ETH zürich

ETH RISK CENTER

ETH Risk Center Activity Report 2020-2021

Foreword

In 2020 and 2021, the covid-19 pandemic struck the world. Despite the challenges, and thanks to unexpected opportunities for technology-driven transformations, the ETH Risk Center kept growing its activities.

In the last two years, we welcomed three new Members. The Center kept expanding its education programmes with new and innovative MSc courses on resilience and on new technologies in banking and finance, as well as and a contribution to the prestigious executive MBA co-organised by ETHZ and the University of St Gallen., the embaX.

We hosted many events - often online - and broadened our community by reaching out to participants across the world, thanks to the technology that kept us connected throughout lockdowns.

In 2022 and beyond, the Risk Center will keep focusing on the resilience of human and engineered systems, deep uncertainty and climate change, and new technologies in banking, insurance and finance.

We hope you enjoy reading this report!

Prof. Giovanni Sansavini
Chairman of the Steering Committee

Dr. Hélène Schernberg
Executive Director

Dr. Bastian Bergmann
Coordinator, Master of Advanced Studies, MTEC

New Members

In 2020 and 2021, we welcomed three new members.

Prof. Dr. Stefano Brusoni
Chair of Technology and Innovation Management (D-MTEC)
Stefano's research focuses on innovation and technical change, at the interface between strategy and behavioral sciences. He has published on journals such as Strategic Management Journal; Administrative Science Quarterly; Organization Science; Academy of Management Journal; and many others. He is Senior Editor of Organization Science. He is also a founder and entrepreneur, currently active in EdTech.

Prof. Dr. Kenny Paterson
Applied Cryptography Group (D-INFK)
Kenny's research is in the area of Cryptography, with a strong emphasis on the analysis of deployed cryptographic systems and the development of provably secure solutions to real-world cryptographic problems. He co-founded the Real World Cryptography series of workshops to support the development of this broad area and to strengthen the links between academia and industry. He is co-chair of the IRTF's research group on Cryptography, CFRG. This group is working to provide expert advice to the IETF in an effort to strengthen the Internet's core security protocols.

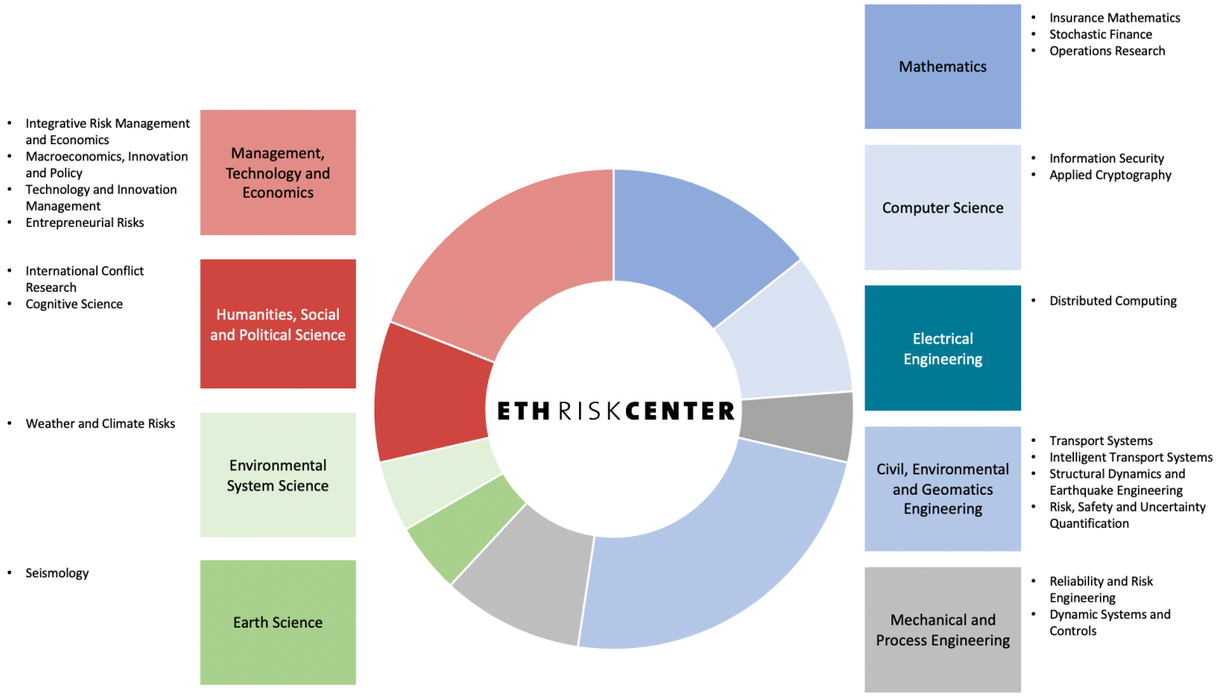
Prof. Dr. Roger Wattenhofer
Distributed Computing Group (D-ITET)
Computer Engineering and Networks Laboratory (TIK)
Member since 2021
Roger works on understanding risk in networks. His methods are a combination of algorithms, game theory, data science, machine learning, and building software. The topics change over time, and currently include fintech, economy, cryptocurrency, blockchain, e-voting, democracy, and graph neural networks.

