To Rent or not to Rent? Mechanics, Causes and Consequences of Ricardian and Quasi-rents in the Oil Industry

Will Gochberg
Washington University

Victor Menaldo
University of Washington

How are Quasi-rents different from Ricardian Rents? How do both differ from Market Power Rents? Do differences in institutions, rulers' time horizons, and policies determine what type of rents predominate? Using the oil industry as a laboratory, this paper explicates the key differences between rent types and explores their causes and consequences. Sometimes, the state generates oil rents through appropriation (Quasi-rents); other times, several states engage in collusive behavior to reduce the global supply (Market Power Rents). Or, the underlying basis of oil rents may be a lack of the diffusion of technology or knowhow that therefore allows some firms or oil fields to monopolize a cost advantage that translates into consistently greater economic profits than its rivals (Ricardian Rents). Most simply, rents may bespeak immutable geological features (Ricardian Rents) and have nothing to do with engineering prowess (also Ricardian Rents) or opportunistic holdup by shortsighted state authorities (Quasi Rents). This is similar to when the state imposes price controls on any industry, making it impossible for economic actors to recover their long run costs. And this makes it more likely weak states will continue to appropriate Quasi-rents across economic sectors, fueling underdevelopment.

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How are Quasi-rents different from Ricardian Rents? How do both differ from Market Power Rents? Do differences in institutions, rulers' time horizons, and policies determine what type of rents predominate in an economic sector? Across an economy? Does this matter?

Using the oil industry as a laboratory, this paper explicates the key differences between these rents and explores their mechanics, causes, and consequences. Sometimes, the state generates oil rents through appropriation (Quasi-rents). Or, the underlying basis of oil rents may be a lack of the diffusion of technology or knowhow that therefore allows some firms or oil fields to monopolize a cost advantage that translates into consistently greater economic profits than its rivals (Ricardian Rents). Most simply, rents may bespeak immutable geological features (Ricardian Rents) and have nothing to do with engineering prowess (also Ricardian Rents) or opportunistic holdup by shortsighted state authorities (Quasi Rents).

Spelling these nuances out helps us make sense of the fact that while some oil rich countries are highly developed, including the United States, Canada, and Norway, others are institutionally dysfunctional and poor, such as Venezuela and Iran. Simply put, the appropriation of Quasi-rents by myopic governments *is*, in a sense, underdevelopment. When governments such as Mexico's nationalize and then tax their oil sectors into the ground, it reflects their relatively short time horizons. This is similar to when the state imposes price controls on any other industry, and thus makes it impossible for economic actors to outrun depreciation and recover their long run costs. In turn, this pushes firms to engage in business models centered on

relatively short time horizons as well—or, ironically, make investments that are less likely to depreciate quickly, yet are inefficient.[1]

The generation of Market Power Rents may also be a symptom of underdevelopment. By weaponizing regulation to erect barriers to entry that will foster fiscal monopolies that are easier to tax, governments may be able to pay for essential public goods—national defense, for example—at the expense of consumer surplus and a larger overall pie (Menaldo 2016).

By the same token, the presence of Ricardian Rents may bespeak *development*. If governments promote human capital and foster innovation, they may drive companies to reach economies of scale and achieve cost efficiencies, which generates Ricardian Rents. This is the case for Apple Incorporated, for example, which has exploited continued process innovations to reap competitive advantages and thus Ricardian Rents in the now mature market for smartphones. The logical conclusion is that if governments and firms in oil abundant countries engaged in different political and economic strategies and behaviors they could potentially produce and tax even more lucrative and reliable sources of rents with fewer pernicious side effects. Depending on government policy, certain globally competitive firms may acquire cost advantages from hard to emulate investments in human capital, technology, or organizational restructuring.

Focusing on Saudi Arabia and Mexico, ahead we will explore how states foster different sources of oil rents. Saudi ARAMCO is the posterchild for Ricardian Rents. While in the Saudi case a large share of those are due to intrinsic geological features, the country's oil extraction

[1] For example, by over-investing in forms of tangible capital that suffer from low rates of wear and tear instead of in intangible capital, such as software, with a high turnover rate.

costs were considerably higher in the past, before the kingdom decided to invest heavily in human capital and take a "more hands-off approach" to governing its national oil company (NOC). We thus argue that Saudi oil rents are not purely the product of geographic good fortune; rather, the kingdom's investments in human capital and technology have allowed it to consistently reap sizable rents; conversely, we elucidate why monarchs have eschewed Quasi-rent appropriation.

We also exploit a firm level database to investigate the prevalence of Ricardian Rents in the international oil market: the Orbis dataset, which identifies firms at the NAIC six-digit level, helps us illustrate the magnitude and distribution of these rents across hydrocarbon companies. We find that, for most countries/oil companies, the costs of production are relatively high and, consequently, Ricardian Rents lower than one might have expected. Saudi Arabia is indeed exceptional, therefore, even if this is not entirely due to geological luck.

Conversely, Mexico's PEMEX is the avatar of Quasi-rents. Had it been allowed greater autonomy and opportunities to reinvest in exploration and production, its costs would be much lower today, and its oil production would concomitantly be higher.

In turn, these differences in strategies reflect differences in underlying political and economic institutions. To foster the competitive markets where Ricardian Rents are generated, a state must often make credible commitments to enforce property rights and refrain from expropriation. When it cannot do so, it is left with little choice but to appropriate Quasi-rents—and, in the process, deter many sophisticated investments from taking root in the first place.

Moreover, the type of rent, whatever its source, circumscribes future government action. Saudi Arabia would have had to tread very carefully had it enjoyed Quasi-rents like those available from Venezuela's Orinoco oil fields instead of Ricardian Rents. It simply cannot

extract too much oil without permanently damaging the industry. Conversely, if you held everything constant about Venezuela's oil endowment but changed the rents from Quasi-rents to Ricardian, then the extractive policy of Chávez and Maduro may have been sustainable (see Appendix 3). Instead, they killed the goose that laid the Golden Eggs by extracting as much as they could in profits at the expense of investing in upkeep. The reason: revenue-starved rulers who head weak institutions may heavily discount the future and appropriate Quasi-rents, a viable strategy in the short term that ultimately vitiates the total pool of taxable rents in the long run.

The implications for the political economy of natural resources in particular and development studies in general is profound. Perhaps if the institutions and incentives that drive states to help generate oil rents in the first place were fundamentally different, then states would find ways to create and exploit less pathological and perhaps even larger rents elsewhere. Why undertake efforts to hold up inefficient state-run oil production and extract Quasi-rents when you could incentivize tech platforms to reach economies of scale, exercise market power, and earn innovation and network effect rents from trillion-dollar industries that are less volatile and (arguably) less maligned? In other words, why loot PEMEX when you could instead foster and tax the next Amazon?

The inability to credibly commit leads to the over-exploitation of the natural resource (e.g., the extraction of Quasi-rents) and to simultaneous under-investment in the rest of the economy. Hence, the potential to extract rents from the natural resource does not drive institutional failure, which then in turn retards development. Instead, institutional failure drives high rent extraction and slow development.

Moreover, this may imply that the revenue flows from natural resources that are used in cross-country research are noisy and potentially biased (see Menaldo 2016): high revenue flows

could be the product of the extraction of Quasi-rents, and therefore driven by and not the cause of weak institutions, or by high Ricardian Rents, which could be exogenous, or could be the product of past investments to lower the costs of production.

RENTS' CENTRAL ROLE IN POLITICAL ECONOMY

A huge literature in political economy theorizes that "rents" matter: they help us explain political and economic life (see Acemoglu and Robinson, 2012; Bueno de Mesquita et al., 2003; Gandhi, 2008; Levi, 1988; and Meng, 2020). Politicians and economic actors pursue them, in both democracies (Mohdati & Roe, 2003) and autocracies (Truex, 2014)—and at the expense of economic efficiency (Krueger, 1974; Tullock, 1967) and state capacity (Besley & Persson, 2011). Rents corrupt politics (Keefer, 2007; Keefer & Knack, 2007; Rose-Ackerman, 1974). They keep democracy at bay (Ross, 2015). While they may sometimes reduce violence and engender political stability (North, Wallis, & Weingast, 2009), they may also breed instability (Dorsch & Maarek, 2018; Klašnja, 2016).

Another big literature has helped endogenize rents. Bates (1981) argues that in the post-colonial nation states of Sub Saharan Africa, incumbents pandered to nascent, yet narrow, urban constituencies that could provide them with reliable political support and easy-to-extract revenues. This called on adopting industrialization policies that ran against these countries' comparative advantage and were subsidized by indirect taxes on the countryside imposed via marketing boards, endowing them with monopsony consumer surplus. It also called on erecting protectionist barriers for infant industries rooted in overvalued exchange rates and the politicized distribution of credit, generating monopoly profits. Gehlbach (2008) describes the creation out of whole cloth of a vodka industry in northwestern Russia's Pskov oblast after the fall of the Soviet Union. While the potential for this industry was always present, it was only when a relatively

weak state faced empty coffers that the regional government encouraged local officials to develop a fiscal monopoly they could tax at low cost. Haber, Razo, and Maurer (2003) tell a similar story when exploring the reasons behind Mexico's industrialization.

When looking at oil, in particular, researchers often argue that political and economic institutions and structures determine oil rents and rent extraction motives (e.g., Haber, 2006; Andersen, et al. 2017), as well as the pace of resource extraction and its overall intensity (Menaldo, 2016; Mahdavi, 2020). A compelling theory literature seeks to explain this endogeneity (e.g., Robinson et al., 2006), modeling its endogenous extraction path, where the price path implicitly captures the (investment) cost trajectory. This depends on politicians' discounting, among other things—see also Menaldo (2016). A sophisticated empirical literature relies on instruments to capture rents' exogenous variation (e.g., giant oil discoveries, as in Tsui, 2010 and Menaldo, 2016; or differences in oil prices, as in Ramsay, 2011).

David and Wright (1997) are the seminal contribution. During the Second Industrial Revolution in the United States, this included the existence of an educated, if not entrepreneurial and ambitious, cadre of prospectors, geologists, and engineers, as well as the existence of geological information such as cadastral surveys and maps. David and Wright (1997) discuss how the ready availability of this knowledge in the US case explains why, despite the fact that the country was not unusually endowed with mineral or oil wealth, it rose to become the number one producer of most industrial metals and oil by the 1960s. Menaldo (2016) explains why there was a reversal during the 20th Century, wherein developing countries acquired the necessary technology to look for and drill oil despite low quality institutions and weak state capacity.[2]

[2] Although see Harding & Cust (2020), who disagree with this finding.

The existing literature does not usually explicitly categorize and consider all the specific market structure sources of rents, however. Market Power Rents, with monopoly profits as the extreme case, differ fundamentally from Ricardian Rents, which reflect producers' endemic productivity disparities. And both differ from Quasi-rents, a byproduct of the difference between short run and long run costs.

These distinctions matter because, ultimately, some types of rents are harder to appropriate by governments than others and, in turn, institutions and time horizons dictate what type of rents weak governments will cultivate and ultimately capture. When capital depreciation is slow, for example, governments may face strong incentives to appropriate Quasi-rents. Ricardian Rents may be relatively hard for governments to capture, because in some industries it may be impossible for the state to identify particular firms' marginal costs or, even if they can do so, to target firms with unique tax rates tied to their idiosyncratic costs.

