

## **Microeconomic Theory: Wonders or Miracles**

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My esteemed teachers and colleagues,

We generally use this expression - “my esteemed teachers and colleagues” (*morai v'rabotai*) – as a matter of routine. But this is not the case tonight. All of my university studies were at the Hebrew University of Jerusalem, and when I looked at the faculty list, ten clear pictures of Hebrew University faculty members came to mind. I could see them writing on the board, standing and lecturing with enthusiasm, some with a smile and some with a serious demeanor, while I looked up at them from my student’s desk with great admiration: Shmuel Agmon, Yisrael Auman, Yitzhak Englard, Michael Bruno, Aharon Barak, Arie Dvoretzky, Menachem Yaari, Hillel Furstenberg, Michael Rabin, and Saharon Shelah. When I look at this list today, I realize how lucky I was. Was there ever another university or “prestigious” college in the world that could offer its undergraduate and masters students such an impressive list of faculty members?

I was told that this lecture is supposed to be an academic one, but could also be personal. So, permit me to note that everything I will say today in the academic context is completely subjective, controversial and perhaps describes myself more than microeconomic theory. And, more than anything, the subjective nature of the things I will say is exemplified by the person I believe to be most responsible for the fact that I found myself involved in microeconomic theory. Indeed, from the gallery of esteemed teachers I mentioned, he is completely unknown in the field of economics. I doubt he will ever be appointed as an economic advisor to the finance minister and, as far as I know, he is not trained in the field of law. He has not even written articles on mathematical economics and I doubt he intended to lead me to choose the path I did (though he certainly thought I was not talented enough to become involved in his line of work). The man I’m referring to is the mathematical logician Saharon Shelah.

I would sit with my friends at the cafeteria of the National Library in the middle of the day, with our notebooks full of the puzzling things that Saharon Shelah (like other teachers in the Mathematics Department in Jerusalem) wrote on the board. We were in great awe from this encounter with intellectual perfection, but we also had a vague feeling that these things, despite - or perhaps because of - their great abstractness, had some connection to life. We were witness to a strict adherence to norms of definition and proof, and unwillingness to compromise on a single detail. We became acquainted with the beauty and splendor of a model, a statement and a proof, and with the purity of things emanating from the mind.

But these things spoke to us because of our interest in the world around us. We tried to give mathematical concepts some realistic meaning derived from the concepts of our daily world. And we tried to explain these wonderful mathematical statements not only as links between concepts in the mathematic world, but as links in a world of concepts that so fascinated us as young students after the army: the world of human interaction.

A year after these cafeteria discussions, I met the second teacher who is responsible for my academic pursuits, Menachem Yaari. As part of a term paper assignment, Menachem referred me to a wonderful book by Amartya Sen on social choice theory. This book has a very unusual structure. Each chapter is accompanied by another chapter marked with an asterisk. In the chapters that are not marked with an asterisk, a discussion is conducted on the various axioms of social choice theory; in the chapters with the asterisks, the discussion is converted into a series of precise definitions and proofs. When I read this book, I realized two things. First, I realized that economics is interesting, something I didn't realize previously. Second, I understood that this connection between the world of concepts expressed in everyday language and the world of mathematical symbols is not just child's play.

If prior to this encounter with Menachem Yaari I could regard myself forgivingly, as one would regard a child who sees characters and stories in leaves, mountains and shadows, then after this encounter with Yaari's lectures and Sen's book, I understood that what we were doing in the cafeteria (instead of doing other things) was in fact an activity that innocently probed the heart of microeconomic theory. Indeed,

microeconomic theory involves precisely those abstract concepts related to interactions between people (that is, the chapters without the asterisks) and its working tools are mathematical models (the chapters with the asterisks). And, in my opinion, the most difficult problem in understanding the significance of “microeconomic theory” is to understand the connection between these concepts and tools. This issue was puzzling for me then, and it remains unclear to me now. Nonetheless, I’d like to discuss this a bit this evening.

To speak concretely, let’s look at one of the simplest models, one that is considered successful in the world of microeconomic theory: Hotelling’s main street model. In its simplest form, the mathematical model merely defines two numbers in the range between 0 and 1; each of the numbers represents the solution for a particular optimization in which the other number is a parameter. This is not very interesting, to say the least. But we’re not interested here in formulas and equations unless they come with a background story. The background story sounds like a fable, or perhaps a Talmudic question: Two peddlers who sell the town’s newspaper compete for the customers scattered along the main street. One peddler says “I want all of the customers,” and the second says, “I want all of the customers.” Note, as Menachem Yaari pointed out in his lectures here some years ago, the peddlers in this microeconomic model do not declare, “The whole street is mine” because they claim this as their right. They enter the fable only with wishes, not with rights. And their wish is that as many customers as possible purchase a newspaper at their newsstand. Their only action, in this simple version, is to choose a location for the newsstand. They do not compete against one another through prices and we do not allow them to shoot, curse or sue each other.

