Transformation, Not Diversification?

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I. Introduction

The collapse in oil prices that started in 2014 has put diversification at the forefront of the policy debate in many nations that have been dependent on fossil fuel production. Many oil rich countries have indeed either announced or already put in place policies to help transform their economies and move away from the dependence on oil. Diversification strategies have been pursued in the past and historically those managed by the state have not worked. That's because top-down management almost inevitably shies away from actions that would facilitate the diversification process because it does not empower managers (and their teams) who are best able to guide the process and adapt to new circumstances. In other words, states should not concentrate on the end goal—that is diversification—and focus instead on what is required to get there, no matter how disruptive that transformation process might be to traditional production.

Energy markets are subject to changes in technologies that affect producers and users alike. These changes—such as certain innovation in oil drilling techniques or in battery technology for automobiles—can be risky for oil companies and national economies that depend on fossil fuel production.[1] But technological change can also offer new opportunities for growth and profit.

The biggest risk to producers and economies comes from changes that cause oil price collapses followed by a protracted period of low prices, as is occurring now (see Figure 1). What is more is that low prices could strand oil reserves—which will be left in the ground because they are no longer economical to extract—a sharp blow to economies whose national wealth is heavily bound up with fossil fuel reserves.

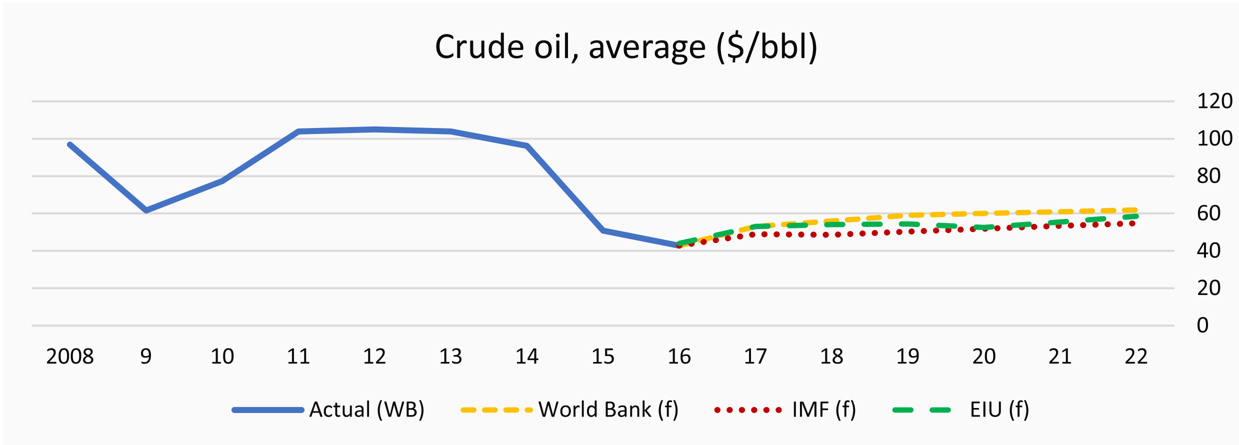
The opportunities associated with technological change include potential improvements in extraction efficiency that permit profitable production of oil at lower prices. Other changes not directly associated with oil, such as the development of technologies around renewable energies, can allow economies that have say a high potential for solar irradiation to limit the risks of trying to develop non fossil fuel industries and better align with the goals set by the 2015 Paris Climate Accord. The accord, if adhered to, will reduce the burning of oil, natural gas and coal and further depress their prices.

Policies geared toward "behavioral change"—i.e. change in attitude toward innovation and risk taking of managers and employees—especially as they relate to how firms govern themselves, can complement policies that have so far focused almost exclusively on improving the business environment outside the firm. Specifically, to induce behavioral change, policies should aim at turning state owned enterprises (SOEs) in the oil sector into publicly listed corporations. That would enhance their

[1] Oil and fossil fuels are used interchangeably thereafter.

transparency and efficiency and make them more accountable. The result should be that instead of timidly approaching diversification, SOEs would be sitting at the technological frontier in the energy sector and exert positive spillovers to the rest of the economy that would drive overall development. That is, of course, a tall order but one that should be the goal.

Figure 1. low for long



Sources: World Bank (WB), International Monetary Fund (IMF) and Economist Intelligence Unit (EIU), Commodity prices reports.

Note: f stands for forecast.

The focus on transformation—rather than diversification—also has important policy implications for the energy (-producing and -using) industry and the ever-growing number of countries that are dependent on the exploitation of energy resources. This new focus has also broader relevance for the global community as it relates to the economic consequences of the needed transformation of energy markets to support the goal of limiting global warming by reducing greenhouse gas emissions.

The remainder of this paper is as follows. The second section explores the role of technological change in shaping energy markets. The third section discusses the nature of the risks and opportunities associated with the changes occurring in energy markets. The fourth section argues for the need for economic transformation of oil dependent economies and SOEs. The fifth section concludes on the modalities for the shifting landscape for "big state oil."