18 Full Members from 9 Departments of ETHZ
2 Associate Members from EPFL and Steinbeis University

Information Security (Prof. Basin)
Integrative Risk Management and Economics (Prof. Bommier)
Weather and Climate Risks (Prof. Bresch)
Technology and Innovation Management (Prof. Brusoni)
International Conflict Research (Prof. Cederman)
Insurance Mathematics and Stochastic Finance (Prof. Cheridito, Prof. Teichmann)
Transport Systems (Prof. Corman)
Cognitive Sciences (Prof. Hölscher)
Intelligent Maintenance Systems (Prof. Fink, Associate Member)
Macroeconomics: Innovation and Policy (Prof. Gersbach)
Applied Cryptography (Prof. Kenny Paterson)
Reliability and Risk Engineering (Prof. Sansavini)
Entrepreneurial Risks (Prof. Sornette)
Structural Dynamics and Earthquake Engineering (Prof. Stojadinovic)
Risk, Safety and Uncertainty Quantification (Prof. Sudret)
Seismology (Prof. Wiemer)
Operations Research (Prof. Zenklusen)
Distributed Computing (Prof. Wattenhofer)
Prof. Weidmann, previously head of Traffic Planning and Transport Systems, is now Vice-President for Infrastructure of the ETH Executive Board
Advanced Risk Technologies (Prof. Aleksandar Jovanovic, Associate Member, Steinbeis University Berlin)

An interdisciplinary pool of expertise

The Risk Center is an interdisciplinary competence center of ETH zurich. It is a cluster of specialists from contrasting research areas who pool their knowledge and experience to develop innovative solutions to risk- and resilience-related issues.



Steering Committee
Prof. Giovanni Sansavini (Chairman) (MAVT)
Prof. Antoine Bommier (MTEC)
Prof. Patrick Cheredito (MATH)
Prof. Christoph Hölscher (GESS, FRS II)
Prof. Bozidar Stojadinovic (BAUG)

Advisory Board
Kurt Meyer (Chairman), RiskTalk
Anne Bouverot, Technicolor
Stefan Brem, BABS
Marc Gordon, UNISDR
Prof. Claudia Klüppelberg, TU München
Peter Giger, Zurich Insurance Group
Prof. Tso-Chien Pan, Nanyang Technological University
Patrick Raaflaub, Swiss Reinsurance Group

Partnership Council

Partners represent foundations and industry partners who donate significant financial support for projects and programs to the ETH Foundation on risk-related initiatives.

Axa Winterthur
Credit Suisse Group
Swiss Re Group
Zurich Insurance Group
Axpo Trading

Visiting Researchers

In 2020 and 2021, 4 scientists visited the Risk Center. One stayed for a year, having arrived before the pandemic. They contributed to research projects and various events.

Prof. Marie Kratz
ESSEC Business School

Prof. Kratz visited the Risk Center in March 2020. She was involved in onging research projects at the ETH Risk Center and she was interacting with ETH Risk Center Members and with ETH D-MTEC students.

Prof. Marco Broccardo
University of Trento
Department of Civil, Environmental and Mechanical Engineering

Prof. Broccardo visited the Risk Center from July - September 2021. The goal of his visit was to pursue work on modeling the impact of contagion control measures on the economy of a region. The objective was to develop a pilot and an example and go back to SwissRe (and other potentially interested Risk Center partners) to see funding for further collaboration. Given Prof. Broccardo's work on disaster resilience of urban communities, the second objective was to examine the use of Gaussian processes to model post-disaster recovery. In this field, he collaborated with Risk Center Members Prof. Stojadinovic as well as with Professors Sansavini and Sudret. The third objective was to investigate the use of Bayesian updating to integrate early post-disaster damage information into probabilistic models for regional damage and recovery prediction, all in the scope of the ongoing Risk Center DynaRisk project. Prof. Broccardo also gave a Risk Center seminar in the Fall 2021 series.

Prof. Paul Martin Mai
Kaust University
King Abdullah University of Science and Technology
Kingdom of Saudi Arabia

Prof. Mai visited the Risk Center from August 2021 to January 2022. He was involved in onging research projects with the Chairs of Stefan Wiemer and Bozar Stojadinovic, but also with other professorships and researchers at the Risk Center and at ETH overall. Prof. Mai contributed to teaching: A seminar within the ERDW and BAUG departmental seminars; He offered a special seminar (block course, 3 days) on computational earthquake physics for master and PhD students of ERDW and BAUG; He gave a talk at the Risk Center Fall 2021 Seminar Series.

