

Elvin E. Rot

Nobelova nagrada za 2012.



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TEORIJA STABILNIH RASPOREDA II

Rezime

Švedska Kraljevska akademija nauka dodelila je u 2012. godini Nobelovu nagradu za ekonomiju Lojdu Šeplicu i Elvinu Rotu za teoriju stabilnih raspodela i praksu tržišnog dizajna. Ova dvojica američkih istraživača radila su nezavisno jedan od drugog kombinujući osnovnu teoriju i empirijska istraživanja, i uz eksperimente i praktičan dizajn doprineli su izuzetnom razvoju ovog polja istraživanja i unapredili performanse mnogih tržišta. Šeplic je dao početni teoretski doprinos ovom polju istraživanja, a Elvin Rot ga je razvio, unapredio i u praksi sproveo. Njihova istraživanja pomažu u objašnjavanju tržišnih procesa, na primer pri radu na raspodeli lekara u bolnice, učenika u škole i ljudskih organa za transplantaciju pacijentima.

Ključne reči: Švedska Kraljevska akademija, 2012. godina, Nobelova nagrada za ekonomiju, Lojld Šeplic, Elvin Rot, teorija stabilnih raspodela, istraživanje, praktičan dizajn, teorija igara

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Alvin E. Roth

Nobel Prize for 2012

THEORY OF STABLE ALLOCATIONS II

Summary

The Swedish Royal Academy awarded the 2012 Nobel Prize in Economics to Lloyd Shapley and Alvin Roth, for the theory of stable allocations and the practice of market design. These two American researchers worked independently from each other, combining basic theory and empirical investigations. Through their experiments and practical design they generated a flourishing field of research and improved the performance of many markets. Shapley provided the fundamental theoretical contribution to this field of research, whereas Roth, a professor at the Harvard University in Boston, developed and upgraded these theoretical investigations by applying them to the American market of medical doctors. Namely, their research helps explain the market processes at work, for instance, when doctors are assigned to hospitals, students to schools and human organs for transplant to recipients.

Keywords: Swedish Royal Academy, 2012, Nobel Prize in Economics, Lloyd Shapley, Alvin Roth, theory of stable allocations, research, practical design, game theory.

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Švedska Kraljevska akademija nauka dodelila je u 2012. godini Nobelovu nagradu za ekonomiju Lojdu Šepliju i Elvinu Rotu za teoriju stabilnih raspodela i praksu tržišnog dizajna. Šepli, profesor emeritus na Univerzitetu Kalifornija u Los Anđelesu (UCLA), dao je početni teoretski doprinos ovom polju istraživanja, a Elvin Rot ga je razvio, unapredio i u praksi sproveo. Njihova istraživanja pomažu u objašnjavanju tržišnih procesa, na primer pri radu na raspodeli lekara u bolnice, učenika u škole i ljudskih organa za transplantaciju pacijentima.

Šepli i Rot su četvrta grupa ekonomista koja je dobila Nobelovu nagradu na temelju izraživanja unutar teorije igara. Pre njih ovu nagradu dobili su: 1994. godine Neš, Harsani i Selten; 2005. godine Ojman i Šeling i 2007. godine Hurvic, Maskin i Majerson. Očigledno, teorija igara postala je jedna od najtrofejnijih grana ekonomije, zajedno sa finansijama i makroekonomijom, ali ih prevazilazi svojom sveprisutnošću i moćima koje nude njeni analitički alati. Ova dvojica američkih istraživača radila su nezavisno jedan od drugog kombinujući osnovnu teoriju i empirijska istraživanja, i uz eksperimente i praktičan dizajn doprineli su izuzetnom razvoju polja istraživanja i unapredili performanse mnogih tržišta (Pantelić, 2014, str. 112).

Po vokaciji ekonomista koji svoj naučni rad zasniva na eksperimentima, Rot je iskoristio ključna načela u teoriji igara kako bi dizajnirao tržišta na kojima cena nije alokativni mehanizam.

Dobar primer toga je uparivanje donora i pacijenta kada je potrebna transplantacija bubrega sa idejom da se za što više bolesnika nađu novi organi. Tako je, zahvaljujući Rotu i uz Šeplijev

algoritam, do sada spašeno na hiljade života, a samo 2008. godine šest života šestostranom razmenom odgovarajućih organa.

