Erio Castagnoli: scientist, teacher, mentor and friend

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Erio Castagnoli, an Italian excellence in Mathematics applied to Economics and a legend for thousands of students, left us in January 2019.

He was missed right away.

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1 Biography

Erio Castagnoli was born on July 2, 1943, in Mantua.

He graduated in Economics in 1967 at the University of Parma, where he began his academic career under the guidance of the great Eugenio Levi (see Castagnoli (2009)).

After holding teaching positions in Parma and Brescia, in 1980 he became full Professor in Financial Mathematics, in Parma, where he taught Calculus, Financial Mathematics and Decision Theory.

He also chaired the Financial Mathematics Institute "E. Levi" from 1981 to 1985, and the Library of the Faculty of Economics from 1982 to 1984.

In 1985 he moved to Bocconi University, in Milan, where he stayed until his retirement in 2013.

In Milan, he revived the Institute for Quantitative Methods, which he chaired for a long time, being able, during the years, to attract to Bocconi University some of the best Italian financial mathematicians and decision theorists. He was one of the founders of the Master in Quantitative Finance and Risk Management, as well as its first chairman from 1999 to 2004. In 2007, he founded the Department of Decision Sciences which he chaired until 2008.

He was a member of the Academic Senate of Bocconi University from 2005 to 2008. In 2015, Erio Castagnoli received the title of *Emeritus* Professor.

At Bocconi, Erio taught Calculus, Financial Mathematics, Mathematical Methods for Economic Analysis, Mathematical Methods for Finance, and Financial Evaluation; he also inaugurated the courses of Risk Management, Decision Theory and Game Theory. His optional course on the foundations of Mathematical Finance was the most popular among students in the later Eighties. One of the reasons of his success as a teacher was his exemplar ability to gracefully lead students to the core of the various questions.

He also taught Financial Mathematics in the Master in Quantitative Finance and Risk Management.

Erio also taught courses about Financial Mathematics, Mathematical Analysis, Probability Theory, Optimization Theory and Decision Theory for the Ph.D. Programs in Economics at Bocconi University, in Economics at the University Ca' Foscari of Venice, in Mathematics applied to economic problems at the University of Trieste, in Statistics at the University of Milan.

Furthermore, he taught Financial Mathematics at Finafrica in Milan (1986-1990), at the Istituto per l'Automazione delle Casse di Risparmio Italiane in Rome (1988-1990) and at several banks in Milan (1988-1992). For over a decade, he cooperated with the University of Trieste, where he was a member of the Faculty Committee of the PH.D. Program in Mathematics applied to economic problems until 2002, and a member of the Advisory Board of the PH.D. Program in Economics from 2002 to 2005.

He was P.I. for several research projects funded by the Italian Ministry of Education and by National Council for Research (CNR) and the president or the member of many Selection Committees for academic positions.

He organized several international meetings and workshops, held a lot of seminars in Italian and foreign universities, and published over one hundred scientific works and several books.

Erio was also appointed to several executive positions in different scientific and cultural communities.

He was a member of the Board of Directors of the *Consorzio interuniversitario lombardo per l'elaborazione automatica* (1990-1993).

From 1986 to 1989, he was Secretary General of the Association for Mathematics Applied to Social and Economic Sciences, then he was Vice-President twice (1990-1993, 1996-1999) and member of the Scientific Committee. Furthermore, he was one of the early editors of the *Rivista di matematica per le scienze economiche e sociali*, the previous incarnation of this journal.

He was a member of the Selection Committee for the Mortara Scholarships of Bank of Italy, from 1998 to 2003. Finally, he was a member of the *Unione Matematica italiana*, of the *Istituto Italiano degli Attuari*, of the Italian Association of Operations Research and of the American Mathematical Society.

From 1992 to 2006, Erio Castagnoli was a member of the Board of Directors of the *Banca Agricola Mantovana* and, from 2000 to 2017, of the Board of Directors of the *Fondazione della Banca Agricola Mantovana*. He was also a member of the Academic Board of the *Accademia Nazionale Virgiliana di Scienze*, *Lettere e Arti.*

Finally, from 2005 to 2012, he was a general supervisor for the monumental work *Storia di Mantova* (Romani (ed.) 2006-2012).