Prof. Adam Dominiak
Department of Economics
Virginia Polytechnic Institute & State University

Prof. Dominiak visited the Risk Center for 1 year starting in January 2021. He was involved in onging research projects at the ETH Risk Center. Prof. Dominiak gave talks at the Risk Center Seminar Series and at Workshops. He gave a course entitled "Decision-Making under Ambiguity and Unawareness: Theory an Applications" in the Spring semester 2021. In Fall 2021 he organised the workshop: "Risk and Unawareness: How To Manage Risk Against the Unknown Unknowns". While collaborating on a few research projects with Prof. Dr. Hans Gersbach's group, Prof. Dominiak interacted with ETH Risk Center Members and with ETH D-MTEC students.

Finsuretech: New Technologies for Finance and Insurance

The financial manager of the future commands a wide set of skills and boasts a profound understanding of technological advances and how they enhance business and impact society as a whole. Finsuretech bundles expertise among ETH researchers and professionals across emerging areas like machine learning, cyber security, distributed ledger technology, digital currencies and quantum computing and translates it into integrative research and education opportunities.

Faculty

Mathematics: Profs. Patrick Cheridito (RiskLab, Risk Center), Josef Teichmann (Stochastic Finance Group, Risk Center), Mario Wüthrich (Insurance Mathematics, RiskLab)

Management & Economics: Hans Gersbach (Macroeconomics: Innovation and Policy, Risk Center)

Computer Science and Electrical Engineering: Kenneth Paterson (Applied Cryptography Group, Risk Center), David Basin (Information Security Group, Risk Center), Roger Wattenhofer (Distributed Computing Group, Risk Center)

Engineering: Olga Fink, EPFL (Chair of Intelligent Maintenance Systems, Risk Center)

MSc Course: New Technologies in Banking and Finance

Technological advances, digitization and the ability to store and process vast amounts of data has changed the landscape of financial services in recent years. This course unpacks the innovations and technologies underlying these transformations and reflects on their impacts on financial markets. It is taught by ETH faculty and finance professionals.

The course starts with an introduction to Machine Learning in Finance. Professionals support students in acquiring an understanding of the scope and limits from real cases and professional insights.

The second topic is distributed ledger technologies. For centuries we lived in a world of centralized finance. DLT is a historic disruption of our current financial infrastructure. Decentralized Finance (DeFi) seeks to combine open-source building blocks into sophisticated products using blockchain technology as a technology of inclusion, enabling peers to interact via a common ledger.

Finally the course covers an introduction into quantum computing and outlines future areas of application, ranging from portfolio optimization and pricing to simulation.

The students are fresh minds with a tech focus from various ETH MSc Programs: Engineering, Data Science, Computer Science, Mathematics, Physics, Management and Economics. They wish to integrate technology and business and are eager to team up with professionals for innovative solutions and career transition to finance and insurance.

Education for Professionals

See „Machine Learning in Finance, Tools, techniques, risks and opportunities“ page 13.

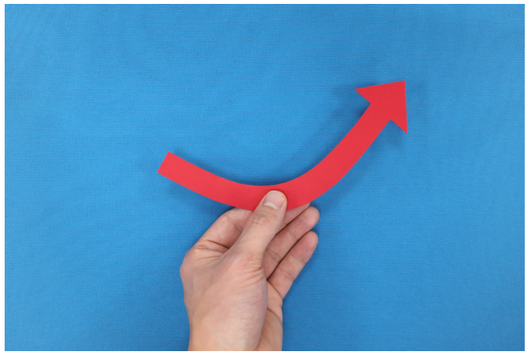
Risk Center at the Swiss Finance Institute (SFI): Master Classes

Lecturers: Bastian Bergmann & Josef Teichmann.

2020: 3 classes on *Machine Learning in Finance: Its Technology in Perspective.*
2021: 3 classes on *Machine Learning in Finance: Balancing Randomness and Explainability.*

Resilience in the New Age of Risk

In 2021, the Risk Center strengthened its activities around the topic of resilience, building on a close cooperation with the Future Resilient Systems program (see page x). This resulted in a series of joint webinars on resilience that are now a stable element of the Risk Center's calendar, a new, ground-breaking master's course on resilience - the first of its kind worldwide.



The Resilience Webinars are hosted by the Risk Center three times per semester. Guest speakers are researchers from the FRS II program.

The MSc course Resilience in the New Age of Risk was co-created by the Risk Center and FRS II. The first course ran in the Fall 2021 and featured academic experts and industry practitioners from the Risk Center's partners.

Research-wise, current research at the Risk Center explores the pricing of resilience to extreme climate-related events for insurance purposes. Stay tuned for future events on the topic.