Rotova Nobelova nagrada primer je jednakog vrednovanja struke koja ekonomsku nauku oplemenjuje novim teorijama, ali i one koja je teorijama našla svakodnevnu primenu menjajući život na bolje. Njegova nagrada se može razumeti i kao ulazak bihevioralne i eksperimentalne ekonomije u osnove ekonomske nauke, kao putokaz u kojim pravcima ova disciplina treba da se razvija.

Elvin Rot se rodio 18. decembra 1951. godine u Njujorku, SAD. Njegovi roditelji, Lilijan i Ernest, bili su nastavnici u srednjoj školi. Dva su osnovna motiva, kako navodi Elvin u svojoj autobiografiji povodom Nobelove nagrade, koja su bila ključna u njegovom izboru profesije kojom će se u životu baviti: lansiranje američkog satelita 1958. godine, koje je s pažnjom pratio na radiju, na času u razredu i stav njegovog starijeg brata Teda da je nauka najbolja za njegovu buduću karijeru. Zbog toga je i bio veoma srećan što je mogao da prati Teda koji je pohađao kurs o nauci na Kolumbija univerzitetu namenjen srednjoškolcima. Elvin se pokazao izuzetno uspešnim na ovom kursu te se 1968. godine, iako nije završio srednju školu, sa 16 godina, upisuje na Kolumbija univerzitet, u školu za inženjerstvo i primenjene nauke.

Nakon diplomiranja 1971. godine prelazi na Stenford univerzitet gde će magistrirati 1973. i doktorirati 1974. godine. U narednim godinama radio je na više univerziteta: Ilinois (1974-82),

Pitsburg (1982-98), Harvard (1998-2012) i Stenford (2012). Na ovim univerzitetima saradivao je sa brojnim znanim i namanim istraživačima iz ekonomske, matematičke i psihološke struke i sa njima uradio niz značajnih



The Swedish Royal Academy awarded the 2012 Nobel Prize in Economics to Lloyd Shapley and Alvin Roth, for the theory of stable allocations and the practice of market design. Shapley, a professor emeritus at the University of California in Los Angeles (UCLA), provided the fundamental theoretical contribution to this field of research, whereas Roth, a professor at the Harvard University in Boston, developed and upgraded these theoretical investigations by applying them to the American market of medical doctors. Namely, their research helps explain the market processes at work, for instance, when doctors are assigned to hospitals, students to schools and human organs for transplant to recipients.

Shapley and Roth are the fourth group of economists who won the Nobel Prize based on their research in the field of game theory. Before them, the Prize was awarded to: Nash, Harsanyi and Selten in 1994; Aumann and Schelling in 2005; and Hurwicz, Maskin and Myerson in 2007. Evidently, game theory has become one of the most rewarded branches of economy alongside finance and macroeconomics, which she surpasses owing to its comprehensiveness and powers enabled by its analytical tools.

These two American researchers worked independently from each other, combining basic theory and empirical investigations. Through their experiments and practical design they generated a flourishing field of research and improved the performance of many markets (Pantelić, 2014, p. 112).

Economist by vocation, Roth, whose scientific work was based on experiments, used the key principles of game theory to design markets on which the price was not an allocation mechanism. A good example is the matching of donors and patients needing a kidney transplant, with the goal of finding new organs for as many patients as possible. Thus, thanks to Roth and Shapley's algorithm, thousands of lives have been saved, and only in 2008 six lives owing to a six-party exchange of suitable organs.

Roth's Nobel Prize is an act

of recognition for the profession which has enriched economic science with new theories, and which has found the way to apply theories in everyday life, changing it for the better. His prize can also be understood as the entry of behavioral and experimental economics into the rudiments of economic science, indicating the directions in which this discipline should continue to develop.

Alvin Roth was born on 18 December 1951 in New York, USA. His parents, Lillian and Ernest, were high school teachers. As Alvin states in his autobiography written to mark his winning of the Nobel Prize, there were two basic motives that determined the choice of profession he was to entertain his entire life: i.e. the launch of an American satellite in 1958, whose radio broadcast he eagerly followed while sitting in class, and the opinion of his elder brother Ted that science could be his future career. This is why he considered himself fortunate to be able to follow Ted in attending the Science Honors Program at Columbia University, targeted at high school students. Alvin turned out to be extremely successful at this course, hence in 1968, when he was 16, without having graduated from high school, he entered Columbia's School of Engineering and Applied Sciences.