The customer in our story, who leaves his other pursuits for a moment, sees the two peddlers and goes to buy a newspaper from the newsstand closest to him. If the two newsstands are the same distance from the customer, they will each have an equal chance of getting his business. To complete this story, we need to say something about the schedules of the two peddlers. The Hotelling model assumes that the two peddlers set up their newsstands somewhere along the street at the beginning of the day, simultaneously and independently of each other.

Where will each of the peddlers set up their newsstands? Of course, the best location for each peddler depends on the other's location. If his competitor sets up at the right end of the street, it would be best to locate his own newsstand to the left of his rival, toward the center of the street. If the competitor is located on the left end of the street, the peddler should locate his business further to the right. If the competitor sets up at the center of the street, our second peddler should do so too in order to attract half of the demand. When I refer to the center of the street, I mean the median point at which the number of customers located to the peddler's left is equal to the number of customers to his right.

Here the fable draws to a close. Fables have endings – and happy endings. In microeconomics, the end is called a “solution” and it is characterized by being “stable” relative to something. The accepted solution to such situations is called the Nash equilibrium. The Nash equilibrium of Hotelling's main street model is a pair of points located on the main street, with each point representing the location of one of the peddlers. In order to be in equilibrium, each location must be an optimal one given the location of the second peddler. In this way, we arrive at a mathematical model of two maximizations integrated with one another: the solution for each peddler is derived from the solution for the other.  $X$  and  $Y$ , where  $X$  is optimal relative to a function in which  $Y$  is a parameter, and  $Y$  is optimal relative to a function in which  $X$  is a parameter.

Any situation in which the two sides are not located at the median point of the customers on the street is not stable. Why? If both of the peddlers are not located at the same spot, then it would always be best for each peddler to move closer to his rival in order to increase his market share. And whenever the two peddlers are situated at the same place, but not at the median point, then each peddler could grab more than a 50-percent share of the market by moving closer to the median point (without passing it). So we are left with only one stable situation – when both peddlers are located on the median point.

Much has been written about Hotelling's model. Some of these are alternative interpretations. Economists change the points on the town's main street to a spectrum of sugar content in cola and arrive at a model of competition between two

manufacturers competing over a product characteristic. One of the conclusions is that the solution of having both sellers located at the same point is not desirable from the customer's point of view. Political scientists look at each point on the main street as a political position on a one-dimensional scale (right versus left). Each candidate situates himself on the political map with the intention of receiving a majority of votes. Each citizen is situated somewhere on the political map and chooses the candidate closest to his ideological and political position. The solution means that if there are two parties in the political arena, their platforms will be identical.

The model has also been expanded in many directions. I would especially like to mention the extension of this model to macroeconomics, where there are a number of merchants in the market, and not just two. When there are three merchants in the model, there is no equilibrium. When the merchants situate themselves in any three locations on the street, there will always be at least one of the three who would do better for himself by moving to another point.

As noted, Hotelling's model is a very central model in microeconomic literature. But I return to our basic question. What exactly does it mean that the two parallel optimizations I described to you (optimal X given Y and optimal Y given X) has only one solution:  $X=Y=1/2$ ? And what if there is no solution for three parallel optimizations that describe the Nash equilibrium in the case of three merchants? And what would it have meant if these interactive optimizations (like many others) actually had many solutions? The answers to these questions are not at all clear to me.

One approach says that we have a model here that constitutes a basis for envisioning the world – not the world of fables, but the world in which we live. The model is seen as an attempt to predict human behavior based on data about the possible actions and the preferences of the units operating on the range of possible results. The model claims to be an objective description of the world. Those working with this model would be happy to add more and more variables to the model: the simplicity of the model only derives from the difficulty of “solving a more complicated model.” The model must be affirmed by reality and if the model fails to yield accurate predictions, then it should be replaced by another model.

If it really turned out that in every case similar to the situation described by Hotelling the competitors located themselves in the center of the map, I would regard Hotelling as true miracle workers. This would mean that the physical description of the situation – who does what and when, what is he interested in and what does he know – provides a sufficient basis for writing a maximization system whose solution is a solution of human behavior, about people just like us: struggling with decisions, becoming angry, loving, vengeful, confused and sophisticated. Everything is erased for the sake of a solution of two parallel maximizations.

