

In Memory of Victoria Kreps



Fig. 1. Victoria in the lecture hall at Mathematical-Mechanical faculty, 1967.

Victoria Kreps was assigned to the laboratory of game theory and operations research of the Leningrad Division of the Central Institute for Economics and Mathematics in 1968, after finishing the Mathematical-Mechanical faculty of Leningrad State University. Even though the field was new to her, in two months, she obtained her first result in game theory, proving that stochastic independence is the only form of dependence of the players' mixed strategies such that every finite strategic game admits a Nash equilibrium [1, 5]. This result assumed that players have access to a common randomization device five years before R. Aumann introduced the concept of a correlated equilibrium, and such settings gained popularity.

In the 70s and 80s, Victoria did a lot of applied research. It was not a good time for game theory in the Soviet Union since the field dealt with conflict and competition, which was problematic under Soviet ideology. Despite this, she published two papers [2, 3] in the *International Journal of Game Theory*, then the leading journal in game theory; an achievement that is certainly unique and almost impossible at that time. The paper [2] was devoted to the uniqueness of equilibrium in bimatrix games, and [3] extended the analysis to games of more than two players. In 1980, Victoria defended her Ph.D. thesis "Vector spaces of games admitting an equilibrium", which was greatly delayed due to the anti-semitic climate of the time.

In the 90s, Victoria started to work in a new direction emerging from the works of R. Aumann and M. Maschler — repeated games with incomplete information. These were the most fruitful years of her academic career. In this type of game, the less informed player infers information about the state from the history of more informed player's actions. No closed-form solutions for these games were then known. In a series of papers, Victoria and V. Domansky identified and studied in detail several classes of repeated games having explicit solutions [6, 7, 9, 10, 11, 14, 16, 19]. The paper [9] was the first to establish the connection between repeated games and problems of optimal transportation, which 20 years later become an important tool in the study of these games. Starting with [11], a number of papers

were devoted to models of financial markets giving an endogenous explanation of random walk behavior occurring in price dynamics through the “masking” actions of the insider. The basic model with continuous prices was introduced by B. De Meyer and H. Moussa Saley; V. Kreps and V. Domansky extended the model by assuming the minimal currency unit, which surprisingly changed the long-run equilibrium behavior and allowed them to describe the equilibrium explicitly in a variety of settings. These results are well known internationally and became the foundation of the long-term friendship with the French and Israeli schools of game theory, many research visits, and connections. Victoria also continued to study questions about the structure and uniqueness of equilibrium [5, 8, 12, 17, 22].

In 2010, Victoria defended her Habilitation thesis “Strategic randomization in making competitive economic decisions: a game theory approach” [13]. It was devoted to the game-theoretic consequences of asymmetry of information in financial markets, as well as the problem of ranking on the basis of multi-dimensional data.

Victoria was open to new problems and, in the last ten years, collaborated extensively with younger colleagues, e.g., [15, 18, 22]. Two students, M. Sandomirskaya and F. Sandomirskiy, defended their Ph.Ds under her supervision.

Victoria was a talented organizer, able to find unexpected solutions to seemingly hopeless situations. She played a key role in organizing the first international game theory conferences in St. Petersburg in 1996 and 2001. In 2015, largely due to her energy and resourcefulness, the International Game Theory Laboratory was founded at the Higher School of Economics at St. Petersburg, led from the start by H. Moulin. She was active in the research life of the laboratory and spared no effort in its development, helping to solve complicated organizational matters. In the last few years, all the scientific and administrative activity of the laboratory of Theoretical Economics at the Institute of Regional Economic Studies also came under her care, which she headed and to which she attracted a number of talented young researchers.



Fig. 2. Victoria in the same lecture hall at the alumni meeting, 2018.

