adriana Seber (2017). *Latin America: The next region for haematopoietic transplant progress*. Bone Marrow Transplantation, 23 January 2017, doi: 10.1038/bmt.2016.361, Epub ahead of print.
- Gratwohl Alois, Carmen Ruiz de Elvira, Michael Gratwohl, Hildegard Greinix and Rafael Duarte (2016). *Gender and Graft-versus-Host Disease after Hematopoietic Stem Cell Transplantation*. Biology of Blood and Marrow Transplantation, 22 (6), 1145-1146.
- Niederwieser Dietger, Helen Baldomero, Jeff Szer, Michael Gratwohl, Mahmoud Aljurf, Yoshiki Akatsuka, Luis Bouzas, Adriana Seber, Dennis Confer, Hildegard Greinix, Mary Horowitz, Minako Iida, Jeffrey Lipton, Mohamad Mohty, Nicolas Novitzky, José Nunez, Jakob Passweg, Marcelo Pasquini, Yoshihisa Kodera, Jane Apperley and Alois Gratwohl (2016). *Hematopoietic Stem Cell Transplantation Activity Worldwide in 2012 and a SWOT Analysis of the Worldwide Network for Blood and Marrow Transplantation Group (WBMT) including the global survey*. Bone Marrow Transplantation, 51 (6), 778-85.
- Gratwohl Alois, Marcelo C. Pasquini, Mahmoud Aljurf, Yoshiko Atsuta, Helen Baldomero, Lydia Foeken, Michael Gratwohl, Luis Fernando Bouzas, Dennis Confer, Karl Frauendorfer, Eliane Gluckman, Hildegard Greinix, Mary Horowitz, Minako Iida, Jeff Lipton, Alejandro Madrigal, Mohamad Mohty, Luc Noel, Nicolas Novitzky, José Nunez, Machteld Oudshoorn, Jakob Passweg, Jon van Rood, Jeff Szer, Karl Blume, Frederic R. Appelbaum, Yoshihisa Kodera and Dietger Niederwieser (2015), for the Worldwide Network for Blood and Marrow Transplantation (WBMT). *One million haemopoietic stem-cell transplants: a retrospective observational study*. The Lancet Haematology, 2 (3), e91-e100, http://dx.doi.org/10.1016/S2352-3026 (15) 00028-9.

Research in energy markets

- Benth Fred-Espen and Florentina Paraschiv (2017). *A space-time random field model for electricity forward prices.* Journal of Banking and Finance. (Best Paper Award, Energy and Commodity Finance Conference 2016, Paris.)
- Kiesel Rüdiger and Florentina Paraschiv (2017). *Econometric analysis of 15-minute intraday electricity prices.* Energy Economics, 64, 77-90.
- Hagfors Lars, Hilde Kamperud, Florentina Paraschiv, Marcel Prokozcuk, Alma Sator and Sjur Westgaard (2016). *Prediction of extreme price occurrences in the German day-ahead electricity market.* Quantitative Finance, 16 (12), 1929-1948.
- Keles Dogan, Jonathan Scelle, Florentina Paraschiv and Wolf Fichtner (2016). *Extended forecast methods for day-ahead electricity spot prices applying artificial neural networks (ANN)*. Applied Energy, 162, 218-230.

- Paraschiv Florentina, Risto Hadzi-Mishev and Dogan Keles (2016). *Extreme Value Theory for heavy-tails in electricity prices.* Journal of Energy Markets, 9 (2), 21-50.
- Hagfors Lars, Peter Molnar, Florentina Paraschiv and Sjur Westgaard (2016). *Using quantile regression to analyze the effect of renewables on EEX price formation.* Renewable Energy and Environmental Sustainability, 32 (1), DOI: https://doi.org/10.1051/rees/2016036.
- Frauendorfer Karl, Florentina Paraschiv and Michael Schürle (2016). *Cross-border effects of the German electricity market fundamentals on the Swiss electricity prices.* Working paper (part of the final report of the project "Econometric analysis of the determinants of electricity wholesale prices in Switzerland and Germany" financed by the Swiss Federal Office of Energy).
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- Gross Michael (2016). *Risk Control im Rahmen der Governance von Stromübertragungsnetzbetreibern.* Dissertation #4524, University of St. Gallen.
- Paraschiv Florentina, Stein-Erik Fleten and Michael Schürle (2015). *A spot-forward model for electricity prices with regime shifts.* Energy Economics, 47, 142-153.
- Opitz Christian (2015). *Energiedienstleistungen – eine Verständnisfrage.* Aqua und Gas (9): 12-16.

Research in finance

- Utz Sebastian (2017). *Corporate scandals and the reliability of ESG assessments: Evidence from an international sample*, Review of Managerial Science, in press.
- Utz Sebastian (2017). *Over-investment or risk mitigation? Corporate social responsibility in Asia-Pacific, Europe, Japan, and the United States,* Review of Financial Economics, in press.
- Dorfleitner Gregor, Sebastian Utz and Maximilian Wimmer (2017). *Patience pays off - corporate social responsibility and long-term stock returns,* Journal of Sustainable Finance and Investment, in press.
- Aepli Matthias, Karl Frauendorfer, Roland Füss and Florentina Paraschiv (2016). *The Predictive Power of Multivariate Dynamic Copula Models.* Under review.
- Paraschiv Florentina and Pierre-Antoine Mudry (2016). *Stress testing techniques for portfolios of commodity futures, using extreme-value theory and copulas.* In R.J. Fonseca et al. (eds.): Computational Management Science – State of the Art, 17-22, Springer.
- Gutsche Robert (2016). *Goodwill in der Bilanz: Zum fragwürdigen Ansatz von Anschaffungskosten einer Investition, die sich schlussendlich „amortisieren" muss – Ein Plädoyer, Spekulation wieder Anlegern zu überlassen.* Zeitschrift für Internationale Rechnungslegung, 9, 369-375.
- Gutsche Robert (2016). *Equity-settled Share-based Compensations: Fairly Presented and Decision Useful?* Zeitschrift für Internationale Rechnungslegung, 2, 79-87.
- Gutsche Robert and Giorgio Ciocca (2016). *Retail investors' attention and momentum strategies – Evidence from the S&P 500.* Under review.
- Gutsche Robert and Sven Baumeister (2016). *The impact of CSR reporting quality on analyst forecast accuracy*. Under review.
- Gutsche Robert, Jan-Frederic Schulz and Michael Gratwohl (2016). *Firm-value Effect of CSR Disclosure and CSR Performance*. Under review.
- Rous Jan Martin (2016). *Institutional Investing and Feedback Effects in Capital Markets.* Dissertation #4558, University of St. Gallen.
- Paraschiv Florentina, Pierre-Antoine Mudry and Alin Andries (2015). *Stress testing techniques for portfolios of commodity futures, using extreme-value theory and copulas.* Economic Modeling, 50, 9-18.

- Gutsche Robert (2015). *Intangibles, quo vadis? Eine kritische Analyse von IFRS 13 und IFRS 3.* Zeitschrift für Internationale Rechnungslegung, 10, 193-198.
- Gutsche Robert (2015). *IFRS 13 - Fair Value Measurement: From Cost to Value? – Eine Bestandsaufnahme des Status Quo*. Zeitschrift für Internationale Rechnungslegung, 3, 107-110.
- Aepli Matthias (2015). *Portfolio Risk Forecasting – On the Predictive Power of Multivariate Dynamic Copula Models.* Dissertation #4322, University of St. Gallen.
- Rüdlinger Mark (2015). *Contingent Convertible Bonds – An Empirical Analysis of Drivers and Announcement Effect.* Dissertation #4420, University of St. Gallen.