But, you need a lot of political cynicism to describe the Republican Party and the Democratic Party as parties espousing identity positions and the two candidates for prime minister in Israel as Siamese twins. The Hellenists and Hasmoneans did not cross paths on their way to the center of the political spectrum in the Temple plaza. When money is involved, and not only values, things are also not so clear. Not all textile factories manufacture the same clothes; and more than two companies operate in the cola market in the United States and the situation there does not seem so unstable.

I decided to evaluate this approach in one of the easier areas to do this. The model is simple. The arguments are simple. The fable is well known. And the solution does not seem groundless. But even this model, which is so far from the complex and sophisticated models that we microeconomic theorists deal with, does not generate miracles.

I would like to speak briefly about two other approaches to the essence of these models, of the type of model presented by Hotelling. One approach regards the solution of a model as a recommendation for the user, not as a prediction. An advisor to a businessman or politicians might say that the model does not predict the world before you met me, but it will predict the world after you listen to me. There are policy recommendations, written in reports with colorful binders, which are centered upon a type of Hotelling model. In schools of business administration (and not only there), these kinds of microeconomic models constitute a real user's guide. Most students look for ways to utilize what they learn. Consequently, as every tester knows, conducting an experiment in game theory with MBA students generates very different

results than those of other students. I'm sorry, but I've never understood why a model can serve as a basis for a recommendation, even when the model has a single equilibrium. Why should I assume that the player I'm competing against, or playing with, will act according to the model's solution? Sorry, I don't understand.

And there is another approach, a quite serious one I think, which I would like to focus on for a moment before returning to Saharon Shelah. According to this approach, the purpose of a model like Hotelling's is to provide intuition. The model is not the real battle of life. Rather, it's a type of mental exercise. Just as a soldier trains on a model before battle, a microeconomist practices his intuition on a model. Thus, for example, several top microeconomists in the United States recently advised the federal government on planning the mechanism used for selling certain telecommunication frequency bands. No one thought that there was any familiar auction model appropriate for this particular spectrum auction. However, it was claimed that microeconomic experts have good intuition and that this intuition did not come from experience with auctions, but rather from their work with microeconomic models like that of Hotelling, only ones that are more complex.

This doesn't sound bad. Woe to the chess player, battlefield commander or businessman who does not think about the actions of his rival. Isn't this a common mistake we make - disregarding our rival's considerations, what guides his actions, attributing to him our considerations, and completely ignoring what he wants and believes? But do microeconomic models indeed help those who learn them to develop such abilities? I do not have an unequivocal answer to this question. Those who think that microeconomic models have developed their intuition are evidently expressing how they feel.

As for me, I occasionally have a perception of something that I believe springs from my microeconomic research. But I'm not sure that if instead of devoting the past twenty years to these models I had done something else related to human interactions, I would not have gained understandings that were no less useful for me or for my employer. But I am left with the feeling – and I don't want to contend that it's anything more than a feeling – that the study of microeconomics or game theory is not the most effective way to develop a person's tendency to see things from the

perspective of the other participants (whether in competitive or cooperative situations). Strategic thinking, I'm afraid, also encourages self-centered considerations. And again, allow me to refer here to Menachem Yaari's lecture in 1992, when in his measured way he criticized microeconomics for ignoring ethical considerations and basing the entire theory on considerations of interests. Our ability to see from here what they see from there, for purposes of war or peace, seems to me to be more a matter of personal characteristics. Your nursery teacher Nehama, your schoolteacher Yona, perhaps your mother or a book like "Corazon" (*Halev* in Hebrew) have more to offer in this area than a thousand game theory models.

And there is another approach that you probably assume I would like to advocate. We do not predict, we do not recommend and we do not teach strategic thinking. Just as a model of logic is not a prediction for the way people attribute values of truth to sentences in natural language, we are also not a recommendation for the user and our purpose is not to teach people to "think correctly." We study the logic of various possible considerations of decision makers in interactive situations. We learn from Hotelling's model that each of the peddlers wants to win the largest market share possible and that this – when operating alone – constitutes a power, a logical power, moving the peddlers toward a stabilization in the center. In real life, the players have many additional considerations besides wanting to grab the largest market share possible. They have traditions. They do not necessarily regard the situation as a one-time situation. The order of simultaneous moves is not necessarily the way they perceive the situation. They don't always act to maximize what they define as their goal. They use other decision-making mechanisms, such as imitating the neighbors, and are very unsure of how the others perceive the situation. We, observing from the side, have no way of knowing when they are seeing things in one way or another.

