Conclusion

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This book overviews the need to analyze the sociology of the oil price as not only being the result of economic transactions but also as a social institution in itself. This perspective offers the possibility to reflect upon the oil price beyond supply and demand dynamics, and further understand it as an endogenous factor in relation to societies. This distinction refers to the *homo sociologicus* approach, which takes a different path from the widespread *homo economicus* perspective that has shaped a large part of the scholarly literature on the topic. In short, *homo sociologicus* frames the analysis of the actorness of societies in economic processes.

An emphasis on *homo sociologicus* doesn't refute market fundamentals. Of course, as is the case in any commodity market, supply-demand dynamics and geopolitical interactions constitute an important casual chain in the oil sector. Short and mid-term oil price dynamics are influenced by stockpiles, quality of crude and demand dynamics. Market platforms are established and attract a large number of trading transactions comprising paper trading on stock markets. What is important here is the social value of the price, considered as a symbol in the terms proposed by Pierre Bourdieu. In the same line of argument, the oil price is a metaphor of IPE—a widely referenced and widely known commodity valuation affecting societies beyond the oil sector as such. The *homo sociologicus* approach provides an explanation for the role of information flows impacting the price and impacting perceptions surrounding the price.

The *homo sociologicus* approach chosen as the main framework of this book leads to the conclusions briefly summarized below.

Natural Resources are What Societies Make of Them

The book emphasizes the importance of various social approaches to resources. Socio-economic practices entail a value being placed on natural resources. Furthermore, societies react to resources and perceive threats and opportunities. The *homo sociologicus* approach suggests non-linearity between social reactions and economic

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dynamics of resource use. The resource-society interaction includes social understanding of scarcity and environmental damage caused by the use of resources, various evolutionary processes relating to human adaptability to the natural environment as well as resource regimes and social perceptions of threats and issues. Resources have been objects of evolution and institutional adaptation toward use of resources has taken place. Thus, by taking a different path from the commonly followed resource-determinism approach, one may open a variety of analytical perspectives related to resource-society interaction in general and to the IPE of the energy transition in particular.

It has been noted that scarcity-based approaches have stimulated perceptions of insecurity in relation to finite resources since the days of Thomas Malthus and William Jevons. In a similar manner to these classical scarcity-based concerns, debates surrounding the energy transition agenda reflect risk aversion in relation to the climate change deemed to be caused by the extensive use of hydrocarbons. Furthermore, societies are taking an increasingly negative stance toward the oil industry despite its importance for civilization as it currently stands and despite the petroleum industry's efforts to increase the rational use of resources.

Even the decline in investment into the oil sector may be driven by social aversion toward environmental risks stemming from hydrocarbons. At the same time, oil's negative image may engender another long-term concern: a decrease in activities related to oil exploration and production will not match the future energy demand. As Robert Dudley, a former CEO of BP, notes in a recent statement, 'good intentions [lead] to bad outcomes' and 'many trillions of dollars of investment in oil and gas will still be required to counter the substantial decline rates of existing fields'.[1] Without entering into the detail of the discussion launched by this oil major, one may observe the implications of social approaches to the industry for resource dynamics, and hence for the value of the resources. Furthermore, the issue of resource scarcity comes back despite the historical evolution of human adaptability to energy needs.

In her introductory remarks, Michelle Foss reminds us of Paul Frankel's conception of the oil markets' inability to self-adjust to economic realities. She defines the emerging uncertainties surrounding the oil price as a new 'Frankelnomics', shaped by a constant surplus of oil and a persistent risk of price erosion. One might argue that increasingly negative social attitudes toward oil adds to such uncertainties. Now, with growing social fears as to the effects of climate change and symbols related to the energy transition, erosion of the oil price gives rise to a new era of uncertainty. As Michelle Foss puts it, uncertainty is not equivalent to risk since risk can, at least theoretically, be measured.

Paradoxically enough, the era of uncertainty coincides with an era of more competitive oil market, in which political drivers of price have been reduced. Throughout his analysis, Samuele Furfari identifies the vital role of oil in the global energy mix. In his in-depth historical overview, Furfari explains the difficult evolution of the oil

[1] Quoted in the *Financial Times,* 10 October 2018, available on URL: https://www.ft.com/content/8072171a-cc89-11e8-b276-b9069bde0956 (last accessed on 1 March 2019).

markets from oligopolies and cartels to a 'normal' commodity market. Despite growing inter-fuel competition, Furfari justifies skepticism as to the ability of renewables to replace hydrocarbons but notes that hydrocarbons have become more competitive mostly because of energy efficiency policies and technological diversification in traditional fuels. These dynamics, which have increased oil's competitiveness, reveal a structural change in the oil markets, while price dynamics remain crucial for the global economy, stocks and even political developments.

Furthermore, he raises a similar question to Michelle Foss about uncertainty: what is the future of the oil price?

Furfari thus lays useful groundwork for a further discussion carried on by Matus Misik and Andrej Nosko about perceptions of energy security and sociology of price. Market-driven approaches in the oil sector have not generated a change in the perception that the oil price is persistently high and unfair.

The oil price is defined by socio-economic processes that affect resource structures. The existing market-based approach proportionally relates oil reserves to price dynamics. Oil resources are valued by the markets through a price; the oil price stimulates demand structures and, above all, engenders stakeholder views as to the importance of oil as well as a perception of the profits needed for any long-term investment dynamic.

Despite the absolute growth in oil demand, the relative importance of oil has declined due to growing inter-fuel competition. At the same time, this structural change reveals that the economic value of a resource does not always have a linear relationship with the price of the commodity. The oil price gained its importance over the past few decades, during which the relative importance of the sector declined. A mismatch is persistently observed between the relative decline in the importance of oil as a resource and the enduring importance of the oil price metaphor.

Nonetheless, the oil price constitutes a crucial benchmark for newly emerging energy sources. A lower oil price increases the economic and social costs of new technologies since the availability of cheaper oil products can engender resistance to the usage of biofuels or liquefied natural gas instead of oil products. As Samuele Furfari notes, oil price growth, when it occurs, can facilitate the penetration of new fuels and stimulate further inter-fuel diversification. Somewhat a similar viewpoint is given by Misik and Nosko in their description of new technological challenges to oil.

Although this book does not go into the detail of this subject, it opens up an important area for future research. The energy transition creates a challenge described by Thijs Van de Graaf as a trend toward a new IPE of climate change. He points out, among other things, that the link between the energy transition and fossil fuels in political economy has mostly been overlooked. Hence, the impact of the oil price on social acceptance and social costs will need to be debated at some point. Stakeholders' reactions toward the energy transition, toward the oil industry and toward the oil price may constitute various sides of the embeddedness processes.