Master theses in energy markets

- Birlea Ioan Ilie (2017). *Herausforderung Elektrizitätsversorgung Brasilien - Analyse des Elektrizitäts-systems und Entwicklung einer Markteintrittsstrategie im Bereich Photovoltaik.*
- Bosshart Tobias (2016). *The Behavior of Selected Oil Price Drivers since 2000 - An empirical analysis taking into account structural changes in the oil market*.
- Bucher Christoph (2017). *Energiedienstleistungen Schweizer EVUs - Aktuelle Aktivitäten, Markt-bearbeitungsstrategien und die Rolle der Kunde.*
- Cop Prek Andrej (2016). *Interdependencies between Day-Ahead and Intraday Market.*
- de Lancastre Luis (2016). *Are natural gas prices across the atlantic basin converging? A statistical cointegration analysis*.
- Galli Renato (2017). *Flexibilität von Pumpspeicherkraftwerken in der Schweiz.*
- Hetterich Jonas (2017). *Stresstests in der Europäischen Bankenbranche - eine kritische Analyse.*
- Jürgensen Yannic (2017). *The Influence of Syndication Structure and Dynamics on the Venture Capital Performance - A US Portfolio Company Valuation Perspective*.
- Leitner Perceval (2017). *Brexit - The economic effects on the United Kingdom.*
- Pianetti Claudia (2017). *Entwicklung eines idealtypischen Innovationsprozesses für mittelgrosse Schweizer Energieversorgungsunternehmen.*
- Pit Henk-Jan (2017). *The Strategic Response of Listed European Energy Producers to the Introduction of Renewable Energy Sources*.
- Schwarzen Dominique (2017). *Datenbasierte Geschäftsmodelle für EVUs - Ausgangslage und mögliche Anwendungsfelder.*
- Schlote Hagen (2017). *An empirical comparison of alternate regime-switching models or electricity spot prices.*
- Simmen Jonathan (2016). *Dynamics of Crude Oil Differentials - The Impact of Arbitrage and State Shift.*
- Vogel Alexandra (2017). *Kundenzentrierte Geschäftsmodellinnovation für Energieversorgungs-unternehmen*.
- Zumtaugwald Andre (2016). *Estimation of the WACC for the Swiss Energy Industry.*

Bachelor theses in energy markets

- Churyukanov Alexander (2017). *Blockchain-Anwendungen im Energiesektor - Anwendungsfelder, Projekte, Geschäftsmodelle.*
- Jovanovic Aleksandra (2017). *On the potential of sourcing Biodiesel in the Balkans - Arbitrage opportunities.*

- Koch Sean (2016). *Auswirkungen eines tiefen Ölpreises auf Volkswirtschaften und Finanzmärkte am Beispiel von Brasilien und China.*
- Pidoux Mathieu (2016). *The Geopolitical Implications of Energy Trading*.
- Rivollet Adam (2016). *Physical Commodity Trading and the Advantages of Switzerland in this Industry.*
- Schmid Daniel (2016). *Statistical Analysis of EPEX Spot Power Prices and Profitability Study of Flexible Power Generation and Battery Storage.*
- Tschan Michael (2016). *Speicher und Flexibilitätsmärkte.*
- Vetterli Benjam (2016). *Valuation of Onshore Wind Parks.*

Master theses in finance

- Bickel Raphael (2017). *Disclosure of "All Other Segments" Under IFRS 8 - An Analysis of European Blue Chip Companies.*
- Bourquin Jean-Luc (2016). *Portfolio optimization with multi-objective differential evolution.*
- Burchielli Francesco (2016). *Basel III - an update.*
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4. Business activities

The transfer of results from fundamental and applied research carried out at ior/cf-HSG has led to the development of customized software applications. Based on the expertise and experience gained from diverse research and project activities, the institute offers a broad scope of services and products in the fields of energy and finance. The following sections present the software applications and related services that are provided by ior/cf-HSG, partially in cooperation with partner companies. In addition, also ongoing consultancy projects are described.

4.1 Energy

The ior/cf-HSG has established the software family BIT@EPI (Business Information Technology at Electric Power Industry) providing solutions for operational tasks and managerial decision problems situated in this energy sector. BIT@EPI is constantly developed further according to enhanced methodologies as well as to new or changing practical needs. The applied modular concept is especially suitable to handle the heterogeneous problems arising in the respective application fields and to overcome the challenge of a dedicated quantitative analysis.

The modules developed cover the modeling of price forward curves and of spot price dynamics, portfolio optimization of utilities, and the valuation of virtual power plants. BIT@GAS.PFC constitutes a supplementary module which allows an automated generation of regime-dependent PFCs with a daily granularity for several trading hubs of natural H-gas.

Within the reporting year, in particular automated trading algorithms for the electricity intraday market have been developed and implemented. These algorithms efficiently close ever changing open positions due to updated prognoses of renewable energy production (wind, photovoltaics) and own intraday market activity.

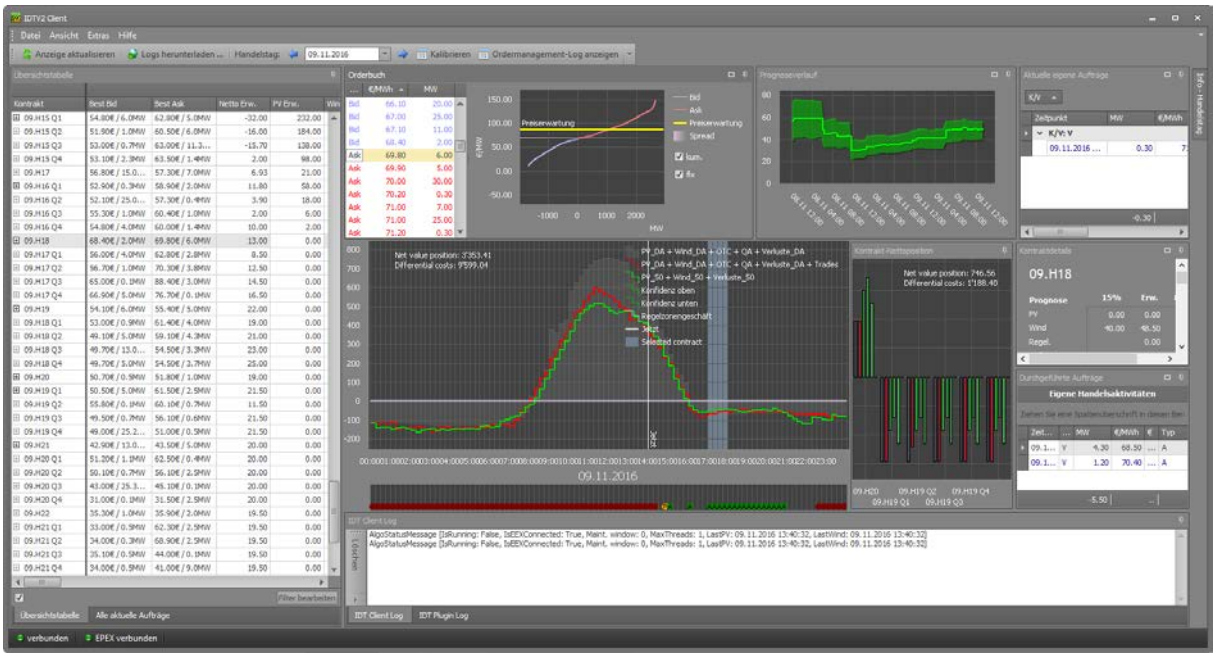
4.1.1 Automated intraday trading for TSOs

Given the stochastic nature of renewable energy sources like wind, photovoltaics, and water, these types have a strong impact on the volume and prices on the intraday market for electricity at the EPEX SPOT power exchange. German transmission system operators (TSOs) have to market this electricity on the day ahead as well as on the intraday market. In cooperation with an European TSO, the ior/cf-HSG developed automated trading algorithms which incorporate the price and volume probabilistics and which take the relevant risk management guidelines into account. The algorithms are embedded into a commercial energy trading system and automatically place orders on the intraday market aiming at an effective management the TSO's net position which varies due to changing generation prognoses and own intraday market transactions.

German TSOs are obliged to forecast and to market at the EPEX SPOT power exchange the available energy of those wind generators, photovoltaic units, and small hydro plants which have not opted for the so called method of 'direct marketing'. In general, the respective predicted renewable energy is traded by the TSO on the day-ahead auction market. However, the prognosis at day-ahead market closure is not perfect, and new prognoses of power production do arrive periodically up to the actual time of delivery. The deviances lead to open positions which have to be traded on the intraday market in order to minimize the residual energy for which the cost of balancing energy will become effective.

From the operational point of view, the monitoring of all tradable products (hour contracts, 30-minutes contracts, and quarter hour contracts – not even taking into account configurable block products) cannot be managed continuously and effectively by single human traders. The complexity has even more increased due to newly designed specific contracts which are tradable separately within each delivery area up to 5 minutes before delivery. In this challenging setting, the utilization of automated trading

algorithms may ensure a continuous, consistent, and cost effective manner of closing the changing open positions while assuring compliance with imposed risk management directives and trading guidelines.



Automated intraday trading: clipping from the trading algorithm GUI

The ior/cf-HSG developed and implemented automated trading algorithms which are embedded as a Java plugin into a commercial energy trading system. Through this commercial energy trading system, the algorithms are supplied with all relevant historic and current prognosis and market data like the order book for every single tradable contract. Newly placed orders on the intraday market are immediately received and the algorithm can react instantaneously by placing matching orders on the market itself. The placing of orders is also done via the trading system, thereby enabling the user to manually interfere in exceptional situations.