Risk Center Research Affiliates

In 2021, the Risk Center awarderd the title of Research Affiliate to ETH scientists and lecturers with particularly close ties to the Center.

Research Affiliates are key actors of Risk Center activities (seminars, workshops, lectures, research projects, etc). They may use resources of the Risk Center and in exchange stand ready as expert interlocutors for the Center's future projects.

Recognized for their scholarship in their respective fields, the Research Affiliates advance the Risk Center's major research themes in collaboration with ETH faculty. While "Risk Center Research Affiliate" is not an honorary title, we would like to acknowledge the contributions they make to the intellectual life of the Risk Center.

2021 Research Affiliates

Dr. Sandra Andraszewicz, D-GESS (Cognitive Science)

Dr. Sebastian Becker, D-MATH (RiskLab)

Dr. Volker Britz, D-MTEC (Macroeconomics and Policy)

Dr. Stefan Frei, D-INFK (Cyber Risk lecturer)

Dr. Arnaud Goussebaile, D-MTEC (Integrative Risk Management and Economics)

Dr. Yves Reuland, D-BAUG, (Structural Dynamics and Earthquake Engineering)

Risk Center Project "Future Money"

Risk Center projects foster application-oriented basic research by offering a pragmatic opportunity to explore and develop, at an early stage, visionary ideas of high social relevance. Our flagship project ***Future Money*** is conducted at the Chairs of *Macroeconomics: Innovation and Policy* of Prof. Hans Gersbach and *Distributed Computing* of Prof. Roger Wattenhofer. It is partly financed by Swiss Re.

The current monetary system is the result of an evolution extending over several centuries. How it compares to alternative systems is a long-standing question. New technologies that could possibly be used in various parts of the monetary system have fueled the academic and public debate on whether and how our monetary system could and should change.

The Future Money projects explores the challenges of our current monetary system and investigates alternatives that rely on new technologies to make it more stable.

Output completed - Working Papers

Florian Böser and Hans Gersbach (2021), Leverage Constraints and Bank Monitoring: Bank Regulation versus Monetary Policy, CER-ETH – Center of Economic Research at ETH Zurich, Working Paper 21/358, June 2021

Bank leverage constraints can emerge from regulatory capital requirements as well as from central bank collateral requirements in reserve lending facilities. While these two channels are usually examined separately, we are able to compare them with the help of a bank money creation model in which central bank reserves have to be acquired to settle interbank liabilities. In particular, we show that with regard to bank monitoring, monetary policy via collateral requirements leads to a unique collateral leverage channel, which cannot be replicated by standard capital requirements. Through this channel, banks can expand loan supply and deposit issuance when they face liquidity constraints, by raising the collateral value of their loans with tighter monitoring of firms. The collateral leverage channel can improve welfare beyond standard bank capital regulation. Our results may inform current policy debates, such as the design of central bank collateral frameworks or the question whether monetary policy remains effective in times with large central bank reserves.

Florian Böser and Hans Gersbach (2020), Monetary Policy with a Central Bank Digital Currency: The Short and the Long Term, CEPR Discussion Paper No. DP15322

We examine how the introduction of an interest-bearing central bank digital currency (CBDC) impacts bank activities and monetary policy. Depositors can switch from bank deposits to CBDC as a safe medium of exchange at any time. As banks face digital runs, either because depositors have a preference for CBDC or fear bank insolvency, monetary policy can use collateral requirements (and default penalties) to initially increase bankers' monitoring incentives. This leads to higher aggregate productivity. However, the mass of households holding CBDC will increase over time, causing additional liquidity risk for banks. After a certain period, monetary policy with tight collateral requirements generating liquidity risk for banks and exposing bankers to default penalties would render banking non-viable and prompt the central bank to abandon such policies. Under these circumstances, bankers' monitoring incentives will revert to low levels. Accordingly, a CBDC can at best yield short-term welfare gains.

Florian Böser (2021), Monetary Policy under Subjective Beliefs of Banks: Optimal Central Bank Collateral Requirements, CER-ETH Working Paper 21/357.

We study how the subjective beliefs about loan repayment on the side of liquidity-constrained banks affect the central bank's choice of collateral standards in its lending facilities. Optimism on the side of banks, entailing a higher collateral value of bank loans, can lead to excessive lending and bank default. Pessimism, though, can entail insufficient lending and productivity losses. With an appropriate haircut on collateral, the central bank can perfectly neutralize the banks' belief distortions and always induce the socially optimal allocation. Under uncertainty about beliefs, the central bank's incentives to set looser collateral standards increase. This reduces the risk of deficient bank lending if sufficiently pessimistic beliefs realize. In extreme cases, monetary policy aims at mitigating productivity losses only, instead of also avoiding bank default.