Focus on Embeddedness: Markets are Shaped by Their Stakeholders

The *homo sociologicus* approach suggests that markets are shaped by human interactions, policies are influenced by social perceptions and technological changes are inherent to macro-social involvement in the technological change. Market institutions are created by social interactions and form part of broader embeddedness processes. We may still observe different perspectives on embeddedness and an evolution of the schools of thoughts since Karl Polanyi proposed this concept for the scholarship of political economy. In this regard, the sociology of price initiated by a prominent sociologist Pierre Bourdieu offers an interesting perspective for further academic debate stemming from the embeddedness concept. According to this perspective, price is about social symbols which influence supply-demand mechanisms.

As pointed out by Misik and Nosko, The sociology of the oil price is an interesting field of analysis. As the best-known commodity price, the oil price is highly sensitive on information and speculation. Since social actors can affect development of symbols, information flows in oil markets constitute the key factor in price dynamics. In our case study, oil producing states, financial institutions and Price Reporting Agencies contribute to data collection, oil benchmarks and price references. Michelle Foss notes that the time horizons of oil price volatility differ between short and long-term dynamics. Differences reflect various perspectives of traders and industries. Unpredictability subsequently stems from the varying time horizons used by market stakeholders. The focus is primarily on short and mid-term transactions, whereas structural developments are influenced by long-term dynamics and unexpected events.

A large part of the existing scholarly literature rather focuses on producer-consumer juxtaposition partly reflected by tensions between producers' cartel OPEC and importing states. It may be counter-argued that the actual role of OPEC has changed since the well-known oil shocks of the 1970s.

As Samuele Furfari explains, OPEC has only a limited ability to influence price in the context of oil oversupply, given the large number of actors involved in the sector. His point is further underlined by Thijs Van de Graaf, who discusses OPEC's role as a price-maker. The core question he poses is that of whether OPEC has become irrelevant as a cartel, and what OPEC can do in light of the energy transition to decarbonization. Instead of answering this question within the wider context of OPEC's diminishing power, he notes that OPEC has never been a cartel. Instead, as an international organization, it has been able to adapt to the international environment and was therefore responsible for creating its own importance in the oil markets.

The actorness of OPEC has been crucial in making itself important in the context of the newly emerging oil markets. Among other things, OPEC is able, during periods of price erosion and oversupply, to contribute at least to some extent to the stabilization of prices through the introduction of production quotas. In this way, it has acquired a more positive image among market participants: instead of being a cartel that partitions the oil market, it becomes an organization that helps to balance markets in times of uncertainty. Given the importance of the oil price for the competitiveness of

most alternative fuels, and taking into account that the stability of the stock markets partly relies on commodities prices, OPEC's role as a balancing power is viewed in a positive light by businesses.

Van de Graaf points out that the challenge for OPEC consists in the absence of a coherent approach toward the climate change regime shaped by the UNFCCC and the recent Paris Agreements. By avoiding price erosion, OPEC may attempt to positively contribute to the energy transition. Nevertheless, questions remain about its ability and willingness to do so.

The sociology of the oil price does not only concern direct implications for the markets. The indirect effects of various political approaches taken by stakeholders matter equally. The oil price engenders profit expectations in producing states even though the price dynamic has shifted to buyer-oriented markets. The question of resources stimulates normative dynamics surrounding the oil sector. The importance of actorness in defining natural resources and in developing security rhetoric has been demonstrated throughout the book. Veronica Lavista explains that the norms of oil resource control—'governmental take'—have been developed across the national discourses of oil-producing states. Institutional norms have also been created, stemming from observed political discourses. For many oil producers, control of the oil industry relates to the domestic economic development in a broader sense, even beyond hydrocarbon exports themselves.

In turn, a need for lower prices constitutes an important driver of political discourse in energy dependent states. The chapter written by Misik and Nosko discusses the situation in Central and Eastern Europe as an illustrative example of this. Their chapter describes the way in which regional stakeholders have been sandwiched between the rhetoric of competitive pricing and the rhetoric of diversification of physical oil supplies, which requires additional investment and hence higher expenditure. Over time, higher expenditure creates a positive context for oil demand and may therefore contribute to a price increase in the longer term. This would produce the reverse of the effect intended in the initial objectives.

Rhetoric concerning the oil price is particularly interesting in the case of Russia, as highlighted by Alexander Etkind, Kacper Szulecky and Ilya Yablokov in their chapter. A discourse on oil price can take different shapes and different perspectives and even create beliefs and images. In turn, the oil price needs to reflect growing domestic demands. The so-called social price of oil requires that the price attains a certain level. In this context, beyond issues of Russian domestic politics, observers may note states' willingness to influence the oil price in order to satisfy social price of oil even despite industry dynamics and the interests of domestic industries.

Ultimately, the oil price reflects various interactions, information flows, states' perceptions and symbols. The sociology of the oil price is a complex phenomenon in the current IPE structures. In fact, while short-term dynamics demonstrate higher volatility and fragmentation among actors involved in the sector, long-term dynamics reveal the existence of drivers behind a higher oil price, and sometimes even a demand for a higher oil price. Consequently, the price erosion explained above consistently leads to a mismatch between economic dynamics and social perceptions of the price. Although current oil market structures reveal a de-institutionalization of

the predictability of the price, societies may expect the oil price to remain the pivotal element in the global economy, despite the significant challenges that have occurred in energy markets in recent years.

Economic and Social Institutions Differentiated

In order to understand the oil price beyond supply-demand dynamics, and also to integrate the energy transition into the oil price discussion, one need to 'sociologize' the economic concepts and to craft them within a broader macro-social context. As Guy Peters notes, a variety of institutional approaches allow us to view the oil price both as an institution and as an institutional environment. The oil price is a historically evolved institution inherent to social perceptions of power, wealth and of necessary benchmarks in economics and law. It constitutes an institutional environment when it influences economic institutions of states and of markets.

Given that seeking to define institutions amounts to a moving target, the scope of the analysis to which they are subjected may vary across theories and evolve over time. Peters notes that old conceptions of institutionalism are being challenged by new conceptions that increasingly integrate societies and the actorness of social agents into the scheme. In this respect, Peters suggests that a distinction should be drawn between economic and social institutions. He argues that the institutionalization of economic interactions is associated with long-established market practice. The oil price volatility and related uncertainty creates a context for the de-institutionalization of economic institutions surrounding the oil price. The institutional approach can even challenge the widespread understanding of a market as being the mainstay of predictability. De-institutionalization can in fact provide an explanatory ground for the uncertainty problem evoked by Michelle Foss.

Likewise, OPEC has been deemed to be a factor of institutionalization—either as a constructive element in the markets or as in terms of the problem of dependence on the cartel. As explained by Thijs Van de Graaf, OPEC, despite its own efforts, doesn't control the price, while lasting low oil prices may bring about new risks for the IPE, including political instability in oil-producing states and international security concerns that follow from this. The mismatch between OPEC's ostensible power and its weakness in the face of market realities constitutes one of the dimensions of de-institutionalization.