II. The role of technological change in shaping energy markets

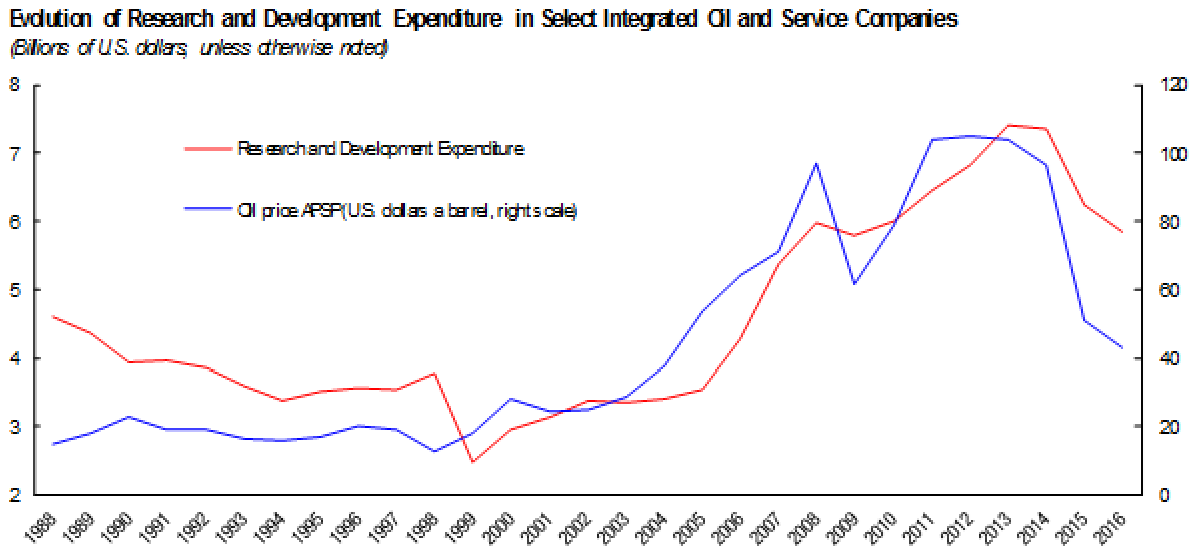
The literature on understanding energy and more broadly economic cycles can be interpreted as entertaining two views–one narrow, the other broad.

The narrow view emphasizes short term factors as key determinants of energy and more specifically oil market fluctuations. It emphasizes that relatively small shocks such as a disruption of production can have outsized effects on prices. The underlying assumption is that supply and demand cannot change very much in the short term, regardless of what happens to prices. People cannot easily shift their commutes or change their vehicles. Oil producers cannot turn a production spigot on and off. (Blanchard and Gali, 2009; Hamilton, 2003). In fact, the long lead time between first investment and first production in the oil sector is often used to explain the boom and bust cycles in prices.[2] Or as many in the industry put it, "the best cure for low oil prices is low oil prices." That's because low oil prices discourage investment in production capacity which eventually causes prices to rise as existing oil fields–which can be tapped at relatively low marginal cost are depleted.

But the adage gained its currency before the advent of shale oil production, which can be turned on and off much faster than conventional production. The new shale oil production—made possible by new technologies such as hydraulic fracturing ("fracking") and horizontal drilling—will lead to shorter and more limited oil-price cycles. In the narrow view, however, technological innovation--both among producers and users—results from exogenous—that is independent, external—forces. The data seem to suggest otherwise—that technological change is, in economic parlance, endogenous to market developments. Periods of high oil prices tend to stimulate expenditure in research and development and subsequently innovation (Figures 2 & 3).

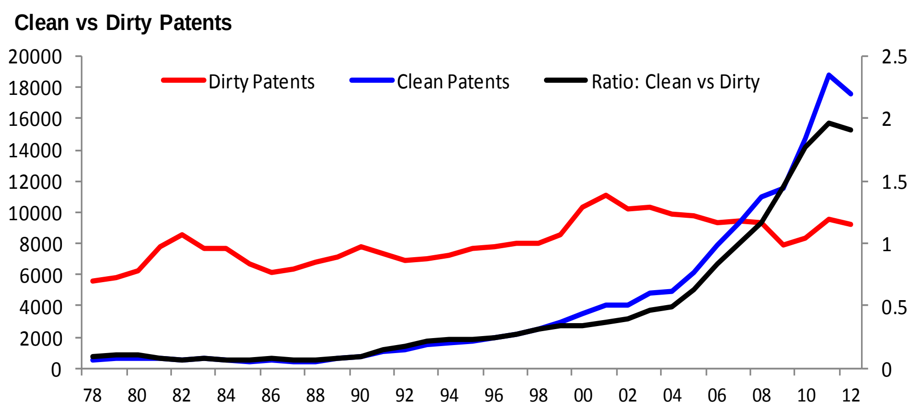
Figure 2. research and development and oil prices move in sync

[2] The anticipated nature of lead times for conventional oil raises concerns as to whether lead times are valid explanations for boom and bust cycles especially if agents are forward-looking and/or that they learn.



Source: IMF, Primary Commodity Price System; Bloomberg L.P.
Note: APSP= average petroleum spot price - average of U.K. Brent, Dubai, and West Texas Intermediate, equally weighted. The list of companies included are Baker Hughes, BP P.L.C., Chevron, ExxonMobil Corporation, The Halliburton Company, Royal Dutch Shell plc, Total S.A., and Schlumberger Limited.