Work in Progress: *Why Bank Money Creation*

Hans Gersbach and Sebastian Zelzner (2022), Why Bank Money Creation, Center for Financial Studies Working Paper No. 678.

We provide a rationale for bank money creation in our current monetary system by investigating its merits over a system with banks as intermediaries of loanable funds. The latter system could result when CBDCs are introduced. In the loanable funds system, households limit banks' leverage ratios when providing deposits to make sure they have enough "skin in the game" to opt for loan monitoring. When there is unobservable heterogeneity among banks with regard to their (opportunity) costs from monitoring, aggregate lending to bank-dependent firms is inefficiently low. A monetary system with bank money creation alleviates this problem, as banks can initiate lending by creating bank deposits without relying on household funding. With a suitable regulatory leverage constraint, the gains from higher lending by banks with a high repayment pledgeability outweigh losses from banks which are less diligent in monitoring. Bank-risk assessments, combined with appropriate risk-sensitive capital requirements, can reduce or even eliminate such losses.

- Presented in internal workshop & seminar
- Scheduled presentation at the research seminar at Uni Regensburg (May 2022)
- Submitted to OxFit Conference 2022
- Paper accepted for EEA-ESEM 2022 Conference

Hugo van Buggenum, Hans Gersbach and Sebastian Zelzner (2022), Currency Competition and Payment Frictions, mimeo.

We examine the efficiency of private currency competition in an overlapping generations model. Private currency is issued as digital tokens redeemable for a fiat currency such as US dollars. In sequentially incomplete markets, issuing short-term contracts (i.e., tokens) in order to finance long-term investment opportunities can enhance allocative efficiency. Without risk and in the absence of payment frictions, free competition in the issuance of private currencies implements the first-best.

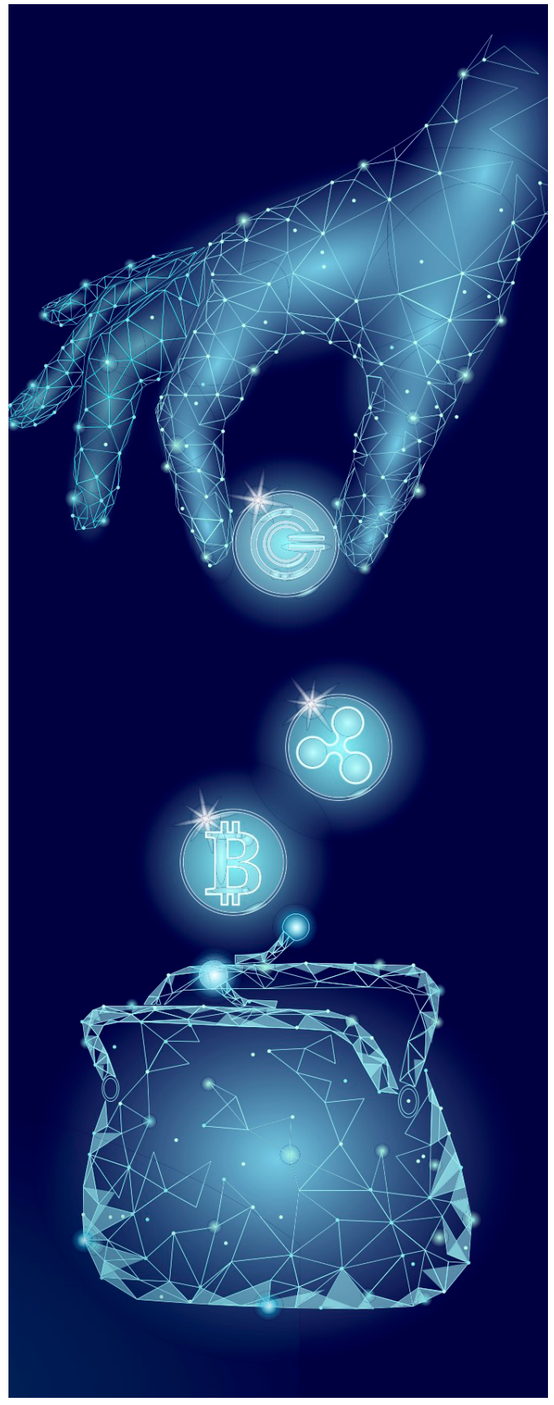
A draft with the basic model is ready, a full draft is expected in the summer 2022.

Past Conferences

- Oxford-Saïd/Risk Center at ETH Zurich Macro-Finance Conference 2021, Oxford
- Many seminar presentations

Completed doctoral theses

- Florian Böser (2021), Essays on Private Money Creation and Monetary Policy, Doctoral Thesis ETH Zurich.
- Ewelina Laskowska (2021), Money Creation, Financial Frictions, and Bank Dividends, Doctoral Thesis ETH Zurich.



