

Book of Abstracts

XXII Workshop On Quantitative Finance

held on web on 28-29 Jan 2021, hosted and organized at the University of Verona

# Preface

## 1 Some history, aims and committees

The Workshop On Quantitative Finance 2021 was the XXII edition of a series of annual meetings, whose purpose is to stimulate discussion on theoretical and practical aspects of Quantitative Finance. Its web site is at

<http://dse.univr.it/qfw2021/>

The first edition was promoted by Fabio Antonelli, Emilio Barucci and Carlo Mari, and held at the University of Pescara (2000), in years when the Mathematical Finance discipline was starting to spread in Italy. The editions that followed took place at the universities of Pisa (2001), Verona (2002), Torino (2003), Siena (2004), Milano Bocconi (2005), Perugia (2006), Venezia (2007), Roma Tor Vergata (2008), Milano Politecnico (2009), Palermo (2010), Padova (2011), L'Aquila (2012), Rimini campus of the University of Bologna (2013), Firenze (2014), Parma (2015), Pisa Scuola Normale Superiore (2016), Milano Bicocca (2017), Roma Tre (2018), Zurich ETH (2019), Napoli Parthenope (2020). Since the 2005 edition the workshop became an international meeting, as more and more fellows from abroad, both young PhD students and well recognized scholars, appreciated it so much that some of them participate regularly, and some of them became part of the scientific committee. This year the 43 among presenters and discussants came from 15 different countries, from the USA to Europe to Turkey to Singapore. The Workshop took place online, via Zoom, and was organized and sponsored by the Department of Economics of the University of Verona. The organizing committee was composed of Maria Flora, Alessandro Gnoatto, Marco Patacca, Letizia Pellegrini, Athena Picarelli, Roberto Renò and me, and worked very efficiently under the direction of Roberto Renò.

The aim of the Workshop series is to promote the exchange of ideas that are relevant to researchers and practitioners, and cover topics in Mathematical Finance, Quantitative Risk Man-

agement, Portfolio Optimization, Computational Finance, Financial Economics, Econophysics, Financial Econometrics, Statistics of Financial Markets, Corporate Finance, and related fields. To encourage and allow the widest possible participation, the workshop series traditionally has no registration fee. Submission of extended abstracts is encouraged, but simple presence is welcome too. In particular the Workshop allows to strengthen and corroborate scientific exchanges, to enlarge networks within the scientific community working in Quantitative Finance, and crucially opens to contributions by people working in Italian and foreign banks, in financial institutions, in insurance companies and similar entities, in order to keep contact with practical problems needing deep analysis and research. In Italy the meeting represents an annual appointment to collect most of the people in the field and especially young people, allowing them to be known and appreciated and to find opportunities for the prosecution of their research activity.

For the edition of 2021 the scientific committee decided to further emphasize the role of the young people for our scientific community, and opened the call for papers (launched on November, the 3rd, 2020) only to PhD students who did not yet complete their PhD by the submission deadline (December 8, 2020). The scientific committee evaluated all the 31 submitted extended abstract, and selected 14 of them for an oral presentation, 15 scholars presented a poster while 2 decided not to participate. This volume contains the extended abstracts of all the 29 presenters. All of them gave their consensus to the publication.

The scientific committee of this year was composed of: Emilio Barucci (Politecnico di Milano), Giacomo Bormetti (University of Bologna), Francesco Cesarone (Roma Tre), Rocco Ciciretti (Roma Tor Vergata), Andrea Consiglio (Palermo), Stefania Corsaro (Napoli Parthenope), Christa Cuchiero (Vienna), Giuseppe De Marco (Napoli Parthenope), Marina Di Giacinto (Cassino), Marco Frittelli (University of Milano), Fabrizio Lillo (Bologna), Elisa Luciano (Torino), Maria Elvira Mancino (Firenze), Zelda Marino (Napoli Parthenope), Claudio Morana (Milano-Bicocca), Massimo Morini (Banca Imi), Aldo Nassigh (Unicredit), Mustafa Pinar (Bilkent), Roberto Renò (Verona), Emanuela Rosazza Gianin (Milano-Bicocca), Mathieu Rosenbaum (Ecole Polytechnique, Palaiseau), Peter Tankov (ENSAE-CREST), Josef Teichmann (ETH Zurich), Tiziano Vargiolu (Padova).

