



UNIVERSITÀ DEGLI STUDI DI MILANO

DIPARTIMENTO DI MATEMATICA "FEDERIGO ENRIQUES"

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Lectures delivered by Marco Frittelli

Invited Speaker:

- 1) *Dominated Families of quasimartingale and supermartingale measures*, Programme on Financial Mathematics, Newton Institute for Mathematical Science, University of Cambridge, Cambridge, March 17, 1995
- 2) *Asset pricing in frictional markets*. Programme on Financial Mathematics, Newton Institute for Mathematical Science, University of Cambridge, U.K., June 2, 1995.
- 3) *Valuation principle in security markets models with frictions*. Workshop on Mathematical Finance, Columbia University, New York, October 9, 1995.
- 4) *Valuation principles in complete and incomplete markets*. Forschungsseminar Quantitative Methoden in der Oekonomie, Zurich University, November 11, 1996.
- 5) *Entropy minimization and valuation principles in incomplete markets*. Humboldt University, Berlin, November 28, 1996.
- 6) *Certainty equivalent and no arbitrage pricing in incomplete markets*. Vienna University, June 19, 1997.
- 7) *Valuation principles in incomplete markets*. Stochastic Analysis in Finance and Insurance, Mathematisches Forschungsinstitute Oberwolfach, Oberwolfach, Germany, September 15, 1997.
- 8) *Certainty equivalent and no arbitrage: a reconciliation via duality theory*. ETH Zurich, November 27, 1997.
- 9) *Duality methods for pricing in incomplete markets*. Banach Center, Symposium on Stochastic Systems, Warsaw, Poland, June 6, 1998.
- 10) *Certo equivalente dinamico*. "Università della Svizzera Italiana", Lugano, April 15, 1999.
- 11) *Sublinear risk measures and pricing rules*. The Bachelier Colloquium on Mathematical Finance, Université de Franche-Comte, Besançon, France, March 29, 2000.
- 12) *Minimal measures and utility maximization*. Freiburg University, Germany, July 13, 2000.
- 13) *Utility maximization in incomplete markets*. The Bachelier Seminar on Mathematical Finance, H. Poincaré Institute, Paris, November 24, 2000.



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- 14) *Optimal solution to utility maximization in incomplete markets*: International Conference on Mathematical Finance, Shanghai, China, May 12, 2001.
- 15) *Entropy in mathematical finance*, Workshop: "Application of Information Theory in Biology, Finance and Physics", Banach Center, Warsaw, Poland, May 21, 2001.
- 16) *Arbitrage and preferences*, Minisymposium "Mathematical modeling for pricing and hedging financial risk", EMS-SMAI-SMF Conference: Applied Mathematics and Applications of Mathematics, Nice, France, February 13, 2003.
- 17) *The interplay between preferences and arbitrage, super-replication, risk measures*. Stochastic Analysis in Finance and Insurance, Mathematisches Forschungsinstitute Oberwolfach, Oberwolfach, Germany, March 5, 2003.
- 18) *Preferences and risk measures*, Università della Svizzera Italiana, Lugano, March 20, 2003.
- 19) *On a class of dynamic risk measures*, Humboldt University, Berlin, June 12, 2003.
- 20) *Super-replication price and preferences*, EMS Weekend, Lisbon, Portugal, September 14, 2003.
- 21) *Duality in mathematical finance*, Semimartingale Theory and Practice in Finance, Banff International Research Station for Mathematical Innovation, Banff, Canada, June 4-10 2004
- 22) *Utility maximization in incomplete markets with unbounded processes*, The Second Bachelier Colloquium on Mathematical Finance, Université de Franche-Comte, Metabief, France, January 12, 2005.
- 23) *Utility maximization in incomplete markets with general semimartingales*, Winter School on Mathematical Finance, Lunteren, The Netherlands, January 24, 2005.
- 24) *Risk measures and capital requirements for processes*, ETH Zurich, April 7, 2005.
- 25) *A unifying approach to utility maximization in incomplete market with general semimartingales*, Bachelier Seminar, Paris, April 15, 2005.
- 26) *A unifying approach to utility maximization in incomplete market with general semimartingales*, Programme on Quantitative Methods in Finance, Newton Institute for Mathematical Science, University of Cambridge, U.K., April 26, 2005.
- 27) *Capital requirements for processes* Programme on Quantitative Methods in Finance, Newton Institute for Mathematical Science, University of Cambridge, U.K., June 7, 2005.
- 28) *A unifying framework for utility maximization problems with unbounded semimartingales*, The Fields Institute: Seminar series on Quantitative Finance, Toronto, Canada, October 26, 2005.