Of course, there are important exceptions. As early as Bina (1989), students of the political economy of oil were exposed to the difference between classical and neoclassical approaches to conceptualizing rents, and the different ways in which rents are created in the oil sector. Gaddy & Ickes (2005, pp. 563-4) decompose oil rents, which they define, as we do, as economic profits above and beyond opportunity costs, which include the cost of capital and depreciation. They identify both after tax, available profits (directed to shareholders) and the portion of rents that are either taxed or reduced via excess costs, which may mean higher wages paid to state employees, and price subsidies. They then further discuss the political economy of the subcomponents of "captured rents" in terms of who directly benefits from their appropriation, which they call "claimants". Their analysis also suggests that the owners of the energy assets

may view the appropriation of their rents by the government as an investment that improves their property rights security.

More recently, Alexeev & Zakharov (2022) call on researchers to "differentiate among different types of oil rents as they often accrue to different actors and can serve different purposes". The authors argue that rents in the form of windfalls that accrue to local budgets are particularly vulnerable to misappropriation by government officials. In turn, this fosters inequality and foments social protests in oil rich regions. Alternatively, tax-related rents collected in contexts with less corruption may result in increased spending on public goods, potentially leading to lower income inequality. They test and confirm these intuitions on a Russian panel dataset that exploits exogenous price shocks as well as a change in federal law that discontinued Moscow's policy of sharing oil extraction taxes with local budgets.

We follow in these efforts. We argue that Market Power Rents, Ricardian Rents, and Quasi-rents are also endogenous to institutions and rulers' decision making. Because government policy influences firms' costs—or at least where their marginal revenues intersect with their industry's marginal cost curve vis-à-vis the respective good or service—it determines their profits, at least in the short-run. Take the monopoly rents obtained by pharmaceutical companies that secure patents for valuable drugs; or the rents enjoyed by financial institutions when states ration bank charters.

Some politicians may face irresistible incentives to appropriate Quasi-rents in the short run, even if it means less investment in the long run. Take oil. Consider the "long term" as eighteen months from now for an unconventional oilfield in West Texas, versus eighteen years from now for a big, conventional offshore play in the Gulf of Mexico. If the government

discounts the future a bit more than the market rate—e.g., the interest rate on 10-year Treasury Bills—the latter may simply never materialize. The former most certainly will.

A PRIMER ON RENTS

A rent is simply the minimum return required to guarantee that the inputs to production, or the provision of a service, would be directed towards their current use.[3] In other words, rents are "excess returns" that do not affect incentives. Consider a condominium that a property owner decides to rent. Assume her costs, including insurance and maintenance expenses, are $3,000. Further, assume that the apartment fetches $4,000 on the open market. Does that mean her rents are $1,000? In a very direct sense, yes. However, suppose that when the rent she is able to charge on the open market is under $3,500, she does not bother to lease out her apartment. This reveals the owner incurs $500 in additional, intangible costs from renting out the unit and it is only at $3,500 or above that she decides to lease it out: if the owner only earns $499, the apartment stays empty.

As a practical matter, researchers can't measure intangible costs. So, to measure "rent" economists normally take the difference between revenue and costs; moreover, an element of costs is an assumed "normal return" below which individuals won't bother to run their firms, or invest their capital, or rent their apartments. This is a strategy we ourselves undertake ahead.

The upshot is that rents do not impact supply in the short run. If you reduce rents, the supply of a good or service remains the same. Conversely, if you raise rents, the supply also remains the same.

[3] In Appendix 1, we discuss market prices and how they are related to rents in general.

When economists refer to the so-called short run they mean there is no time for additional investment. Returning to our example, no matter how high rents go, the owner has only one apartment to lease out. Thus, she has no incentive/opportunity to increase the supply of dwellings regardless of whether the rent she receives is $500 or $5,000. Likewise, for an oil field, the short-run is the amount of time it would take to expand output in that field via additional investment. For a country, it is the amount of time it would take to either expand output in existing fields or discover and develop new fields. In the short term, most profits and interest payments are rent, and this holds as true for oil fields as it does apartments on the rental market.

What about rents in the long run? While the supply of apartments is fixed in the short run, in the long run investors can build more apartments. When the economic rent per apartment is only $500, an owner might choose to lease out her unit, but she has little incentive to go out and either buy or build more of them. But at $5,000, she may have that incentive. As soon as that happens, the $2,000 that were once economic rents are no longer such. However, as we shall see ahead, Ricardian (differential) Rents can endure in the long run if knowhow and technology are not easily transferred or if locational differences persist. Also, Market Power Rents can be indefinitely protected with barriers to entry, constraining supply and thus protracting outsized profit margins.

Then there are Quasi-rents, which is the delta between the surplus two parties generate together and what they otherwise earn in the marketplace. These rents are available only because both parties generate and must therefore divide surplus through their exchange. Because contracts are incomplete, this allows one or both parties to try to renegotiate the division of their gains from trade. But this occurs after each party made irreversible investments (sunk costs) that were specialized to each other. How does time factor into this?

A Quasi-rent is a rent only when one ignores fixed costs. Consider the condominium example again. Excluding the property owner's opportunity costs, it carries $3,000 in costs. Of that, suppose that $1,000 is the maintenance cost and the other $2,000 is the mortgage cost. Well, if the monthly rent on an apartment fell below $3,000, the owner would default on their mortgage, but the apartment would still exist. Therefore, the apartment generates Quasi-rents of up to $2,000 per month.

Assumptions about Rents in the study of Natural Resources

Most researchers who study the political economy of natural resources, especially oil, assume they are large, unearned, "externally generated," and "easy to capture".[4] Oil revenues are treated as interchangeable, whether they come from the heavy oils of the Orinoco Basin or the unconventional deposits of the Vaca Muerta giant offshore fields or the easy-to-extract petroleum of Ghawar. Yet rents are not the same in these cases: investors' time-frames vary due to geological and thus technical differences; the amount of up-front money and capital expenditures needed to be reinvested also differ. Moreover, the type and size of oil rents are ultimately a byproduct of the interaction of geology, industrial organization, technology, and markets, both regional and international.[5]

The extraction, production, sale, and expropriation of oil can generate different sources of rents and governments can have a big impact on what type are created. Oil rents may exclusively

[4] Adam Smith (1776) (as cited in Karl, 1997) described mineral rents as "the income of men who love to reap where they never sowed." On all these points see Ross (2015).

[5] Researchers who recognize this include Brooks and Kurtz (2016), Haber, Maurer, and Razo (2003), Mahdavi (2020), Maurer (2011), and Menaldo (2016).

bespeak immutable geological features (the chief source of Ricardian Rents). Or they may reflect engineering prowess (another reason for Ricardian Rents). Or, alternatively, shortsighted state authorities may arrogate rents by engaging in opportunistic holdup that prevents them from recovering their long run costs (Quasi-rents). Or, the underlying basis of oil rents may be a lack of technological diffusion or knowhow that allows some firms or oil fields to monopolize a cost advantage that translates into consistently greater profits than its rivals (Ricardian Rents)—and, by enforcing stringent non-compete clauses, the state may exacerbate this skewed distribution of gains.[6]

RICARDIAN RENTS

In a competitive industry with free entry and exit, and where no firm has market power, the costs of production are (in the short term at least) increasing in the quantity of the good produced. And this is also true for the long run supply curve in an increasing cost industry.

[6] Some researchers unpack the term "rents." Mahdavi (2020) acknowledges the presence of large Quasi-rents in extractive industries—above and beyond Ricardian and Market Power Rents—to explain why state intervention in the oil sector tends to be exceptional: nationalization allows dictators to protract their rule, even if doing so means there is less to tax in the future. He persuasively argues that the state can swoop in and easily dial oil extraction rates up with minimal investments and without disrupting the greater economy or restructuring the legal and administrative system. Similarly, Manzano and Monaldi (2008) identify the presence of not only sizable Ricardian Rents for oil fields with costs below the marginal producing field in the market, but also Quasi-rents captured by states that renege on contracts with private oil firms by increasing taxes on production after the latter have sunk considerable investment costs.

Figure 2 displays the latter scenario and therefore captures long lasting Ricardian Rents: it illustrates that an upward sloping, long run supply curve allows some firms to receive positive economic profits indefinitely.

As Figure 1 indicates, the ultimate price in a market characterized by Ricardian Rents is determined by the least efficient producer, which produces the quantity where the supply curve and demand curve intersect and is basically indifferent between remaining in the market and exiting the market. That firm's unique marginal cost curve, and specifically where it intersects with the market demand curve—at the point lying immediately below the minimum of its average cost curve—is going to dictate the price for all market participants.

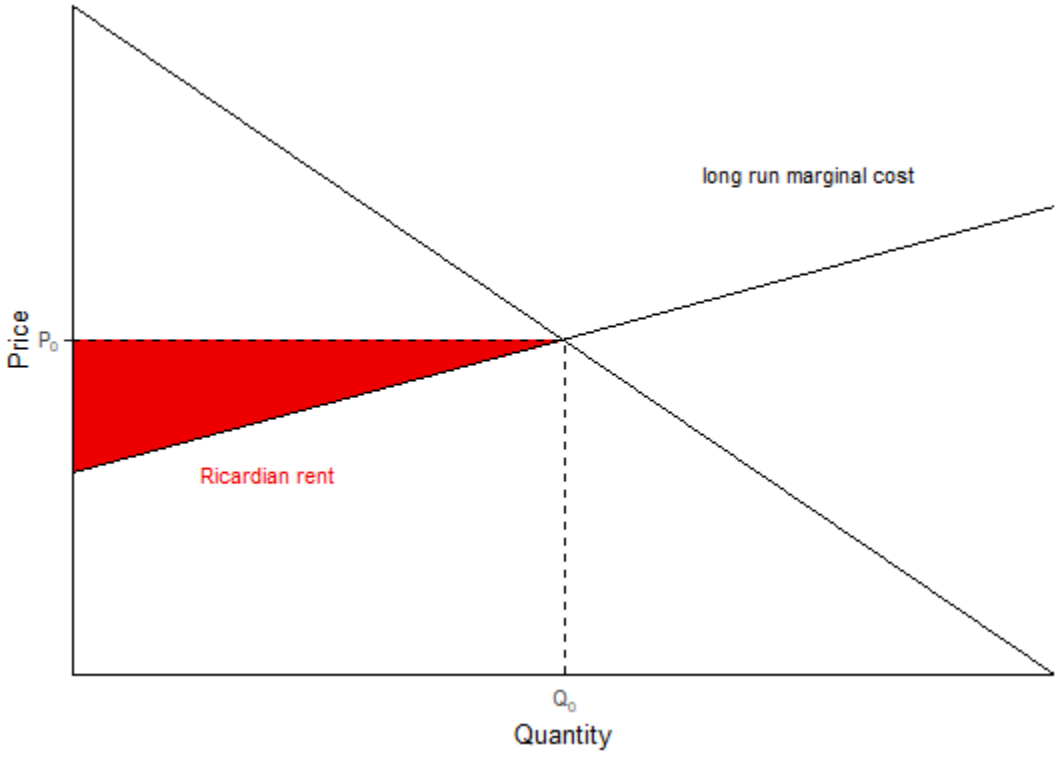

Figure 1. Ricardian Rents in an Increasing Cost Industry

Notes: the supply curve is upward sloping and bespeaks the price over the long run. In the case of this product, the most efficient firm earns Ricardian Rents that represent the vertical difference between the quantity it produces and the final price, determined where the marginal costs of the least efficient firm intersects the demand curve.