## 2 The sessions

The typologies of the presentations were varied: theoretical, applicative, numerical, empirical or mixed. The oral presentations were divided into parallel sessions, which took place within two separate virtual rooms. In total 6 sessions took place: 2 for topics on Mathematical finance, and one session for each one of the fields Financial econometrics, Volatility, Asset pricing and Mean field games. The Poster sessions were located in a separate virtual room, and were 2: session 1 was located at the end of day 1, session 2 at the end of day 2. I briefly illustrate the oral presentations, listing them in topics order.

### *Asset prices*

**Francesco Cordoni**, supervised by Fulvio Corsi (University of Pisa), and Stefano Marmi and Giulia Livieri (Scuola Normale Superiore, Pisa), presented a model for the price dynamics of  $M$  financial assets as the result of the equilibrium among the trading simultaneous activities of  $J$  agents. That extends the previous analysis in the literature which was considering 1 asset. The assets are traded in discrete time, their liquidity and the volume of the orders are accounted for and their impact on the prices are modeled. The execution cost of a strategy is defined and Nash equilibria of the game are found both under the minimization of a mean variance functional and under the maximization of expected CARA utility functional. Conditions for existence and uniqueness of equilibria are established, the existence of arbitrage opportunities exploiting the market-impact costs is investigated, and the market stability is analysed in terms of the Nash equilibrium.

**Stefan Rigger**, supervised by Christa Cuchiero (University of Vienna), presented a particle system model for controlling the stability of a banking system. In a network of  $N$  banks, the asset value of each bank  $i$  decreases of an amount  $\alpha/N$  whenever another bank  $j$  defaults. In fact, in that case bank  $i$  lends money to bank  $j$ . A solution to the limit particle system as  $N \rightarrow \infty$  can be interpreted as the aggregate loss of a typical bank, in a large banking system, caused by defaults from other banks. The main result of the paper is having proved the conjecture in Delarue et al. (2019) that the *minimal solution*  $\underline{\Delta}$  of the limit system, which turns out to be limit of solutions of perturbations of the particle system, is also a *physical solution* of the limit system. That lends itself to a new numerical method for approximating a physical solution using representations of the minimal solution.

## *Pricing of contracts*

**Maria Arduca**, supervised by Cosimo Munari (University of Zurigo), made a theoretical paper which deals with the problem of pricing today replicable future, but not yet traded, payoffs in an illiquid market with frictions. The proposed pricing functional is consistent with market prices and minimal risk thresholds according to the agent's preferences, and delivers classical no-arbitrage prices when the market is frictionless.

The aim of **Fabio Baschetti**, supervised by Giacomo Bormetti (University of Bologna) and Pietro Rossi (Prometeia Society, Bologna), and his coauthors was to conduct an accurate and fast simultaneous evaluation of plain vanilla call and put options on a given underlying asset. They devised the SINC method, which is applicable whenever the model gives to the asset log-price, at the option maturity time  $T$ , a characteristic function (CF) known in analytic or semi-analytic form. The method is based on truncating the probability distribution function and, exploiting the properties of the sinc function, expanding each option price in a Fourier type truncated series involving the mentioned CF. The approximation is shown to converge to the right price. Within the rough Heston model, the method has the same accuracy as the competitor COS method. However, when the CF is known analytically, then a Fast Fourier Transform is applicable to the SINC method, and, in comparison with Carr and Madan (1999) and Lewis (2000, 2001), the approximation error and the computational cost are much lower.

**Paul Hager**, supervised by Peter K. Friz (Technical University in Berlin), presented how to tackle an optimal stopping problem, such as pricing an American option, when the price model for the underlying is non-Markov, nor a semimartingale but admits a *lift* to a specific rough path process. The *signature* of the process is considered, and it is shown that the exposed problem is solved by looking at signature stopping times. Further, an approximation of the solution is delivered by means of a proper truncation of the signature.

**Ofelia Bonesini**, supervised by Markus Fischer and Giorgia Callegaro (both from Padova University), dealt with the rough path Bergomi model for the log-price of an asset, which suits to describe the implied volatility of short maturity contracts in equity markets better than the classical semimartingale model. In particular, the *product functional quantization* generalizes the commonly used discretization of the process by generating a desired number of whole approximating trajectories. That allows the pricing of path dependent payoffs. An application to pricing VIX futures is illustrated together with a comparison with other techniques.