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- 29) *Risk measures and capital requirements for processes*, XII Workshop on Derivative Securities and Risk Management, Center of Applied Probability, Columbia University, New York, October 28, 2005.
- 30) *Risk measures and capital requirements for processes*, Seminar at The McMaster University, Canada, November 1, 2005
- 31) *A unified framework for utility maximization problems: an Orlicz space approach*, Carnegie Mellon, Pittsburgh, USA, April 3, 2006.
- 32) *Utility maximization with unbounded semimartingales: on the supermartingale property and on the indifference price*, Carnegie Mellon, Pittsburgh, USA, April 10, 2006.
- 33) *Indifference price and risk measures in Orlicz spaces: modeling catastrophic risk*. International Workshop on Mathematical Finance and Insurance, Lijiang, China, May 29, 2006
- 34) *A Unified framework for utility maximization problems: an Orlicz space approach*, University of Munich, Germany, June 9, 2006.
- 35) *Advanced course on risk measures: five lectures*, Technical University of Lisbon, June 21-23, 2006.
- 36) *Risk measures on Banach lattices and Orlicz spaces*. Conference on Risk Measure, Evry, France July 6, 2006.
- 37) *Indifference price with unbounded processes and claims: an Orlicz space approach*. Illinois Institute of Technology, Chicago, USA, October 5, 2006
- 38) *Risk measures on Banach lattices and Orlicz spaces*, Annual Conference on "Dynamic Risk Measures and Robust Control in Finance", Bendheim Center for Finance, Princeton University, USA, October 6-7, 2006.
- 39) *Indifference price with unbounded processes and claims: an Orlicz space approach*. Boston University, Boston, USA, October 10, 2006
- 40) *Indifference prices and convex risk measures in Orlicz spaces*, Annual Meeting of the American Mathematical Society, New Orleans, USA, January, 5-7, 2007.
- 41) *Risk measures on Banach lattices and Orlicz spaces*, Austin University, Texas, January 8, 2007.
- 42) *Indifference Price for general semimartingale: an Orlicz space approach*, University of California at Irvine, May 2008.
- 43) *Ten Lectures on Convex Duality Methods in Mathematical Finance*, NSF/CBMS Regional Conference, University of California at Santa Barbara, June 22-27 2008.



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- 44) *Utility maximization and indifference pricing: an Orlicz space approach*, Plenary Lecture at the 5th World Congress of the Bachelier Finance Society, London, UK, 15-17 July, 2008.
- 45) *On the conditional certainty equivalent*, University of Southern California USA, April 2009.
- 46) *Robust representation of dynamic quasiconvex maps*, Workshop on "Foundations of Mathematical Finance", during the Thematic Program on Quantitative Finance, Fields Institute, Toronto Jan. 2010.
- 47) *On the representation of conditional quasiconvex maps*, Nomura Centre, University of Oxford, UK, Jan. 2010.
- 48) *Five Lectures on Duality Methods in Mathematical Finance*, Third Summer School in Mathematical Finance, African Institute for Mathematical Sciences, Capetown, South Africa 2010
- 49) Guest Lecturer in the Course: "Foundations of Mathematical Finance", during the Thematic Program on Quantitative Finance, Fields Institute, Toronto April 2010.
- 50) *Dual representation of conditional quasiconvex maps*, University of California at Santa Barbara, Oct. 2010.
- 51) *On quasiconvex dynamic risk measures*, University of Southern California, USA, Nov. 2010.
- 52) *On quasiconvex dynamic risk measures*, Plenary Lecturer at the SIAM Conference on Financial Mathematics and Engineering, San Francisco, Nov. 2010.
- 53) *On quasiconvex dynamic risk measures*, Research in Options, Mathematics and Finance Conference, Rio de Janeiro, Brazil, Dec. 2010.
- 54) *Complete Duality for Quasiconvex Conditional Maps*, Seventh Seminar on Stochastic Analysis, Random Fields and Applications, Ascona, Switzerland, May 2011.
- 55) *On Quasiconvex Dynamic Risk Measures and Performance Indices*, ICIAM 2011 Conference, Vancouver, Canada, July 2011.
- 56) *Two applications of quasi-convex analysis*, UCSB, USA, April, 2012.
- 57) *On Quasiconvex Dynamic Risk Measures and Performance Indices*, Quantitative Methods in Finance, Cairns, Australia, June 2012.
- 58) *On Quasiconvex Dynamic Risk Measures and Performance Indices*, Perspectives in Analysis and Probability, Conference in Honour of Freddy Delbaen, ETH, September 2012.