On the basis of Peters' theoretical observation, one may ask if institutional dynamics (including de-institutionalization and conflicts between social institutions) provide an alternative causal explanation of controversies and conflicts in oil instead of the producer-consumer juxtaposition. Most conflicts and controversies in this area may be explained by reference to changes in institutional structures. These may include changing price mechanisms, conflicts surrounding access to resources, controversies between IOC and NOC-based governance of resources and controversies surrounding the energy transition.

By adopting a more specific focus on the oil price, we observe that in contrast to economic institutions, social institutions can create durable perceptions, practices and norms. On the basis of these assumptions, a development of international norms despite price uncertainty and the de-institutionalization of long-term market relations becomes an illustrative example of social institutions.

Although oil geopolitics has frequently been perceived as primarily a conflict-driven process, it has also generated important impetus for the development of international law. Lavista shows that international investment arbitration has largely benefited from conflicts surrounding access to resources and has even given international law greater legitimacy in global economic relations. The oil conflicts have contributed to the development of norms alongside economic globalization and have perhaps also indirectly contributed to the mundialization process.

Lavista's analysis reveals that a mismatch is emerging between economic de-institutionalization and price volatilities on the one hand and social norms surrounding the oil price on the other. The core challenge for international arbitrators is that of taking into account oil price volatility in calculating damages in the event of expropriation of hydrocarbon assets. She notes that individual decisions by arbitral tribunals regarding price volatility engender legal consequences across the sector. At the same time, there is no perfect ('objective') method by which to take account of volatility. Hence, the *problematique* of de-institutionalization of markets gains a tangible dimension affecting one of the core components of the global economic order—international norms.

Accordingly, one may observe a de-institutionalization of economic institutions coupled with enduring social intuitions of the oil price. Thus oil price sociology requires one to look beyond the oil markets to understand the oil price symbols inherent in political interrelations.

The Oil Price and Social Symbols

It may be that a lack of institutionalization surrounding the oil price as well as its symbolic importance engenders various political perceptions of oil. The oil price becomes a reference for political rhetoric and considerations of power that may not match economic market realities.

In energy dependent states, the oil price can be associated with security perceptions and the so-called securitization process, as demonstrated by Misik and Nosko. In this regard, the oil price can even create an image of vulnerability even though the balance of power in the markets has shifted toward buyers. Being a non-linear reaction to a threat, securitization stimulates social perceptions of energy dependence and of dependence on oil imports. However, these perceptions do not relate solely to an existing energy dependence. It is also often engendered by factors endogenous to societies, whereas energy dependence as such is an exogeneous structure. Hence, as a social process, securitization can be engendered by threats that are either exaggerated or unreal. Furthermore, perceptions of dependencies from a security standpoint may

persist longer than the changes in market structures described by Furfari. It is possible that the new 'Frankelnomics' will provoke new security concerns in the future, while existing threats persist across societies.

This leads us to an even more interesting observation. Even though markets are widely seen as a solution for energy security, oil markets—which have, broadly speaking, become competitive—still constitute a security concern. Accordingly, social perceptions of threat can subsist regardless of the existence of competitive buyers markets.

The oil price shapes social minds and political reactions well beyond the market as such. It engenders self-confidence in oil-producing states and even generates the semantics of power and conspiracy theories, as demonstrated by Alexander Etkind, Kacper Szulecky and Ilya Yablokov. The authors posit the *problematique* of the oil price affecting domestic political discourses. Their chapter ponders whether the oil price constitutes one of the core issues for democratic processes around the world. In this way, the authors of the chapter propose 'making sense of chaos' and emphasize the importance of the embeddedness processes in perceptions of oil prices. And their perspective differs from the path-dependency concepts relating to resource curse: it concerns a different form of path dependency that relates more to discourses and beliefs than to resources. One of the crucial questions posed by the authors of this chapter focuses on governments' abilities to neglect democratic processes on the strength of the national revenues derived from oil exports and hence independence from domestic societies.

The authors note that conspiracies surrounding the oil price relate to wish fulfillment. The oil price becomes a reference, a symbol, only remotely connected to real price drivers. Rhetoric surrounding the oil price tends to be directed toward a domestic audience by creating the image that it strengthens the country vis-à-vis its perceived opponents—in this case, Russia and the West in general. The authors of the text point out that the oil price can constitute a set of beliefs occuring in domestic politics.

In this context, the authors of the chapter indirectly refer to the concept of 'carbon democracy' from a new sociological perspective. The existence of resources constitutes one of the elements of the overall picture, whereas political rhetoric and social beliefs are primary factors in the game. Issues surrounding carbon democracies, which have been widely debated in the context of political science may need to be assessed further in the light of the *homo sociologicus* perspective. Probably, a recently emerged term of 'carbonism' reflects this set of symbols persisting across the oil producing states.

In summary, the oil price is inherent to social structures in both producing and consuming states. As a result, the sociology of the oil price should go beyond the producer-consumer juxtaposition and resource distribution. The price is primarily a social process. For this reason, the oil price can be seen as a metaphor reflecting symbols of power, beliefs and expectations.

Future Areas for Research and Debates

If a large part of the existing scholarship focused on the detrimental effects of the high oil price, the next generation of scholarship might need to look at the implications of erosion of the oil price for security, security perceptions, economic hardship for stock markets and the de-institutionalization of the oil markets. The potential scope of the research questions that might be addressed is wide. For example, how can a balance be struck between short-term oversupply coupled with decline in investment and long-term needs for petroleum? How can a balance be struck between achieving a competitive oil price and top-down approaches to support alternative fuels? What are the implications for OPEC's future in its efforts to avoid de-institutionalization of the oil markets?

To date, the sociology of the oil price offers a causal explanation of changes in pricing mechanisms over time, in exaggerated estimates of the oil cartel, a non-linearity between resource nationalism and possession of resources, and in persistent profit expectation despite the volatility of the oil markets. The sociology of the oil price currently extant is influenced by the energy transition processes. The sociology of the oil price also offers a path for future research and will be pivotal in the energy transition processes and the newly emerging IPE of climate change. Climate change mitigation implies new symbolic meaning of oil price. In turn, a carbon price, as proposed by proponents of greenhouse gas emission abatement, gains a renewed attention beyond older symbol related to the polluter-pays principle emerged back since discussions at the Club of Rome. Increasingly, an anti-oil attitude of emerging pro-climate movements contribute to the new symbols in international political economy.

In the light of the growing worldwide interest in the energy transition, a focus on hydrocarbons is ever-increasing. Economic security concerns stemming from fears concerning climate change bring back King Hubbert's belief in the need for radical social change to adapt to the resource environment. In many cases, industry expert communities and policymakers are investigating the potential for material transformation of the resource base and resource use in order to resolve the longstanding incompatibility between societies and resources. The feeling of incompatibility between economic growth and preservation of the environment seems to persist while the rhetoric behind it consistently changes. All these multifaceted aspects of policies will at some point require an understanding of the social institutions behind these processes and of embeddedness, which either helps or hinders energy transitions and policy implementation.

