Kayrros Series

> The Oil Games

Episode 1 – July 8, 2017

By Jean-Michel Lasry, Antoine Halff and Antoine Rostand

"The unprecedented transparency brought to oil markets and the oil industry by machine learning and unconventional data such as satellite imaging and social media works wonders for current developments and short-term forecasts, but for the medium to longer term analysts and industry stakeholders must still rely on modeling"

Introduction

However, the track record of traditional energy economists in this area falls far short. In the Oil Games, we propose a new approach to medium and long-term oil-market modeling based on game theory. In our view, this provides a superior conceptual framework for predicting oil market developments.

The Oil Games are as a series of interconnected episodes in which we will try to explain and predict market behavior using Kayrros' extensive knowledge of the energy industry, the world economy, mathematics and game theory in particular. The series' target audiences include the practitioners, investors, and observers of the oil industry who are interested in finding new ways of understanding this fascinating business. The authors are Jean-Michel Lasry, Antoine Halff and Antoine Rostand. This is an ongoing story with future episodes being published in sequence by Kayrros. Here is the inaugural installment, in which we propose to apply the economic model of innovation to the oil and gas sector.
It is obvious that there is a clear disconnect between the classical economic theory of the oil and gas markets and the reality of those markets as practitioners experience it. This is equally true for any other extractive industry for that matter.

Zweig's Wisdom

Many traditional energy economists still subscribe to the now thoroughly discredited Hotelling theory, according to which oil prices appreciate inexorably as finite resources get depleted. Yet markets have disproved this view time and time again with forecasts of resource depletion continually pushed into the future. Stefan Zweig one famously quipped that Brazil is the country of the future and will always be so. A similar point could be made, perhaps more accurately, about the extractive industries—there are 25 years of reserves in the ground, and there always will be.

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The Gaming Parlor

When thinking about oil, a more useful reference than the Hotelling model can be found in the economics of innovation. There are striking parallels between innovation and oil and gas exploration and production (E&P). Like innovation, growth in the extractive industries is endogenous, not exogenous. Over time, on average, discoveries and capacity expansion mirror demand growth and reserve depletion. Oil and gas discoveries may best be described as adaptation, as a natural response to shifts in supply and demand. This may come as a surprise to theoreticians, though not to industry practitioners. Furthermore, the complex interplay of competition and development that is at the heart of innovation is also at play in the oil industry.

Rules of the game

Marx believed in the endless accumulation of capital and the resulting steady erosion of profit margins. Schumpeter has shown however that Marx failed to take the role of innovation into account. Schumpeter's theory of creative destruction explains how innovation keeps resetting the clock of capital formation: capital doesn't accumulate but gets periodically destroyed and entire sectors of economic activity fall by the wayside as new ones emerge and obliterate them. Over time, that process gives rise to new monopolies and rents that temporarily restore profits, until the cycle repeats. Schumpeter's contribution to economic thought can itself be seen as the creative destruction of Marxist theory.

Building on Schumpeter's insights, growth economists like Paul Romer and Philippe Aghion have more recently shown how innovation, far from being accidental or exogenous, is a product of its time, and a necessary outcome of economic circumstances. Innovation is an endogenous form of economic development and a balancing point between supply and demand in a certain market, that being the market for research and development (R&D) and innovation.

In the economic theory about oil and extractive industries, most of the literature hinges on resource scarcity, the idea that oil and mineral resources are finite, non-renewable and destined to depletion. The Hotelling rent model calculates commodity prices by walking backwards from the theoretical future point when resources will have run out. Likewise, Hubbert's peak, the theory behind the once popular belief in peak oil supply, also revolves around the central tenet of production-induced depletion.