Figure 3. the rise of cleaner technologies in transportation



Source: Aghion, Dechezlepretre, Hemous, Martin and Van Reenen (2012), calculations based on the PATSTAT database.

The “broad” view emphasizes “medium run” factors, specifically (endogenous) technological change. The insights from that literature date at least back to Kondratiev and Schumpeter (i.e. creative destruction theory). To the extent of our knowledge, little attention in the economics literature has been paid thus far to the role that technological changes play in shaping the dynamics of energy markets. Nevertheless, research on medium term business cycles (Gertler and Comin, 2005) can help us understand oil and energy market developments. Among other things, this research emphasizes the endogenous nature of technology adoption in explaining economic cycles (Anzoategui et al. 2016). One of the key mechanism is the so-called market size effect that drives entry and (process) innovation in the sectors affected by the market change (Acemoglu et al. 2004).

The problem with the broad view is that the precise timing at which technological changes affect expectations—and hence energy prices—is hard to determine empirically. Moreover, the potential consequences of these technology changes on supply and demand for energy are uncertain. In determining the impact on prices one need to be cognizant about the importance of "learning" associated with new technologies including in relation to the pace of their adoption and diffusion which can differ widely over time and space.

A. Rethinking the 2014 oil price collapse

In the 2014 oil price collapse, most studies have emphasized excess supply (Arezki and Blanchard, 2014) as the dominant factor, Because a sudden increase in supply, a seemingly exogenous development, was the overarching reason for the drop, there should have been a strong positive impact on the global economy.[3] So far, there has not been one (Obstfeld, Arezki and Milesi-Ferretti 2016).

Part of the reason may be that the increase in supply was not an independent change but one due to powerful shifts in technology. Technological innovation and the subsequent adoption of new recovery techniques—including for drilling and processing—have given rise to new sources known as “unconventional oil.” For example, oil produced from shale (also known as tight oil), has become a major contributor to the global oil supply. Provided they are effective and widely adopted, improvements in recovery techniques increase the size of technically recoverable oil reserves. This increase, in turn, changes the outlook for oil supply—with potentially large and immediate implications for oil prices—by changing expectations about the future path of oil production. Increased supply lowers oil prices, but even if this has the effect of reducing investment, and hence production, the industry is nonetheless forced to become more efficient to compete with unconventional production, unleashing automatic stabilizating forces.

Innovations in recovery techniques typically follow periods of prolonged high prices or changes in regulations that render the new techniques more economical. New oil sources often come on stream in times of need—because of, say, the depletion of existing conventional sources—and in places like the United States and Canada that have economic and institutional systems more favorable to both innovation and the adoption of new recovery techniques. Innovation has led to significant improvements in

[3] In contrast with the (seemingly exogenous) supply component, the demand driven component of the oil price decline is a symptom of slowing global economic activity rather than a cause.

drilling techniques such as 3D imaging and fracking. Fracking, in which water is injected to free up petroleum trapped in layers of rock, gave rise to the production of shale oil in the 2000s. In the wake of the two oil crises of the 1970s, which dramatically increased oil prices, successive improvements in techniques for deep-water drilling spurred production in the North Sea and the Gulf of Mexico. In both instances, innovation paved the way for new oil sources in relatively high-cost producing locales and gave rise to tensions with the lower-cost producers from the Organization of Petroleum Exporting Countries (OPEC), which in the 1980s and again more recently responded strategically by adjusting their production levels.

III. Risks and opportunities associated with the oil price collapse

Technological changes on oil and energy markets can both threaten and enhance the outlook for economies and companies that depend on oil.

A. Risks

from surpluses to deficits

The protracted low oil prices have had dramatic, if divergent, effects on oil exporters. The fall in oil prices led to decreases in real income. But the severity of the effect of the decline in the price of oil on GDP depends very much on how dependent a country is on oil exports, and on what proportion of oil revenue goes to the state.

According to the International Monetary Fund, for example, before the 2014 decline, energy accounted for 25 percent of Russia's GDP, 70 percent of its exports, and 50 percent of federal revenues. In the Gulf Cooperation Council countries in the Middle East, the share of oil in federal government revenue is 22.5 percent of GDP and 63.6 percent of exports. In Africa, oil exports accounts for 40-50 percent of GDP for Gabon, Angola and the Republic of Congo, and 80 percent of GDP for Equatorial Guinea. Oil also accounts for 75 percent of government revenues in Angola, Republic of Congo and Equatorial Guinea. In Latin America, oil contributes, respectively, about 30 percent and 46.6 percent to public sector revenues, and about 55 percent and 94 percent of exports for Ecuador and Venezuela.

In most oil-dependent economies, the oil price decline led to fiscal deficit and an associated current account deficit. Some countries were better-equipped than in previous episodes to manage that adjustment. A few, such as Norway, have put in place policy cushions—such as fiscal rules that constrain overspending in good times and saving funds— and have more credible monetary frameworks. These policies have helped countries stave off or moderate recessions even when they have a sharp increase in their current account deficit. That said, oil dependent economies have to look beyond the stabilization of their economies and worry about new risks because they rely so heavily on fossil fuels for development.