Our incomplete attempt to provide an analysis of the oil price institution may be of use in seeking to understand the social symbols behind debates surrounding the carbon price. As correctly identified by Thijs Van de Graaf, a new perspective within IPE—the one of climate change mitigation—is about to emerge. The carbon price may become a new factor impacting on economies and businesses. In turn, applying a supply-demand analysis may not suffice to achieve an understanding of

the emergence, development and implications of the carbon price. The sociology of price remains an unexplored area in the energy transition.

It is possible that the next era will be marked by ongoing uncertainties over both oil and carbon prices. At any rate, scholars will need to address a number of questions: does the era of oil price erosion require a higher carbon price and thus decrease willingness to pay for the climate change mitigation? Or will the carbon price become the main driver of economic change? Will it achieve sufficient embeddedness to reshape socio-economic actors' behaviors? Or will it constitute a cause for social conflict of a kind exemplified by the social unrest recently seen in France and by the growth of populist movements? Will the carbon price play only a marginal role in the top-down energy transition, making the costs of the latter even higher? Or, again, will the carbon price help to mitigate the negative effects of climate change so that current perceptions of resource-society incompatibility will fade in a manner similar to the classical Malthusian dilemma? Finding answers to all these questions will require further elaboration of the sociology of price under *homo sociologicus* approach.

Afterword

Minding the Gap

Oil is the industry everyone loves to hate, and the oil price is its symbol. From its debut in the nineteenth century, oil has been a blessing and a curse, unlocked vast wealth, and fueled hard grievances. More often than not, its price seems to sum up everything that is wrong about it. Governments fall over the price of oil. Ministers get sacked for it. Producers go to war about it. Price shocks sink some economies, lift others, or change the map. Whatever its level, the price is never right. Depending on one's perspective, it is either too high, too low, inconsistent with supply and demand, or too volatile. When too high, critics have their pick of villains: Wall Street 'speculators', predatory exporters, extortionary governments, Big Oil holding consumers over a barrel. When too low, the usual suspects include greedy IOCs, a monopolistic OPEC, anti-Russian conspiracies, the tragedy of the commons. Above all, oil prices are unpredictable, soaring to new highs or crashing down in model-busting gyrations that always seem to catch the 'experts' off-guard.

Few industries have generated as much running commentary as oil. The vast and ever-growing library devoted to it is as old as the industry itself and is one of its distinctive features. The question of the oil price looms large in this library, directly or tangentially, sometimes through narratives of exposure purporting to reveal the industry's dark side or the schemes of a subset of conspirers to control it all. Ida Tarbell's *History of the Standard Oil Company* belongs to this tradition. So do the many works on oil price formation and oil fiscal regimes that sprouted in the 1950s and 1960s around the time of the birth of OPEC. So do many of the documents referenced in the various chapters of this book. So does this book itself.

What is it about the oil price that makes it such an enduring but elusive topic of interest, and often of controversy? Why the endless exposé? Why do commentators, writing at different points in history, under different oil price regimes, keep returning to it? Why do changes in the oil price so often take us by surprise, and what do we find so captivating about its twists and turns? The neo-classical view of the oil market as seen through the lens of resource distribution, rational choice and supply/demand

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fundamentals—what Andrei Belyi calls 'the producer-consumer juxtaposition'—has little to say about these questions. *Homo economicus* comes short. The late Paul Frankel's comment, recalled by Michelle Foss in her introduction, about the industry's inability to self-adjust is a tacit acknowledgement of the limitations of this approach.

The traditional blind spot to the 'risky' and 'most uncertain' nature of the oil business argues for a broader approach. Financial analysts and the trading community nevertheless remain largely partial to empirically observable and quantifiable factors, collectively known as market 'fundamentals'. In contrast, Belyi's *homo sociologicus* approach considers less easily measurable or calculable drivers, the price impact of the endogenous factors of human existence, such as relations between states, industries and societies, and finds in them the foundation of a new, broader, theoretical framework of understanding.

Because these endogenous or 'institutional' drivers are not as standardized and easily measurable as supply and demand, it has longed seemed expedient to dismiss them as intangible and immaterial. Barrels coming out of a field can be counted, inventories measured, demand metered. All of these figures can be factored into forecasting models as inputs or calculated as outputs. How does one fit non-market factors such as those explored by this book into a model?

However elusive the institutional dimension of oil prices may appear, it pays to take it into account. The very fact that the oil price so often serves as a controversy magnet denotes its institutional nature: if the price was solely driven by narrowly defined supply and demand fundamentals, there would never be any price surprise, nothing to argue about. Exogenous factors are by definition a given, not something one can take issue with. Oil price debates suggest the price is at least partly driven by non-fundamental, endogenous factors and that we recognize it as such.

Oil price disputes, controversies over price formation, real or imagined pricing disparities are all indicators of sorts—meaningful, informative and often actionable signals in their own right. Tarbell's *History* is a case in point. Like the oil literature of the 1950s and 60s, that foundational narrative turns the oil price into a kind of allegory, a key to broader struggles of human society. In her voice as in that of the many that followed her, the oil price becomes a rallying cry, a banner.

Remarkably, neither the growing sophistication and maturity of the oil market associated with spot and futures trading nor the transparency in oil pricing made possible by the price reporting agencies (PRAs) and electronic trading platforms have eradicated the chronic perception of mispricing and of pricing distortions and inequity. Far from it. The evolution of the market has only served to inspire new grievances, the IT revolution to better disseminate conspiracy theories. But new data technologies, by shedding more light on the market fundamentals and their relationship to oil prices, also provide fresh insights into the workings of non-fundamental, institutional factors that were previously dismissed as intangible.

Today, in the face of climate change, the price again stands on the cusp of discontinuity. Expectations of a fundamental repricing of oil assets are on the rise, whether to the upside on the back of climate policies aimed at internalizing climate externalities, or the downside on the expectation that new technologies and competition from

low-carbon energy will cut oil's share of the fuel mix and send the value of reserves through the floor. Such a reset would however require that the carbon footprint of the various sources and uses of oil be accurately and reliably measured—something mainstream technology cannot do. Here too, emerging, unconventional data technologies have a role to play in making third-party greenhouse gas emission measurements a reality, thus enabling repricing and reform. The next chapter in oil price history may well be written by data scientists.

Rallying behind the price

Oil price debates loom large in oil history. Such haggling regularly brings to the fore key sociopolitical and ideological questions of rent sharing, economic policy and societal choices. Public interest in oil pricing spikes at key junctures in the development of the oil industry. Each growth spurt, each turning point comes with pricing discontinuities and their attendant exposes of mispricing, campaigns for price fairness, or disputes over the distribution of the oil rent. As with market narratives in general, however, not all of these stories may be taken at face value.