New prognoses for the relevant renewable energy production entail the algorithmic calculation of optimal energy amounts which shall be traded on the market according to the currently observed order book for every single contract. Additionally, arbitrage possibilities may be taken into account for overlapping contracts, like an hour contract and its contained 4 quarter hour contracts. The calculations are based on fitted probability distributions of the observed intraday trade prices, prognoses of the renewable energy generation, and on parameterizable directives and preferences. The placement of own originary or aggressive orders on the market is enhanced by a precalculation of own potential trade orders which allows instantaneous reactions to new visible orders in the exchange order book.

The trading algorithms are completed by monitoring, signalling, and reporting functionalities.

Project staff: *Dr. Gido Haarbrücker, Claus Liebenberger*

4.1.2 Price prognoses and data analyses for electricity markets

For nearly ten years now, ior/cf-HSG provides an information service which includes long- and short-term prognoses as well as analyses of related volatilities. For the electricity markets Germany, Austria, and Switzerland, hourly price forward curves (HPFCs) and corresponding confidence bands are generated for a long-term horizon of up to six years. This information is complemented by short-term spot price prognoses, analyses of volatility structures, spot and forward risk profiles, and intraday price limits.

Trading and hedging within physical or financial electricity markets demand a sophisticated valuation of various contract types as well as a profound risk analysis and management. All these tasks strongly depend on the quality of the underlying HPFC. Additionally, the stochastic price dynamics (volatility etc.) has to be taken into account. Otherwise, the analyses would disregard relevant risk sources.

With regard to the generation of HPFCs, special attention has to be paid to the absence of arbitrage, to the correct modeling of cyclical price components (the seasonality over different time spans, e.g. of one year, one week, and one day), and to the consistency of forward price and spot price dynamics. The latter consistency holds when the current expectation of the uncertain prospective spot prices (over the respective maturities) matches the currently observed futures' prices. In this sense, a HPFC does not contain the 'most likely' values of the spot prices in the future but rather represents the expected values of the probability distributions of the hourly spot prices. Furthermore, the neighbouring geographical regions Germany, Austria, and Switzerland and cross-border auctions require a consistency among the respective market HPFCs.

For the following markets, HPFCs are generated for every trading day of the respective energy exchange: Germany/Austria (Phelix) and Switzerland (Swissix), which are both traded at the European Energy Exchange EEX; furthermore, for Austria which is traded at the Energy Exchange Austria EXAA. Every HPFC covers a time horizon of '5 years +', i.e. the remaining period of the current year plus the 5 subsequent calendar years. The calculation is carried out overnight in an automated way for the very next exchange's trading day, always based on the then available market data.

The above mentioned markets plus France are enhanced by the generation of a so called EE variant ('Erneuerbare Energien') of the respective HPFC: These variants reflect the marketing potential for power producers of renewable energy, as with the begin of 2010 the German transmission system operators are obliged by the 'Erneuerbare Energien Gesetz' to trade at the respective electricity exchange that amount of renewable energy, for which the producers did not opt for the 'direct marketing' method.

We take into account these new marketed energy amounts in an implicit manner: our studies based on historical data revealed that the classical way of assuring the resulting HPFC to be free of arbitrage (going along with a kind of shifting a scaled shape curve over small time windows according to the underlying base and peak futures products) may lead to 'price anomalies' within the HPFCs in the following sense: the price relation of neighboring hours does not reflect the respective price relation of the observed spot price. Particularly, this behavior could be observed at the transitions from peak to off-peak periods. In order to overcome such inconsistencies, a supplementary constraint set is used within the optimization problem which ensures the arbitrage freeness of the HPFCs: Based on historic price differences over a rolling time window of ca. 3 months, specific ranks of the ordered differences are taken as proxies for upper and lower confidence bands; these bands serve as upper and lower limits for the absolute price differences of neighboring hours within the HPFCs to be generated.

In the reporting year, we started the additional generation of separate HPFCs and EE HPFCs for the market areas Germany and Austria. This is due to the planned split of the German-Austrian price zone in Q3 2018 which has led the EEX to already introduce individual Phelix-DE Futures and Phelix-AT Futures.

The EE HPFC family with hourly granularity is enriched by a supplementary quarter-hour HPFC (QHPFC) for Germany/Austria: The QHPFCs incorporate quarter-hourly price patterns, are consistent with the respective HPFC, and cover the same time horizon '5 years +' as the hourly HPFCs do.

So-called 'Spike HPFCs' complement the offered spectrum of electricity price forward curves: these spike-based HPFCs reflect the incompleteness of the power markets. They are available for the markets Germany/Austria (Phelix), Switzerland (Swissix), and France at the EEX and enable, e.g., a consistent stress testing for energy supply companies.

Short-term prognoses are determined for the markets Germany/Austria (Phelix), Switzerland (Swissix), and France at the EEX. These prognoses are delivered in the form of five confidence bands

which represent an approximation of the real probability distribution of the hourly spot prices for the next three days (seven day for the EE variant, respectively). The determination relies on the seasonality within the respective HPFC, on the 24-hours term structure of the volatility (on a week-ahead basis), and on the stochastic dynamics of the clearing prices. Every confidence band is given by pairwise quantile information, thus coping with the fact of asymmetric spot price distributions. In particular, the volatility at the 'short end' (i.e. for the very near future) plays a significant role for the 3-day and 7-day prognoses: because historically, electricity markets exhibit the same behavior of volatility clustering as financial markets do, i.e. a phase of high volatilities with high price amplitudes is followed by a phase of low volatility with minor price amplitudes and vice versa.

Furthermore, a point forecast for the next 24 hours is provided together with supplementary information on the term structure over the same time span: the forecast is given by the mode of the probability distribution of the spot price, i.e. that price which will most likely occur – with an accuracy of +/– 1€; the term structure is determined on a day-ahead basis reflecting the magnitude of the short-term price fluctuations.

For the markets Germany/Austria (Phelix), Switzerland (Swissix), and France at the EEX as well as for Austria at the EXAA, hourly spot risk profiles are determined on a daily basis. The calculation of these risk profiles takes the respective spot price dynamics into account, based on the difference of the 95% quantile and the respective HPFC. All spot risk profiles cover the next seven days; due to the asymmetric price dynamics, the risk profiles have to be provided separately for long and short positions. The hourly granularity of the profiles supports a RAROC (Risk Adjusted Return on Capital) driven trading and allows a quantitative risk assessment of open positions within trading books.

The intraday markets are covered by the information category 'price limits' for the markets Germany/Austria, Germany, Austria (Phelix) and France at the EEX. These price limits are provided numerically and graphically in form of up to five price intervals per hour. Depending on the respective price range in which the current intraday price lies, a recommendation can be derived which intraday trade action is more promising: either to close or to hold an open long or short position.

Detailed information on this service provided by the ior/cf-HSG (on the sales level supported by Powel AG, Basel) is available on www.iorcf.eu/dynamics.

Project staff: *Dr. Gido Haarbrücker, Ass.Prof. Dr. Michael Gratwohl, Claus Liebenberger*

4.1.3 Risk-adjusted contract and portfolio management

E!nvestigate has been developed as a state-of-the-art and multitasking decision support system. It supports participants within the energy sector to cope with today's challenging business processes and tasks involved. Various types of delivery contracts and the own net position can be investigated, going along with an optimal value-oriented or quantity-oriented procurement strategy. The remaining risk exposure is split into several categories according to the respective risk sources; corresponding risk premia are quantified which are in line with the market under consideration. Special reports and export functions provide the information which is typically required by the different business units like sales department, (risk) controlling, or procurement. Due to its broad functionalities, *E!nvestigate* addresses likewise utilities, trading firms, and electricity producing companies.

Initially, the focus of utilities – and thus as well of the software applications used in the respective field – was primarily directed at a low-cost and preferably safe coverage of the predicted load. But this limited perception fades out other important aspects which are affected by a load forecast and a corresponding procurement: the quantification of residual risks, their implications for pricing one's own delivery services, and influences of a single procurement/hedging strategy for the overall net position. In response to these broader practical requirements, the ior/cf-HSG concentrates on further developing a decision support system which covers the tasks of procurement, sales, and risk management in

an integrated way. Modern, liberalized electricity markets with both physical and financial electricity trading define the rules for an effective decision support system.

To give an example of a typical situation, utilities face industrial customers who want to get an offer for the electricity supply over a specific time period according to their business needs. Traditionally, two type of supply contracts exist for this purpose: a schedule delivery, where the customer gets his electricity following exactly a pre-specified load prognosis, or a full delivery which permits the customer to deviate from the load prognosis, i.e. the electricity actually delivered can be higher or lower than has been predicted. In either case, in order to evaluate a fair offer price, one has to distinguish between the price for the electricity itself and the price for the remaining risks within the contract offer which are implicitly taken by the utility. *E!nvestigate* supports the user by solving these different pricing problems.