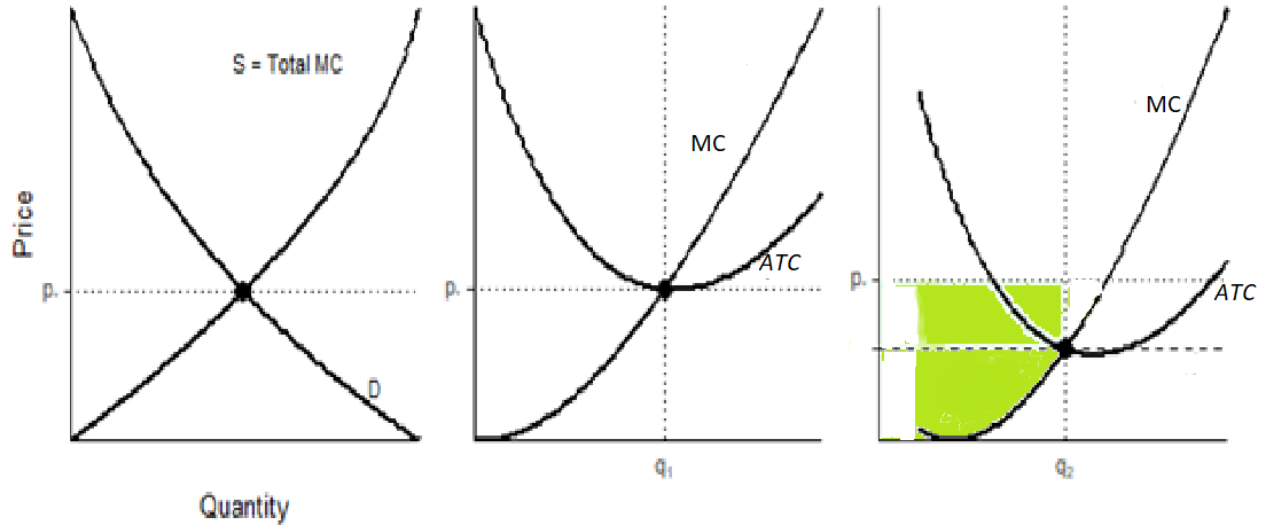

Figure 2. Cost Curves for Firms Competing in Markets with Ricardian Rents

Notes: the total market supply curve is represented by the first panel (from the left). The second panel represents the quantity produced by the least efficient producer producing for the market (first panel). The third panel (from the left) represents the quantity produced by an efficient producer; the green rectangle represents its Ricardian Rents, which are the difference between the quantity it produces at its lower (than the least efficient producer's) marginal costs.

This is represented by the second panel in Figure 2. On the one hand, the average cost curve for both efficient firms (third panel from the left) and inefficient firms (second panel) is u-shaped: at the lowest levels of output the average cost per unit is high, falls as the firm approximates the optimal scale of production, captured by the u's bottommost point, and then rises again once output exceeds that scale. On the other hand, the average cost curve is shifted down for an efficient firm (third panel from the left), as is its marginal cost curve.

Therefore, as with the price, in this case the available producer surplus (rents) will also be dictated by the producer with the highest marginal costs. While the most inefficient producer earns zero economic rents, all other producers with lower marginal costs than it will earn profits. More efficient firms, with lower marginal costs, either because they have lower overhead, or better technology, or more skilled human capital, or whatever intangible advantage, will earn the wedge between the marginal costs of the least efficient firm and their own marginal costs. While

the profits for an efficient firm are illustrated in Figure 2 in the third panel from the left, the cumulative profits earned by all producers are illustrated by the red triangle in Figure 1. Adding these wedges together for firms that lie on the market supply curve from left to right as it slopes upward and before it intersects with the demand curve yields the total producer surplus.

Markets with long run upward sloping supply curves (Figure 1 and Figure 2, first panel from the left) inhabited by a mix of both very inefficient and hyper efficient firms (as shown in Figure 2 in the second and third panel) are often ignored or misunderstood by researchers who attribute any and all economic profits to market power. To the contrary: the first thing to note is that there are no deadweight losses in such a market and firms are price takers. That means that firms cannot ration quantity without other firms swooping in and increasing the total quantity supplied up to the point where the demand curve intersects with the supply curve.

Moreover, these rents are not a byproduct of scarcity or uniqueness in an absolute sense, only a relative one. Several efficient producers can earn Ricardian Rents as long as they enjoy differential productivity vis-à-vis other producers. Therefore, Ricardian Rents reflect two interrelated facts. First, high quality inputs, technology, and talented management and human capital are not uniformly distributed.[7] Second, resources that furnish more efficient producers with a competitive edge cannot be easily copied or learned by other firms.

[7] Amit and Shoemaker (1993) provide a list of eight firm attributes (so-called strategic assets) that are conducive to Ricardian Rents, in that they are relatively scarce, yet appropriable; not easily copied nor tradable nor substitutable; and unusually durable. These characteristics allow some firms to enjoy lower costs and thus gain higher margins—even when they compete in an

Finally, while the difference between Market Power and Ricardian Rents may suggest a tradeoff between these two sources of profits, it is always better to become a monopolist (or collude to charge prices like one) than maximize Ricardian Rents. To see why, first consider a hyper-efficient producer in a competitive market that produces the lion's share of the oil but faces a competitive fringe. Suppose it instead had the possibility of becoming the only game in town. On the one hand, if it decreases the quantity of oil it produces so as to produce exactly half of the quantity supplied by the competitive market (the Lerner Margin), this would position it above the minimum of its average cost curve, on the downward sloping portion (see Figure 2, Panel C). While this would decrease its Ricardian Rents, said reduction would be eclipsed by the rents it earns in a monopoly market: with an upward sloping supply curve, the size of the producer surplus is always larger than the green area in Figure 2, Panel C, let alone the difference between the green area and reductions in that area. By contrast, an inefficient producer sees greater profit from pushing towards supply reductions (as part of a cartel) that would increase Market Power Rents. This helps explain why an inefficient oil producer such as Iran, for example, invariably favors bigger OPEC production cuts than more efficient ones such as Saudi Arabia.

To understand why, consider that Market Power Rents are when firms price above marginal cost by constraining quantity. That means that the cross-elasticity of demand between its products and potential substitutes is inelastic enough that they enjoy the luxury of constraining supply and the room to increase price. Monopoly power is the extreme of this

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arena defined by competitive prices, where consumer surplus is maximized, and deadweight losses are non-existent.

situation, where producers are able to reduce quantity by half and maximize revenues where their own marginal revenues intersect with the marginal cost curve. In this situation, the cross-elasticity of demand between its products and potential substitutes is fully inelastic (it faces no substitutes).

We take this issue up in Appendix 2. After laying out the microeconomic logic behind Market Power Rents in general, we discuss the mixed evidence for Market Power Rents in the oil industry, focusing first on the infamous case of Standard Oil before its breakup by the U.S. government and the OPEC cartel. The reason we do not dedicate space to examining this strategy in the main body of this paper is because, as Appendix 2 argues, it is not clear that rationing quantity to increase price is actually logically effective or empirically likely.

Applying Ricardian Rents to the Oil Industry

Before launching into a detailed discussion of Ricardian Rents in the oil industry, it behooves us to understand their prominence and magnitude in general. First, consider some descriptive statistics on the costs per dollar of revenue for 118 firms operating in the global oil industry in 2014; results for 2013 almost identical.[8] The variation is enormous: the standard

[8] We obtained these values by dividing the real costs of goods and services sold by real operating revenue in 2010 dollars. The numerator is correlated with material input costs at greater than .99 (material costs represent only a portion of intermediate inputs). The data is from the Orbis dataset (from Bureau Van Dijk), which observes firm level unconsolidated financial information at the six-digit 2012 North American Industry Classification System (NAICS) level. The data across the descriptive statistics, graphs, and analyses that follow are from a sample of firms that report costs, revenues, and profits and are listed in the 211111 Category. This includes firms that

deviation is 2.1 (variance is 7.2). Indeed, the minimum value is 0 (both Zakordonnaftogaz DP, a Ukrainian company, and RSG, an American company, share this value) and the maximum is 18.2 (EOG Resources, a British company). This and other large values (the 99th percentile is reached at 14.1) drag the mean up to .92 (the skewness is 7.2), even though the median is .61. We note values greater than 1 imply the firm is most probably losing money.[9]

Several graphs can help put some flesh on these numbers. Let us begin with those that depict the industry's cost structure before moving on to industry profits.

Figure 3 summarizes the cost data on a country-by-country basis. It is a global map of oil firms' average cost structure, with the mean value calculated from each of the firms operating in each country in our sample: Australia, Austria, Bermuda, Brazil, Cayman Islands, China, Denmark, France, Germany, Great Britain, Greece, Hong Kong, India, Indonesia, Ireland, Iran, Italy, Norway, Oman, Pakistan, Spain, Sweden, Ukraine, the United States, and Vietnam. The

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develop or operate in hydrocarbon fields and are primarily engaged in the recovery of liquid hydrocarbons from oil and gas wells, including oil sands. The patterns and results are generally the same if we instead observe firms in the 213112 Category: firms that primarily provide support activities for oil and gas operations.

[9] We also note that oil price realizations can vary across firms depending on oil quality, location, transport bottlenecks, and long-term contracts, thus introducing noise. However, we also note that this heterogeneity is strongly positively correlated with cost differences, muting its influence on the ratio of costs to revenues. Ideally, we would use barrels of oil as the denominator; however, we have been unable to obtain that information: oil companies treat it as a commercially valuable trade secret.

map displays a lot of diversity. Countries such as Brazil, Norway, and the U.S. boast relatively efficient oil producing firms with average costs per dollar of revenue as low as 0.22, 0.25, and 0.37, respectively. China, with more middling efficiency, lies at 0.76. And countries such as Oman, Iran, and the U.K. have less efficient oil producing firms: at 0.9, 0.96, and 1.4, respectively—which is not entirely unsurprising given that these latter countries house several aging fields that require enhanced oil recovery techniques (see Menaldo 2016).