Tarbell's *History*, serialized in *McClure's Magazine* in 1902–04, is one of the earliest examples of such storytelling. Writing in the Rockefeller era, Tarbell lifts the veil on the dark side of the early oil industry. Her work occupies a special place not just in oil history, but also in American journalism and US politics. Rockefeller's Standard Oil was then the archetype of the Trusts that had transformed American society and the US industrial landscape, Rockefeller himself a Gilded Age robber baron on steroids. Tarbell's book, weaving together previously available public records and her own reporting into a powerful narrative of exposure, has been credited with facilitating not only the antitrust suit later brought by Theodore Roosevelt's government against Standard Oil, but the broader wave of reforms of the Progressive era. Its third chapter, 'The Oil War of 1872', is one of a group of three articles whose publication in *McClure's* in January 1903 is widely held as marking the birth of 'muckraking' journalism.[2]

The piece focuses on a 30-year-old bid by Rockefeller to manipulate railroad fees and bring mom-and-pop producers in Pennsylvania, the cradle of the US oil industry, under his control. As often in such narratives, rumors and conspiracies loom large. 'For several days an uneasy rumor had been running up and down the Oil Regions', writes Tarbell. '[…] On every lip was but one word, and that word was "conspiracy"'.[3] As she relates how small producers push back against Rockefeller, the oil price comes into focus. 'No part of the testimony before the [Congressional

[2]The other two articles in that issue were Ray Stannard Baker's "The Right to Work," on the anthracite coal strike, and Lincoln Steffens' exposé on political corruption, "The Shame of Minneapolis."

[3]Ellen F. Fitzpatrick, Ed., Muckraking: Three Landmark Articles, Boston & New York: Bedford Books of St. Martin's Peress, 1994, p. 60.

investigation] committee made a worse impression than that showing that one of the chief objects of the combination was to put up the price of refined oil […]'.[4]

In this seminal piece, the oil price is a symbol of Big Oil, and Big Oil a symbol of the Trusts. Oil at the turn of the twentieth century, let alone in the 1870s, was not quite as ubiquitous a product as it would soon become. Nor does it dominate the US energy mix, let alone that of the world. But Standard Oil's market power and ability to manipulate oil prices exemplified that of the Trusts to distort and rule the broader economy:

> "It was evident to everybody that if the railroads had made the contracts as charged […], nothing but an absolute monopoly of the whole oil business […] could result […] And if this could be done in the oil business, what was to prevent its being done in any other industry? Why should not a company be formed to control wheat or beef or iron or steel, as well as oil? […] If the oil men yielded now, all industries must suffer from their weakness."[5]

Whether the muckrakers deserve all the credit they got for the Progressive era's reforms, as some critics have questioned, is beside the point. Tarbell's popular, hard-hitting expose successfully waved the oil price flag to rally support for legislative reform, helping set into motion the sequence of events that led from the end of the Rockefeller pricing regime to the Achnacarry Agreement of 1928, the secret deal that bound together Rockefeller's main successor company, Standard Oil of New Jersey, with the other two Majors of the time, Royal Dutch-Shell and the Anglo-Persian Oil Company (the future BP).

Fast-forward a few decades, and the underpinnings of price formation are once again in the crosshairs, this time of nationalists and revolutionaries. The wave of discontent around oil that took off in Latin America in the interwar and gained global momentum after World War II, culminating in the birth of OPEC in 1960 and the following wave of nationalizations, fed on a vast literature of oil price studies ranging from the journalistic and the militant to scholarly treatises on oil fiscal regimes and models of price determination. Like the *History of Standard Oil*, these exposes of perceived distortions and inequity provided the rationale for sweeping institutional change.

Many of these studies focus more on questions of price formation, profit sharing and rent distribution than on oil price levels as such. In *Venezuela: Oil and Politics*, former Venezuelan President and Accion Democratica leader Romulo Betancourt (1908–1981) tackles many price-related issues, from the cost competitiveness of Venezuelan production to the allocation of oil revenues between foreign companies and host government, the venality of Venezuelan rulers and their failure to put oil income to good use. But Betancourt, an early oil nationalist, stops short from suggesting a 'right' price level or passing judgment on the fairness of the oil price (other than to criticize the high level of domestic oil product prices in Venezuela).[6] OPEC itself, at the time of its creation, called for the stabilization of oil prices but did not explicitly set any price target. Although historian Fuad Rouhani recalls that OPEC

[4] Ibid., p. 67.

[5] Ibid., p. 68.

[6] Romulo Betancourt, *Venezuela: Oil and Politics*, Boston: Houghton Mifflin Company, 1979.

'came into being on a price-raising issue',[7] its founding charter explicitly focused only on price stability.[8] Not until member countries started nationalizing their oil industry and marketing their oil production directly did the group as such came to regard the achievement and maintenance of specific price levels as part of its core mandate. By the 1990s, 'price management' had become the name of the game for the producer group.

Few OPEC members have more forcefully embraced the oil price as focal point of militancy than revolutionary Iran.[9] The country's track record of oil nationalism goes back to the Mossadegh government of 1953. The Pahlavi government also harbored nationalist views on oil policy. Historian Shaul Bakhash notes the Shah 'effectively used opportunities to raise oil prices and whittle down the hold of the oil companies over the Iranian oil industry'.[10] Nevertheless, his successors thought he kept oil production too high and 'that oil income was being squandered and the country's chief natural resource was being needlessly exhausted'.[11] While in exile, Khomeini often railed against the plunder of Iran's oil resources. His adviser Abol-Hassan Bani-Sadr, later a finance minister and president of the Islamic Republic, penned volumes to denounce oil as 'an instrument for the exploitation and domination of the developing and oil-producing countries by the industrial powers'.[12] Once in office, the new leaders promptly sought to maximize revenues through higher prices. Oil production was kept in check and sales shifted from a few long-term contracts to a larger number of smaller, shorter-term deals at higher prices. Various formulas were cooked up to raise prices further. Within OPEC, Tehran became a leading price hawk, pushing for faster and steeper price hikes. When prices began to soften, it argued for production cuts. While Iran itself did not always stick to these policies, price hawkishness became part of its revolutionary culture. The belief that consumers ought to pay more for oil and could afford to do so gained renewed currency in the twenty-first century under President Mahmood Ahmadinejad.

As in the Standard Oil days, the oil price in the era of decolonization became a symbol, though of a wholly different kind. Whereas for Tarbell, Rockefeller's quest for higher oil prices reflected illegitimate monopolistic aspirations, for Third-World

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[7] Fuad Rouhani, A History of O.P.E.C., New York: Praeger Publishers, 1971, p. 4.

[8] As reflected in the charter's first Resolution: "That members can no longer remain indifferent to the attitude heretofore adopted by the oil companies in affecting price modifications; that members shall demand that oil companies maintain their prices steady and free from all unnecessary fluctuations; that members shall endeavor, by all means available to them, to restore present prices to levels prevailing before the reduction; that they shall ensure that if any new circumstances arise that in the estimation of the oil companies necessitate price modifications, the said companies shall enter into consultation with the member or members affected in order fully to explain the circumstances…" Cited in Rouhani, pp. 77–78.