The traditional supply contracts are augmented by two additional categories: (i) pure feed-in contracts, where the 'customer' in fact produces energy (mostly from renewable energy sources) and sells this energy to the utility, and (ii) combined supply and feed-in contracts, i.e. the customer receives (scheduled or flexible) energy from the utility and simultaneously may produce own energy to be fed back into the grid. In particular, the lattercombined type contracts exhibit an increased risk in case the expected supply and production are not provided as separate data but only in a netted way: Because then, the effective volume and related price risks may be underestimated substantially for the separate supply and feed-in side.

With some slight adaptions only, all procedures mentioned above also apply to the related problem of investigating the utility's own net position and analyzing the inherent risks. Additionally, specific restrictions, which are characteristic for managing a utilities' net position, can be imposed for the analysis: in particular, limits for the acceptable peak and off-peak long or short net position (still remaining after having optimally hedged) for specific time intervals.

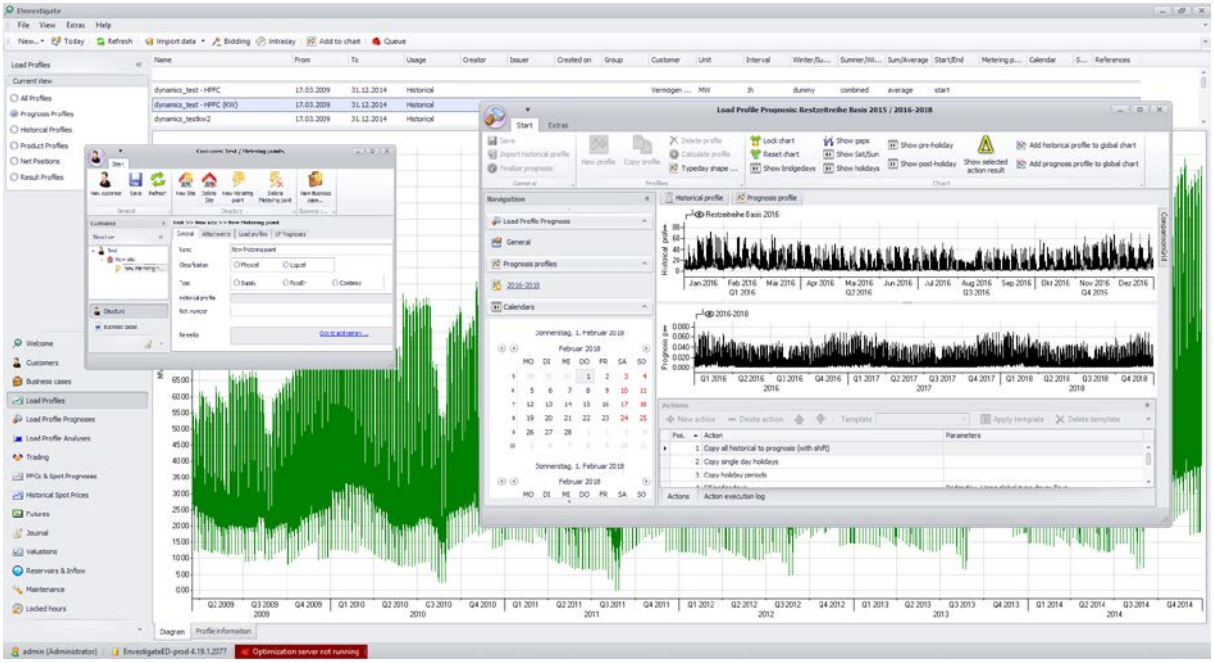
As far as the hedging strategies are concerned, two alternative approaches can be pursued: either a quantity-oriented or a value-oriented one which fit best the expected energy quantity to be delivered (received, respectively) or the expected value of the energy to be delivered/received (obtained by valuing the predicted load with the current HPFC), respectively. Depending on the pursued hedging strategy of the utility, a purchase list at optimal cost can be calculated.

Such a purchase list directly leads to deals which should have to be performed. Intended and performed deal may be entered – together with relevant information for internal accounting purpose – and administered within *E!nvestigate*; just the trades themselves have to be executed in an external trading system. Special functionalities, which are related to trade products or to accounting periods, allow to review former procurement situations and to monitor the completion of pending procurement activities.

Even having performed the procurement/hedge – irrespective of the chosen procurement strategy –, several risks may remain which have to be assumed by the utility. These risks are due to still existing imponderables: price risks (prices of hedge products may change during the contractual offer period or during the period which is necessary to buy the hedge products) as well as conjoint quantity and price risks caused by an imperfect hedge (any residual open position has to be closed later on at the cost of the uncertain future price) or by a price/load correlation in the case of full deliveries (typically, the customer's demand is higher than predicted in those periods where the spot prices are higher than 'normal' and vice versa).

For these and further risk categories, *E!nvestigate* quantifies the contract-specific risk such that 'fair' risk premia may be imposed to the intrinsic electricity price. Along with the provided profit&loss distributions and corresponding statistical indicators, a sophisticated risk analysis can be carried out by the user. Offer reports support the sales department in its activities: these customizable reports may be generated in an automated way and rely on the fair price for the electricity and on the evaluated risk premia.

E!nvestigate is enhanced by a supplementary workflow module which incorporates the operative workflow process into the software: Triggered by inquiries of the sales department and other incidents, the relevant steps within the interaction of the back office, sales department and procurement department can be carried out in a transparent and retraceable way. Recurring tasks as, e.g., contract valuations based on newly arrived HPFCs, can be scheduled and run in an automated, event driven way.



***E!nvestigate:* clippings of the multitasking system**

On the technical and operational level, the software BIT@EPI.PFO represents a powerful and flexible decision support system by an integrated provision of the following features: a graphical user interface, multitasking capability, export/import and filtering features, tabular and graphical representations, pdf report generation, and user management as well as archiving and managing functions for all types of relevant data (contracts, calculations, load predictions, HPFCs, historical spot prices, etc.) in an attached database.

Project staff: *Dr. Gido Haarbrücker, Ass.Prof. Dr. Michael Gratwohl, Claus Liebenberger*

4.1.4 Regime-dependent natural gas price forward curves: BIT@GAS.PFC

Valuing natural gas supply contracts requires price forward information for the respective market/hub and for the entire contract period under consideration. The ior/cf-HSG offers such price forward information with daily granularity for the market area of the Dutch Title Transfer System (TTF) as well as for two German market areas, operated by Net-Connect Germany (NCG) and by Gaspool Balancing Services (GPL). The provided information for each market area consists of two price forward curves (PFCs) representing two regimes determining the shape of the respective curve: a cyclical and an anti-cyclical regime. The first regime results in a strong seasonal price pattern stressing mainly the temperature dependency of natural gas spot prices; such an expectation can be thought of being the product of rather low future storage levels compared to the expected demand. The second regime, presumably a situation of high future storage levels, is characterized by a spot price expectation that shows almost no seasonality. A mechanism for generating these regime-dependent PFCs has been implemented in the software module BIT@GAS.PFC. For the above mentioned markets/hubs, a respective cyclical and anti-cyclical gas PFC is automatically generated on a daily basis. Subscriptions to the information service may be received by e-mail and are downloadable from a special website.

A price forward curve (PFC) is supposed to be free of arbitrage possibilities with respect to traded forward or future contracts and to feature typical seasonal price patterns if applicable. Due to limited storage capacity, its primary use for heating purposes, and the fact that natural gas is traded on regional markets (versus a global market like for heating oil), a certain degree of seasonality can be expected to be present in natural gas spot prices. Therefore, this seasonality also needs to be incorporated into the PFC for natural gas deliveries. Comparable to electric power HPFCs, assumptions about seasonality are especially crucial if the availability of traded contracts with respect to future delivery periods diminishes. If for example only a single future price is available for a longer future time period, the shape of daily forward prices of the respective period is completely determined by the applied seasonality assumptions.

The ior/cf-HSG offers PFCs with daily granularity for three continental European natural gas trading hubs: TTF, NCG, and GPL. The futures prices used to ensure the PFCs to be free of arbitrage are taken from the ENDEX (Netherlands) and the EEX (Germany) exchange. When turning to typical spot price patterns, it can be stated that prices for the three market areas move closely together and that there is no stringent historical price pattern. Several of the past years were characterized by periods of detectable temperature dependency and by periods of rather sideways or flat price development in accordance with the development of storage levels. Based on these observations, we deem it appropriate to speak of two regimes: one that leads to detectable temperature dependency, and a second one that implies only slight seasonality. We name these two regimes cyclical and anti-cyclical, respectively. The degree to which gas storages were filled at a certain point in time in comparison to actual demand is one explanatory factor.

Forward risk profiles are determined for all three trading hubs. These profiles cover the same period as the respective PFC; their calculation takes the respective forward price dynamics into account which is based on the difference of the 95% quantile and the respective PFC. Due to the asymmetric price dynamics, the risk profiles have to be provided separately for long and short positions. The daily granularity of the risk profiles supports a RAROC (Risk Adjusted Return On Capital) driven trading and allows a quantitative risk assessment of open positions within the trading book.