Stranded assets

The historical COP21 agreement to keep global warming below 2 degrees Celsius and the technological innovation (such as declining cost of renewable energy sources and electric cars) have accelerated the global energy transition away from oil and more generally fossil fuels. That means that many fossil fuel reserves will remain underground, unexploited. Indeed, to keep mean global surface temperature below 2 degrees Celsius, only 300 to 400 gigatonnes of carbon can still be burned–a third of the reserves of major private oil and gas companies. To abide by international commitments to limit global warming, a third of oil, half of gas, and 80 percent of coal reserves should be kept in the ground forever (McGlade and Ekins, 2015). This would mean keeping unburned one third of oil reserves in Canada and the Arctic, 50 percent of gas and 80 percent of coal (mainly China, Russia, US). In the Middle East, reserves are three times larger than their "carbon budget". In other words, 260 billion barrels of oil in Middle East cannot be burnt. In addition to stranded reserves, the structures and capital used in extraction and in exploitation of fossil fuel can also become stranded.

One implication of the potential stranded assets is that it could lead to a race to burn the last ton of carbon. That could in turn lead to the so-called green paradox whereby regulation aiming to limit carbon emissions end up raising the latter at least in the short run (van der Ploeg, 2011). Some commentators have argued that the collapse in oil prices and the attempt on the part of major oil exporters with low marginal cost of production to crowd out higher marginal cost producers could delay the energy transition (Arezki and Obstfeld, 2015; Aghion and al. 2016).

While the risk of stranded assets for fossil fuel exporters appears to be remote, it does pose an existential threat that dependent economies cannot afford to ignore.

B. Opportunities

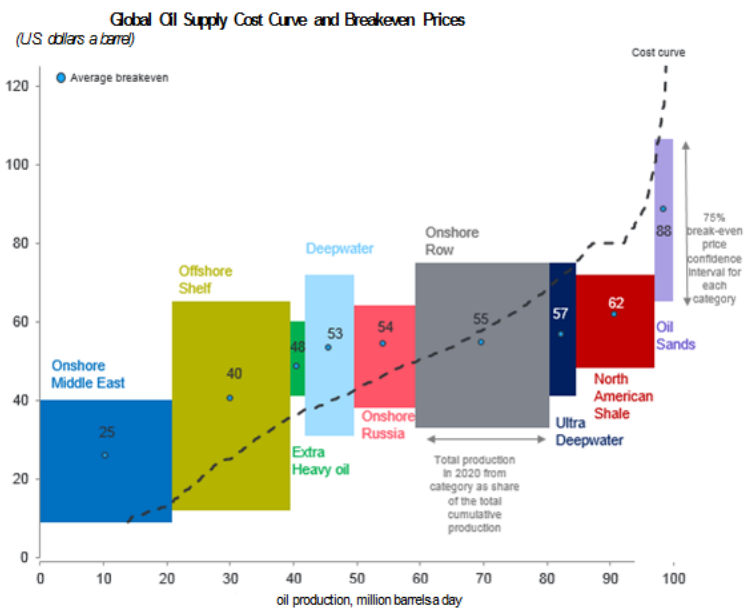
Efficiency gains

Although the abrupt decline in prices led in turn to a reduction in investment and expenditure, there is a silver lining for corporations as the reduced spending leads to large operational efficiency gains.[4] This benefit is generally not recognized because the commonly held belief is that that the cost structure—which is often proxied by the lowest price at which it is economical to produce a barrel of oil—is constant and driven by immutable factors, such as the nature of the oil extracted and the associated geology (see Figure 4). In practice, the cost structure depends on many factors, including technological improvements and the extent of "learning by doing," which both permanently reduce costs. In some instances, breakeven prices have fallen in sync with oil prices. That type of shift is explained by operational efficiency gains that help the service industries that support oil production (infrastructure, drilling supplies, transportation, storage, and the like) significantly reduce their costs. For shale oil production, the extraordinary resilience to the decline in oil prices

[4] There are two main sources associated with the reduction in the aggregate cost structure following the oil price collapse. The first is the reduction in exploration and investment in higher cost fields which mechanically drives down aggregate costs. Second, the operational efficiency gains in the form of optimizing the use of entrants also cause a downward shift in the aggregate cost structure. The downward shifts are thus partly temporary.

can be explained by important efficiency gains and also by the fact that shale production came online at the onset of an investment cycle in which learning by doing was important. The shale cost structure is likely to increase somewhat because expanded oil production will require an increase in investment and the cost of capital is likely to increase if U.S. interest rates rise as expected.[5]

Figure 4. the static view of breakeven prices



Source: Rystad Energy research and analysis;
Note: NAM = North America. The breakeven price is the Brent oil price at which NPV equals zero, considering all future cash flows using a real discount rate of 7.5%. Oil refers to crude oil, condensate, and natural gas liquids.

Renewables

[5] The shift in the cost structure has not been uniform across unconventional sources. Oil sands production costs have continued to grow at high rates, in part because of the high costs of decommissioning processing plants.