[9] Shaul Bakhash, *The Politics of Oil and Revolution in Iran*, Washington, DC: The Brookings Institution, 1982.

[10] Bakhash, p. 3.

[11] Bakhash, p. 2.

[12] Bakhash, p. 5; Paul Vieille and Abol Hassan Banisadr, *Pétrole et Violence: tereur blanche et résistance en Iran*, Paris: Editions Anthropos, 1974; Abol-Hassan Banisadr, Naft va Salteh ["Oil and Domination"], Tehran, 1977.

revolutionaries low oil prices represented colonial plunder. In both cases, oil prices stood for something larger: muckrakers like Tarbell fought Rockefeller in reactionary defense of small businessmen against the rising tide of Big Capital; Marxist revolutionaries like Bani-Sadr and charismatic Islamist leaders like Khomeini championed high oil prices not only as a way to raise revenues but also as a revenge against western exploitation, a triumphant assertion of sovereignty, a demonstration of Third World or Islamic power. The oil price became a banner for a broader socio-political and/or geopolitical agenda—and the narrative of exposure, a call for (pricing) regime change.

Beyond boom and bust

The endless quest for the 'right' oil price that runs through oil history from Tarbell to OPEC and beyond is of course an impossible one, since the price reflects an inherently precarious and shifting balance not just between market forces of supply and demand but more deeply between underlying socio-economic forces that are always in motion. So is, a fortiori, the elusive quest for oil price stability. The very criteria of oil price fairness are constantly subject to change. Just as the oil price flag often stands for something else, so too does the quest for oil price stability masks the pursuit of other objectives. There just is no such thing as oil price equilibrium.

There is often daylight between what market participants publicly identify as the right oil price and where they are actually driving it, between their declared price appetite and the reality of their interests. The oil flag can be a false flag. Producers may ostensibly call for a price premium but sell at a discount. Consumer countries may claim to seek 'affordable' oil to power the economy but prop up its price with taxes to curb demand and emissions. The rise of prosumers, i.e. countries that are both producers and consumers, blurs the line between these categories. Old narratives rooted in the consumer–producer juxtaposition ignore this reality. Groups that root for price stability may actually seek, and benefit from, price instability.

The same parties can simultaneously or at different times express contradictory views of what constitutes fair oil prices, adopt in close succession diametrically opposed price targets, or pursue diverging price strategies. When the shale revolution crashed the oil market in 2014, OPEC first exacerbated the price plunge by raising production—only to later reverse course and seek Russia's help in pursuit of higher prices. Perceptions of price fairness are in many ways as cyclical as the market itself. During the 2002–08 super-cycle, OPEC's price stabilization band failed to contain the rally; instead, the group kept moving its goalposts as the market raced ahead until it finally embraced windfall revenues as the new normal. In his first major interviews with international media after his father's ascent to the throne, Saudi Crown Prince Mohammed bin Salman surprised the market by claiming indifference to oil prices. He surprised it again three years later by sacking a respected oil minister, allegedly for failing to give oil prices a big enough boost ahead of the Aramco IPO.

The traditional *homo economicus* explanation of these gyrations is simplistic. According to this view, long lead times and high capex are responsible for the oil industry's chronic overshooting and undershooting in production capacity investment and the resulting boom/bust cycle: when prices are low, profit margins drop and companies cut spending, eventually leading to a supply shortfall and a run-up in prices down the road. This in turn causes investment—and production—to rebound, setting the stage for the next selloff. This view does not account however for the diverging behaviors of different producers at the same time or the countercyclical investment pattern of large suppliers like Saudi Arabia. Nor does it explain shifts in price perception, the periodic reset of price objectives by market participants, or OPEC's chronic cycling between the pursuit of higher prices and that of market share.

Recent advances in mean-field game theory reveal a more complex set of drivers than the binary ebb and flow of supply and demand and capture more of the institutional depth of the oil price cycle. Far from being the mere unintended consequence of over- and under-investment, new research shows boom-bust swings serve a purpose. Cost disparities between large, low-cost producers and smaller, higher-cost ones drive diverging sets of interests and behaviors. As the marginal barrel sets the price, cost-advantaged producers (Standard Oil, the Seven Sisters, Texas drillers, OPEC) have less to gain from driving higher-cost competitors entirely out of the market than from allowing them just enough market share to keep prices sufficiently high and maximize revenue per barrel.

To maintain their own optimal market share, the dominant producers must keep prices on a roller coaster, alternating between selloffs and rallies. Their natural interest is to band together to collectively manage production and keep prices on the move. Chronic price crashes benefit the dominant coalition by weeding out excess higher-cost supply and allowing it to periodically regain market share. So do rallies, not only by lifting short-term revenues, but also by raising the production costs and undermining the efficiency of the competing 'fringe' as small, high-cost companies scramble to lift capacity and take advantage of higher prices—in a mad rush that makes them all the more vulnerable to selloffs. Whether consciously or not, the dominant coalition's oft-stated objective of market stabilization is thus window-dressing. The group's real interest is not in price stability but rather in market share stability, which can best be achieved by cycling through higher and lower prices.

Advanced game theory thus makes it clear there is more to the oil price than supply and demand. Boom-bust cycles are not just the by-product of the consumer–producer juxtaposition but the result of internal tensions within the producer camp and supply-management policies pitting one group of exporters against another. Further complicating the picture is the fact that the composition of these groups is fluid. Outside of a small core, OPEC membership is a revolving door, with countries joining in or dropping out as their internal conditions allow. Fluid as the institutional boundaries of OPEC may be, the effective boundaries of the dominant coalition do not actually match them very closely. Russia, now one of the world's top three producers and a low-cost player to boot, has effectively become a leader of the coalition but does not belong to OPEC. At the time of writing, Brazil is reportedly

considering joining. Others, like Venezuela, while still technically OPEC insiders, have effectively joined the fringe.

At the measurements' edge

One might have thought that the growing transparency of the oil market, by limiting the scope for manipulation, would have made the oil price less subject to controversy, and easier to explain on fundamental grounds. Far from eliminating price grievances, however, the changing nature of the oil market has sparked new ones. Similarly, the data science revolution has cast new light on oil market fundamentals without removing the need for non-fundamental explanatory factors. Far from erasing the operational relevance of these factors, AI-empowered data technologies have sharpened our understanding of the role of non-fundamental factors in price formation and for the first time made their impact more rigorously quantifiable.

The world oil market has transformed since Tarbell and the birth of OPEC, but controversies around oil prices continue to swirl. Oil consumption has grown, trade flows crisscross the world in ever denser networks, the market's liquidity has deepened as the number of participants has surged. Spot trading, futures exchanges and electronic trading platforms have quickened the market's pace and accelerated the spread of price information. Tarbell's expose of the Rockefeller pricing regime took months of painstaking investigative work. Information on today's mature oil market travels fast. Arbitrage players spot micro-discrepancies in oil pricing as they occur. New data sources push the boundaries of information on fundamentals. In so doing, they also help delineate the role of non-fundamental factors.