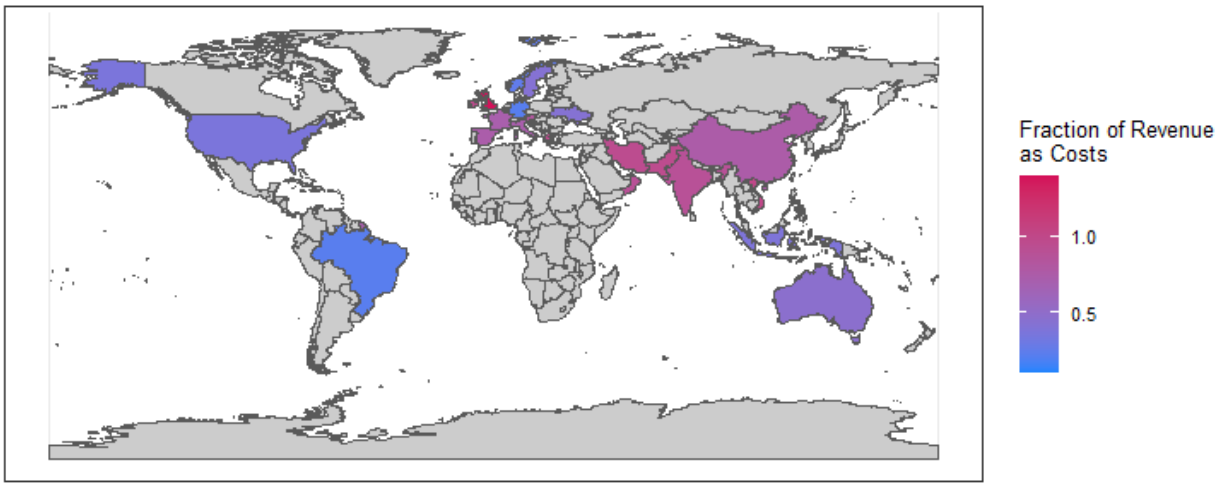

Figure 3. Global Map of Oil Firms' Average Cost Structure

Notes: this is a map of oil firms' average real costs of goods and services by real operating revenue in 2010 dollars by country. These are 118 firms that develop or operate in hydrocarbon fields and are primarily engaged in the recovery of liquid hydrocarbons from oil and gas wells, including oil sands. They are listed as 211111 in the six-digit 2012 NAICS system. The countries that have firms in the dataset are: Australia, Austria, Bermuda, Brazil, Cayman Islands, China, Denmark, France, Germany, Great Britain, Greece, Hong Kong, India, Indonesia, Ireland, Iran, Italy, Norway, Oman, Pakistan, Spain, Sweden, Ukraine, the United States, and Vietnam. Source: Orbis.

Now we switch to looking at firms as the unit of analysis. Figure 4 is a bar plot of the 118 firms in our sample. Figure 5 is a rough proxy for these oil producers' marginal costs; the x-axis depicts the extensive margin, firms sorted by their costs, not a quantity measure of output,

rendering the graph only an imperfect representation of an oil supply curve (as footnote 11 explains, we cannot gain access to the amount of oil produced by firms in the dataset).

Nevertheless, as is necessary for Ricardian Rents, the "cost curve" is clearly upward sloping, albeit in a non-linear fashion; it reaches an inflection point at around the 75th percentile of the distribution (.92) where, driven by the least cost-efficient firms (the "marginal" producers, so to speak), it becomes sharply steeper.[10] This mirrors the distribution of costs in other industries (Galetovic 2017).

[10] The sample excludes some smaller and less prominent oil operators. While these are not necessarily missing at random, we do not fear that their omission threatens any of the descriptive or statistical inferences we document. Take the "inflection point" in Figure 5: it is not driven by the exclusion of middling-cost operators, such as those operating in sub-Saharan Africa. If we take "middling" to mean what oil industry experts typically refer to, those that fall anywhere in the fraction of revenue as costs range between 50 and 70 percent, these producers are well represented in the sample. They include, for example, Faroe Petroleum, Northern Petroleum, Limited Atlantic Petroleum, Ukrnafta Publichne, Summit Exploration and Production, Equus Petroleum, Tisagaz Zao, Jkx Oil & Gas, Kunlun Energy, Elnusa Tbk, Lucas Energy, Petrolatina Energy, Poltavska Gazonaftova, Origin Energy, Petrochina, Tecnicas Reunidas, and Sabah Shell Petroleum Company.

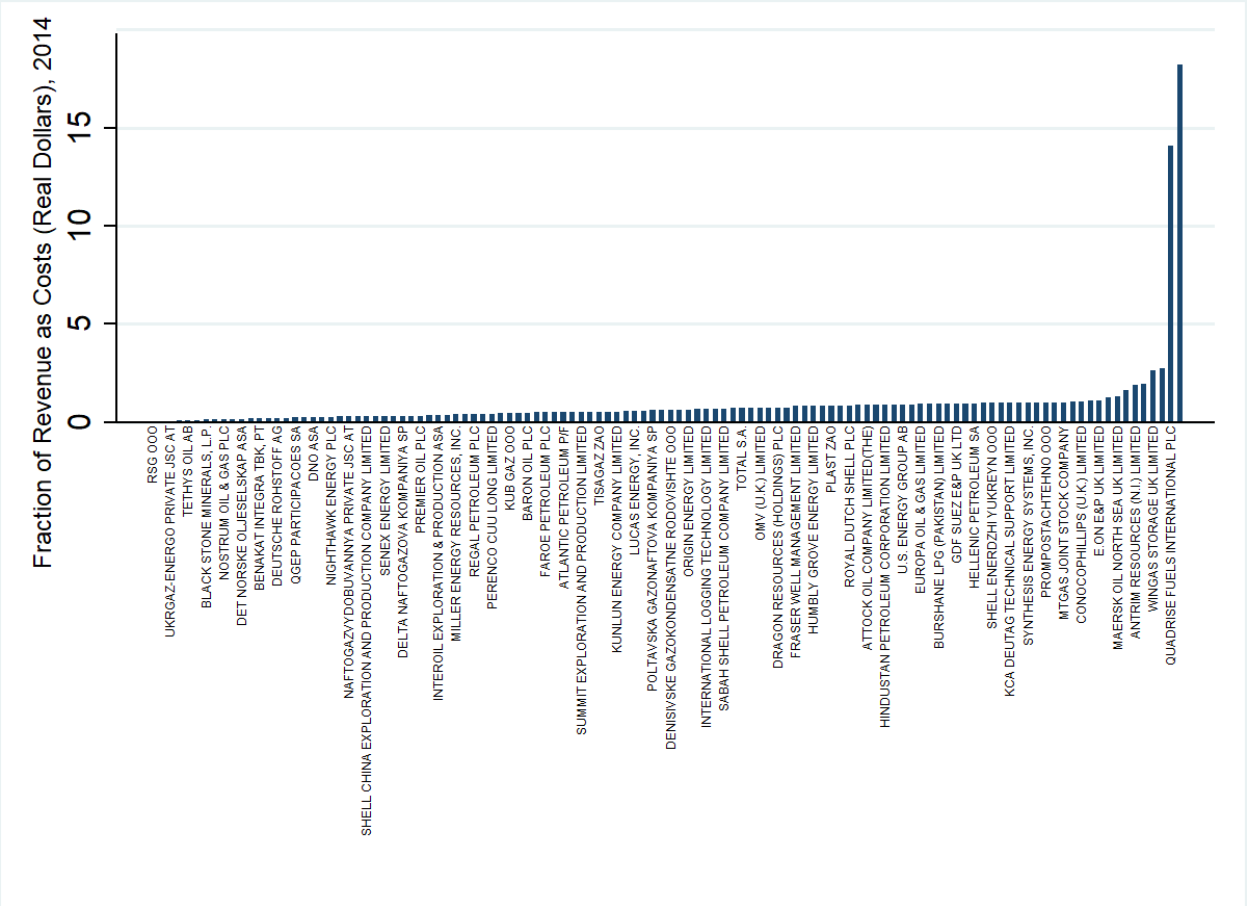

Figure 4. The Distribution of Cost Per Unit of Revenue for Oil Industry Firms

Notes: this is a bar plot of the real costs of goods and services by real operating revenue in 2010 dollars. These are 118 firms that develop or operate in hydrocarbon fields and are primarily engaged in the recovery of liquid hydrocarbons from oil and gas wells, including oil sands. They are listed as 211111 in the six-digit 2012 NAICS system .
Source: Orbis.

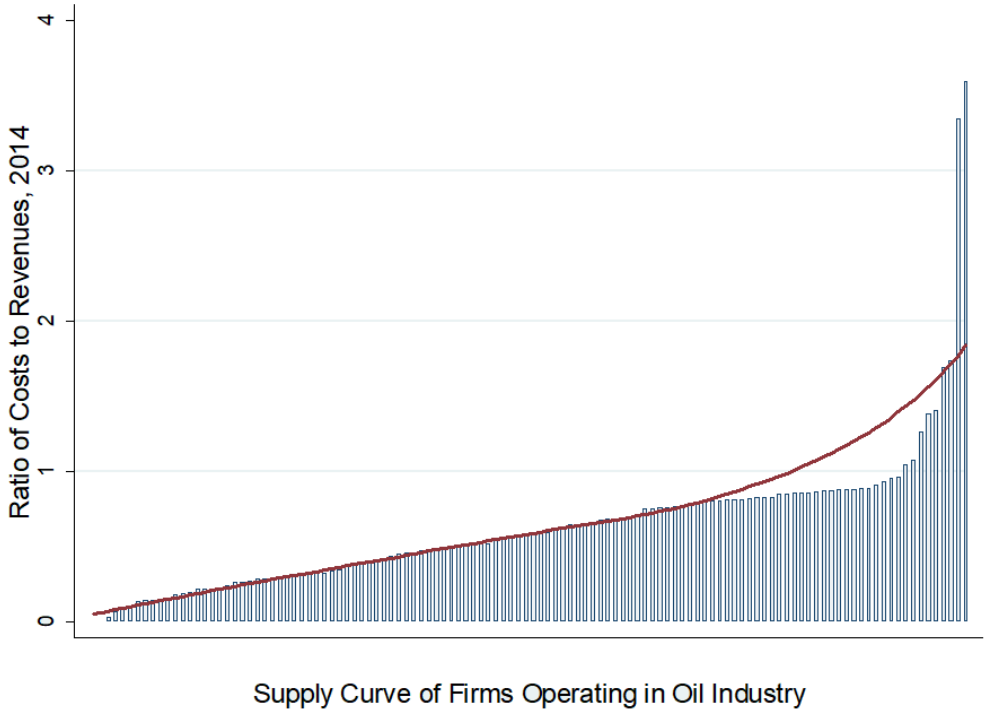

Figure 5. Upward Sloping "Supply" Curve for Oil Industry Firms

Notes: We estimated a proxy for the supply curve by running a Lowess regression of the inverse hyperbolic sine of the costs per unit of revenue (the real costs of goods and services by real operating revenue in 2010 dollars) against the firms' rank order in the distribution of this variable and overlaid it over the bar plot represented by Figure 4. We transformed the variable in this manner because it has multiple zero values; results are similar if we use other transformations or use the untransformed version. These are 118 firms that develop or operate in hydrocarbon fields and are primarily engaged in the recovery of liquid hydrocarbons from oil and gas wells, including oil sands observed in 2014. They are listed as 211111 in the six-digit 2012 NAICS system.
Source: Orbis.