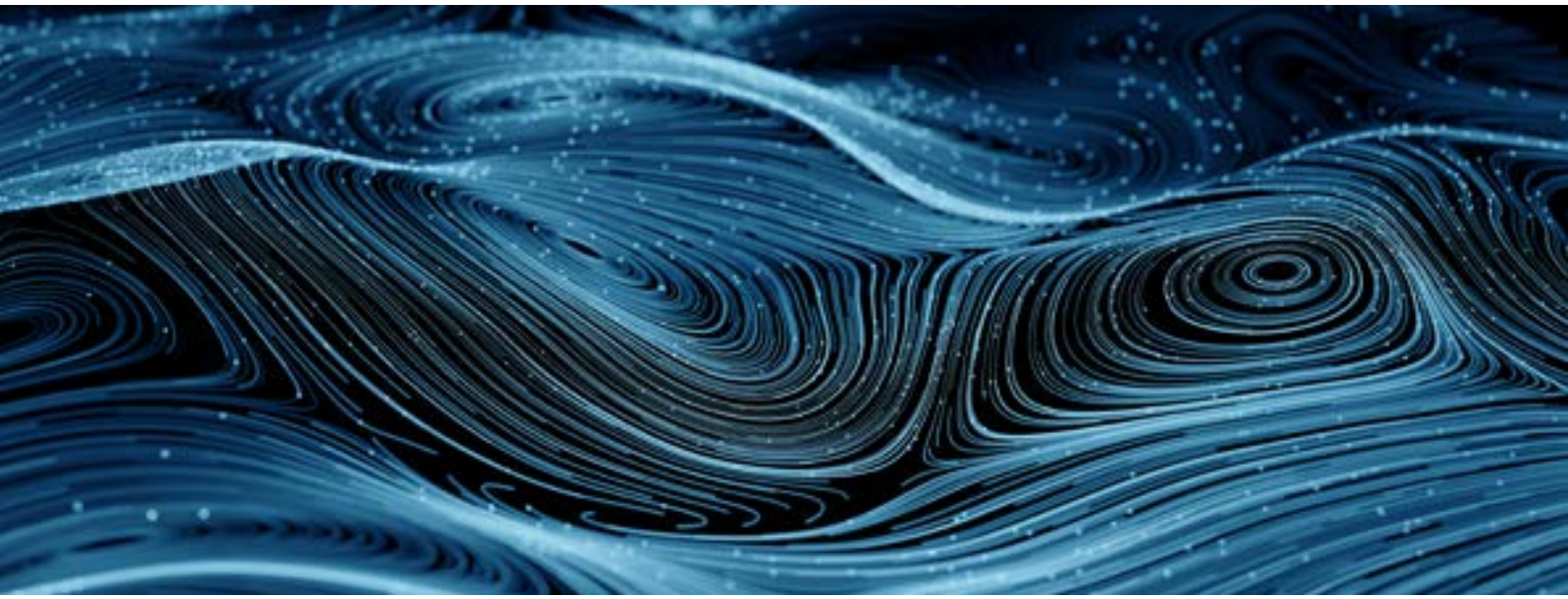
In a recent work1, Y. Achdou, P.N. Giraud, J.M. Lasry and P.L. Lions (AGLL) offer an alternative concept: that of endogenous growth in mineral resources and production capacity. This approach makes more sense of the last four decades of history in extractive industries. Its basic idea is simple: new discoveries are not a product of happenstance but result from deliberate, purposeful efforts undertaken in response to supply and demand balances. The finding of new resources is thus not an exogenous development but part and parcel of the market's dynamics.

In other words, the idea is to apply to prospective activities in the extractive industries a similar approach to that of endogenous growth in technological innovation. In both cases, growth is the direct outcome of research (prospection), discoveries (finds), and the products (production) made possible by these discoveries. Growth has no set limits, whether resource-based or otherwise; it is essentially limitless. Its rate is the result of an equilibrium between supply and demand for R&D in the field of innovation, or, E&P in oil industry terms.

Such an approach holds the key to one of the most puzzling mysteries of the last half century: the fact that there are always, at any given time, at least 25 years worth of reserves (be it of zinc, nickel, etc.). This clearly stems from the fact that new subsurface finds follow market signals, from the ups and downs of global demand to the depletion of mature deposits.

While the AGLL model works well across the extractive industries, it is, however, not as tight a fit for the oil industry as it is for mineral resources like zinc or nickel. That, as we shall explain below, is because of the heterogeneity of oil industry actors compared to those in the mining sector.

To claim that growth in the oil industry is endogenous is tantamount to saying that the entire sequence of activities leading to oil production – from exploration to discovery, from the assessment and delineation of new deposits to their development – stems from investment decisions made by economic actors based on expected profits. This might sound like a truism for most industry practitioners. The point is that, unlike traditional oil economists, we take this truism seriously. We believe in this self-evident truth, even though most of the literature of economic theory ignores it and rests instead on diametrically opposite hypotheses such as the Hotelling rent that cannot be reconciled with the available data.



Meet the players

There is another lesson to be drawn from the comparison between the economics of innovation and those of oil prospection.

Recent research by Philippe Aghion shows that the interplay of competition and innovation is more complex than it seems. Aghion's theoretical works, based on a great wealth of data, reveal that:
There is no innovation without competition. If you are a monopoly, why bother with innovation, especially if there is no risk of a new entrant?

Some competition is good for innovation: you need it to defend or increase your market share. You must come up with new products to protect your profit margins.

More competition breeds more innovation, but only up to a point. Too much competition discourages innovation: what is the point of innovating if you can only hold on to the benefit of your innovation for a short while, as each innovative product of process risks being immediately outdated by another one? If in a given sector the cycle of innovation becomes so fast that new entrants constantly threaten incumbent innovators, then the latter will give up and the flow of innovation will freeze.

In other words, innovation, and innovation-driven development form an inverted-U function of competition: a little bit of innovation speeds up development, a lot hinders it. This is one of the reasons for the laws designed to protect industrial property, notably through patents, in traditional industries.

Transposed to the oil and mining sector, these observations result in the following:

In the absence of competition, the oil and mining industries will have few incentives to work hard to find new deposits or expand production. If you are an oil or mining monopoly, why bother with expanding reserves or raising production capacity, especially with a high barrier to entry? If demand is inelastic, decline rates and supply constraints will only boost profits.

A little bit of competition provides a good incentive for industry to find new reserves or expand production capacity, especially if lower-cost or higher-quality reserves can be identified and brought on line. The point is to defend or increase market share and protect profit margins.

Too much competition hinders the quest for new reserves and increased production capacity: why sink money into E&P investments without the prospect of a decent payback?

The above-mentioned AGLL model clearly shows the constant tango of competition and development in the extractive industries even though its authors have yet to elaborate on this takeaway from the model in more detail.

In the case of the petroleum industry, the emergence of shale oil may represent a sudden step change in the competition between sources of supply to a degree that may hinder E&P activities over the medium term. More on this in the next episode. **To be continued…**

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