Victoria, or, to everyone, simply Vita, had many friends. She was always interested in people with all their successes and failures and was genuinely interested in everything that happened in their lives. The problems of others were her own. If

someone needed help, she spared no effort to assist. Due to Victoria, many scientists started on the path to success, now working all over the world. She possessed an unfaltering sense of dignity, and even those who were used to talking to others from on high, would never permit themselves to do so in her presence. She was a very strong, determined person, never despaired, and never gave up. Already seriously ill, she wrote three papers [20, 21, 22] and continued her work until her last day.

Her colleagues and friends across the world grieve for her passing.

The main works of Victoria Kreps:

1. **V.L. Kreps** (1970). *Finite coalition-free games with dependent strategies*. In Collected Papers in Game Theory (ed. by N.N. Vorobiev), 211–215. Erevan (in Russian).
2. **V. Kreps** (1974). *Bimatrix games with unique equilibrium points*. International Journal of Game Theory, 3(2), 115–118.
3. **V. Kreps** (1981). *Finite N-person noncooperative games with unique equilibrium points*. International Journal of Game Theory, 125–129.
4. **V.L. Kreps** (1984). *On quadratic forms non-negative on the orthant*. Journal of computational and mathematical physics, 24(4), 497–503 (in Russian).
5. **V. Kreps** (1994). *On games with stochastically dependent strategies*. International Journal of Game Theory, 23(1), 57–64.
6. **V. Domansky, V. Kreps** (1994). *“Eventually revealing” repeated games with incomplete information*. International Journal of Game Theory, 23(2), 89–99.
7. **V. Domansky, V. Kreps** (1995). *Repeated games and multinomial distributions*. Zeitschrift für Operations Research, 42(3), 275–293.
8. **V. Kreps** (1997). *Game theoretic axioms for utilities with random choices*. In *Constructing Scalar-Valued Objective Functions* (pp. 137-149). Springer, Berlin, Heidelberg.
9. **V. Domansky, V. Kreps** (1999). *Repeated games with incomplete information and transportation problems*. Mathematical methods of operations research, 49(2), 283–298.
10. **V. Domansky, V. Kreps** (2002). *Social equilibria for competitive resource allocation models*. In *Constructing and Applying Objective Functions*, pp. 408-419. Springer, Berlin, Heidelberg.
11. **V. Kreps** (2009). *Repeated games simulating exchange auction and recursive sequences*. Journal of Computer and Systems Sciences International, 48(4), 604–615.
12. **V.L. Kreps** (2010). *On game-theoretic characterisation of stochastic independence*. Discrete Mathematics & Applications, 20(3), 277–289.
13. **V.L. Kreps** (2010). *Strategic randomization in making competitive economic decisions: a game theory approach*. Habilitation thesis (in Russian).
14. **V. Kreps, V. Domansky** (2013). *Repeated games with asymmetric information modeling financial markets with two risky assets*. RAIRO-Operations Research, 47(3), 251–272.
15. **M. Gavrilovich, V. Kreps** (2015). *On a class of optimization problems with no “effectively computable” solution*. Zapiski Nauchnykh Seminarov POMI, 436, 122–135.

16. **V. Domansky, V. Kreps** (2016). *Bidding games with several risky assets*. Automation and Remote Control, 77(4), 722–733.
17. **V. Kreps** (2017). *On maximal vector spaces of finite noncooperative games*. International Game Theory Review, 19(02).
18. **M. Gavrilovich, V. Kreps** (2018). *Games with symmetric incomplete information and asymmetric computational resources*. International Game Theory Review, 20(02).
19. **V. Kreps** (2019). *Bidding models and repeated games with incomplete information: a survey*. Automation and Remote Control, 80(2), 362–379.
20. **V. Kreps, L. Petrosyan** (2020). *Bibliography of Robert John (Yisrael) Aumann scientific papers*. Contributions to Game Theory and Management, XIII, 441–448.
21. **V.L. Kreps** (2020). *Linear spaces of games on the unit square with equilibria in pure strategies*. Mathematical game theory and applications, 12(3), 3–18 (in Russian).
22. **V. Kreps, A. Matveenko** (2020). *A mathematical note on the value positivity for matrix game*. International Game Theory Review, 22(01).