Erio Castagnoli passed away on January 9, 2019.
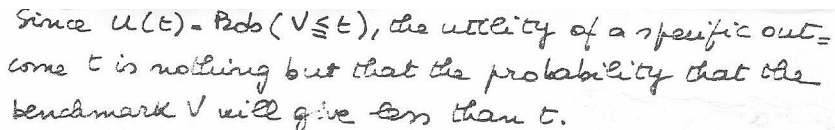
2 The scientist

The peculiar sense of science of Erio Castagnoli was characterized by a wide-ranging vision which let him capture unexplored connections among different subjects and propose original and powerful unifying generalizations.

Erio was a prolific researcher. His plurality of interests led him to write on a great number of topics, although his work mainly contributed to Decision Theory and Mathematical Finance.

He observed that both fields deal with price systems. Decision Theory studies preferences among random quantities, that is, subjective price systems for them, whereas Mathematical Finance focuses on market price systems; that is, on the interpersonal effective prices at which exchanges take place. Thus, the common problem of the two disciplines is the study of a price system for random variables which satisfies appropriate rationality conditions (named, depending on the contexts, coherence or no arbitrage). This can be approached, with different levels of generality, also through Functional Analysis; this inspired most of Castagnoli's research from 1990.

Erio also gave contributions to Generalized Concavity, Financial Mathematics, Optimization and Functional Analysis.

Erio's most important contribution to Decision Theory is presented in the works with Marco LiCalzi about 'utility without utility', published between 1990 and 2006 (Castagnoli 1990; Castagnoli and LiCalzi 1996; 1999 (see Fig. 1); 2006; Castag-

Since $u(t) = Prob(V \leq t)$, the utility of a specific outcome t is nothing but that the probability that the benchmark V will give less than t.

Fig. 1 An autograph passage from Castagnoli and LiCalzi (1999)

noli and Favero 2010). In these papers, the authors propose a new interpretation of the Expected Utility *à la* von Neumann and Morgenstern, according to which the expected utility of a lottery can be read as the probability that it outperforms a given (random) benchmark chosen by the decision maker (for instance, the benchmark may represent the welfare of the decision maker who decides 'to do nothing' and just take the consequences of the *status quo*).

Furthermore, if the benchmark is stochastically dependent on the random variables to be ranked, the revisited model generalizes the classical one.

Such a new formulation turns out to be very fruitful. It allows to interpret expected utility as an ordinal judgement\ranking and to consider from a new perspective the concepts of stochastic dominance, risk aversion, as well as the possible violations of the axioms of the traditional model. From an operational point of view, the result leads to different analyses of classical problems, such as, for instance, portfolio selection (Castagnoli and LiCalzi 1993; 1994).

'Utility without utility' inspired many works by other Authors and allowed the reinterpretation of different models of preferences representation. In the most general version of 2006, a connection with a well-known result of Debreu (1960) was found, and Castagnoli went on studying it until 2019 (Castagnoli, De Donno et al. 2016; 2023).

Other original and powerful results can be found in:

- the analysis with Fabio Maccheroni (2000) first, and successively with Maccheroni and Massimo Marinacci (2003) of the restriction of independence axiom in Decision Theory to a family of convex cones, leading to an extension of the classical CEU model by Schmeidler (1989) and MEU model by Gilboa and Schmeidler (1989);
- the contributions, with Maccheroni and Marinacci (2002; 2004), on premium calculation principles in Insurance.

In the first paper, the authors study insurance prices in incomplete and competitive financial markets. They show that, if a price system is internal, sublinear and consistent with the market, the prices are the maxima of their expected payments with respect to a family of risk neutral probabilities. Furthermore, a decomposition of the price in a net premium and a safety loading can be obtained. The second paper shows that, if market prices are expected values *à la* Choquet, the presence of one frictionless asset may cause the absence of frictions on the whole market. If prices depend only on the distribution with respect to a given nonatomic probability measure, any risk asset makes the market frictionless. Analogous considerations also hold for any law-invariant coherent risk measure;

- the works, with Gino Favero (2007), and successively with Gino Favero and Claudio Tebaldi (2011) about a sublinear or convex functional for the representation of preferences or market prices, with interesting applications to insurance prices and to the no arbitrage concept. In particular, these papers show that no arbitrage is a local property which can *destroy* a price system only when the system is positively homogenous, whereas, in general, it can be considered as a slight anomaly;
- the analysis of super-replications of prices, with the result that the impossibility of convenient super-replications in Mathematical Finance can shed a new light also in Decision Theory where it allows to *enrich* an incomplete preference (Castagnoli, Favero et al. 2009; Castagnoli, De Donno et al. 2023).