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- 59) *Tutorial on Risk Measures*, Three Lectures at Ecole CEA EDF INRIA – Systemic Risk and Quantitative Risk Management, Paris, Oct. 2012.
- 60) *Tutorial on Risk Measures*, Four Lectures at the Workshop on Non Linear Expectation and Stochastic Calculus under Knightian Uncertainty, Institute of Mathematical Science, National University Singapore, June 28, 2013.
- 61) *Robust Arbitrage*, Quantitative Finance Retrospective Workshop, Fields Institute, Toronto, October 27, 2013.
- 62) *Conditionally evenly convex sets and the representation of conditional maps*, Southern California Probability Symposium 2013, USC, Los Angeles, December 7, 2013.
- 63) *Conditionally evenly convex sets and the representation of conditional quasi-convex risk measures*, Mathematical Finance Colloquium, USC, Los Angeles, February 3, 2014.
- 64) *Robust Arbitrage under Uncertainty in Discrete Time*, Workshop on Mathematical Finance, Banff Canada, May 2014
- 65) *Robust Arbitrage under Uncertainty in Discrete Time*, Advances in stochastic analysis for risk modeling, CIRM, Marseille France, September 2014.
- 66) Systemic risk Measures, IMPA, UCLA, March 24, 2015
- 67) *Model Free Arbitrage and Superhedging*, Mathematische Kolloquium, LMU Munich, June 11, 2015.
- 68) *Model free arbitrage and superhedging duality*, Advanced Methods in Mathematical Finance Conference, Angers, September 2015.
- 69) *Model Free Arbitrage and Superhedging*, International Conference on Stochastic Analysis and Applications, Hammamet, 19-23 October 2015.
- 70) *Model-free Arbitrage and Superhedging*, Research in Options 2015, IMPA Rio de Janeiro, December 2015.
- 71) *A unified approach to systemic risk measures via acceptance set*, King's College London, March 2016.
- 72) *Disentangle Price and Risk*, Risk Measures Workshop SAIF, Shanghai China, October 2016.
- 73) *Disentangling Price and Risk and Model Risk*, Pricing-Hedging Duality Workshop, ETH Zurich, March 2017.
- 74) *Pathwise Finance: Arbitrage and Pricing-Hedging Duality*, CFMAR-UCSB, USA, May 2017.



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- 75) *Pathwise Finance*, Workshop on Recent Advances in Model Uncertainty, LMU-Munich, June 2017.
- 76) *Pathwise Finance: Arbitrage and Pricing-Hedging Duality*, CFMAR International Conference on Stochastic Analysis and Applications, Hammamet, October 2017
- 77) *Disentangle Price, Risk and Model Risk*, Advances in stochastic analysis for risk modeling, CIRM, Marseille France, November 2017.
- 78) *On Fairness of Systemic Risk Measures*, Mathematical Finance Seminar, Bielefeld University, Germany, April 2018.
- 79) *On Fairness of Systemic Risk Measures* Advanced Methods in Mathematical Finance, Anger, France, August 2018.
- 80) *On Fairness of Systemic Risk Measures*, International Conference on Control, Games and Stochastic Analysis, Hammamet, Tunisia, October 2018.
- 81) *On Fairness of Systemic Risk Measures*, ETH Zurich, November 2018.
- 82) *On Fairness of Systemic Risk Measures*, SIAM Conference on Financial Mathematics, Toronto June 2019
- 83) *Systemic Optimal Risk Transfer Equilibrium*, SIAM Conference on Financial Mathematics, Toronto June 2019.
- 84) *Systemic Optimal Risk Transfer Equilibrium*, Advances in Stochastic Analysis for Handling Risks in Finance and Insurance, CIRM, Marseille France, October 2019.
- 85) *Systemic Optimal Risk Transfer Equilibrium*, International Conference on Control, Games and Stochastic Analysis, Hammamet, Tunisia, October 2019.
- 86) *Multivariate Systemic Optimal Risk Transfer Equilibrium*, Research in Options 2019, IMPA Rio de Janeiro, December 2019.

Invited speaker in Italy:

- 87) *Quasi-martingales in frictional markets*. International Conference organized by the University of Udine in honor of Prof. Alberto Frigerio, Udine, September 13, 1994.
- 88) *Probabilità equivalente di martingala: applicazione nei mercati finanziari*. Seminars of the "Centro Volterra", Università Tor Vergata, Roma, March 15, 1995.
- 89) *Metodi di valutazione in mercati finanziari Incompleti*, Modena University, October 23, 1996.