Subscribers to the information service – on the sales level offered in cooperation with Powel AG, Basel – are supplied with two PFCs per trading hub: the PFC corresponding to the cyclical and to the anti-cyclical regime. Convex combinations of these two PFCs are again free of arbitrage and represent the continuum of possible seasonality effects. The subscriber may use several convex combinations of the two regimes (or PFCs) for scenario analyses and/or can choose a single combination in accordance with his subjective assessment of future evolutions.

Project staff: *Ass. Prof. Dr. Michael Gratwohl, Dr. Gido Haarbrücker, Claus Liebenberger*

4.2 Finance

Ior/cf-HSG offers also software products and services for the financial industry. It provides solutions for the following applications: The software tool "Margin Optimizer" determines improved replicating portfolios based on dynamic strategies for variable banking products (also known as non-maturing assets and liabilities), e.g., savings and sight deposits or variable-rate mortgages. Benchmarking analyses of replicating strategies for non-maturing products are also offered in form of consultancy projects. In a collaboration with a retail bank, forecasts of relevant balance positions are generated, based on a thorough econometric analyses of their dependencies on interest rates. Finally, parameters of client rate and volume models are estimated that are needed as input for internal risk models.

4.2.1 Margin Optimizer

Margin Optimizer is software for the control and quantification of the potential risk of non-maturing assets and liabilities in a bank's balance. Based on the analysis of a large number of representative scenarios for the evolution of future interest rates and volumes, the tool calculates dynamic replicating portfolios that take into account the risk inherent to changes in these factors. Compared to static approaches that are currently still standard in the banking industry, the dynamic replication allows a substantial increase and stabilization of the margins of variable positions.

Usually, a bank's balance consists to a large extend of assets and liabilities without contractually defined maturity. This includes in particular savings and sight deposits as well as variable mortgages. The characteristic feature of these so-called non-maturing assets and liabilities (NoMALs) is that the bank may always adjust the client rate – at least partially – to the current level of market rates. On the other hand, clients have the option to withdraw their investments or repay their mortgages, respectively, anytime at no penalty. It can often be observed that customers react to changes in market rates, e.g., by substituting their variable mortgages by fix-rate mortgages when interest rates are below their long-term average. Likewise investors shift their savings deposits during periods of high rates into bonds with long maturities. Therefore, significant fluctuations in the volumes of these positions result on both sides of the balance. This makes the management of these accounts particularly difficult.

Although clients may withdraw or repay the corresponding volumes anytime, the money usually remains in the accounts over longer periods. From the bank's point of view, it would be inappropriate to designate them as daily maturing positions because in reality the funds are much longer available. It is therefore required to assign a realistic "term profile" to an account without contractually defined maturity. To this end, the bank defines a so-called replicating portfolio that mimics the cash flows of the original position. In this way, uncertain cash flows are transformed into (apparently) certain ones and managed as such. However, this transformation depends strongly on assumptions and requires an adequate modeling of the problem.

The software tool "Margin Optimizer" is based on a multistage stochastic programming model. It uses stochastic models for the dynamics of the relevant risk factors: Market rates, client rates and volume of the underlying position. The market rates are currently described by a term structure model with factors for the level of the yield curve and the spread between its short and long end. The model for the client rates reflects their characteristic tardiness. Finally, the volume model takes the dependency on interest rates into account.

The software generates a large number of representative scenarios for the future outcomes of the risk factors in such a way that their relevant statistical properties (i.e., certain moments) are preserved. Then the optimal transactions along each scenario are determined. The resulting decision on the replication of the variable position exhibits not only an optimized risk profile. It is also more efficient since the multistage dynamic optimization of the portfolio anticipates a future reinvestment or refinancing risk (and the corresponding profits or losses for different future rates). The experience made so far indicates

that the margins of non-maturing assets and liabilities may be substantially increased and stabilized by the implementation of future investment or refinancing strategies.

Project staff: *Dr. Michael Schürle*

4.2.2 Benchmarking of replication strategies for non-maturing assets and liabilities

The ior/cf-HSG has a vast experience in modeling non-maturing assets and liabilities (NoMALs) from research as well as practical projects with industry partners that go back to 1993. Activities in this field include the assessment of standard approaches for the construction of replicating portfolios, modeling the evolution of client rates and product volumes as well as the design of a dynamic replication model based on multistage stochastic optimization methods. This experience is offered to banks for an assessment of their current approaches for managing NoMAL positions.

Since the future cash flows of NoMAL positions are uncertain due to their inherent options, banks usually determine a replicating portfolio to transform uncertain payments in apparently certain ones. On this basis, the associated interest rate risk is managed and transfer prices are determined that split the margin into a compensation of the retail business unit which acquired the funds and the contribution of the treasury for a possible term transformation. The determination of an "accurate" replication is therefore of utmost strategic importance for a retail bank.

The common approach applied by most banks in Switzerland (and other European countries) is the construction of a replicating portfolio using simple money and capital market instruments. This method is also explicitly supported by the Swiss Financial Market Authority (FINMA). The total volume is split into time buckets that consist of several tranches with the same initial maturity. In each time bucket, every month one tranche matures and is renewed by an instrument with the same initial maturity. When the product volume changes, all tranches are proportionally increased or decreased. Thus, the non-maturing position is translated into a portfolio with constant duration.

However, this approach has several deficiencies both from a theoretical and a practical point of view. The assumption of constant durations is problematic as usually the product volumes are highly sensitive to changes in interest rates and may vary significantly over time. This can be critical in the current market situation, as interest rates are historically low. In case they rise in the near future, it must be expected that clients withdraw liabilities. Then, positions in the replicating portfolio must be squared, which can lead to the realization of losses when these are originated from times of low market rates.

As an alternative, which is also suggested by the FINMA, the bank's option to adjust the client rate and the clients' option to add or withdraw volume can be modeled directly. This means that stochastic models for the dynamics of market rates, client rates and volumes must be defined and calibrated to the available data. Then, client rates and volumes are projected into the future by Monte Carlo simulation over a certain time horizon. Specific characteristics of the client rate dynamics like caps, floors or asymmetric adjustments may easily taken into account as well.

The simulation of the client rate cash flows and volume changes over the time horizon allow a valuation of the non-maturing position. In general, the value of an asset product is above and that of a liability product below par. This reflects the fact that mortgage or loan rates are higher than the level of market rates while deposit rates are lower, i.e., the marketing of non-maturing products provides an additional value over investment or refinancing in the interbank market. In particular, a stochastic pricing method allows directly the derivation of a transfer price.

This approach allows that the management of the non-maturing products and the marketing policy is guided by the outlook for the bank. For instance, expected changes in the client rates and/or volumes may lead to a negative indicated margin under the current pricing regime (i.e., the present value of an asset product is below and that of a liability product above par). In this way, a required change in the

client rate of the corresponding product is indicated, or the current pricing strategy must be reconsidered in general. Furthermore, the interest rate sensitivity of the non-maturing product can be determined by passing stressed yield curves to the valuation model. Retail and treasury department can therefore coordinate their pricing and hedging strategies to produce stable incomes.

Both methods require a deep understanding of the underlying assumptions and a careful application of the apparently simple standard replication model because of its pitfalls, the stochastic modeling approach due to its complexity. The ior/cf-HSG offers interested banks an assessment of their currently used methods for the replication and management of NoMAL positions. This allows unlock potentials for increased margins and reduction of risks. Both became a challenge of strategic importance for retail banks in the current low interest rate environment.

Project staff: *Dr. Michael Schürle*

4.2.3 Modelling Volumes and Client Rates of Retail Banking Products

The volumes of retail banking products show significant variations over time that can be attributed to changes in clients' demand, depending on the current level as well as the expected evolution of interest rates, offered product rates or other factors. The identification of the relations of product volumes on these factors provides valuable information for various applications like risk management, budget planning etc.

Over many years, ior/cf-HSG has built competences for the modeling of retail banking products in the context of its activities of developing decision models for non-maturing assets and liabilities. These types of accounts offer bank clients the possibility to add or withdraw money anytime and are therefore characterized by significant volume fluctuations. On the other hand, the bank may adjust the client rate of such products at discretion.

One result of these research activities are models that allow the verification and quantification of observed or suspected dependencies of product volumes on market rates, the corresponding client rate and other (macro-) economic variables. Furthermore, specific characteristics of the client rate dynamics like delayed or asymmetric adjustment to changes in market rates can be explained. Beside the use for the valuation and hedging of the risk of variable banking products, models of this type may also be exploited for the budget planning of banks, and the methodology might be extended to explain the volumes of fix-rate positions as well.