Any oil market participant has been through times when the oil price did not quite seem to reflect fundamentals—that is, when prices ostensibly departed from where experts thought they ought to be based on their understanding of supply/demand balances (as reflected for example in inventory data). For true market believers, such gaps have less to do with market manipulation or pricing irregularities than with a partially obstructed view of fundamentals—hence the value of the oil price as a fundamental indicator in its own right. Prices have long been held as the best gauge of market conditions. Prices are real time. Prices do not lie. In contrast, fundamental balances are pieced together through protracted data reporting, collection, aggregation, dissemination and analysis. Public data are heavily OECD-centric, which was fine when the OECD made up most of the oil market, less so now that its market share has sunk to less than half, despite a steady creep in membership. The lag between price and fundamental data often makes oil prices the canary in the coal mine, an early indicator of trends that can only be detected and confirmed in hindsight.

The gap between prices and fundamentals has narrowed, however, since new data technologies powered by artificial intelligence started harvesting information from ground sensors, satellites, social media, smartphones, the internet of things, etc., to offer an increasingly complete and timely view of the oil supply chain (production, inventories, trade flows, refinery operations). Whereas in the past a market view

extrapolated from partial and lagged data suggested a disconnect, today's fuller and timelier picture reveals a tighter fit. For example, with all countries factored in, the reverse correlation between crude prices and inventories that seemed to fall apart circa 2003 is back and often approaches 100%. And with inventory data now captured in near real time, it is prices that lag fundamentals, not the reverse.

Yet the new data also show that prices and fundamentals often do clash. Stocks and prices, normally inversely correlated, sometime do move in the same direction. These seeming anomalies do not occur randomly. Natural language processing reveals flare-ups in the media or social media using certain keywords when prices go their own way. OPEC headlines or presidential tweets send markets haywire. Talk of policy shifts or political changes draws a wedge between prices and fundamentals, resets market expectations and opens the door to market 'sentiment'. Once an intuitive, subjective notion, the latter is now legitimised by data science as a measurable force whose role and impact can be rigorously detected.

Unreliable data are no longer a good explanation for price surprises. Far from being an artifact of flawed statistics, discrepancies between prices and fundamentals are positive indicators of incipient institutional change. The correlation between prices and fundamentals comes under stress when the social and institutional contracts underpinning the oil market and oil price regime are being renegotiated—such as when market participants expect a change in producer countries' export targets, shifts in fiscal regimes and investment terms, or armed clashes affecting operations at oilfields or export terminals—even if conditions on the ground remain unaffected. While in the past identifying these moments of flux was a matter of intuition and expert judgment, new data technologies now make them visible and allow market players to time and measure their impact. Once nebulous and qualitative notions, these factors can now be empirically observed and objectively quantified with algorithms fed on automated data.

Fundamentals reconsidered

Re-examining these institutional, sentimental factors inevitably leads to a re-examination of fundamental factors as well. 'Sentimental' pricing regimes are inherently short-lived. They are by definition bridge periods, when market participants respond to underlying discontinuities in policy and/or underlying institutional arrangements before such discontinuities become reflected in fundamentals. Sooner or later, oil prices and inventories realign. Either expectations of policy change are fulfilled, as when OPEC enacts production cuts anticipated by the market and rewards bullish bets by driving inventories down to levels consistent with higher prices. In this case, the disconnect works as 'transitional' indicator of institutional change. Or they do not, and it is prices that move back to their previous level and realign with fundamentals. In that case, the disconnect is 'transitory'. Disconnects that last are no longer disconnects but effectively mark a reset, a paradigm shift towards a 'new normal', and new forms of structural relationships between prices and fundamentals.

This pivotal function of 'sentimental' price regimes speaks to one the issues at the heart of this book, the juxtaposition between 'exogenous' and 'endogenous' or 'the difference between *homo economicus* and *homo sociologicus*'. In the book's conclusion, Belyi notes that 'although one does not exclude the other, the divide between the two concepts is mostly about priorities in the causal chain. In particular, the debate between these two approaches prompts the following question: are exogenous economic interests or endogenous social relations the primary factor in economic developments and transactions'?

The chapters in this book show the relationship goes both ways: to consider the institutional dimension of the oil price inevitably leads to an examination of its interplay with fundamental factors, to an investigation of the interaction between *homo economicus* and *homo sociologicus*. It is not just oil prices that are at least partly driven by endogenous factors of human and sociological relations, as opposed to physical, exogenous factors of supply and demand. So are supply and demand themselves. At the same time, endogenous factors are partly shaped by exogenous factors.

Henry Deterding, the founder of Royal Dutch Shell, reportedly noted that 'petroleum is the most unusual product in world trade—its sale is only limited by what can be produced'. This view of the oil market as supply-driven and constrained only by issues of oil availability and scarcity is central to peak oil theory and the long-prevailing Hotelling model of reserve valuation. It has been thoroughly debunked. For the last 60 years, there has always been 20 years of reserves remaining.

Belyi observes how the invisible hand of the market provides for the constant replenishment of oil reserves, underscoring the impact of endogenous factors of human innovation, ingenuity and investment in supply replacement. The US shale revolution has helped thoroughly discredit Hotelling by providing a vivid example of the price sensitivity of petroleum reserves, replacing fears of scarcity with a sense of supply abundance. On paper, the shale success story is a textbook illustration of the price responsiveness of reserves: supply shortfalls lift prices and incentivise investment, which in turn foster exploration and advances in technology, which unlock reserves. The idea that oil sales are unconstrained by finite resources and that supplies grow endogenously on the strength of human innovation and in response to price signals has by now gained broad currency.

Less widely understood is the fact that price rallies can also inhibit supply growth by fueling resource nationalism and encouraging host countries to seek a higher share of the oil rent rather than production growth. Oil price rallies and selloffs are both self-correcting and self-sustaining. As the saying goes, the best cure for low prices is low prices, and the best cure for high prices is high prices. But rallies and selloffs can also feed into themselves through cycles of resource nationalism: in a rally, host countries can maximize short-term revenues by grabbing a bigger piece of the rent through tighter fiscal and investment terms, which in turn discourage investment and further curb supply, leading to ever-rising prices.

Demand is also both endogenous and exogenous, rising and falling in response to not only price signals but also consumer preferences, economic and demographic trends, and changes in technology, urbanization patterns, etc. Some of these factors may not be primarily driven by oil prices or oil market fundamentals.

The impact of price signals is thus far from straightforward but works its way through multiple channels and can be deeply affected by institutional factors that vary greatly from one country to the next. Establishing causality between endogenous and exogenous factors of oil price formation and ascertaining which is the primary factor in economic developments and transactions can thus be tricky. It may be more accurate to speak of interplay and mutually offsetting or reinforcing impacts between the two.