The technological changes driving the energy transition from fossil fuels to renewable sources present economic opportunities—including for those countries that risk stranded assets. One of the most notable trends in energy consumption is the increased use of renewable energy resources as the cost of renewables such as solar and wind have declined. These cost reductions are the result of research and development efforts to promote clean energy and energy efficiency ("grey" technology). Research and development (R&D) investment dates back to the 1970s, when fossil fuels reached record-high prices. Unsurprisingly R&D was then mostly government funded because the private sector typically does not internalize the positive externalities associated with an increase in R&D especially at the early stage of development of the technology. Public R&D spending early on, however, paved the way for corporate R&D spending during the 2000s, another period of high fossil fuel prices. The result has been a flow of technological innovations across sectors, including the development of electric and natural-gas-powered vehicles.[6] The International Energy Agency forecasts that the share of renewables in global total primary energy consumption will increase from 14 percent in 2013 to 19 percent in 2040 as a result of expected energy policy changes. Electricity generation is set to change dramatically: renewables are expected to be used to generate about 34 percent of all electricity by 2040, up from 22 percent in 2013.[7]

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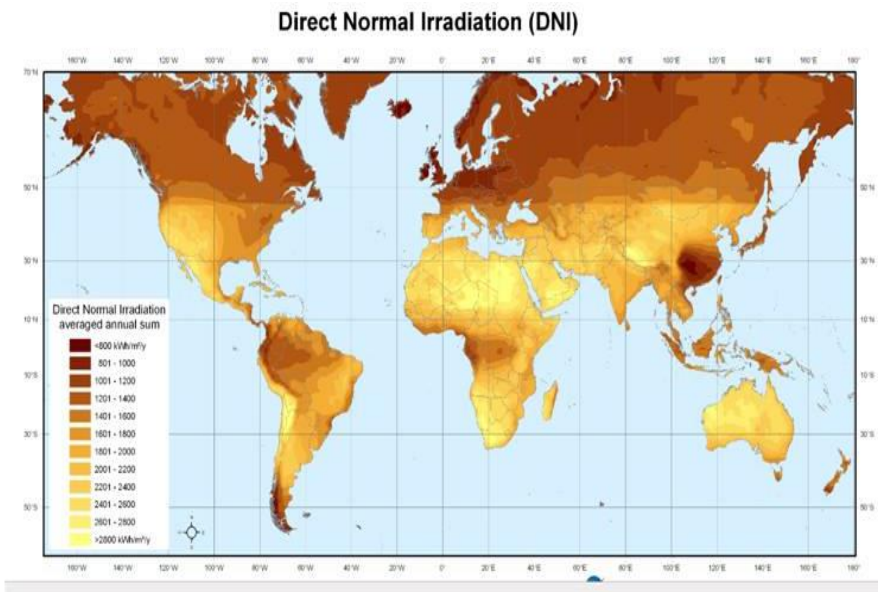
[6] The outlook for alternative fuel vehicles is somewhat mixed. There has been an increase in use of compressed natural gas for transportation, particularly commercial fleets and buses. But sales of electric cars, notably plug-in hybrid vehicles, still have a low penetration rate, accounting for less than 1 percent of car sales in the United States. Unsurprisingly, electric car sales in the United States have decreased with the recent drop in gasoline prices.

[7] One obstacle to increased use of renewable energy in power generation is intermittency and hence reliability. Unstable supplies of wind, sun, and rainfall can trigger a mismatch between supply and demand. Addressing this will require ramping up of supply during daily peaks to achieve load balancing. In other words, the intermittencies associated with the increased usage of renewables trigger spikes in

Many Middle East and North African economies are investing in renewables. According to the U.S. National Aeronautics and Space Administration, solar power concentration is highest in the Middle East and Africa and parts of Asia and the United States, (see Figure 6). The United Arab Emirates—an oil-exporting country—and oil-importer Morocco, have both embarked on ambitious efforts to develop renewable energy resources. The United Arab Emirates wants to draw 24 percent of its primary energy consumption from renewable sources by 2021. Morocco, the host of the 2016 United Nations Conference on Climate Change (COP22), has unveiled the first phase of a massive solar power plant in the Sahara Desert that is expected to have a combined capacity of two gigawatts by 2020, making it the world's largest solar power production facility. But even if an economy has the natural endowment of renewable resources, developing them can be difficult unless the economy has the needed infrastructure, human capital, and soft capital—the right enabling environment (Collier and Venables, 2012).

demand for "controllable" power, for example power generated from natural gas. To overcome this problem, the power sector needs to develop economical battery backup technology and foster electricity exchange. Battery technology has shown steady progress, suggesting that electricity storage technology eventually will facilitate a more widespread reliance on renewables.

Figure 6. the geography of solar potential



Source: U.S. National Aeronautics and Space Administration

IV. The need for transformation

A. Focus on the process

A change in approach is needed. Many fossil fuel exporters feel the need to diversify their economies, but very few have (Venables, 2016). The regulatory and technological change sweeping energy markets make diversification more urgent.

But diversification efforts are often stymied by the top-down approach of the state, which has not allowed managers and other economic agents to feel empowered enough to innovate and take risks. For example, the incentive structure of state-owned companies in many countries have failed to consistently encourage managers and employees to achieve their full potential and adapt to the technological changes rapidly affecting their industry. Indeed, instead of concentrating on core issues, many state-owned companies often embark on missions outside their core activities and competencies, innovate very little and struggle to keep talented employees.