Upon graduation, in 1971 he moved to Stanford University where he gained his master degree in 1973 and his PhD in 1974. In the subsequent years he worked at several universities: Illinois (1974-1982), Pittsburgh (1982-1998), Harvard (1998-2012), and Stanford (2012-). At these universities he cooperated



Elvin E. Roth prima Nobelovu nagradu od Švedskog kralja Karla XVI Gustava u Stokholmskoj koncertnoj dvorani, 10. decembra 2012. godine

Alvin E. Roth receiving his Prize from His Majesty King Carl XVI Gustaf of Sweden at the Stockholm Concert Hall, 10 December 2012



eksperimenata i napisao samostalno ili sa saradnicima mnogobrojne radove.

Dok je pohađao posle diplomanske studije odlučio je da istražuje teoriju igara posle predavanja gostujućeg profesora Majkla Mašlera sa Hebrejskog univerziteta u Jerusalimu. Njegov savetnik, prijatelj i podrška da se u radu ne demotiviše bio je Bob Vilson čiji su radovi u tom periodu bili veoma popularni. Elvin je odlazio u biblioteku i čitao njegove radove, a jedan od tih mu je pomogao u pripremi disertacije koja se odnosila na tada popularan model igara sa transferom korisnosti i na istraživanje utvrđenih setova mogućih ishoda koji su Nojman i Morgenstern predložili kao soluciju takvih igara.

Rotov prvi posao bio je na Illinois univerzitetu po pozivu Bila Zangvila koji je napravio grupu za operativno istraživanje u Biznis školi. Pre odlaska za Illinois posetio je Oskara Morgensterna na Njujorškom univerzitetu kako bi ga obavestio o svojim dosadašnjim istraživanjima i radu na Nojman-Morgenstern rešenju. U sledeće tri godine posetio ga je više puta. Voleo je da s njim vodi obične razgovore o ljudima, ali je tada često govorio i o onome što trenutno radi: "Tada sam se osećao kao Kolumbo koji kraljici Izabeli podnosi raport koja su ostrva pronađena u njeno ime!"

Sa kolegom psihologom Kitom Murnganom napisao je desetine radova istražujući različite aspekte teorije igara, uključujući Nešovo

rešenje problema utvrđivanja ishoda kada dve osobe pregovaraju. Sa Kitom, kolegom Fransoa Šoumejkerom i svojim studentom Majkom Malufom razvio je neke aspekte eksperimentalnog dizajna, kao što su binarna lutrija igara i verovatnoća ponavljanja igara, koji se i danas koriste.

Na univerzitetu Illinois počeo je da predaje teoriju igara. Kako bi bolje razumeo ovu oblast, istraživao je radove o Nešovom rešenju i set radova o Šeprijevim vrednostima. Shvatio je da neke aksiome ne može da objasni svojim studentima te je počeo da piše radove u kojima je istraživao ideju formalizovanja Šeprijeve vrednosti kao korisne funkcije igara. Ta odluka ga je motivisala da se okrene i novim istraživanjima.

Zajedno sa Endijem Postlvejtom, novim asistentom na Illinoisu, 1974. godine istraživao je strukturu jezgra, ukoliko su preferencije igrača poznate. Taj pristup je karakterisao nešto što se tada zvalo kooperativna teorija igara. U ovom periodu bavio se uparivanjem donora i pacijenata. Predavanja koja je držao

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with numerous known and less known researchers in the field of economics, mathematics and psychology, with whom he conducted a series of significant experiments, and wrote many papers, either independently or with his associates.

During his postgraduate studies he decided to do research in game theory after taking a class from Michael Maschler, a visiting professor from the Hebrew University of Jerusalem. His advisor and friend, who encouraged him when he was about to lose motivation, was Bob Wilson, whose papers were quite popular at that time. Alvin would go to the library and read his papers, one of which in particular helped him prepare his dissertation, which concerned the then popular models of games with transferable utility, and the exploration of stable sets of potential outcomes that von Neumann and Morgenstern



had proposed as solutions of such games.

Roth's first job was at the University of Illinois, after a phone call from Bill Zangwill, who was putting together an operations research group in the business school. Before leaving for Illinois, Roth visited Oscar Morgenstern at New York University to tell him about the research he conducted until then, and his work on von Neumann-Morgenstern solutions. Over the next three years, he visited him several more times. They loved to reminisce about people, and they would often discuss what Roth was currently working on: "I sometimes felt a little like Columbus reporting back to Queen Isabella about the new lands that had been discovered in her name!"

Together with his colleague, psychologist Keith Murnighan, he wrote dozens of papers exploring various aspects of game theory, including Nash's solution to the problem of determining the outcome of two-person bargaining. With Keith, his colleague Françoise Schoumaker, and his graduate student Mike Malouf, he developed some experimental designs, such as binary lottery games or probabilistically terminated repeated games, which remain in use today.