Outreach

Risk Center outreach fosters interdisciplinary exchanges on risk- and resilience-related topics. Our seminars, workshops, lectures and conferences build a bridge between industry and academia, thus encouraging collaborations. Each event offers mind-broadening perspectives on various topics, and a networking opportunity!

Due to the onset of the COVID-19 pandemic, we cancelled most of the Spring 2020 Seminar Series. Meanwhile, we hosted a few webinars:

September to December 2020

Fall 2020 Seminar Series
Exploring the causes and consequences of the COVID-19 pandemic.

8 December 2020

8th Dialogue Event on *5G: Balancing Opportunities and Risks*

The next generation of wireless technology will transform telecommunication networks. To meet our increasing data requirements, the bandwidth, capacity, and reliability of wireless broadband services will expand. The billions of connected devices that are predicted to make up the Internet of Things (IoT) will communicate in real time thanks to drastically lower latencies. Faster speeds will foster business innovation across countless areas of the economy.

5G will transmit and receive radio signals over an expanded range of frequencies, each offering unique risks and opportunities. High frequency waves will improve speed but are less penetrative (e.g. through walls), with shorter transmission ranges (a few hundreds of meters instead of several kilometers). 5G thus requires more antennas and the societal acceptance of higher levels of electromagnetic radiation.

More connected devices mean more exposure to attacks. IoT devices typically have poor security features. Moreover, hackers can also exploit 5G volume and speed to steal much much more data much faster. A large-scale breakthrough of self-driving cars and other IoT applications certainly requires a quick enhancement of security features to avoid cumulative damage at a catastrophic scale.

Privacy issues, security breaches and espionage constitute additional concrete risks. Breaches from built-in hardware or software backdoors should be considered. Finally, the current market for 5G infrastructure revolves around a handful of firms, raising the issue of concentration risk.

February to May 2021

Spring 2021 Seminar Series

Spring 2021 Resilience Webinars

24 June 2021

9th Dialogue Event on *Cyber Risk in Critical Infrastructure*

Critical infrastructure is increasingly complex and interconnected. Vulnerability to cyber-attacks is a major concern, as illustrated by recent large-scale events. Confidence in data and systems security is key.

Infrastructures providing enery, telecommunications, water and transportation are vital to our societies and economies. The digital revolution causes a major shift in the way they operate.

Mission-critical assets and processes on which infrastructure relies are powered by operational technology (OT). The Internet of Things accelerated the integration of OT with information technology systems. The emergence of Industry 4.0 increases the reliance on highly connected devices. These trends augment the attack surface of critical infrastructure environments.

At the same time, cyber-threats are ever more sophisticated. Inappropriately updated legacy OT and industrial control systems become more vulnerable.

It is essential to improve the resilience of our critical infrastructure to cyber attacks. This event aims at helping decision-makers develop their strategies and plans for greater cyber resilience.

9-10 July 2021

2021 Oxford Saïd – Risk Center at ETH Zürich Macro-finance Conference Money, Liquidity, and Financial Stability.

This hybrid conference in-person/Zoom washeld at Saïd Business School in Oxford. Topics were at the intersection of financial intermediation and macroeconomics, both theoretical and empirical, with a strong focus on theory.

September to December 2021

Fall 2021 Seminar Series:
Emerging risks in health and healthcare

Fall 2021 Resilience Webinars

28-29 October 2021

Conference: *Choice under Unawareness: Information, Behaviors and Markets*

The outbreak of the Covid-19 pandemic demonstrated that many decisions are made in a state of unawareness. Unawareness arises when decision-makers cannot even conceive of the contingencies that affect the outcomes of their decisions. The conference reviewed the recent advances in modeling decision-making under unawareness, the applications of these models to financial markets, information economics and risk-taking behavior.

23 November 2021

Workshop: *Transformations, Resilience, and Social Tipping Points*

The 2nd Annual Workshop of the Economics for Net-Zero Emissions initiative of the ETH Domain was co-hosted by the Risk Center.

About 30 participants from science and practice met in Zürich's Giesserei in Oerlikon.

24 November 2021

Roundtable on Behavioral Science in Business

The Risk Center and the Chair of Cognitive Science of ETH Zürich hosted an industry roundtable (invitation only) on the use and impact of behavioral science in business.

Outreach program 2022

February to May 2022

Seminar Series (every week)

Resilience webinars (3/semester)

September to December 2022

Seminar Series (every week)

Resilience webinars (3/semester)

November 2022

10th Dialogue Event

New concepts for risk assessment and pricing of Extreme Threats

in Public-Private Partnerships and Insurance

Educating the 21st Century Risk-Managers

Education is crucial to disseminate knowledge and foster impact in academia, industry, government agencies and in society. The Risk Center offers education opportunities ranging from master level or advanced study courses to continuing education. Two new, ground-breaking courses were created in 2021, on new technologies in banking and finance and on resilience.