In an ongoing collaboration with a retail bank, the econometric tools that emerged from this research are used to analyze the dependency of product volumes on market and client rates as well as the relations between different complementary products. The results are used to calculate forecasts of the future volumes of the relevant balance positions that are consistent with the bank's expectation of future interest rates. These forecasts provide valuable information for the budget planning.

Another subproject conducted with the partner bank consists of the analysis of volume flows between different asset and liability positions that are caused by clients' reaction to changes in the level of interest rates. The bank uses risk management software that requires the specification of transition matrices for these volume flows where a large number of parameters must be specified for different interest rate regimes. A sophisticated estimation approach was developed for this purpose and implemented as a software tool.

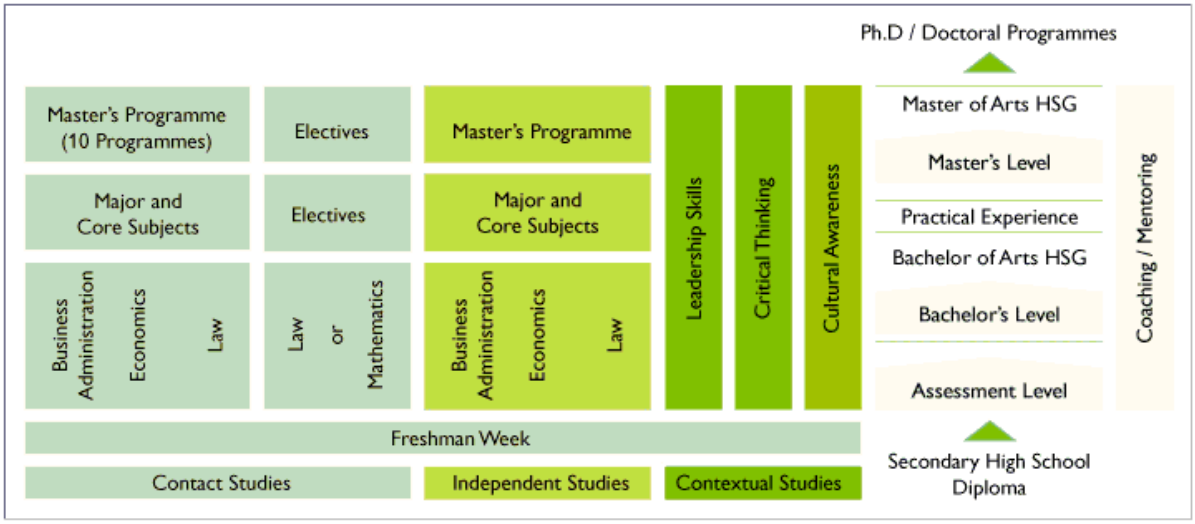
In the reporting period, different client rates models were implemented that take the aforementioned characteristics of retail products better into account than the approaches in the existing software solution. Extensive tests were conducted with the bank's historic data as well as scenarios of possible future interest rates. As promising results turned out, the bank will now use these models for the risk management of significant balance positions.

Project staff: *Dr. Michael Schürle*

5. Teaching

The University of St. Gallen (HSG) covers the fields of Business Administration, Economics, International Affairs, Law, and Law and Economics. Academic degrees can be obtained at the bachelor, master, and doctoral level. The degree courses at HSG start with the Assessment Level of one year providing an introduction to the academic subjects, requirements, and objectives of the University of St. Gallen. In this first academic year, the students are familiarized with the requirements of studying and acquire their first academic competences. Teaching in this Assessment Year acquaints students with the basic knowledge of their respective disciplines as well as of scientific methods. It enables them to work on and solve theoretical as well as practical problems within an appropriate period of time. On the Assessment Level, all students pass together through the same stages in order to qualify for the Bachelor level.

Students who have passed the Assessment Year examinations as a whole will be able to proceed to the bachelor level and opt for one of the majors "Business Administration", "Economics", "International Affairs", "Law", and "Law and Economics". As a rule, undergraduate courses extend to a total of 6 semesters, namely two semesters at the assessment level and four semesters at the bachelor level. The awarded degree "Bachelor of Arts (HSG)" is a first academic degree that qualifies the graduates for professional work and enables them to enter working life. After having obtained a bachelor degree, one may continue with studies at the master level. This level aims to carry out in-depth theoretical and practical work in certain fields with selected specialties. The University of St. Gallen offers eleven master programs in the fields of Business Administration, Economics, International Affairs, and Law. The programs take three or four semesters and end with the award of the degree "Master of Arts HSG".



Three-level and three-pillar model forming the foundation for the studies at the University of St. Gallen (Source: www.unisg.ch)

The ior/cf-HSG offers courses on both the bachelor and the master level. With regard to teaching on the master level, the institute participates primarily in the master program in "Banking and Finance" (MBF) but part of its offered courses also belong to the master program in "Quantitative Economics and Finance" (MiQE/F) or to the master program in "Accounting and Finance" (MAccFin). All courses offered by the institute rank among the categories *Contact Studies* or *Independent Studies*. At the doctoral level, the institute contributes to two Ph.D. programs offered by the University of St. Gallen to obtain a doctor's degree in "Management" (PMA) or in "Ph.D. in Finance" (PiF).

5.1 Trading Room

From traditional stock and bond markets to complex energy trading, from plain vanilla products to complex derivatives, the HSG Trading Room opens up a virtually unlimited horizon in terms of simulating real market conditions.

In September 2015, on the initiative of Rector Prof. Dr. Thomas Bieger, the ior/cf-HSG successfully launched the HSG Trading Room, a high-tech trading floor equipped with state-of-the-art trading software, Thomson Reuters and Bloomberg access. The HSG Trading Room significantly enhances active learning opportunities at the University of St. Gallen. Its objective is to support and promote sustainable and responsible learnings and research in finance related fields. Located in the Tellstrasse building, it offers an experiential learning environment and space for 21 to 42 students per session.

Prof. Dr. Robert Gutsche, Assistant Professor of Finance and Accounting at the School of Management joined the ior/cf-HSG for this project. He was in charge of implementing the first trading course, "Asset-based Commodity Trading" (see the course description on the following pages). With the launch of the CC Security Analysis, the ior/cf in 2017 successfully implemented two more courses to the Trading Room, enhancing the trading room's role as a lab for trading and investment analysis.

The concept of the Trading Room was presented at the 2017 Annual Meeting of the American Accounting Association conference in San Diego by Robert Gutsche and Alexandru Rif. The presentation and subsequent discussion opened up new opportunities for the consolidation of the Trading Room as active teaching lab for trading and investment analysis.

5.2 Bachelor level

5.2.1 Asset-based Commodity Trading

Lecturers: *Prof. Dr. Karl Frauendorfer, Ass.Prof. Dr. Michael Gratwohl, Ass.Prof. Robert Gutsche, Ph.D., Ass.Prof. Dr. Sebastian Utz, Dr. Michael Schürle, Alexandru Rif MA, HSG.*

In the last years there has been a notable influx of energy trading by financial institutions and portfolio investors who view commodities in general, and energy in particular, as a distinct asset class which exhibits a low (or possibly negative) correlation with traditional equity and fixed-income investments, and therefore improves portfolio risk-return characteristics through the effects of diversification.

The course introduces students to the trading fundamentals of selected energy markets, energy investment concepts, as well as trading techniques and strategies for energy and energy derivatives. The course consists of three parts:

1. Introduction to markets and trading tools
2. Trading sessions and
3. Performance measurement and discussion

The focus lies on the risk-adjusted management of open positions with tradable instruments for consumption commodities in volatile markets.

5.2.2 Fundamental Business Analysis: Using Financial Statements

Lecturer: *Ass.Prof. Robert Gutsche*

The financial statements are the primary means of communication of corporate information to investors. At the same time the also primary source of information for investors. The information contained in the financial statements are highly relevant for investment decisions. For this reason a competent evaluation and interpretation of financial statements information is of central importance for the allocation of resources. The aim of this course is to enable students to read financial statements, to understand and to be able to derive investment decisions based on this analysis. The course combines the analysis of financial statements and the evaluation of securities from the perspective of an investor.

The course has the very practical emphasis on methods for analyzing and valuing firms using financial statements. Several case studies are integrated. By completing this course, students will be student will feel competent in writing a thorough, credible equity research report or investment analysis that meets the highest standards. The course is of interest to those contemplating careers in investment banking (particularly in equities), security analysis, equity hedge funds, private equity, consulting, public accounting, and corporate finance. And it will also help with personal investing.