The best part of working with models of microeconomics, in my opinion, is discovering general principles that can be expressed in natural language in regard to the patterns of human thinking. Hotelling's model is what is called a zero-sum game. The players have an absolute conflict of interests. Whatever the rival receives is part of what I will not receive. Whatever is better for me will be worse for him, and vice versa. The pattern of behavior called maximization teaches the player to choose an action that would be the best for him, under the most pessimistic assumption of how

his rival will behave. And here the MAXMIN statement teaches us that in a zero-sum game, this pattern of behavior is equivalent to the logic of the Nash equilibrium. The two concepts appear at first glance to be so far apart, but here we've demonstrated to ourselves that they lead to the identical conclusions in games with absolute conflicts of interest. Wonderful.

This, in my view, is the purpose of macroeconomic theory. Not a search for miracles, but rather a quest for what Yisrael Aumann called in his lecture "connections." He wasn't referring to just any connections between mathematical objects, but between patterns of thinking, ways of examining human interactions that are realistic when judged by the considerations they entail and not by their results. These considerations must be formulated in a simple way. They should be commonplace, but definitely do not need to be universal or exclusive. The microeconomic model examines them in isolation and simply tries to understand them a little better. It is not a search for miracles that will unfold before our eyes, but rather a search for the wonders in the way people think about the interactive world in which they operate.

Thus, one of the wonderful achievements of microeconomics is the discovery of an equivalence between the core (a concept relating to the ability of groups of players to organize for the benefit of all) and the concept of competitive equilibrium, which is centered around a system of prices. The merchants take these prices as a given and there is a harmony of balance between supply and demand. When the number of merchants in the market is "very large," the core and competitive equilibrium are identical. The formulation of the model and the proof of Yisrael Aumann's statement are not miracles, do not offer a recommendation or predict anything. But it is exciting in that it reveals a wonderful fact about two ways of looking at an exchange market.

I worked for several years on models of negotiation, another area where there is one person who says "I want everything" and another person who also says "I want everything." But in this case, both will remain empty-handed if no agreement is reached. However, after years devoted to game model theories of negotiation, I don't regard myself as a better candidate than anyone else in this room to conduct negotiations or serve as an advisor for them. I also do not think that my work with these models has sharpened my negotiating intuitions in the marketplace. What I do

feel is that I now understand better, after all these years, that there are certain patterns of argumentation in the negotiating process that have some interesting characteristics, which we do not have time here to explain. The patterns of argumentation I learned are just some of many and it seems to me that I can now express them abstractly and understand their “internal logic” a bit better now. And that’s all.

I started off by saying that the things I (and also others, I think) understand from microeconomic models are completely subjective, and describe myself as much as they describe economic theory.

When I was a boy and Hanukkah had passed, I would look out the window of my room in the morning, past two green trees, hoping to see white snowflakes. I wanted so badly to see snow falling that I thought about becoming a meteorologist. A meteorologist, I figured, is the first one to know that snow is coming. But after several nights that started with the forecast, “Tonight there will be snowfall in the mountains,” and ended in bitter disappointment, as well as a number of mornings when I awoke in surprise to see unheralded snowfall, I reached the conclusion that the meteorologist is not really the first one to know when snow is falling. The first one to greet the snow, I concluded, is the neighborhood grocer, Aryeh Mansdorf, who woke early to pray before starting to arrange the milk bottles.

Later, I decided I wanted to be a lawyer, who would use his wit and razor-sharp logic to defeat his rivals. To prepare myself for this heroic mission, I borrowed from the library Shmuel Hugo Bergman’s book “Introduction to Logic.” What I remember from this book is not the art of argumentation, but rather the description of tin soldiers lining up in the courtyard. Several resounding defeats in classroom debates on “For and Against Youth Movements” made it clear to me that charm is more important in arguments than the rules of deduction. And as for viewing the theories I deal with as a source of policy recommendations: I had the good fortune of growing up in one of the wonderful neighborhoods of Jerusalem. There was Rabbi Meizel from my father’s synagogue on holidays; the communist Sela Marcel who ate everything, as long as it wasn’t kosher; Aunt Hannah, who left her husband in Siberia and came to Israel with her two children; the Yemenite butcher; the widow whose son got involved in crime; and the intellectual Yaacovson, who wrote a book explaining the Jewish

commandments. This left me in great awe of the people there, as those who understood human interaction very, very well.

So, I don't know when it will snow and when prices will change. I am not battling for justice and am not even an enthusiastic advocate for changing the economic order. I don't feel myself authorized to offer advice to anyone based on my professional knowledge. I find myself denying that the things I deal with can serve as a basis for predicting anything about the future and I don't believe these things should be judged by their usability. There are no miracles in microeconomics, but perhaps there are wonders. From my studies in the Mathematics Department in Jerusalem, I learned the criteria for recognizing wonders and sometimes I even saw them in microeconomics. I continued to study microeconomics simply as a curious person trying to understand the logic of human interaction a little bit better. Perhaps this is not such a big deal. But I hope that it's also not such a trifling matter either.