**Alessandro Doldi**, supervised by Marco Frittelli (University of Milano), dealt with finding a reference price of a general financial contingent claim, through penalized subhedging. The considered evolution for the price  $X$  of the underlying asset occurs at discrete time but is model free. The reference derivative price is set to be the infimum among the sums of the claim expectation under a martingale measure  $Q$  and a penalization term accounting for the distance of  $Q$  from a chosen estimator  $\hat{Q}$ , as  $Q$  varies. The subhedging strategies are semistatic with a dynamic component in  $X$  and a static part in options on  $X$ . Under appropriate conditions, two duality results are proved, stating that the sought reference price equals the supremum of a suitable pricing functional for the subhedging instruments and which in general is non-linear. A reference price for the claim is then found under the most general case.

*Risk quantification*

**Francesco Benvenuti**, supervised by Kim Christensen and Bezirgen Veliyev (CREATES, Aarhus University), presented a  $d$ -dimensional asset price Ito semimartingale model  $X$  added with an independent noise and aimed to determine the principal component of the volatilities matrix, given high frequency observations of the asset prices. In order to smooth the impact of the microstructure noise a preaveraging is applied to the observations, then estimators are given for: the volatility matrix; the integrated (in time) highest eigenvalue; and the relative integrated (in  $dX_s$ ) eigenvector, which constitutes the *principal component*. Asymptotic results for the latter two estimators are provided and a simulation study illustrates the application of the estimates in a three factors asset price model.

**Giacomo Toscano**, supervised by Maria Elvira Mancino (University of Firenze), illustrated estimators of the integrated leverage (IL) between the price of a financial asset and its volatility, both assumed to be Ito semimartingales, given discrete observations of the asset price. The construction follows a two steps procedure based on the integrated covariance Fourier estimation method by Malliavin and Mancino (2002). In the first step the Fourier coefficients of the volatility are reconstructed, and in the second step the 0-th Fourier coefficient of the covariance between the asset price and the reconstructed volatility is estimated. A central limit theorem holds, showing that the estimator of the IL is rate-efficient. The asymptotic variance (AVar) however depends on the choice of the implemented kernels, and with the Fejer kernel in the second step it is possible to obtain better AVar than competitor estimators, but not the lowest possible. An empirical application to S&P500 prices (2006-2018) shows that adding the extra term, given by the asset return scaled by

the leverage effect, in an HAR model to predict the next-period volatility, significantly increases the model explanatory power.

**Ilaria Gianstefani**, supervised by Roberto Renò (University of Verona), presented an empirical study that at last explains a liquidity puzzle arised since 2001. Previous results in the literature documented that, using monthly data, the variability of an asset liquidity is negatively correlated with the asset returns, however that was at odd with the economic theory. The paper shows that using more frequent returns (one-minute) the improved estimate of the liquidity variability shows a positive relation with the asset returns. Further, on simulated data, it is shown that if there was no correlation between the dollar volume and its volatility then the relation would be positive, whatever the sampling frequency.

#### *Portfolio selection*

**Enzo Miller**, supervised by Huyên Pham (University Paris-Diderot), made a theoretical paper also containing a numerical illustration, which tackles the optimal mean-variance portfolio selection in an incomplete, non-Markov, non-semimartingale assets price model, where the variance-covariance matrix is rough. The optimal portfolio is shown to solve a Riccati backward stochastic differential equation, which applies to several models used in the literature, and some recent results are extended.

#### *Stochastic games*

**Camilo Hernandez**, supervised by Dylan Possamaï (ETH Zurich), presented the connected optimal control problems typical of a bargaining between an agent and a principal both maximizing their utilities. We are in continuous time, under the time inconsistency introduced by a non exponential discounting function, and under moral hazard, where the principal is only aware of the output process that is controlled by the agent but not of the agent strategy. A representation of the problem with an extended Backward Stochastic Volterra Integral equation allows to identify the type of contracts inducing equilibria for the agent, and to reformulate the problem of the principal. Under the risk-neutral specification of the utilities functions, that leads to explicit optimal contracts.