Now we seek to demonstrate that the cost structure of firms operating in the oil industry maps onto profits. In other words, that lower costs translate into higher Ricardian Rents. First, consider that a simple linear regression of the inverse hyperbolic sine of oil firms' Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) per worker against the inverse hyperbolic sine of its costs per unit of revenue yields an R-squared of .13 and implies that a 1

standard deviation increase in costs is associated with a 0.4 standard deviation decrease in profits (p-value < .001).[11]

Next, consider a more sophisticated take on this regression: Figure 6 is a graphical illustration of a Lowess regression that depicts the non-linear relationship between costs and profits. Despite the presence of an outliers that is quite profitable despite high costs—Rio Bravo Oil—it is clear that lower costs translate into higher profits across most of the distribution of firms' costs.

So, what are the sources of Ricardian Rents in the oil industry? These most obvious are associated with several "natural" attributes. First, consider several geological parameters. These include the features of the anticlinical trap—a fold structure characterized by an arch of non-porous rock that covers a porous stratum, therefore trapping oil and gas—that is drilled into to extract the oil such as closure features, source rocks, and seal rocks. Next, consider fluid and gas characteristics. Gravity, or how heavy the oil is compared to water, is among them. So is the oil's viscosity and the liquid to gas ratio.

[11]EBITDA is a proxy for cash flow and thus a firm's profitability. We transformed the variables in this manner because they have zero and negative values; results are similar if we use other transformations or use the untransformed versions. The analysis was performed on 2013 data and n = 190; 2014 data yields very few IBITDA values.

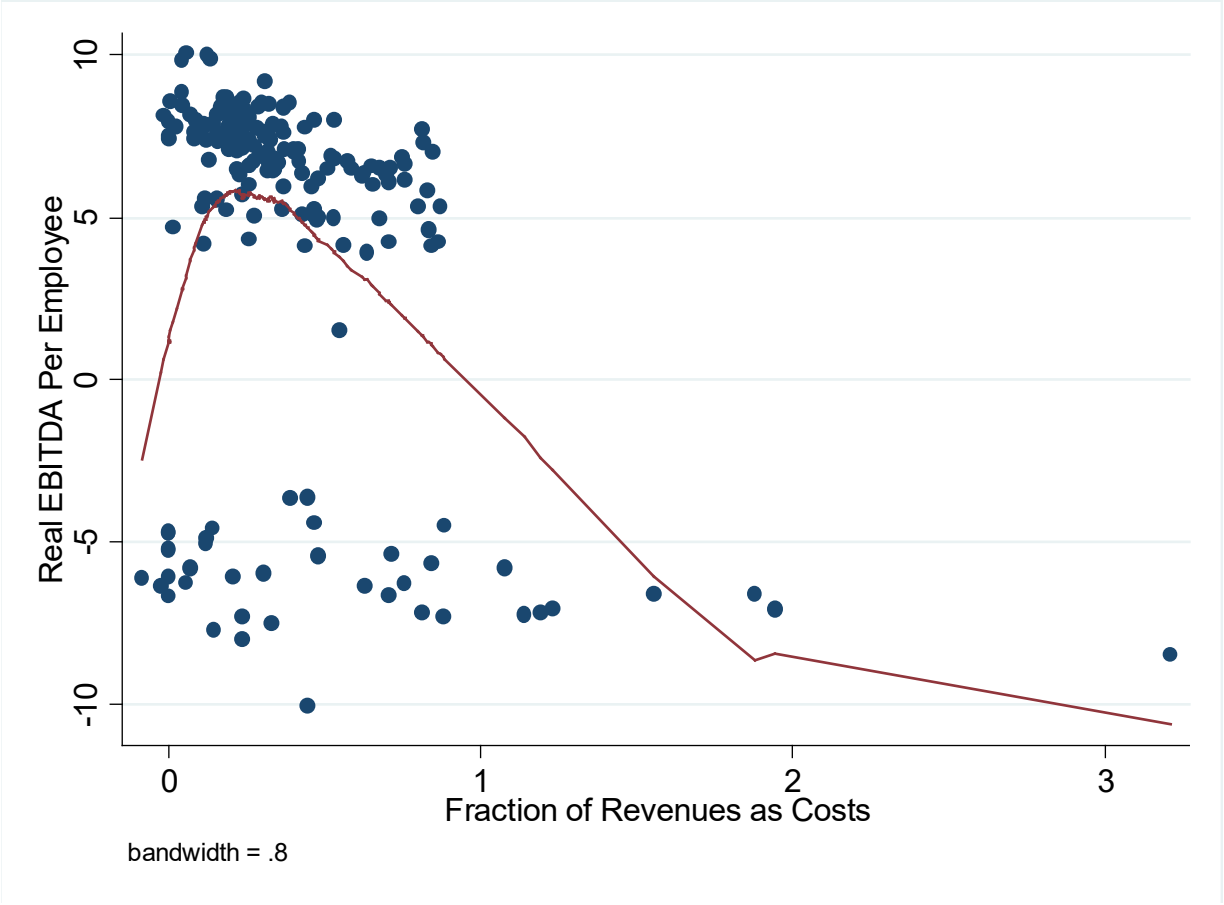

Figure 6. The Relationship between Costs and Profitability in the Oil Industry

Notes: This graph depicts a Lowess regression of the inverse hyperbolic sine of firms' EBITDA per employee against the inverse hyperbolic sine of their costs per unit of revenue (both in 2010 dollars). We transformed the variables in this manner because they have zero and negative values; results are similar if we use other transformations or use the untransformed version. These are the 190 firms operating in the oil and gas industry contained in the previous analyses. Source: Orbis.

But as in other industries, randomness is only one possibly source of Ricardian Rents in the oil extraction sector. Research on superstar firms is centered on their ability to earn sizable Ricardian Rents, not Market Power Rents, because of investments in information technology that give rise to inimitable sources of knowhow. In turn, this endows them with a competitive advantage and consistent profit edge without representing a barrier to entry or monopoly power

(Bessen & Righi, 2019; Galetovic, 2017). In the oil industry, a similar process may also revolve around technological investments complemented by formidable human capital endowments.

We confirm this intuition with a simple analysis. Because any productivity enhancing innovation takes some time to materialize, we calculated the fourth lag of hydrocarbon extraction firms' R&D spending in 2010 dollars (and then take its hyperbolic sine)—we lack sufficient longitudinal data to calculate deeper lags— to represent that gestation period. We then ran a regression of oil firms' costs, again operationalized as the inverse hyperbolic sine of the costs per unit of revenue (in 2010 dollars), against our aforementioned proxy of firms' innovation efforts.

The results are as follows: increased investments in innovation by an oil firm four years prior maps onto decreased costs (robust p-statistic is .04; n= 146) in a substantively significant manner: increasing R&D spending by 1 percent leads to a 9.5 percent reduction in oil extraction costs. This speaks directly to the importance of Ricardian Rents in the oil industry: it suggests that some firms are relatively technologically advanced and highly productive—thus facing lower costs than less sophisticated firms. Saudi Aramco is perhaps the most famous case.

Saudi Arabian Exceptionalism

Saudi Arabia faces among the lowest marginal costs (and thus average costs) of any oil producer. It boasts nearly 270 billion barrels of proven crude oil reserves, second only to Venezuela among OPEC members (OPEC, 2016). In 2018, Saudi ARAMCO pumped crude oil in the Arabian Peninsula for US$2.80 a barrel[12], a fraction of their nearest competitors (Di Paola, 2019): Chevron and Exxon pump oil at more than $10 a barrel, for example (Lee, 2020).

[12] In 2018 US dollars.

Why is Saudi Arabia such an outlier? The obvious answer is geology. The areal extent of the Arabian plate's northeast margin shelf endows it with ideal conditions for plentiful, easy-to-extract oil. It has superior carbonate and sandstone reservoirs in good juxtaposition. It also possesses top-notch regional seals and expansive anticlinal traps due to repeated and extensive source rock beds over geological time (see Beydoun, 1998). These are ideal conditions for easy to extract, high-quality oil. Reservoir pressure is high, such that most oil can reach the surface without being pumped, though that is changing as ARAMCO expands its exploration into increasingly difficult to recover areas. A variety of oil grades are produced, including light crude from the Ghawar super giant field, which is easier to extract than the extra heavy oil that makes up a majority of Venezuela's reserves, for example. The Arabian light and extra light grades make up nearly three quarters of ARAMCO production (Saudi Arabia, 2001).

Does Saudi Arabia owe its hydrocarbon exceptionalism purely to good luck? No. The Ricardian Rents Saudi Arabia captures from its oil industry are not just a function of nature's lottery: Saudi ARAMCO prioritized investment in employee education beginning in the 1950s, and at the same time encouraged its own employees (through subsidized credit) to leave the company to start private sector companies to provide the inputs into ARAMCO's production that were otherwise lacking in Saudi Arabia (Stevens, 2011, p. 180). Annual investments in human resource development run to the hundreds of millions of U.S. dollars (Marcel, 2006). ARAMCO invests heavily in research and development, such as through its dedicated Exploration and Petroleum Engineering Center. There is also a history of market-oriented and performance-based culture among management. All the while, the Saudi state has generally taken a more hands-off approach to ARAMCO in contrast to many other Middle Eastern NOCs; this strategy is

facilitated by fairly close historical alignment between the interests of top ARAMCO managers and the Saudi kingdom (Stevens, 2011, p. 187).[13]

ARAMCO's performance, as a combination of favorable geology and competitive acumen, is demonstrated for example by their exploration costs: in 2001, oil minister Ali Naimi suggested it cost 10 US cents per barrel to find new reserves, compared to the $4 dollars per barrel worldwide average (Saudi Arabia, 2001). To be sure, Saudi Aramco's efforts to develop local suppliers is politically motivated and it is unlikely that the country would produce less oil in the absence of domestic suppliers. Yet, it is still the case that the world's *most profitable* oil firms, including Aramco, are those that are making special investments in capital, technology, and organization in ways that give them an inimitable edge. This insight contradicts the notion of passive, sluggish, and corrupt NOCs that sit back and indolently collect nature's bounty, a notion that pervades the literature on the political economy of natural resources (e.g., The Economist, 2006; Eigen, 2006; Heller & Kaufmann, 2019; Pirog, 2007).

In the next section, we return to discussing the Saudi oil industry when addressing why taxing Ricardian Rents, but reinvesting a significant portion of them to outpace depreciation/oil well depletion, has dominated the kingdom's economic and fiscal strategy—and why this has trumped attempts to instead appropriate Quasi-rents.

QUASI-RENTS

[13] The Supreme Council on Petroleum and Mineral Affairs, the Saudi state's oversight arm for the sector, has never made recommendations against ARAMCO's five-year operating and investment plans (Stevens, 2011, p. 187).

Quasi-rents are fundamentally different from Market Power Rents and Ricardian Rents.[14] They have nothing to do with a single firm rationing quantity and therefore raising prices, as in the case of Market Power Rents (see Appendix 2). Nor do they have anything to do with a firm exploiting cost differentials *between* itself and other firms operating in a competitive market, which is what Ricardian Rents are about. In fact, Quasi-rents exist in any market, either a monopolistic one or competitive one, and can coexist (at least in the short run) with Market Power Rents and Ricardian Rents. That is to say, even when there is only one producer of a good that earns Lerner Margins, the potential for someone (or a government) to extract Quasi-rents, in addition to those Market Power Rents, exists; similarly, firms that earn Ricardian Rents can also cough up Quasi-rents.

