

## An Economist's Perspective on "A Beautiful Mind"

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### **Article:**

The Academy Award nominations are out, and they sure are predictable. As always, a movie about an economist picked up a number of important nominations. It happens every year!

I'm kidding of course. "A Beautiful Mind," winner of eight Oscar nominations, has got to be the first big Hollywood movie about a guy who wins the Nobel Prize for Economics. Though actually a mathematician, John Nash, Jr.'s ground-breaking work in game theory ensured that economics would never be the same, and his 1994 Nobel Prize was well-deserved and entirely appropriate. To this day, the concept of "Nash equilibrium" is essential to understanding strategic behavior in economics and other fields.

Like all Hollywood biographies, this one contains a number of inaccuracies. The movie omits mention of the less savory aspects of Nash's life, such as the son he fathered with another woman before he married his wife. And most of Nash's schizophrenic delusions were actually about numerology and geopolitics, not Russian spies. Of course, that's just the nature of Hollywood movie-making.

It's also hardly surprising that the movie's makers were reluctant to discuss the substance of Nash's mathematics. In movie theaters across America, eyes would have glazed over within minutes if Russell Crowe, who plays Nash in the movie, had expounded on non-cooperative non-zero-sum game theory.

I thought "A Beautiful Mind" was a great movie, but I do have one complaint. The one time the movie tries to explain Nash's break-through, it gets it completely wrong! Not only does the example given by the movie Nash fail to reflect the real Nash's work, but it implies virtually the opposite of what the real Nash was trying to show.

If you've seen the movie, you may remember this scene. Nash and the other mathematics grad students are in a bar, and they're all enthralled by a beautiful blonde who enters the room. They all want the beautiful blonde, but Nash convinces them not to all make a play for her, because doing so will anger the woman's friends and the result will be that none of the men will succeed in their romantic endeavors. He proposes a cooperative plan in which the men all hit on the beautiful blonde's less beautiful friends.

This is strategic behavior, to be sure. But it's not the sort of strategy that Nash's game theory addresses. Moreover, the strategy probably wouldn't work, and the real Nash would be the first to see why.

The basic idea of game theory is that many strategic situations can be thought of as games. In a game, the success of one player's moves depends on what the other players do. You can't predict the success of one chess player's moves without projecting the likely reactions of the other player, and then the re-reactions of the first player, and so on.

Many real-world scenarios from economics share this basic characteristic. For example, both Delta and U.S. Airways fly non-stop from Piedmont Triad International Airport to New York's LaGuardia Airport. Executives of both airlines would certainly object to the idea that the competition between them on this route is a mere

game, and yet from the perspective of game theory, that's exactly what it is. In large part, whether Delta's fare will succeed or fail in winning over new passengers will depend on what U.S. Airways charges.

The goal of Nash equilibrium is to identify sets of strategies from which none of the "players" has an incentive to deviate. Think of a game and imagine a set of moves for every player. If any one player can say to him/herself, "Given what everyone else is doing, I should change my move," then the original collection of moves wasn't a Nash equilibrium.

A good example from economics involves cartels. Cartels are illegal within the U.S. under federal antitrust laws, but they can exist internationally, with the best example being the Organization of Petroleum Exporting Countries (OPEC).

The goal of a cartel is to ensure that all of its members restrict output and thereby raise the group's profits. But the problem is that if all other members are cooperating in this way, a particular member can profit even more handsomely by cheating on the cartel agreement and increasing its production. Because of the incentive to cheat on the agreement, cartel cooperation is not a Nash equilibrium.

But in the cartel game, cheating *is* a Nash equilibrium. If everyone else is cheating, it hardly pays a given cartel member to be the only one to adhere to the agreement. This explains why OPEC production quotas have been so difficult to maintain and enforce. All cartel members would earn higher profits if all cooperated, but the incentive to cheat often undoes the agreement.

Let's return to "A Beautiful Mind" and the beautiful blonde. Recall that in the movie, Nash proposes that all the men cooperate. Cooperation sounds wonderful, and in a world in which everyone keeps agreements, the movie Nash's strategy would be fine. But the real Nash realized that an agreement is kept only when all the parties to it have an incentive to keep it.

The movie Nash doesn't mention how his plan would prevent cheating, i.e. how it would keep any of the men from making a move for the beautiful blonde after all. The real Nash would expect one of them to say, "Well, if everyone else is going to settle for one of the others, then I'm going for the beautiful blonde!" And if one of them said that, why wouldn't they all say that? And if they all said that, the agreement would be shot and they'd be back where they started.

The real Nash would appreciate the benefits of cooperation, but he would see that a call for cooperation is wishful thinking in a wide variety of scenarios, including the bar in the movie. The real Nash would undoubtedly predict that the pact made by the men in the bar would fall apart, returning the situation to one of every-man-for-himself.

Cheating isn't always the Nash equilibrium. Sometimes cooperation makes everyone better off without being torn asunder by self-interest. Every game is different, but in the dating game in the movie, cheating looks like it would win. It really is the height of irony that *this* flawed example would emerge as the movie's sole illustration of Nash's genius.

The movie does get a few things right about game theory. It is true that the work of Nash and others has informed the way government conducts antitrust policy and its auctions for the use of the radio spectrum. Game theory has also guided the design of new markets, such as the mechanism by which new physicians are matched with hospital residencies and the market for electricity trading (no Enron jokes here). Game theory has crept into other social sciences, and it even appears in such fields as evolutionary biology and computer science.

Nash's innovation in game theory really was a work of genius. Without knowing it, the makers of "A Beautiful Mind" demonstrate that for the rest of us, understanding genius is itself an elusive goal.