**Emma Hubert**, supervised by Romuald Elie (Université Gustave Eiffel, France) and Dylan Possamaï (ETH Zürich), presented a mean-field game approach to study how an energy producer (principal) can push the consumers (agents) demand to better match the supply. We are in a framework of moral hazard and the consumption process of each agent is driven by an idiosyncratic

noise, specific for the agent and with controlled volatility, and a common noise, representing for instance meteorological variations. In continuous time a continuum of agents is considered, where the principal can look at the average consumption behavior and can feasibly estimate the deviation of a single agent from the mean (for instance in the effort to be responsive). Taking into account such a deviation in the contract proposed by the principal to an agent, the optimal efforts of the consumers are computed and the Nash equilibrium between them is characterised. The generality of the newly proposed contracts is proved and its significant effects are quantified within a specific example.

**Marcos Leutscher**, supervised by Roxana Dumitrescu (King's College London) and Peter Tankov (CREST-ENSAE, Institut Polytechnique de Paris), dealt with a  $N$ -agents game where each agent seeks to choose a control strategy and an optimal time to exit the game such to maximize her reward functional also accounting for the wealth at the time of exit. The model allows for agents interaction through *occupation measures* accounting for the number of players participating in the game at a given time and their controls, and a Nash equilibrium among the players is looked for. In the limit for  $N \rightarrow \infty$ , the *linear programming* approach allows to restrict the region of the feasible occupation measures to ones for which Nash equilibria are found (and further shown to be equivalent to the equilibria found with the martingale approach). That lends itself to implementable approximations of the equilibria in the original problem.

As in the tradition of the workshop series, to each oral presentation was assigned a discussant, thus the full papers were required to the authors. After the presentation the discussant typically summarized the paper pointing out the crucial parts and the relevance in applications or within the theoretical framework, and made some comments, in many cases appreciations, suggestions on the importance of deepening some aspects or better arguing on others, asked for clarifications. The discussions always turn out to be really useful, not only for the presenter, but also for helping the audience to better understand the illustrated topic and to better catch aspects that are often difficult to see when for instance a specific paper is attended for the first time.

Given the reduced possibility of contact this year, to further help the people to meet and discuss, the breaks were organized in different virtual rooms, each room was labeled by the name of a discussion topic and one room was left for free conversation. A good interaction took place also thanks to those possibilities.

### 3 Conclusions

My opinion is that overall the conference turned out to be very exciting and interesting, and brilliantly proved how the field of financial mathematics and econometrics is vibrant and fertile. Clearly, being obliged to do it on-line had painful aspects, in particular as for the limitations of the interactions and the reduced stimulus due to a reduced concentration, given the lack of full immersion. However there were also some advantages: the organization was much faster and simple; many more people than usual could participate, we had 311 registered people, and, adding the speakers, the scientific committee and discussants not from the committee, we can estimate about 350 participants this year, in comparison to the 180 of the last edition; giving the possibility to listen even only 2 or 3 talks of interest when a person is not able to join a conference is an opportunity that sometimes I dreamed of but never dared to think that was really possible on such a broad level; having the facility of making screenshots of slides that are crucial for us is very useful; we did not record the talks, however in some conferences the registrations of some talks are made available to the attendees, and I find it very useful, especially for young scholars, to be able to listen again and trying to deepen the understanding of the topic, how many times have I also dreamed of this in my past experience.

We could ascertain how high the level and the quality of the PhD students are in our scientific community, how international and competitive they are, how stimulating are their supervisors, how wide is the network all of them interact with, how promising is the young generation for the construction of a solid research, how important are the quality, the experience and the network of a supervisor. It is very important that the workshop series will continue in the future to be a fixed, international appointment of the Italian scholars on quantitative finance, further I would wish that a satellite event dedicated to the PhD students as we did this year could be devised, a sort of job market, where the seniors, in Italy and abroad, keep updated on the activities carried out by colleagues in the field with the young scholars, and become aware of the quality and the interests of the possibly future candidates in the university competitions. On the other hand the junior PhD students interested in specific topics could look for their own candidate supervisors.

I want to thank Giampietro Cipriani, Dean of the Department of Economics, the colleagues in the organizing and in the scientific committees, the presenters and the participants for the realization of this workshop, and I wish all the presenters to always be able to make serious and



deep work, with a lot of passion and success. I warmly hope that they will not be discouraged in the face of the obstacles that life will place before them, and sincerely wish them to always have the confidence to be able to find the resources within them, to be able to cooperate honestly with others, to be willing of intellectual honesty and to succeed in being themselves. I wish them a career of satisfaction and that their contributions can help in tackling important and urgent problems sadly affecting our world, and effectively contribute to the construction of an ever better society.

Verona, 15/6/2021

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