5.2.3 Strategic management of utility companies

Lecturers: *Dr. Ivo Schillig, Dr. Christian Opitz*

Nowadays, utility companies face far-reaching entrepreneurial challenges, because of the increasing liberalization of the Swiss energy market – especially in the areas of electricity and gas –, the integration of renewable energies, and the increasing convergence of different energy sources. Due to the market price development on the European energy exchanges and a reduction in the cost of capital for investments in the power grid, network operators are increasingly shifting activities to so-called energy services. Aim of the course is to show the students selected strategic challenges of the energy sector and to work out concrete implications for the strategic management of utility companies based on practical examples.

5.3 Master level

On this level, the institute participates mainly in the *Master Program in Banking and Finance (MBF)*. Some courses also belong to the *Master Program in Quantitative Economics and Finance (MiQE/F)* or to the *Master Program in Accounting and Finance (MAccFin)*. The MBF is one of the leading international finance programs and is an official program partner of the CFA Institute. Offering high-quality education in both theory and application in the fields of financial markets, financial institutions, corporate finance, and quantitative finance, its educational goals encompass three dimensions:

1) *Functional dimension:* Understanding of the function and importance of financial intermediation in the context of the development of economic systems and its integration into the social, legal, and political sphere.
2) *Instrumental dimension:* Knowledge of the theory and application of financial markets, characteristics and implementation of modern financial instruments, and the core functions of modern financial management.
3) *Institutional dimension:* Knowledge of the core functions of the planning, steering, and supervision of financial institutions and their strategic business units.

The MBF program aims at providing students with excellent qualifications for a career start in the world of banking, insurance, asset management, financial consulting, or other finance-related fields. Due to its research orientation, this program is also suitable as a preparation for higher-level academic programs, in particular for doctoral studies. Positioned between theory and practice, the MBF shows a very broad

orientation. Special attention is paid to the interaction between research, teaching, and application. It is offered solely in English. The ior/cf-HSG teaches various compulsory courses, core electives, and independent electives. A major aim of these courses is to provide the program participants with a well-founded methodical competence in the respective subject matters.

Details and up-to-date information on the MBF is available on its website *www.mbf.unisg.ch*.

5.3.1 Quantitative Methods (compulsory in MBF)

Lecturer: *Prof. Dr. Karl Frauendorfer*

Quantitative methods play a major role in empirical work in all fields of economics. In particular in the field of Finance, they provide an important basis for the valuation of many strategic and operative decisions that have to be made in the banking and financial management activity. This course offers a detailed description of modern quantitative methods. The technical details are supported by useful examples and practical applications which help the participants to extract the essential ideas. In combination with the other courses of the MBF, it allows to acquire the necessary competence in order to successfully manage key problems in banking and financial management activities.

The course comprises nine modules with focus on the following topics: Basics in statistics and algebra, basics in simulation, basics in mathematical optimization, simple and multiple linear regression, maximum-likelihood estimation, discrete-time stochastic processes, continuous-time stochastic processes, introduction to arbitrage theory, and factor model and principal component analysis.

5.3.2 Computational Finance (core elective in MBF)

Lecturer: *Dr. Michael Schürle*

The valuation of financial derivatives cannot always be performed by closed-form solutions to the underlying pricing equations. In particular more complex options require the application of advanced numerical methods. This course provides a solid introduction to financial option valuation and the numerical techniques applied by quantitative analysts to price options, assess risks and derive the required parameters from market data. Examples for the implementation of the individual concepts are given in Matlab code.

5.3.3 Energy Finance (core elective in MBF and MiQE/F)

Lecturer: *Prof. Dr. Florentina Paraschiv*

The objective of this course is introduce characteristics of energy markets, ongoing changes due to the energy transition and the impact on price dynamics. Because of the recent widespread liberalization of the energy sector in Europe and the unprecedented growth of energy prices in international commodity markets, it is also important to look at their interdependencies. Using advanced quantitative methods, we answer questions like:

- How did electricity, gas, oil and coal price interdependencies change?
- How can we model particular characteristics of energy price dynamics like spikes and jumps?
- Is there a common market model for energy prices in general?
- Can futures prices be used to forecast accurately spot prices in energy markets?
- How are price-forward curves derived?
- What would be adequate stress testing techniques for extreme movements in energy prices?

The course takes place in the Trading Room and allows students practical experience with energy trading cases.

5.3.4 Advanced Energy Trading (elective)

Lecturer: *Prof. Dr. Florentina Paraschiv*

This course is addressed to students with strong interest in Energy Finance. The sustainable increase in the renewable energies, in particular wind and photovoltaic, poses a particular challenge for electricity suppliers to balance out demand and supply. The trading activity has increased significantly over the last years. In this course, students are challenged to learn how to balance out forecasting errors in renewables through advanced trading strategies. The course builds up a rigorous background of the mechanism of energy markets and, based on this, students develop practical trading skills.

The course consists of two components:

1. A theoretical part where students are introduced to the mechanisms of day-ahead and intraday markets and become acquainted with complex trading strategies.
2. Practical applications in the Trading Room help students to build their trading skills and enrich their knowledge about real world energy trading applications.

5.3.5 Dynamic Equity Analysis and Security Trading (MBF, core elective)

Lecturer: *Ass.Prof. Dr. Robert Gutsche*

The aim of this course is to enable students to derive dynamic investment decisions based on financial and non-financial fundamental information. It combines valuation of equity and derivative securities as well as financial statement analysis with investment/trading decisions and hedging techniques.

The course is of interest to those contemplating careers in investment banking, particularly in equities, security analysis, equity hedge funds, private equity, consulting, public accounting, and corporate finance. The desired learning outcome is particularly supported by the experiential learning environment offered by the HSG Trading Room, which is a high-tech trading floor equipped with state-of-the-art trading software, Thomson Reuters, Datastream and Bloomberg access.

5.3.6 Dynamic Equity Analysis and Security Trading (MAccFin, core elective)

Lecturer: *Ass.Prof. Dr. Robert Gutsche*

We adapted the course "Dynamic Equity Analysis and Security Trading" also for students in the *Master of Accounting and Finance (MAccFin)*, taking into account the different cohort-specific student profiles and program objectives.

5.3.7 Valuation for Accounting

Lecturer: *Ass.Prof. Dr. Robert Gutsche*

Every asset has a value. The accountants just have to find it...

...when a high degree of uncertainty is involved, the measurement of assets, liabilities or equity becomes complex and requires expert knowledge to determine their recognition and measurement in the balance sheet according to the International Financial Reporting Standards (IFRS). This course addresses the most complex valuation topics in accounting from a theoretical and practical perspective. It provides a

framework for valuation and illustrates valuation problems with case studies and high- profile guest speakers from practice.

Students who successfully complete this course will have the knowledge and skills to face even unusual valuation problems in accounting. They will be able to apply expert valuation techniques in the areas of business combinations, including the valuation for goodwill and intangibles, financial instruments, and investment property.

5.4 Doctoral program

The type of academic training of the doctoral studies at the University of St. Gallen enables doctoral students to employ a scientific approach both in theory and practice. On the level of doctoral studies, ior/cf-HSG contributes to the programs "Ph.D. Program in Finance" (PiF) and "Ph.D. Program in Management" (PMA). The PMA is the largest Ph.D. program of the University of St. Gallen and provides either preparation for a research-based professional career (standard track) or for an academic career (scientific track). Students may select one of five specialization areas: Accounting, International Business, Strategy & Management, Business Innovation, and Marketing, which are all offered by the university's broadly-oriented School of Management. The PiF started in the fall term 2013 and represents the School of Finance's expertise.

5.4.1 Asset Pricing (mandatory for PiF, elective for PMA)

Lecturer: *Prof. Dr. Karl Frauendorfer*

The course is a standard first-year PhD course with an introduction to the field, closely following in its structure Cochrane's (2010) book "Asset Pricing", also integrating concepts from Björk (2009) and Back (2010) It provides students with the theoretical foundations as well as the empirical methodology in asset pricing. The course consists of three parts:

1. Optimal Consumption and First-Order Implications
2. Complete Markets: The Turn to Incompleteness
3. Applications

In the applications, we focus on important energy commodities like electricity and natural gas. On the classical commodity markets, the physical delivery of the traded commodities is an integral part of the transaction. These "physical" commodity markets are complemented by purely financial markets where derivative instruments on the underlying commodity are tradable without entailing any physical transaction. The reason for the expansion of these financial markets is the necessity of hedging and reducing risk exposure with instruments like futures, options, swaps etc. However, speculative motivation may also contribute to the increase of financial commodity markets' volumes. This mandatory course covers both types of markets: physical markets and the markets of derivatives, including diverse aspects like, market structures, instruments, prices, risks, hedging and trading.