Master Courses

Introduction to Risk Modeling and Management

The course walks students through various aspects of modelling and managing risk across different industries, contexts and applications. Sessions are taught by risk professionals (industry and government) and academics from diverse disciplines.

Students get familiar with the building blocks of risk modelling: uncertainty, vulnerability, resilience, decision-making under uncertainty. The course covers different approaches to modelling and dealing with as well as mitigating various risks in several industries. They gain an understanding of the relation to the decision-making process in business and the value chain of a company.

Cases range from enterprise risk-management to natural catastrophes, climate risk, to energy market risk, risk engineering, financial risks, to operational risk, cyber risk and more. An additional emphasis is placed on a data-driven approach to smart algorithms applied to risk modelling and management.

The «Risk Case Study Challenge»

In partnership with a Risk Center Industry Partner and supported by Risk Center and ETH faculty, teams of students from diverse backgrounds develop innovative solutions.

Each Challenge involves a Risk Center Industry Partner. The various Case Studies, connected by an overarching theme, are developed with Risk Center and ETH lecturers. They offer students a concrete environment to apply their knowledge, logic, creativity, and problem-solving skills with an emphasis on applications. Typically, the Case Studies are complex, contain ambiguities, and may be addressed in more than one way.

Due to covid-19, the Risk Center was not able to run the Risk Case Study Challenge. A new Challenge is running in the Spring 2022 Semester with Credit Suisse.

New Technologies in Banking and Finance

Technological advances, digitization and the ability to store and process vast amounts of data has changed the landscape of banking and finance. This course unpacks the technologies underlying these transformations and reflects on the impact they have on the financial world. The course covers changes in management as well.

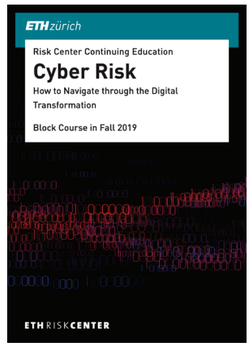
The financial manager of the future is commanding a wide set of skills. Those skills range from a great familiarity with technological advances and a sensible understanding of the impact on workflows and business models. Students with an interest in finance and banking are invited to take the course, although they may not have any explicit theoretical knowledge of financial economics.

Resilience in the New Age of Risk

Our increasingly complex and connected systems face continuously emerging disruptions. Resilience constitutes a fundamental departure from the philosophy of risk-management. With resilience, stakeholders adopt risk mitigation strategies aligned to the theories of complex systems.

Resilience applies to an extremely large array of systems and contexts. Moreover, the topic of resilience is surprisingly absent from most university curricula. This course fills a gap and walks you through a mode of thinking that is bound to shape the way risks and disasters are dealt with in our increasingly connected society. Hence, tomorrow's risk managers will and shall also be "resilience managers".

This course, co-organised with the leaders of the Singapore-ETH Center's Future Resilient Systems II programme, breaks down the concept of complex systems and their resilience. It introduces some of the different flavors of resilience and provides tools for building it in various socially relevant areas (social resilience, engineered systems resilience, organizational resilience...).



Education for Professionals: Block courses

The Risk Center is involved in Continuing Education. In 2021, we ran two Block Courses specifically for risk professionals. They adress two key topics: Cyber Risk, and Machine Learning in Finance.

Machine Learning in Finance
Tools, techniques, risks and opportunities

The course introduces the basic concepts of ML and its most common tools and programming techniques. It reviews several recent applications and examines the scope and limitations associated with the application of the algorithms. It provides the vision and understanding of the many opportunities, costs, and likely performance hurdles of ML tools.

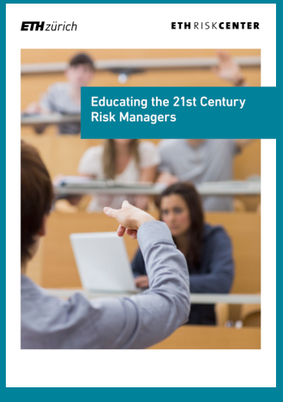
The course contains collaborative exercises with ETH MSc Students from ETH Analytics Club. 3-4 professionals team up with 2-3 MSc Students with a focus on Data Science and Machine Learning. Groups choose between solving join predefined exercises or professionals bring up their own cases. The MSc Students with an interest in real cases learn from the professionals' insights and the latter benefit from the student's coding skills.

Cyber Risk: Navigating the Digital Transformation

This course offers an integrative perspective on cyber risks and helps understand the essential developments, the principles, the challenges as well as the limitations and the state of practice in cyber risk from the technological, economic, legal, and insurance perspective. It focuses on tangible takeaways that cyber risk stakeholders in all organizations can use to strengthen their resilience

Interested in our Education Opportunities?