But if countries were to shift their focus from the end goal, diversification, to how to get there—that is, on the transformation process—they may find it easier to diversify. By embracing transformation, countries will focus on getting incentives rights for economic agents and turn into friends the technology and innovation that energy markets now see as disruptive enemies. They are less likely to stumble or to resist changes.

Indeed, adapting to technological changes in energy markets can help the sustainability of economies that depend on oil revenues. More agile economic systems with the appropriate corporate governance structures can more easily leverage existing technological innovation to mitigate risks associated with potential disruptions in energy markets and even create opportunities, including in renewables.

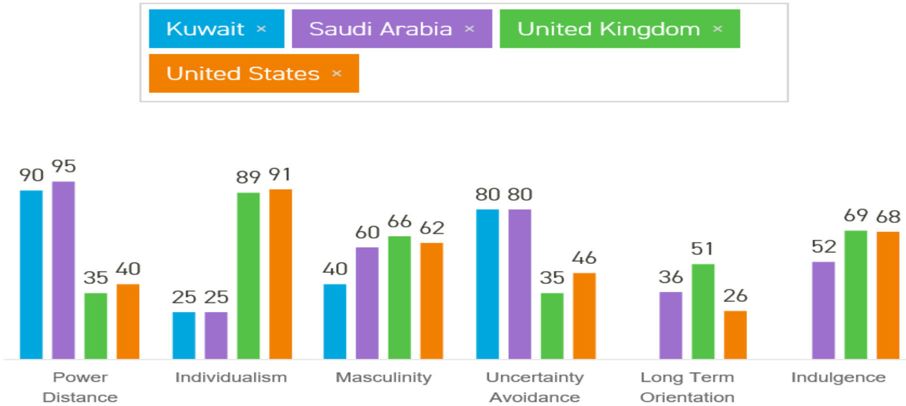
B. Transformation as behavioral change

The literature on the so-called resource curse has long emphasized the role of strong institutions in alleviating the challenges faced by resource rich countries such as the Dutch disease (loss in competitiveness), volatility, excessive spending and indebtedness, and conflicts (Frankel, 2012). What has been less explored is the role of attitudes, especially toward innovation and risks. Societal attitudes toward innovation and risks affect how governments, firms, and citizens react to market disruptions, including those that originate from technological change. Attitudes toward innovation vary considerably across countries. The most relevant psychological traits that can affect the ability of some oil-dependent economies to innovate are power distance (the way in which power is distributed), avoidance of uncertainty, and individualism (as identified by Hofstede Insights, a Dutch social psychologist. Oil-dependent economies tend to be subject to more power distance, avoidance of uncertainty and less individualism than diversified economies (see Figure 7).

Overall, oil-dependent economies tend to innovate much less than non-dependent economies. Indeed, a casual look suggests that natural resource dependent economies, not just those dependent on oil, spend far less on R&D spending (see Figure 8).There is however substantial heterogeneity across economies.

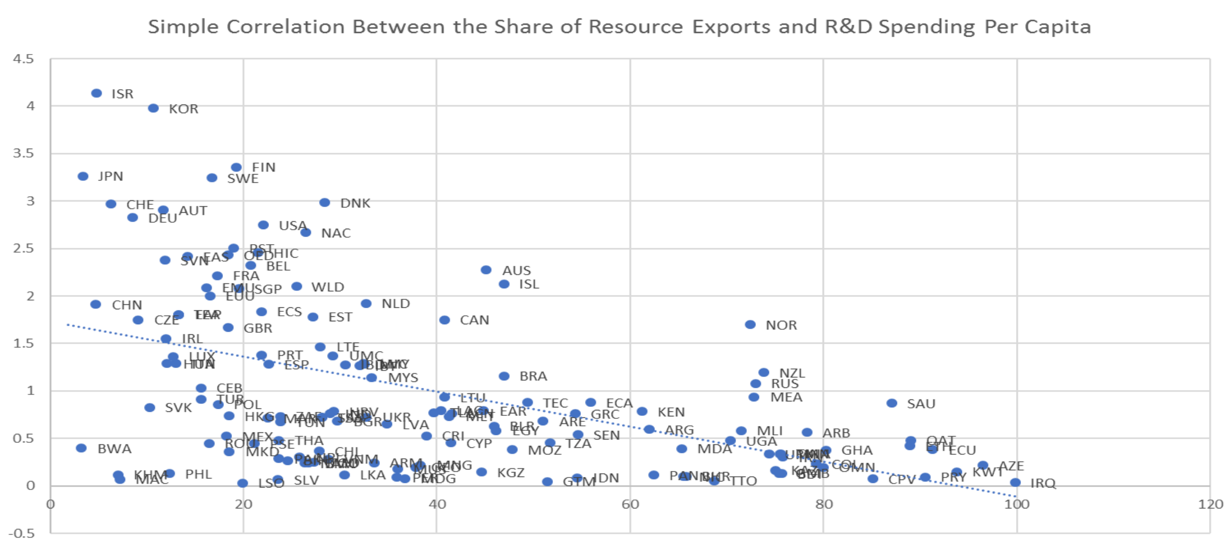
But it is not only external factors (institutions that mediate interaction “between firms”) that explain differences in performance across resource economies, factors that relate to “within firm” governance are also important and have received little attention.