Quasi-rents only exist when four conditions obtain. First, there is a difference between short-run and long-run costs. Second, these long run costs are tied up in asset specific investments. Third, this difference can be appropriated—either by the owners of the factors deployed to produce the good themselves or an outside party, including the government. Finally, researchers such as Klein et al. (1978) and Williamson (1985) argue that firms subject to the appropriation of Quasi-rents must be operating in a context governed by incomplete contracts; that allows an opportunistic actor, acting with guile, to surprise them: swoop in and arrogate the wedge between their short- and long-run costs.

Therefore, to properly understand what Quasi-rents are, we first have to outline how long-run prices are determined in a marketplace, as well as how they differ from short run prices. And, in order to do that, we first have to distinguish between fixed costs and variable costs.

[14] This section is inspired by, and draws closely from, Galetovic and Haber (2017).

Fixed costs are incurred irrespective of the quantity of a good produced; for example, the rent paid by a business to lease a warehouse. Variable costs vary with the quantity produced; for example, payments incurred by businessowners for the inputs required to make widgets.

If the government appropriates Quasi-rents, it can bankrupt the owner of the factor of production and induce her lender to lose its capital. While the particular factor might not entirely disappear, it may, however, eventually be taken off the rental market—even if in the short run the owner continues to rent it out.

Consider the previous example about an apartment for rent. If the government imposes a ceiling on rents below the lender's long run marginal costs, it may nonetheless continue to cover the short run costs of leasing out the apartment—such as paying fees to a rent management company—and continue to rent it out in the short run. However, the bank may not be able to cover the long run costs such as refurbishing the apartment building or upgrading it for future rental markets, let alone building more units.

Ultimately, the tangible infrastructure and capital that fixed costs purchase depreciates and must be replaced, or at least repaired. Sunk costs that are asset specific cannot be redeployed by their owners to alternative uses; it's expensive to both reinstall and reconfigure them; there are not only transportation and process costs involved in doing so, but also transaction costs.

While prices allow factor owners to recover their production costs, what it takes to recover variable costs (in the short run) may be appreciably less than what it takes to recover fixed costs. Moreover, when these fixed costs are sunk and specific, factor owners are constrained: since they cannot redeploy those investments, they are in a sense held hostage by them, and must keep reinvesting in them, so to speak, to outrun depreciation. That means that, over the long run, factor owners must command prices that allow them to defray repairs and

replacements if they want to stay in operation. To determine long-run marginal costs in the oil industry, one has to estimate future capital and operating expenditures for Yet-to-find Fields (YtF). Sometimes those costs number billions of dollars and mean that even with relatively high international oil prices, break even prices over longer horizons are appreciably sizable.

It is exactly this scenario that makes factor owners vulnerable to the appropriation of Quasi-rents. In the short run, the firm only has to recover its variable costs to remain in business. It must therefore charge a price that allows it to pay for the inputs that generate the quantity of goods it sells to the market. In the long term, however, the firm must charge a price at the minimum of its long run average cost curve; that implies that it is defraying the fixed costs of these sunk investments. An opportunistic actor, however, can exploit the wedge between these two prices and expropriate that difference.[15]

What does this brazen act of "holdup" entail? The economically rational thing for the firm that is held up to do is to remain in business in the short run since it can continue to recover its variable costs. By the same token, it will exit the market in the long run; it has been deprived of the funds it needs to outrun depreciation and therefore cover its long run fixed costs.

An important logical implication of the unanticipated appropriation of Quasi-rents by opportunistic actors is the foreclosure of other sources of rents: Market Power Rents and Ricardian Rents will only be available in the short run. If the firm that is held up is a monopolist, then it will price above marginal cost—at Lerner Margins—in the short-run to recover these

[15] Minus the salvage value; because if an opportunistic actor tried to include that in her "predation tax" too, then factor owners could just as well sell those sunk assets as scrap instead of continue to produce in the short run to cover their variable costs.

variable costs (see Appendix 2); but it will not have the opportunity to do this over the long run to recover its fixed costs. Alternatively, if the firm earns Ricardian Rents in a competitive market, then it will enjoy returns above the marginal firm in the short run, but that will not save it from bankruptcy in the long run.

Why do some governments operate with relatively short time horizons, appropriating Quasi-rents and perhaps undermining the basis for long-term economic development? For authoritarian rulers, this may depend on the degree to which they are able to institutionalize power-sharing arrangements (Geddes, 1999, p. 123) and whether there is a clear path of succession to the next ruler (Olson, 1993, p. 571). It may also depend on rulers' outside options for enrichment and prestige (Geddes, 1999, p. 126); where rulers lack these options, they are incentivized to use the tools of the state to maximize the extraction of rents in the short term. Menaldo (2016, p. 11) argues that rulers who inherit states with weak capacity and low-quality institutions are forced to turn to quick sources of revenue, including Quasi-rents from natural resources, to fill state coffers.[16]

Quasi-rents in the Oil Industry

Indeed, there are potentially large Quasi-rents to be appropriated in the oil industry, which should attract governments with short time horizons. There are sizable sunk costs that are

[16] Menaldo (2016, p. 80) suggests that high fiscal transactions costs combined with a leader's inability to make credible commitments leads them to appropriate Quasi-rents instead. Keefer (2007) makes a similar argument about young democracies.

asset specific and a big wedge between recuperating long run costs and short run costs.[17] The marginal costs of pumping out oil are typically quite low[18], particularly when you can use the well's own pressure to extract oil (before secondary recovery)—a phase that typically allows for the recovery of 15 to 30 percent of the quantity of oil in a well (Kokal & al-Kaabi, 2010; Lyons & Plisga, 2011, p. 178; Pashakolaie et al., 2015, p. 461). In other words, it is quite easy to recover short run costs once the initial fixed costs are sunk. Thus, the price needed to justify continuing to pump oil from an already active well is quite low too. As long as the oil field is covering its marginal costs, it makes more sense to keep it operating rather than shut it down, remove the machinery, dismantle the structures, and sell off the wells to investors in the market for deep holes in the ground.

Yet, it is not as easy to recover long run costs associated with addressing ordinary capital depreciation and oil well depletion. The oil price has to be significantly higher than short-run marginal costs because significant resources have to be reinvested in exploratory activities, including exploratory drilling, and in developing infrastructure around new oil wells. And these activities are quite risky. They are fraught with formidable geological risks, commercial risks, and political risks (see Berger, 2003; Menaldo, 2016).

Moreover, oil companies undertake capital intensive operations across the production chain—geological surveying, exploration, extraction, transportation, and exportation—that are

[17] Pashakolaie et al. (2015, p. 462), for example, find that the drilling costs of wells in an Iranian field alone are $15 million dollars per well, in 2012 USD.

[18] Adelman and Shahi (1989, p. 6) found that operating costs per barrel (in 1985 dollars) were under or near $1 for most OPEC members from 1955 to 1985.

specific to both oil fields and oil wells. They cannot be easily redeployed to other oil plays by those firms. They are tied up with unique oil fields and distribution networks, as well as petrochemical facilities and export terminals (Davis, 2006). Even their scrap value is steeply discounted, as there are few liquid markets where these assets can be sold off by firms or used as collateral for cash. Therefore, oil companies require relatively high risk adjusted rates of return over the long run.[19] These, in turn, capture the unique opportunity costs of capital they face and increase long-run marginal costs significantly above short-run ones.[20]

Suffice it to say, this scenario creates strong incentives for opportunism. It is the basis for one of the most celebrated claims about oil industry dynamics, the so-called obsolescent bargain.[21] When oil and gas exploration and production contracts are signed and financing is committed, investors have substantial power to extract concessions and promises from host governments. After all, they are the ones that possess the technology, capital, and expertise necessary to extract the resources. They are the ones incurring the risks and sizable fixed costs. Over time, however, this power shifts to the hosts. The plants, machinery, and storage facilities employed during hydrocarbon production are fixed assets that can be easily confiscated. Investors must make expensive investments in these assets several years before they can realize a return on their investment. While these costs are sunk at the beginning of a project, host

[19]See, for example, the discussion of risk adjusted discount rates (RADR) in the annual Survey of Parameters Used in Property Evaluation published by the Society of Petroleum Evaluation Engineers. Survey respondents report typically using RADRs of between 10 and 25 percent.

[20] See Joskow (1987) on coal and Masten & Crocker (1985) on natural gas.

[21] This concept was introduced by Vernon (1971).

countries can renegotiate the deal to extract better terms later on, or even expropriate private firms and continue to produce hydrocarbons themselves.

Therefore, after private firms have incurred exploration and production risks—and especially when commodity prices rise—states face incentives to increase royalties, introduce windfall taxes, and nationalize production. In this context, private oil companies will continue to extract oil to defray their short run costs, which may be infinitesimally low; but they will stop repairing and replacing worn out equipment, let alone explore for new oil fields and bring new discoveries on line.

It is only upon understanding the nature of Quasi-rents and why their appropriation damages long run cost recovery and implies a secular deterioration in the magnitude of oil reserves that we can appreciate two important things about the global oil industry. First, not all nationalizations are created equal. Mild contract renegotiations differ from full on expropriations and the former may involve an unorthodox tax on Ricardian Rents while the latter may involve the appropriation of Quasi-rents. Second, the treatment of NOCs by governments and their energy and revenue strategies may differ wildly. While one type of NOC, such as ARAMCO, may be allowed to recover its long run costs and generate billions of barrels of oil reserves over long horizons, another type of NOC may be treated like a cash cow in the short run, without regard for maximizing long run oil revenues (see, also, Mahdavi, 2020).

At the end of the day, if a myopic ruler indeed appropriates Quasi-rents, this cannot go on forever. Eventually the oil will be depleted from the extant wells. The appropriation of Quasi-rents, in other words, always has a natural limit. Eventually, extant oil will be exhausted and worries about long run cost recovery may overwhelm short run revenue maximizing considerations.

Yet, and mirroring the theme of this paper, not all Quasi-rents are created equal either. They differ in many respects, from heterogeneity in the amount of sunk costs, to the difference between short-run and long-run costs, to the depreciation rate. Moreover, each of these differences carry distinct political implications. Let us treat each of these differences in turn.

First, assume you have two oil fields, each with low marginal costs. They are the only oil fields in the country, foreclosing the possibility for future investment. The first field, however, required a small sunk investment and the second required a huge sunk investment. While economically they are same, politically they are quite different. Seizing rents from the field with low up-front costs entails raising taxes. Seizing rents from the field with high sunk costs, however, means that the government has to reassign property rights directly to avoid the field operator from defaulting on its debt and going bankrupt.

Now, imagine two oil fields with the following characteristics: high marginal costs and high drilling costs—and, thus, high sunk costs. Ricardian Rents are, accordingly, low. How governments now respond depend on the wells' lifetimes. A field whose wells face a hyperbolic decline rate (as in most unconventional wells) requires new drilling every eighteen months or so. A conventional field, however, does not. While in the short run both fields produce Quasi-rents, what that span of time covers for each operator differs greatly. For the first, the short run is about a year and a half; for the second, it's almost two decades. A government, even if relatively patient, would therefore have very strong incentives to appropriate Quasi-rents in the second case but less so in the first.