Among the publications which Erio particularly liked, we mention: Castagnoli 1998, Castagnoli and LiCalzi 1997; Castagnoli and Favero 2008.

Finally, we mention the posthumous work *Dieci dialoghi celesti* (2021), that Erio sent via e-mail to some friends in December 2018. The *Dialoghi* are a *summa* of his, not only scientific, thought. There, in his inimitable style, he proposes a large collection of cues and intuitions in a very particular form: he imagines that some characters (in every dialogue, a saint and a follower) discuss about the main subjects of Mathematical Finance and Decision Theory. Sometimes the style of reasoning of the saints is irreverent and challenges the mainstream. The result is a sort of encyclopedia of financial knowledge, enjoyable for both neophytes and experts.

3 The teacher and the mentor

Conscious that it is nigh impossible to represent to somebody who did not know Castagnoli his charisma, his intelligence, his culture and his extraordinary sense of humor and irony, we briefly outline some of his personal traits.

First of all, Erio was a great teacher, always very clear, smart and, above all, never boring. Often, among the students waiting for his office hours, one would happen to hear enthusiastic comments or admiration couched behind anecdotes.

Despite his apparently rough personality, he was very generous in terms of science. For instance, at scientific meetings, he soon captured the key point of a presentation: if he didn't appreciate it, he kept silent; but if he liked it, he immediately offered some ideas, especially to young researchers.

In his success with students, Erio was helped by his natural curiosity about everything new or which he did not know. He was really interested in understanding the way of reasoning of younger generations. His love for teaching led Castagnoli to write a huge number of didactic texts. We mention: *Teoria delle decisioni* (1974) and *Matematica per l'analisi economica* (1979), both with Lorenzo Peccati, *Appunti di matematica finanziaria* (1986), a delicious short handbook, able to fascinate even those mathematicians who approached Financial Mathematics with a good amount of scepticism, innumerable lecture notes, in many of which he first introduced innovative contents (two for all: *Utility: who is that girl?* (1988) and *Qualche pennellata sui mercati finanziari* (1991)) and, more recently, the *Abbecedario* (2017).

A particular mention is deserved by *Marchetto*, *il prezzatore perfetto* (Castagnoli, Favero et al. 2009), in which he playfully explained the main ideas of Financial Mathematics by personifying them: for instance, "Marchetto" (Italian for 'Little Mark', making a pun with the Italianization of the English word 'market') is no-one but the financial *Market* itself, giving prices to the random variables listed on the stock exchange. The over 1,000 pages of Marchetto, written in mock-medieval Italian, cover every topic Castagnoli dealt with, from classical Asset Pricing to Risk Measurement (starring the Adeh family, from the initials of Artzner et al. (1999), and to Decision Theory, whose main player is Nemo, '*propheta in patria*', described by Castagnoli as 'a new man, enlightened by the morning star'.

Throughout all these works Castagnoli, often together with Peccati (Castagnoli and Peccati[1] were sometimes defined[2] "scientific twins") proposed a new and modern vision of Financial Mathematics that, at least in part, revolutionized such a discipline in Italy.

Erio's talent and charisma attracted a very high number of students, many of whom successively became renowned researchers or achieved high-ranking positions in financial institutions. Currently, the Italian school of Decision Theory, made largely by students of Erio or people who had close contact with him, is considered among the best in the world.

In closing, some smaller[3] observations. Castagnoli was also characterized by his love for cats (in particular for his Pito), for the Italian language, for culture (especially for geography), for good food, for his cigarettes (rigorously *Diana rosse*), for India, and, above all, by his immense love for Mantua, which he often invited his friends, students and colleagues to, and which brought his friends to name him the[4]*Duke of Mantua.*

4 Selected works of Erio Castagnoli

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[1] Between the reception of the Degree in Economics, 1967, and the promotion to Full Professor, 1980, there was an intense cooperation between them. Both had had Eugenio Levi as thesis supervisor, who, before passing away, told each one about the existence of the other.

[2] See Romani (2019).

[3] From 2019, Favero, Maccheroni and Modesti organize the annual meeting *TD* (*Tributo al Duca*/Decision theory), in honour of Erio Castagnoli (see www.tributoalduca.altervista.org).

[4] Copyright Lorenzo Peccati.

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