At the University of Illinois he started teaching game theory. In order to understand this field better, he examined the papers about Nash's solution, and a set of papers about the Shapley value. He realized that he could not convincingly explain some of the axioms to his students, hence he ended up writing papers in which he explored the idea of formalizing the Shapley value as a utility function for playing a game. This decision motivated him to turn to

Most Important Works

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kao gostujući predavač na Stenfordu 1978. godine našla su se potom u njegovoj prvoj knjizi *Aksiomatski modeli pregovaranja*.

Nakon venčanja sa Emili sa kojom ima dva sina, Arona i Bena, iz Univerziteta Illinois odlazi 1982. godine na Univerzitet Pitsburg. Teorija igara je već bila uveliko poznata, ali još nije bila uspeša u segmentu operativnog istraživanja. Zajedno sa novim saradnicima kreće u dalja istraživanja na modifikovanju algoritama za poboljšanje sistema radi uparivanja diplomaca medicinskih škola sa potrebama bolnica. Sa svojom studentkinjom Saolin Sing napisao je rad u kome se to dokumentuje na desetinama različitih tržišta. Postalo je tada jasno da tajming igra važnu ulogu u razumevanju toga kako tržišta i radna mesta funkcionišu. Njegov tim 2003. godine primenjuje slično rešenje izbora odgovarajućih studenata srednjih škola u Njujorku, gde je na poziv Džeremija Leka sa njujorškog odseka za edukaciju dizajnirao sistem izbora škola. Tada je pokrenuto i kreiranje sistema uparivanja adekvatnih donora za odgovarajuće pacijente.

Iz Pitsburga se 1998. godine seli u Boston kako bi počeo da radi na Harvardskom univerzitetu. Priznanje u obliku Nobelove nagrade dobio je radeći na ovom fakultetu. Osim ovog priznanja dobio je 1990. godine i nagradu "Frederik V. Lenčester". Nakon 14 godina provedenih na Harvardu sa suprugom se seli u Kaliforniju i zapošljava na Stenford univerzitetu.

Interesantno je navesti šta je za Rota bilo najlepše kada je dobio Nobelovu nagradu: "Nagrada je veoma poznata i važna, ali najlepší deo toga bili su mejlovi mojih prijatelja sa kojima nisam bio u kontaktu još od detinjstva. Osim što sam dobio brojne čestitke povodom Nobelove nagrade, ona mi je donela još jedno neočekivano, ali veoma važno priznanje - Japanska karate asocijacija promovisala me je u počasnog člana crnog pojasa sedmi dan".

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other investigations as well.

In 1974, with Andy Postlewaite, a new assistant professor at Illinois, he explored the structure of the core, given the known preferences of the players. That point of view characterized what was then called cooperative game theory. It was in this period that he dealt with matching donors and patients. The lectures he delivered as a visiting professor at Stanford in 1978 were subsequently published within his first book *Axiomatic Models of Bargaining*.

After marrying Emilie, with whom he has two sons, Aaron and Ben, Roth left the University of Illinois for the University of Pittsburgh in 1982. Game theory was already firmly established in economics, but it had not yet thrived in operations research. In cooperation with his new associates Roth embarked on further research concerning the modification of algorithms in order to improve the system for the purpose of matching medical school graduates with the hospitals searching for new staff. With his student Xiaolin Xing, he wrote a paper documenting this in over a dozen markets. It became clear that the timing of transactions was also important in understanding how markets and marketplaces work. In 2003 his team applied a similar solution



to the process of matching students to high schools in New York, where at the invitation of Jeremy Lack from the New York City Department of Education, he designed the school choice system. At that time he also launched the creation of the system for matching

adequate donors with the right patients.

In 1998 he moved from Pittsburgh to Boston, and started working at the Harvard University. The recognition in the form of the Nobel Prize arrived while he was employed at that university. In addition that, in 1990 he won the Frederick W. Lanchester Prize. After 14 years at Harvard, he moved with his wife to California, where he got a position at Stanford.

It is interesting to note what Roth feels was the best part of winning the Nobel Prize: "The Nobel is a very famous prize indeed, widely covered in the press, and the nicest part of the avalanche of emails and other contacts that result from that has been that many old friends have made contact, some of whom I hadn't been in touch with since childhood. It turns out that a Nobel is also followed by other recognitions, and perhaps the most unexpected of these is that the Japan Karate Association in Tokyo has now made me an honorary 7th-degree black belt."