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- 90) *Certainty equivalent and martingale pricing in incomplete markets*. III Italian Conference on Mathematical Finance, Trento, May 27, 1997.
- 91) *Certo equivalente dinamico*, Math. Dept. "Guido Castelnuovo", University of Roma, January 29, 1999.
- 92) *Misure minimax di martingala*, IAC CNR-Roma, January 28, 1999.
- 93) *Certo equivalente dinamico*, Politecnico of Milano, March 11, 1999.
- 94) *Certo equivalente dinamico*, DIMADEFAS, Firenze University, May 19, 1999.
- 95) *Utility pricing in incomplete markets*, Conference on Quantitative Methods in Finance, Math. Dept., University of Milano, November 15, 1999.
- 96) *Principi di valutazione finanziaria*, Politecnico of Milano, November 16, 2000.
- 97) *Optimal investments in financial markets*, Roma University, March 20, 2001.
- 98) *Duality and pricing in incomplete markets*, International Workshop on Functional Analysis Methods in Economics and Finance, Diamante, Cosenza, June 29, 2001.
- 99) *Utility maximization in semimartingale markets models*, International Conference, University of Pisa, September 13, 2001.
- 100) *Dynamic convex risk measures*, Conferenza su Misura e Controllo del Rischio, Roma, June 17-20, 2003.
- 101) *Utility maximization in incomplete markets with general semimartingales*, Luiss-IAC Seminars, Rome, January 19, 2005.
- 102) *Utility maximization in incomplete markets with general semimartingales*, Statistics and Probability Seminars, Politecnico of Torino, March 16, 2005.
- 103) *Advanced course on stochastic calculus with application in finance*: 8 Lectures for junior researchers at the 8th Italian-Spanish Meeting on Financial Mathematics, Verbania, Italy, June 28-29, 2005
- 104) *A unifying framework for utility maximization*, International Conference on Functional Analysis Methods in Economics and Finance, Cetraro, Italy, July 9, 2005.
- 105) *Advanced course on "Valuation Principles and risk measures"*: 12 Lectures at the "Scuola di Alta Formazione in Finanza Matematica", Bologna University, Italy, January 2006.
- 106) *Indifference price and risk measures*, Workshop on "Modelli Dinamici in Economia e Finanza, Urbino, Italy, September 22, 2006.



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- 107) *Indifference price with unbounded processes and claims: convex risk measures on Orlicz spaces*, Stochastic Processes: Theory and Applications: A Conference in Honor of the 65th birthday of Wolfgang J. Runggaldier, Bressanone, Italy, July 2007.
- 108) *Risk Measures and Scientific Impact Indices: from Risk Measures to Research Measures*, DEAS, University of Milano, May 2011.
- 109) *From Risk Measures to Research Measures*, Congresso AMASES 2011, Napoli, September 2011.
- 110) *Risk Measures to Research Measures and V@R*, Università Federico II Napoli, January 2012.
- 111) *Value at Risk with Probability/Loss function*, Prometeia, Bologna, March 2012.
- 112) *Scientific Research Measures*, Bolzano Workshop on Research Evaluation, Free University of Bozen, Italy, May 10, 2013
- 113) *Finanza Matematica e crisi finanziarie*, Lectio Magistralis, AlfaClass Summer School of Mathematics, Politecnico di Torino, September 2015.
- 114) *Systemic Risk Measures*, Dependence and Risk Measures, University of Milano Bicocca, November 2015.
- 115) *On Fairness of Systemic Risk Measures*, Workshop in Honour of Maurizio Pratelli, Pisa University, June 2018.
- 116) *On Fairness of Systemic Risk Measures*, New Frontiers in Stochastics for Economics and Finance, Siena University, May 2019.

Talks:

- 117) *On the existence of equivalent martingale measures*, 22^o International Conference on Stochastic Processes and their Applications, Bernoulli Mathematical Society, Amsterdam, June 93.
- 118) *The minimal entropy martingale measure and the valuation problem in incomplete markets*, AFFI - 13^o International Conference in Finance, French Finance Association, Ginevra, 1996.
- 119) *Certainty equivalent and no arbitrage principles in incomplete markets*, Quantitative Methods in Finance, Canberra, Australia, September 1997.
- 120) *Certainty equivalent and no arbitrage: a reconciliation via duality theory*, International Conference in Finance-AFFI, Lille, France, July 1998.
- 121) *On the martingale measure that minimizes the maximum expected utility*, IME International



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Conference: Insurance, Mathematics and Economics, Losanna, Switzerland, July 1998.