Considering the interaction between exogenous and endogenous factors in oil price formation blurs the line between these two categories, as seemingly endogenous factors can turn out to be driven in part by exogenous ones, and vice versa. Similarly, the line between fundamental and non-fundamental factors in oil prices is more tenuous than it appears, as political or geopolitical developments directly or indirectly impact fundamentals while shifts in market conditions also trigger political and geopolitical consequences. The moving line between exogenous and endogenous factors affects the definition and scope of these categories. There is a dynamic, evolutive quality to the category of oil market fundamentals so that today's definition of what falls within the scope of exogenous or fundamental drivers of oil prices differs from yesterday's, and will likewise vary from tomorrow's. Indeed, the whole history of the oil market may be described as that of the expansion of the category of oil market fundamentals in time.

Climbing the carbon wall

The scope of market fundamentals is partly set by institutional factors. Concerns over stranded assets sparked by climate policy as well as environmental, social and governance principles may already be curbing investment in the oil sector and causing a repricing of oil reserves and of company share prices, if not yet commodity spot and future prices. Forecasts of diminishing oil demand in the context of a decarbonizing economy would be expected to affect estimates of the long-term value of oil assets—even a resulting investment deficit could also cause price spikes along the way. More broadly, any effort to price in the climate and environmental externalities of oil production and consumption will necessarily require the integration of their carbon footprints within the scope of oil market fundamentals.

Concerns over climate change and the environment are taking center stage in public policy, investment strategies and trade agreements. Companies across all sectors of the economy face the urgent need to demonstrate their environmental sustainability. Few sectors are more directly exposed to climate risk than the oil and gas industry. As an example, Larry Fink, CEO of BlackRock, the world's largest asset manager, described 'a fundamental reshaping of finance' in a widely read 15 January

2020 letter. Fink says 'climate change has become a defining factor in companies' long-term prospects', adding: 'With the impact of sustainability on investment returns increasing, we believe that sustainable investing is the strongest foundation for client portfolios going forward'.

Meanwhile, policymakers are also rising to the task. In December 2019, the European Commission adopted the European Green Deal. As European Commission President Ursula von der Leyen noted in prepared remarks: 'The old growth-model that is based on fossil fuels and pollution is out of date, and it is out of touch with our planet. The European Green Deal is our new growth strategy'. The package will likely include a 'carbon border adjustment mechanism' for selected sectors to be introduced by 2021. The EU is taking the lead in climate policies with measures that will likely have far-reaching implications for energy trade and the global economy.

The price trajectory that oil prices are likely to follow as a result of these policies is unclear: prices could fall on reduced demand or rise on lack of investment, triggering a price shock and thus accelerating fuel switching away from oil in disorderly fashion. Implications for the relative pricing of various types of crude oil and refined products appear clearer, however: their respective carbon footprints are set to be key determinants of their prices.

Two main considerations arise from these developments: the need for carbon disclosures and the need for carbon technologies. First, in order to adequately price in the climate externalities of oil, transparency and accountability are a sine qua non. Just as Tarbell's narrative of exposure on Standard Oil provided the impetus for reform and the oil price literature of the 1950s and 60s set the stage for the assertive policies of producer countries and subsequent repricing of oil, so too is a new narrative of exposure on the real climate cost of oil needed for a corresponding repricing. At the time of writing, emission data available from commercial technology do not yet provide the required level of transparency and granularity on the oil sector's share of global emissions and their distribution within the industry. But the capacity to generate detailed measurements of major concentrations of carbon and fugitive methane and identify their sources is rapidly being developed. As the technology is fine-tuned, the GHG footprint of every barrel of oil will be assessed and its price affected accordingly. This new form transparency will set a new standard for oil pricing, expose mispricing and price disparities across crude and products types, and set the stage for a fundamental reset of oil pricing. Crude grades whose price relative to benchmarks is now determined mainly by their differences in gravity and sulfur content will now include carbon footprint as a key price criterion. The relative price of any crude grade or product will thus depend on three main characteristics: GHG, sulfur and gravity. Data science and new technologies will provide the capacity to generate objective, reliable, granular and up-to-date third-party measurements, rather than having to rely on self-reporting by individual companies. They will thus be the enabler of this new pricing regime and the trigger for temporary pricing discontinuity, just as Tarbell and the oil nationalists were in their days. Satellite imaging and other new technologies will make GHG emissions visible and quantifiable, just as they have already shed light on previously opaque aspects of the oil market.

Second, carbon is set to replace production capacity as one of the main constraints facing the oil market. While the idea of resource constraints has largely been debunked, concerns are mounting about the hard limits of our already largely depleted 'carbon budget'. Carbon may not currently qualify as an oil market 'fundamental' and could remain a socio-political consideration rather than a direct price driver. Climate policy and new data technologies are gearing up to change that, however, and turn oil's emission footprint into an exogenous factor, one of its hardest fundamental constraints.

Once climate policy assisted by technological innovation manages to turn carbon into an exogenous driver, industry's oil will be to turn it back into an endogenous driver by developing the technological capacity to overcome this barrier. Just as necessity and human ingenuity, spurred by price signals, helped overcome the challenge of seemingly finite resources, so too will human ingenuity and innovation, spurred by carbon pricing, overcome the challenge of the depletion of our carbon budget—whether through carbon capture, storage and utilization, through carbon offsets, or changes in oil use and demand efficiency. These technological breakthroughs will only occur once data science identifies super-emitters and provides adequate third-party measurements, so that opportunities for impactful improvement can be identified and progress toward abatement and remediation accurately measured.

The next chapter

In the age of the Anthropocene, even the climate is endogenous. The line between fundamental and non-fundamental factors in oil price formation is getting blurrier. While the laws of supply and demand continue to drive market dynamics, supply and demand themselves reflect endogenous factors as much as the hard realities of geology and carbon constraints.

Throughout oil history, industry stakeholders have held up the oil price as a socio-political banner. As climate worries grow and the sustainability agenda gains traction, oil price controversies will again take center stage. Carbon pricing will likely trigger new market discontinuities affecting both the general trajectory of oil prices and the relative price of various crude grades and refined products depending on their relative emissions footprints.

Repricing oil to account for climate externalities may not spell the end of the oil industry but stimulate instead investment in technologies needed to keep oil relevant as fuel and petrochemical feedstock in a low-carbon world. Carbon capture, carbon offsets, demand management and other technologies may help overcome the carbon barrier just as drilling innovation and seismic surveying helped overcome supply scarcity constraints in decades past. If so, oil's ability to adjust depends on the oil price.

Technology looms large in oil's future just as in its history. Data science will likely provide the transparency on GHG emissions needed to measure oil's footprint and extend its prospects in a clean economy.

Accounting for the emission footprint of oil, internalizing the sector's climate externalities entails turning a distant policy concern into a hard market fundamental. Oil's future and its ability to overcome carbon constraints depend in large part on the capacity of price signals to convey societal choices. *The oil price as institution is the key to the industry's survival*.

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