Figure 7. attitude toward innovation



Source: Hofstede Insights

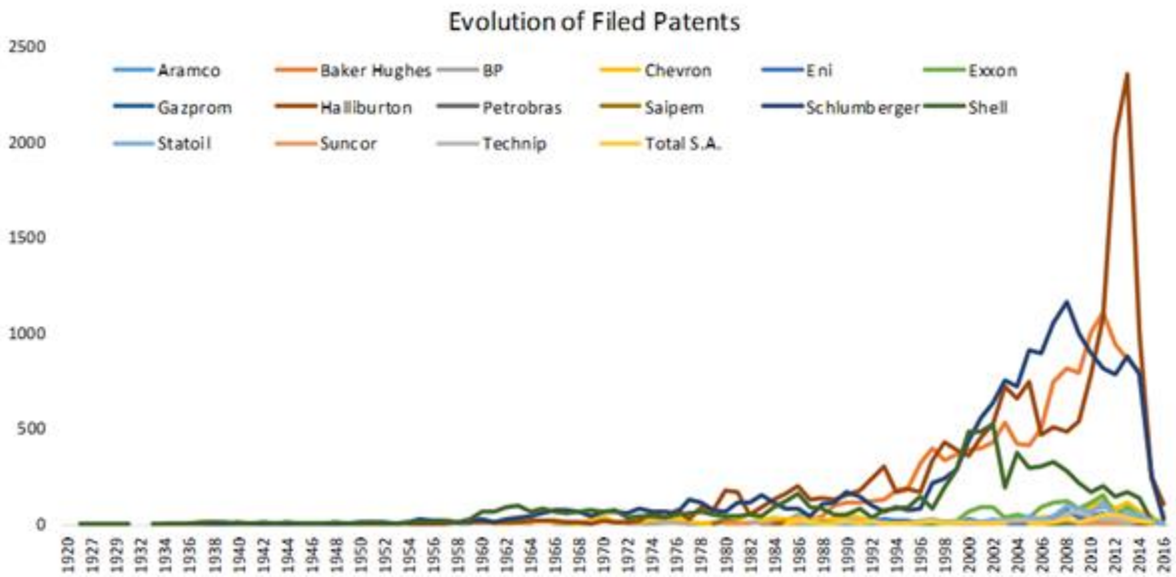
Figure 8. the curse of innovation



Source: World Development Indicators, World Bank

Such within firm factors as corporate governance are important determinants of whether the oil sector can transform and adapt to the changing reality of global energy markets. The data suggest that there are important differences in the level of innovation when comparing corporations—private versus state-owned. State-owned enterprises lag behind when it comes to the propensity to innovate (see Figure 9). Indeed, to the extent that the abundance of resources tends to direct the technological change toward capital-intensive activities such as exploration and extraction, it furthers the specialization of these economies (see Acemoglu, 2002). So, it is all the more important to design the incentive structure to further enhance attitudes toward innovation within the oil sector, also considering the potential synergies between the production of different sources of energy.

Figure 9. patents and corporations



Source: PATSTAT

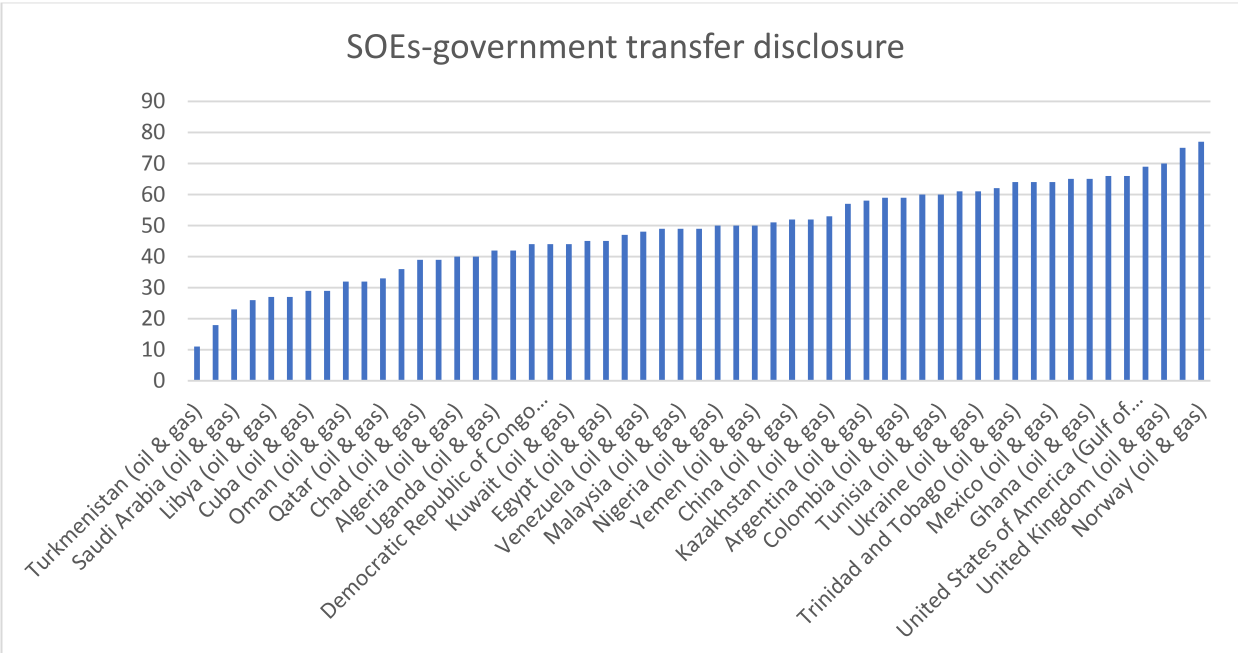
Note: Select companies include Aramco, Baker Huges Intl., British Petroleum, Chevron, Eni, ExxonMobil, Gazprom, Halliburton, Petrobras, Saipem, Schlumberger, Royal Dutch Shell, Statoil, Suncor, Technip, Total S.A. PATSTAT assigns a value of "1" when the patent was granted or "0" when no publication is available that the patent was granted. Publication can take up to a maximum of 18 months. Only effective applications that entered the national phase, with kind code "A" in PATSTAT have been aggregated.