- 122) *On the existence of minimax martingale measures*, International Conference on Mathematical Finance at Hammamet, Tunis, June 15, 1999.
- 123) *Dynamic certainty equivalent*, International Conference on Mathematical Finance at Hammamet, Tunis, June 15, 1999.
- 124) *On the existence of minimax martingale measures*, 10th INFORMS Applied Probability Conference, Ulm Germany, July 27, 1999.
- 125) *Representing sublinear risk measures and pricing rules*, The first World Congress of the Bachelier Finance Society, Paris, June 30, 2000.
- 126) *Optimal solutions to utility maximization and to the dual problem*, The second World Congress of the Bachelier Finance Society, Creta, June 13, 2002.
- 127) *Representing risk measures and preferences*, Quantitative Methods in Finance 2002 Conference, Cairns, Australia, December 9, 2002.
- 128) *A unified framework for utility maximization problems: an Orlicz space approach*, The 4th World Congress of the Bachelier Finance Society, Tokyo, Japan, August, 2006.
- 129) *Dual representation of quasiconvex conditional maps*, The 6th World Congress of the Bachelier Finance Society, Toronto, Canada, June, 2010.
- 130) *Model-free superhedging duality*, The 9th World Congress of the Bachelier Finance Society, New York USA, July, 2016.

Talks in Italy:

- 131) *Caratterizzazione delle martingale nella classe dei processi limitati inferiormente: applicazioni all'arbitraggio*, XVI Congress AMASES. Treviso, September 1992.
- 132) *Sull'esistenza di una misura equivalente di martingala*, XVII Congress AMASES, Ischia, September 1993.
- 133) *Misure equivalenti di martingala: applicazioni alla valutazione di strumenti finanziari*, Mathematical Finance and Economic, CNR-GNAFA Conference, Pisa, October 1993.
- 134) *Valutazioni di opzioni sui futures: un programma software*, Congress Real-time trading nei mercati finanziari, Bergamo University, November 1993.
- 135) *M-sets and dominated families of martingales measures*, International Conference CNR-GNAFA on



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recent advances in Mathematical Finance, Cortona, May - June 1994.

- 136) *Asset pricing in frictional markets*, XXII Congress European Finance Association, Milano, August 1995.
- 137) *Valuation principle in security markets models with frictions*, XIX Congress AMASES, Pugnoli, September 1995.
- 138) *Semimartingales and financial markets*, Seminari of "Probabilità e Statistica Matematica di Milano", Math. Dept., Milano University, May 1996.
- 139) *The valuation problem in incomplete markets: the entropy approach*, Seminar at the CIME Course on Financial Mathematics, Bressanone, July 1996.
- 140) *Entropy minimization and utility pricing in incomplete markets*, XX Congress AMASES, Urbino, September 1996.
- 141) *Utility and martingale pricing in incomplete markets*, XXI Congress AMASES, Roma, September 1997.
- 142) *Pricing in insurance and financial markets*, XXII Congress AMASES, Genova, September 1998.
- 143) *Utility pricing in incomplete markets*, Politecnico of Milano, May 2001.
- 144) *Putting order in risk measures*, XXX Euro Working Group Conference, May 2002, Capri.
- 145) *Cycle of five seminars "Duality in mathematical finance: introduction to convex analysis and duality theory"*, Firenze University, February 2002.
- 146) *Cycle of five seminars "Duality in mathematical finance: arbitrage"* Firenze University, March 2002.
- 147) *Cycle of five seminars "Duality in mathematical finance: valuation principles"*, Firenze University, March 2002.
- 148) *Cycle of five seminars "Duality in mathematical finance: optimal portfolio"*, Firenze University, April 2002.
- 149) *Cycle of five seminars "Dualità in mathematical finance: risk measures"* Firenze University, May 2002.
- 150) *Arbitrage and preferences in stochastic securities market models*, XXVII Congress AMASES, Cagliari, September 2003.
- 151) *A unified framework for utility maximization problems: an Orlicz space approach*, Lecce University,



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September 15, 2006.

- 152) *Indifference price with unbounded semimartingales: an Orlicz space approach*, Lecce University, September 15, 2006.
- 153) *A unified framework for utility maximization problems: an Orlicz space approach*, Venezia, XIII Workshop on Quantitative finance, January 26, 2007.
- 154) *Complete Duality for Quasiconvex Dynamic Risk Measures*, Belgirate, Italy, Games and Decisions in Reliability and Risk, May 19, 2011.