What Did "Beautiful Mind" Game Theory Mathematician John Nash Teach Players in the Energy Market?

By Kazumasa Kusaka

John F. Nash Jr., a mathematician who won the Nobel Prize in 1994 for his contribution to game theory and subject of the popular film "A Beautiful Mind", died recently in New Jersey at the age of 86.

Before game theory was introduced, according to microeconomic theory the welfare of market participants was assumed not to be affected by the decisions and behavior of any other player. The asymmetric approach of game theory analyzes how players in a game can optimize their outcomes in either cooperative or non-cooperative circumstances through adverse selection and signaling.

During the OPEC cartel years, game theory suitably explained what would happen if cartel participants cheated or what would be the outcome if some of the non-OPEC oil-producing countries cooperated.

The 1990s saw that oil markets had become one of the commodity markets dictated by global demand and diversified supplies, as well as by surplus liquidity in global finance. At that time it was economic analysts who could explain and forecast oil prices rather than political analysts knowledgeable about the Saudi royal family.

However, Russian decisions about gas supplies to Europe and other geopolitical risks have now brought the energy market back to Nash's world.

A study group of industry, academics and government officials at the University of Tokyo has been discussing the "shale revolution" since May 2013. But before publishing the outcome as a book, a reverse "oil shock", similar to 1986, took place. Since then there have been many casualties around the world in the upstream oil and gas business, leading to the suspension of development or causing industrial reorganization. We authors of the book also realized that our tiny venture could not escape from the fallout.

Fortunately our original analysis had been from a longer perspective for Japan as a consuming country, focusing on the asymmetric consequences of industrial relocations and job transfers among the regions due to large price differentials, and reflecting the lack of connectivity of pipelines and significant transaction costs in the LNG trade. To reflect the impact of the collapse, we continued our analysis discussing the implications for traditional producers as well as non-economic aspects, before finally publishing the book for the Japanese market in April 2015.

Coming back to game theory and the market, the price collapse of 1986 was triggered by a speech by Saudi Oil Minister Sheikh Zaki Yamani at an Oxford Energy Seminar organized by Robert Mabro. I was in the seminar room when Sheikh Yamani told us of their change to "net back pricing" through which crude oil is priced as a function of product prices, processing and transport costs, abandoning the traditional system of price administration in favor of competition for additional export volumes. Prices fell from $32 to $9 per barrel.

In December 2014, the Saudi oil minister said they will not cut output however far oil falls, giving up their role as a "swing producer" of petroleum. Thus, they tried to defend their market share that had been threatened by the rapid increase of shale oil production. This time prices fell from $100 to $50.

In 1973, William Nordhaus wrote a paper titled "The Allocation of Energy Resources" which assumed complete information concerning the energy resource market would be shared by both energy resource suppliers and consumers. In contrast to this economic model approach for intertemporal allocation and pricing, John Nash had much earlier introduced a game theory among non-cooperative players based on mathematics. It provided a deep insight into the potential outcomes of the decisions taken by players, especially the OPEC cartel and non-OPEC producers.

On whom will this price collapse exert the most influence? The key concept here is the asymmetry among producing countries such as Russia or Islamic State and consuming country such as China and India. The dividend on the policy side is the reduction in long-standing and budget-deficit making subsidies for in fuel in India, Malaysia and Indonesia. The decline in oil prices created room for safely lifting domestic subsidies with the effect of promoting energy efficiency and renewable energy through better functioning of the market.

In 1986, what was at risk were not only shares in the crude oil market but also the development and production of oil in non-OPEC high-cost regions. This gave OPEC a decade before competitors returned to the market, and also saw a slowdown in the development of alternative technology and resources.

This time the difference is that now some renewable technologies have gained competitiveness in the market with the help of policy measures, and the role of oil has been relatively reduced under diversification of demand and supply. The shale revolution is the most prominent new development and is changing the United States into an energy exporter. In addition, energy choices are not solely left to the market, but are also constrained by the requirement to reduce CO2 emissions as well as by energy security policy objectives.

Finally, as is seen in smart grid or smart city projects, due to developments in ICT and energy storage technologies, consumers have been empowered to actively make decisions on both the demand and supply side under the regulatory reform of the energy market. We can interpret this as showing either that the market has started to function on the basis of assumed economics or that the practitioners of game theory have increased.

Is it game theory that now governs our life?

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