Finally, consider differences in depreciation rates. A government's appropriation of Quasi-rents can go on far longer in a place such as Venezuela, with deep reserves and a long

history of technical acumen, and therefore that boasts an oil industry with relatively low depreciation rates, versus a place like Ecuador, a smaller producer, or Guyana, a newer producer.

In some countries' oil industries, there is an important interplay between Ricardian Rents and Quasi-rents. In some places, the government's appropriation of Quasi-rents eclipses any Ricardian Rents because the oil industry is relatively inefficient in terms of its cost structure and, thus, the wedges between the average marginal cost per oil drilling rig and world price is simply too small to really register.

An important example is Russia, where the production costs per barrel of oil are quite steep: they may be as high as $45, on average, per barrel for Russian crude (Warsaw Institute 2021); this is because the marginal cost of producing an additional barrel of crude oil in the Arctic were $120 per barrel of crude oil in 2014 (Knoema 2021). Nonetheless, Russian President Vladmir Putin has increased the revenues extracted from oil and used them as his personal piggy bank to consolidate his rule (Mahdavi 2020, p. 7); this has entailed fewer short run profits available to be reinvested in the oil industry to outlive depreciation and, thus, outrun depletion.

Another illustrative example is Yemen, where the fiscal breakeven oil price (at which the fiscal balance is zero) was a sky high $218 dollars per barrel in 2016 and the external breakeven oil price (at which the current account balance is zero) was also an eye watering $145 that same year (Knoema 2021). In the case of Yemen, successive governments embroiled in civil war and racked by corruption and incompetence failed to reinvest petroleum revenues enough to keep up with depreciation and the exhaustion of oil wells (IMF 2001), such that Yemeni oil fields are now almost totally depleted and no new ones are scheduled to come online (Menaldo 2016).

Finally, Saudi Arabia is a telling example of how when Ricardian Rents are very high, the government may simply not have to ever resort to appropriating Quasi-rents. The short run

marginal cost per barrel of oil in the kingdom, excluding the long run costs of increasing capacity, is only $3 (Knoema). Indeed, Saudi Arabia has had significantly lower extraction costs than other major oil producers since the discovery of oil in 1938 (see Mahdavi 2020, p. 128). This means that even when oil prices scrape the bottom of the barrel, so to speak, Saudi Arabia still earns a wedge between its costs and the international price.

Of course, this is different from the fiscal breakeven oil price; in Saudi Arabia that is relatively high because the kingdom showers its population with billions of dollars in subsidies for fuel, education, housing, and healthcare, putting its fiscal breakeven oil price at $78.9 in 2016, for example (Knoema 2021). If, for example, oil is priced at $30 per barrel, to cover its budgetary expenditures Saudi Arabia has to either take about $50 per barrel from its rainy-day funds, or borrow. In the case of the kingdom, this means dipping into its vast fiscal reserves rather than indulge in Quasi-rent appropriation.

Why is it the case that Saudi Arabia's government eschews raiding the oil industry to finance its vast welfare state when the international oil price is low? As Mahdavi (2020, p. 127-28) argues, this is because its stable monarchical form of government with a predictable succession mechanism have consistently protracted the Saudi government's time horizons, contributing to the kingdom's stewardship of the oil industry. Treating the oil industry as a national treasure that is worth preserving for future generations, successive rulers have made decisions about oil field investment, extraction, and reinvestment with long run sustainability as a front and center concern (see also Menaldo 2016). Recently, for example, Aramco has pledged to increase capital expenditures by 50%, with an eye towards substantially increasing crude oil and gas production over the next decade (Azhar & El Dahan, 2022).

Revisiting the Resource Curse: Oil, Institutions, Corruption and Rents

While we have so far discussed how myopic governments appropriate Quasi-rents in both the oil and non-oil sectors of their economy, this does not rule out the idea that the reason they do so in the first place is because of oil abundance itself. In fact, the so-called resource curse literature posits that the direction of causality runs from the presence of abundant oil to corruption, of which quasi rent appropriation is but one flavor. On the one hand, high levels of resource endowments, and especially big investments in the hydrocarbon extracting capital stock and infrastructure that may create opportunities for governments to appropriate Quasi-rents, might fuel corruption (Bulte et al., 2005; Bhattacharya & Holder, 2010). In turn, this may also fuel the deterioration of political institutions (de Soysa et al., 2020; Ross, 2001).[22]

If resource abundance is what creates weak property rights in the first place, as researchers who identify a resource curse argue (de Soysa et al., 2020), then it may be the case that oil leads governments down a road of Quasi-rent appropriation, both within the hydrocarbon industry and across the economy in general. If the resource curse literature is correct, then oil abundance may be the original cause of chronic underdevelopment. And the Quasi-rent appropriation we have highlighted may be a possible mechanism by which an economic monoculture develops: eventually the oil industry may be the last sector standing as Quasi-rent appropriation across the economy drives out investment in non-oil industries (see

[22] Others argue, however, that low quality institutions drive the exploration for natural resources in the first place (Brunnschweiler and Bulte, 2008; Haber & Menaldo 2011; Menaldo 2016), reversing the causal relationship. Alternatively, some researchers aver that existing levels of institutional quality at the time of natural resource discovery determines whether oil extraction has positive or negative effects on patronage (Mehlum et al., 2006; Robinson et al., 2006).

Brunnschweiler and Bulte 2009; Haber 2007; Menaldo 2016). Of course, the oil industry may itself be an eventual victim of this cannibalization process: ironically, oil abundance may breed premature oil exhaustion.

Important Puzzles and Patterns Revisited

According to a celebrated literature in transaction costs economics, one should almost never observe the appropriation of Quasi-rents on the equilibrium path because firms will anticipate this problem: when they have co-specific assets that are at risk, they will create defensive measures proactively (Klein et al., 1978; Williamson, 1985; Galetovic & Haber, 2017). They will vertically integrate, for example, or develop mutual hostages or something that will make it difficult for them to behave opportunistically vis-à-vis each other. In the case of oil, the biggest retaliatory threat might normally be for the oil company to withhold future benefits from the host country, ruin its reputation, or seize its assets overseas (Menaldo, 2016).

This raises some important questions. If oil companies understand the microeconomics outlined above, and thus the possibility of Quasi-rent appropriation at the expense of long run production, why do they go into countries in which politicians may be tempted to act opportunistically in the first place? Is it that they simply do not understand the political incentives that rulers face in developing countries in general and oil exporting countries in particular? Perhaps IOCs do not have a good sense of rulers' discount rates. Or, might it be that the oil companies themselves have short time horizons and do not necessarily suffer damage from failing to recover their long run costs—perhaps because they have global portfolios and can seek to diversify them in ways in which they can hedge against the appropriation of their Quasi-rents in one oil field or even one oil producing country (Broadman, 1985; Menaldo, 2016)? Or

perhaps oil companies go into oil producing countries in which they might face the appropriation of their Quasi-rents with open eyes and take appropriate defensive measures?

The last possibility, in particular, seems at first blush to reconcile the fact that while the prospects of opportunism are ubiquitous in the oil industry, they might be less than meets the eye. For example, IOCs may shelter their profits, perhaps through transfer pricing, fearing that they are going to suffer from unanticipated tax increases (Gillis, 1982, p. 623; Menaldo, 2016). Or they may shelter the information, infrastructure, and personnel that the host government would need to pump oil on its own, thus keeping the government from rendering them obsolete (Barma et al., 2012, p. 97; Menaldo, 2016).

Another potential answer to these questions is that private investors may not be all that surprised by an act of expropriation, whether hard or soft. Perhaps some oil companies anticipate that, even if particular oil fields and their equipment and infrastructure are "expropriated", a ruler may eventually reach the point where it is necessary to rejuvenate the country's oil reserves, and thus invite the foreign firms back in to help her do that (in joint ventures or production sharing agreements). Future oil prices might be high enough to incentivize a snake bitten IOC to tempt fate again and thus focus on maximizing short run revenues.

More provocatively, these sorts of de facto contractual renegotiations may not actually put long run cost recovery at risk. An IOC may be invited in to help a NOC with the heavy lifting after nationalization and may enjoy the profit motive to do so, including the ability to recover long run costs. What's more: firms may be somewhat complicit in allowing rulers to appropriate some of their Ricardian Rents. They may do so with the tacit understanding that it is only for a short amount of time, and that it will not really cut into their long run costs: that once

they come back in after the "renegotiation," it will be on reasonable terms that incentivize them to continue to explore for new oil and produce it.

In other words, and contrary to conventional wisdom, whether these actions are labeled "expropriation," "nationalization," or "contract renegotiation," they may not actually refer to the myopic appropriation of Quasi-rents. Rulers may instead seek to extract a onetime concession where their cut of the (regular and probably not very outsized) Ricardian Rents increases, but not necessarily damages long run revenues. Indeed, the IOC may never really go away: yes, they are nominally expropriated, but this is really just a furtive renegotiation.

This logic may help explain why the extractive sector is characterized by an unusually large number of costly contract negotiation cycles (Hogan et al., 2010, p. 2; Tomz & Wright, 2010). Hogan and Sturzenegger (2010, p. xiii) refer to this phenomenon as the "Natural Resources Trap." Governments with low credibility—whether because of a history of expropriation, instability, etc.—need to offer generous terms to IOCs to attract their investment and expertise. Yet, these terms are politically challenging for the host country to maintain, especially once resource extraction has begun and the IOC captures a large percentage of the revenues. Host governments face political pressure to expropriate IOCs once production is underway or if there is an outsized increase in the global oil price; this dynamic is exacerbated by the fact that heavy capital investment is sunk early on and is difficult if not impossible to redeploy elsewhere once it is invested in a specific oil play.[23]

[23] As discussed above, this "obsolescing bargain" denotes the balance of bargaining leverage shifting away from the IOC to the host country over time (Vernon, 1971).

In short, perhaps not all rulers are acting opportunistically when they expropriate oil firms in the sense of appropriating Quasi-rents and private oil firms fully anticipate this type of behavior. Foreign firms come back into town after an expropriation in name only, which is really just a contractual renegotiation. This might happen several times, and be influenced by spikes in the price of oil, because both parties know that this is just a contractual renegotiation: after all, contracts are necessarily incomplete and will probably be renegotiated.

Of course, some state-owned oil companies may be the byproduct of the actual, onetime appropriation of an IOCs Quasi-rents. But, subsequent to that event, the state may create a NOC and allow it to recover its own long run costs going forward. That is to say, foreign companies may be expropriated as the sacrificial lamb that gives birth to a functional and enduring state-run company that then re-invests its revenues in the long-run health of the operation. This is not necessarily myopic in the least, in that the government has robbed Peter to pay Paul and set Paul up with a replenishing business opportunity that it can earn a bigger cut from.

Finally, this scenario does not rule out true examples of myopic opportunism. A predatory rule may not allow its country's NOC to recover its long run costs. That is to say, the ruler may engage in opportunistic appropriation of Quasi-rents *after* nationalization at some point as well. Not only will the IOC that is expropriated leave town, perhaps after recovering some or even all of its short run costs while the government figures out how to confiscate the extant wells, but the NOC will be run into the ground. The upshot is that production will eventually decline and reserves never recover.