V. Shifting landscape for "big state oil"?

The adage that "necessity is the mother of invention" seems to have a particular resonance when considering the need to develop economic systems and corporations that are resilient to the transformation facing energy markets. The ability or willingness of corporations to innovate is influenced by their structure of ownership. This is clear when contemplating the challenges faced by large state oil corporations. Embracing the "letter and spirit" of modern corporate governance (that is a function of ownership, organizational structure and manager empowerment) is key to achieving transparency and efficiency.

Indeed, while many state-owned enterprises sit on the largest and cheapest to extract oil reserves, many are heavily indebted (Venezuela, for example). The status quo is not sustainable as they risk becoming stranded firms. Considering the low oil price environment and the need for large investment and technological upgrade, opening up their capital to foreign investors seem to be inevitable. Indeed one key difference between state-owned and publicly listed companies (and private corporations) is that the former typically have soft as opposed to strict budget constraints. Exclusively state-owned enterprises are typically less transparent and less innovative than those with foreign or private participation. Transparency is the best disinfectant. According to the Natural Resource Governance Institute, Norway's state-owned oil sector is among the most transparent when it comes to the disclosure of the flow of funds between corporations and the budget while Saudi Arabia's oil sector is amongst the least transparent (see Figure 10).

Figure 10. transparency



Source: Natural Resource Governance Institute

Exclusively state owned corporations tend to not separate control from management. That typically limits the empowerment of managers, who are key not only to the success of the firm but to economic development in general. In fact, several developing countries have in the past criminalized business mistakes, especially for top executives of state owned enterprises, which discourages employees from risk-taking and economic initiative.

In the past decades, there has been an important shift in opening the capital of state-owned oil corporations, including in China, Brazil and Mexico. In December 2017, Abu Dhabi National Oil Corporation (ADNOC) successfully launched an initial public offering (IPO) one of the first among large Middle East oil exporters. Saudi Arabia, as part of its ambitious plan to transform its economy, has announced that it would sell 5 percent of the state-owned oil company, ARAMCO, in an IPO. That appears to be a step toward emulating publicly owned Western companies such as Exxon, ENI, and BP that once concentrated on oil and gas, but have broadened their focus to become energy companies—balancing their oil and gas assets with other forms of energy.

But can IPO help diversification and spill over to the rest of the economy? How should they be structured?

Publicly listed companies (also to a lesser extent privately owned firms) are typically more transparent. Also, because publicly listed companies have a more diffused ownership and hard budget constraints, management is typically more accountable (to shareholders). Publicly listed firms perform better and are more innovative (Gilje et al. 2016). Indeed, as mentioned earlier, many of these firms were able to significantly increase efficiency after the collapse in oil prices and continue producing at lower prices.

It also matter where the public shares of these companies are traded. Indeed, different stock exchanges are associated with different disclosure rules (in contrast to when a SOE is subject to a private placement). There is a pecking order of stock exchanges in terms of disclosure rules. Choosing the stock exchange where disclosure rules are stricter could thus be seen as a commitment device for SOEs and the associated government to enhance transparency. Indeed, in the United States, the 2010 Dodd-Frank Act requires petroleum and mining companies listed on the Securities and

Exchange Commission to disclose how much they pay to governments (Heuty, 2011). The Europe Union followed suit in 2011 when the European Union (EU) required EU-based companies to disclose their payments to governments for oil, gas, minerals, and logging on a country-by-country and per-project basis. The US and EU rules are more stringent that the Extractive Industry Transparency Initiative, known as EITI, which is voluntary reporting system for payments.

IPOs can also help raise corporate efficiency through enhanced "innovatedness". Indeed, IPOs are typically associated with a significant rise in the number of patents filed (Acharya et. al. forthcoming). Interestingly, R&D significantly increased in the oil sectors of China and Brazil after IPOs by PetroChina and Petrobras.

More broadly, the access to the cheapest oil reserves by major Western corporations has been limited for decades and has hence influenced the direction of technological change (away from an oil-centered global energy mix). As mentioned earlier, these Western corporations have moved from exclusively oil to broader energy companies. If these multinational corporations were to gain greater "access" to the cheapest source of oil, including that in the Middle East at the same time that corporate governance was improving in SOEs, important progress could be made toward promoting cleaner oil technology and facilitating the movement toward renewables among SOEs.

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