5.4.2 Topics in Energy Finance (elective for PiF and PMA)

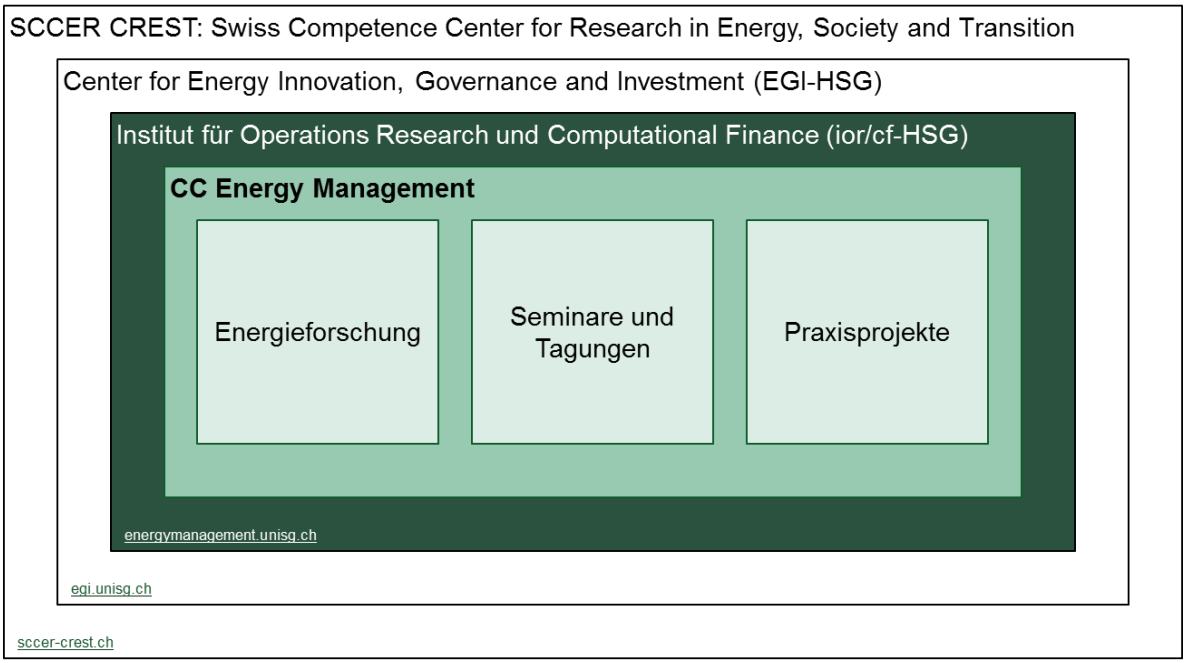
Lecturers: *Prof. Dr. Karl Frauendorfer, Dr. Gido Haarbrücker*

This Ph.D. seminar focuses on nonrenewable and renewable energy sources in conjunction with the tradable energy commodities like electricity, natural gas, and oil. On the classical commodity markets, the physical delivery of the traded commodities is an integral part of the transaction. These 'physical'

commodity markets are complemented by purely financial markets where derivative instruments on the underlying commodity are traded without entailing any physical delivery. The reason for the expansion of these financial markets is a growing interest in hedging and reducing risk exposure through the use of such instruments like futures, options, swaps etc. However, speculative motivation may also contribute to the increase of financial commodity markets' volumes. This doctoral seminar covers both types of markets: physical markets and the markets of derivatives, including diverse aspects like, e.g., market structures, instruments, prices, risks, hedging and trading.

6. Competence Center Energy Management

The Competence Center Energy Management (ior / cf-HSG) of the University of St.Gallen deals with strategic and quantitative issues in the field of conventional and renewable energies. It offers applied research, continuing education courses, congresses and conferences as well as various services related to energy. In addition to consulting projects, these may also include studies and reports integrating current research results.



Anchoring in the Swiss university landscape

6.1 Conferences

The ior/cf-HSG organizes conferences in the energy sector and related fields that propagate knowledge and contacts. The gatherings facilitate personal meetings, discussions and the launch of new projects. The range of topics may extend from the established gas and new electricity conference to associated fields like heat or waste management.

6.1.1 Erdgastagung

The gas conference 2017 "Infrastruktur Herausforderungen der Gaswirtschaft" took place on Friday, March 24th, 2017, in the cantonal council chamber in St.Gallen. Program details can be found on *www.erdgastagung.ch*.

6.1.2 Wärmetagung

The heat conference 2017 "Gebäude: Prüfstein der Energiewende?" took place on Friday, September 5th, 2017 in the cantonal council chamber in St.Gallen. Program details can be found on *www.waermetagung.ch.*

6.1.3 Stromtagung

The electricity conference took place on Friday, December 8th, 2017 "Rechtlicher vs. digitaler Wandel: Implikationen für die Stromwirtschaft" at the SIX Convention Point in Zürich. Program details can be found on *www.stromtagung.ch*.

6.1.4 Abfallsymposium

As part of the closing event of the CAS "Management of disposal and recycling companies ", a public event on the subject of "Vollzug der VVEA in der Praxis" took place on the afternoon of Friday, June 16th, 2017.

6.2 Executive education

6.2.1 Program "Management of utility companies" (CAS)

The energy transition and digitization pose new challenges for managers. The value-added chains are being replaced by value-added networks, which in addition to their own basic training demands new and broader competences for efficient and effective management. The understanding of relevant energy-related topics and their interdependencies characterizes the qualification profile and increases one's own competitiveness in the working world. In the foreground of the successively developed course, therefore, are the important strategic, regulatory and ecological issues in connection with the energy transition and digitization as well as their need for action. The program stands for a practice-oriented, tailored to the needs of the energy industry management education with recognized university certificate (CAS).

Dates:

- 8th implementation: September 14th, 2016 to February 10th, 2017
- 9th implementation: September 6th, 2017 to February 16th, 2018

Structure:

The Program consists of 6 modules (15 days). A proof of performance is provided in the form of a written project work. The aim of this thesis is the elaboration of specific problems of the participants' daily work in an academic manner. It is assessed primarily according to its estimated benefits for operational implementation. For more information, please visit *www.evu-manager.ch*.

6.2.2 Program "Management of disposal and recycling companies" (CAS)

The aim of the course is to build on the existing competences at the University of St.Gallen to provide the participants with the necessary business and regulatory tools to enable them to realize the fundamental change in the Swiss waste management industry triggered by the VVEA towards a circular

economy local / regional / national level. The program stands for a practice-oriented management education with a recognized university certificate (CAS) tailored to the needs of the waste management and recycling industry.

Dates:

- 3rd implementation: February 1th, 2017 to June 16th, 2017

Structure:

The program is part of the program and consists of 5 modules a 3 days (15 seminar days). The proof of performance is provided within the framework of a written project work. The aim of this thesis is to elaborate on specific problems arising from the day-to-day work of the participants. This work is primarily assessed according to its estimated benefits for operational implementation. For more information, please visit *www.entsorgungsmanager.ch* or *www.recyclingmanager.ch*.

6.2.3 Program "Business manager"

The certificate course (VSE) provides practice-oriented, business-oriented and regulatory basic knowledge for managers and junior executives of energy supply companies (cross-border companies).The cooperation with the Association of Swiss Electricity Companies (VSE) ensures that the training takes place at the right level. After successful completion, the participants of the program will receive a VSE certificate and a certificate of attendance from the University of St.Gallen.

7. Competence Center Security Analysis

"The work of a financial analyst falls somewhere in the middle between that of a mathematician and of an orator." - Benjamin Graham, The Intelligent Investor

With the promotion of Ass.Prof. Robert Gutsche, Ph.D. to the position of Vice Director for Equity Research, the ior/cf implemented the CC Security Analysis. The CC Security Analysis aims at providing

Practice-oriented solutions for the analysis of Profitability, Growth and Risk

Independent Research and Teaching in the area of

Fundamental Analysis, Corporate Finance and Security Valuation

Risk Management, Performance Management and Analysis of Risk and Return

Financial Reporting, Regulation and Standard Setting

Mission Statement

Bridging Systemic and Idiosyncratic Risk Analysis through the integration of Fundamental Risk Analysis as well as Behavioral Aspects into Quantitative Risk Analysis.

Foster critical reflection of investing and trading is not a “natural science”, it is driven by market dynamics, crowd behavior and fundamentals.

The CC Security Analysis is active in the Executive Education and offered the following courses in 2017:

1. Valuation, Performance Management and Risk Analysis (since 2016).
2. Advanced Analytics & Security Analysis (Summer 2017)
3. Tactical Asset Allocation and Investment Decisions (Fall 2017)

Contact

Institute for Operations Research and Computational Finance (ior/cf-HSG), University of St. Gallen

Bodanstrasse 6, 9000 St. Gallen		www.iorcf.unisg.ch	Fax	071 224 21 02
Director:	Prof. Dr. Karl Frauendorfer	Karl.Frauendorfer@unisg.ch	Phone	071 224 21 05
Secretary:	Monika Huber	Monika.Huber@unisg.ch	Phone	071 224 21 01