Find out more in our Education Brochure!



Future Resilient Systems: The Singapore-ETH Centre

The Future Resilient Systems programme focuses on enhancing the resilience of urban systems by combining engineering, design and social research.

The Future Resilient Systems (FRS) programme was established by ETH Zurich and Singapore's National Research Foundation in 2014. Since 1st April 2020 the programme is in a second phase of five years of research and brings together principal investigators and researchers from ETH Zurich, Nanyang Technological University (NTU), National University of Singapore (NUS) and University of Illinois Urbana-Champaign (UIUC).

Research highlights

In the second phase of FRS, the research projects are split into three clusters: resilience in cyber-physical systems, resilience in high-density urban systems and distributed cognition for social resilience. Some key research highlights from the tree clusters are, as follows:

Resilience in cyber-physical systems

Dr Jack Chin and Prof. Gabriela Hug developed a data-driven contingency planning method to alleviate the disruption and enhance system resilience. At the core of the method is the formation of ad hoc microgrids that can be promptly executed following a black-out. This study was published in the Journal of Engineering, https://doi.org/10.1049/tje2.12057.

In another study, Dr Gururaghav Raman and Prof. Jimmy Peng examined the individual residential electricity consumption as an indicator of a community's response to unprecedented and disruptive events, such as a pandemic. Using electricity consumption data from more than ten thousand households in Singapore, a strong positive correlation between the progression of the pandemic in Singapore and peak aggregate electricity consumption of residential households was found. This study was published in the journal Proceedings of the National Academy of Sciences.

Resilience of High-Density Urban Systems

Dr Jidong Kang, Prof. Adam Ng, Dr Bin Su and Dr Alexandre Milovanoff who proposed in a recently published study an input–output linear programming model with a stochastic-robust optimisation technique to identify the optimal decarbonisation pathways for light-duty passenger transport under scenario and local uncertainties in technology costs and emission intensities. Application of the model on a case study in China showed that tightening the cumulative CO2 emissions from light-duty passenger transport by 30% of the base case requires large deployment of electric vehicles, especially plug-in hybrids and battery electric vehicles. This study was published in the journal Energy Economics.

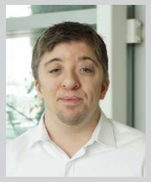
Distributed cognition for social resilience

Nishant Kumar and Prof. Martin Raubal examined the current state of deep learning applications in the domain of congestion prediction. Based on their research survey, they identified a hypothetical U-curve on how current understanding of traffic congestion and road safety (accidents) are related. This study was published in the journal Transportation Research Part C: Emerging Technologies.

Prof. Christoph Hölscher, Director, FRS II

Future Resilient Systems contributes to the resilience of urban systems by a unique combination of engineering, urban design and social research. In order to make sense of unfolding events we need to connect insights across disciplines to identify, e.g., how disruptions in one system impact other systems, and how social and cognitive resilience can be leveraged to cope with such challenges. Overcoming isolated thinking and instilling a resilience culture in various stakeholders and policy makers is an important success criterion for our programme.

Dr Jonas Jörin, Co-Director, FRS II



The world is witnessing an increase of multiple and simultaneously occurring disasters and conflicts. To better manage these events traditional risk management shall be complemented by resilience management. Resilience management is about designing and engineering solutions and strategies to enhance the ability of individuals, groups and physical infrastructure systems to anticipate, absorb, recover and learn from such disruptions.

Key events since 2020

Interconnected: Resilience Innovation for Sustainable Development Goals

24-27 November 2020 | The 4TU Resilience Centre for Resilience Engineering in collaboration with FRS organised a joint virtual conference entitled "Interconnected: Resilience Innovation for Sustainable Development Goals". More than 700 researchers, governmental stakeholders and practitioners discussed and shared knowledge, approaches and experience on how to design, develop, analyse and implement resilience in social-technical-environmental systems. This conference succeeded the 2019 World Congress on Resilience, Reliability and Asset Management hosted by FRS in Singapore.

FRS II Mid-term Review

1-3 June 2022 | The FRS II programme was reviewed by the FRS Scientific Advisory Committee. This event required researchers and principal investigators of FRS II to present their research progress. Beyond the evaluation of the programme, representatives from Singapore agencies were invited in an 'agency session' to receive an update on the progress of FRS II and to re-connect and discuss opportunities for collaboration.

FRS in numbers

- 24 PhD researchers
- 24 Postdoctoral researchers
- 45 Journal publications

Upcoming in 2023

28-30 June 2023 | In partnership with the 4TU Resilience Centre for Resilience Engineering, Stevens Institute of Technology and the Escuela de Gobierno y Tranformación Pública, FRS will co-organise a joint conference on 'resilience' in Mexico City. The thematic focus of this conference will be on urban-related resilience topics, food and environmental resilience.

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