Next, we explore the Mexican case, where the government expropriated oil companies and nationalized the oil industry. Well after those initial events they continued to appropriate Quasi-rents. The Mexican government has failed to allow PEMEX to recover its long run costs

and thus not enough new reserves have come online to outrun their depletion. A similar dynamic has taken place in Venezuela, where the government has extracted rents from PDVSA to the point that it has negative cash flows, and new investments in the sector have all but disappeared.[24]

The Mexican Oil Industry after Nationalization

Since the Mexican government nationalized the petroleum industry in 1938, oil production in Mexico has been managed by a NOC, Petróleos Mexicanos (PEMEX).[25] A ban on joint ventures with IOCs and production sharing agreements, relaxed in 2014, historically meant that PEMEX was essentially the only player in the sector, and crucially the only organization with the leeway to make investments in exploration and future oil production.[26] The NOC has had an outsized importance for government revenues: taxes on PEMEX's oil production has historically accounted for 40 percent or more of government revenues, despite the fact that its

[24]Appendix 3 discusses the Venezuelan case.

[25] See Maurer (2011) for a review of this series of events, and an analysis of who the "winners" and "losers" of this process were.

[26] Despite energy reforms being on the books for six years now, there were limited joint ventures and production sharing agreements between PEMEX and foreign firms by the time we finished writing this paper; indeed, many of these contracts were cancelled by President Manuel Lopez Obrador upon coming to office in 2018. While he then backtracked on his quest to return to the status quo before the reforms, foreign investment and participation in the oil sector has not really been all that forthcoming.

contribution to GDP has ranged from 2 to 6 percent (Tijerina-Guajardo & Pagan, 2003, p. 154-5; Menaldo, 2016).

The Mexican government's high fiscal reliance on PEMEX is explained by a climate where fiscal transaction costs have always been prohibitive. The 1910 Revolution was a crushing blow to an already fragile state. It destroyed vast stocks of capital, both human and physical, and enervated state capacity, retarding the modest political and economic progress achieved under Porfirio Díaz. The decimation of lives and property, combined with mass strikes and protests by miners, railroad workers, and industrial laborers, contributed to the rapid depletion of state coffers.

In the immediate aftermath of the revolution, capital flight sped up, catalyzing a strong, negative shock to investment and economic growth that was then supercharged by the Great Depression.[27] After reaching 18.4% of GDP on the eve of the revolution, domestic investment plummeted and did not return to this level until 1957. By 1926, the investment ratio had fallen to 9.86%. Unsurprisingly, the Great Depression did not help matters; between 1930 and Calles' last year of rule, 1933, the average investment ratio was only 6.6%. The average growth of real per capita income was –2.3%; it took until 1941 for Mexico to regain its 1924 level. Mexico was also forced to make a host of very expensive reparations to the United States and Britain after landholdings and the oil industry were expropriated during the revolution and its wake. The

[27] Notes and Sources for the following figures follow. FDI figures are measured in 1983 dollars and are from OXLAD (2003). Real values are computed using the US Consumer Price Index. The figures on investment and Per Capita GDP are from OXLAD (2003).

upshot of all of these problems is that there was not much of an economy left to tax and the Mexican state faced a dire fiscal emergency.

Successive PRI governments therefore helped create, and eventually took over, large firms with big profits that could be effectively monitored and taxed. Eventually, Mexico's central bank, development banks, and private banks got into the business of financing state-run enterprises. Besides subsidized credit, manufacturers were awarded steep tariffs and quotas on competing imports, barriers to entry that allowed them to capture the domestic market, including restrictions on foreign ownership, and favorable labor laws. Over time, the state increasingly took over many of these companies; by 1982, it owned over 1,000 firms. The government then "looted" these firms by failing to reinvest in them; instead, their profits were deployed to finance the state and shared with political supporters. Depreciation rates outstripped firms' ability to remain competitive; Mexico's railroad, steel, machinery, and chemicals industries fell steadily behind and many companies in these sectors went bankrupt.

The state's appropriation of Pemex's Quasi-rents was therefore not *sui generis*; however, it was extreme. During the 1920s, Mexico ran out of conventional sources of petroleum—those that could be detected by the technology at the time (see Haber, Razo, & Maurer, 2003). This set the stage for the government to eke out revenues from PEMEX—either by hook or by crook. Mexico exported only 15 million barrels of oil in 1938, the year oil was nationalized, compared with 24 million barrels a year earlier, precipitating a steep decline in the Bank of Mexico's foreign reserves. Mexico's level of Oil Income Per Capita in 1930 was only 13 percent of what it had been in 1921.[28] By 1933, Oil Income Per Capita was only 6 percent of what it had been in

[28] Data on oil production and revenues from oil that follow are from Haber and Menaldo (2011).

1920, the year that Mexico fist reached peak oil production. Indeed, Mexico only regained its 1921 production level in the late 1970s, during its second oil boom, after the discovery of an offshore supergiant oil field in 1976. This meant that the government's fiscal take from oil as a percent of total state revenues collapsed from a high of 31.4, in 1922, to 5.4, in 1931. The state would only obtain this level of oil reliance again in 1983. Mexico became a net oil importer after the end of its first oil boom and rescinded all direct taxes levied on oil after the industry's 1938 nationalization—there were simply no profits left to tax.

Once profits recovered in the late 1970s, however, they have not been reinvested in new exploration and production. Shields (2006, pp. 12-13) estimates it would take a yearly budget allocation of $20 billion dollars in order for PEMEX to simply make the exploratory investments that would keep ahead of current rates of oil reserve depletion. Yet, Mexico's government leaves PEMEX with only $10 billion dollars per year to reinvest in new production.

Despite often reaching the top fifty positions in pre-tax revenues for companies worldwide (Stojanovski, 2011), the state's oil taxation scheme leaves PEMEX with little left over to cover current, let alone future, costs (Miranda, 2009). PEMEX earned $108 billion dollars (2010 real dollars) in operating revenues in 2013 and $125 billion the year before that (Orbis Dataset). The basic hydrocarbon tax alone soaks up 60.8 percent of PEMEX revenue and is compounded by a variety of other taxes and royalty payments.

After taxes, PEMEX operates at a net loss (Shields, 2006).[29] Real net profits (2010 real dollars) were $-4.2 billion in 2013 and $-25 billion in 2012 (Orbis Dataset). In 2014, PEMEX

[29] See Ramierz-Cendrero & Paz (2017, p. 478) for a list of the thirteen taxes, royalties, and other duties that PEMEX pays out annually.

paid $50.7 billion in taxes and fees to the state, while taking in $32.6 billion dollars in profits (Ramierez-Cendrero & Paz, 2017, p. 480).[30] In 2019, PEMEX lost US$18 billion (Wall Street Journal 2020). It held $95 billion (2015 USD) in liabilities on its balance sheet in 2005; in 2020 the picture is no better, with $100 billion in outstanding debt, $10 billion owed to suppliers, and $77 billion in pension obligations (Wall Street Journal, 2020).

PEMEX primarily finances new investments with debt; its weak balance sheet makes it exceedingly difficult for it to borrow enough money to address depreciation, including the depletion of Mexico's oil stocks. Furthermore, many long-term investment decisions are ultimately made by the finance ministry, which is staffed with political appointees who lack the technical expertise needed to maximize the NOC's long-term revenue (Stojanovski, 2011, p. 282).

Politics affects PEMEX in other important ways as well. Funds appropriated from it have not escaped misuse; for example, by being used by the ruling party to finance its 2000 presidential campaign (Miranda, 2009, p. 213). Political pressure against reform is compounded by a very strong oil workers union (Stojanovski, 2011). After obtaining power, President Andrés Manuel López Obrador used the 2014 energy reforms pushed through by his predecessor, Enrique Peña Nieto, from the disgraced PRI Party, as a punching bag. This scared off much needed foreign investment. He also poured billions of dollars into PEMEX's downstream refining business, which has proven to be a cost inefficient money pit.

The Mexican government's politicized operation of PEMEX continued into early 2020. As oil prices cratered and nearly all other oil producers were cutting production to stabilize the

[30] Both of these figures are in 2017 USD.

world market price, Obrador vowed to double PEMEX's well count and increase production by 11 percent (Stillman & Millard, 2020). At early May 2020 oil prices, this would result in a loss of $9 per barrel (Whelan, 2020). Meanwhile, PEMEX reported a $23 billion loss over the first quarter of 2020.

While oil prices have since recovered, the global economic downturn caused by the COVID-19 pandemic augurs low demand into the foreseeable future, serving as a strong headwind against PEMEX's financial wellbeing. To be sure, Obrador has pledged to cut the NOCs taxes and inject it with emergency funding. Yet, much of that funding appears to be financing the construction of a new refinery in Obrador's home state, Tabasco. Rating agencies are likely to downgrade PEMEX's bonds, making future borrowing even more difficult (Eschenbacher 2020); this spilled over to Mexico's sovereign debt as well, which has been downgraded by the three major rating agencies, in part because of PEMEX's woes (Whelan, 2020).

CONCLUSION

Not all rents are created equal. The contrasting cases of Saudi Arabia and Mexico's oil industries illustrate why these distinctions matter. The former is a celebrated case of Ricardian Rents. The latter is a basket case and represents the appropriation of Quasi-rents. Though oil rents play an outsized economic and political role in each case, Saudi ARAMCO has operated for decades as a highly profitable, and by all accounts well-run enterprise. PEMEX? The opposite on both counts.

But this is not necessarily a function of Mexico's oil industry in particular. Quasi-rents exist across all manner of industries and myopic governments often appropriate them at the expense of future development. They may suck several sectors or companies dry, instead of

allowing them to reinvest short run profits to address capital depreciation and conduct R&D to improve productivity. Surprise taxes and "operating licenses" that appear out of nowhere, price controls, and the rationing of foreign exchange are some of the ways in which governments may appropriate Quasi-rents from automobile manufacturing, breweries, and farms. See, Venezuela.

This "fiscal strategy" may take anything from a few years to many decades to reach its logical conclusion. First, an industry's total collapse. An example includes the Yugoslavian automotive industry during the 1990s (Vuic, 2010). The Serbian government drove it into the ground—pun intended. Second, serial under-investment or malinvestment across the entire economy. Myopic governments across much of the developing world's economies mortgage the future welfare of their populations when they appropriate Quasi-rents. Oil is just one example.

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APPENDIX 1

WHAT ARE PRICES AND RENTS AND HOW ARE THEY DETERMINED?

In order to properly comprehend what rents are, as well as their different varieties, it is important to first understand what prices are. That is because rents are returns above opportunity costs, which are embodied in prices. All prices—and thus rents—are a function of a demand curve and supply curve intersecting.

The supply curve bespeaks a willingness by firms to produce something or provide a service. This desire, in turn, is defined by firms' opportunity costs and the potential alternative uses of the inputs involved in the production process. It is therefore equivalent to the marginal cost curve. This curve has a relationship (myriad functional forms are possible) to the quantity of a good or service that is produced. While in the short run this curve slopes upwards—which represents increasing marginal costs and also the fact that a greater quantity of a good or service will be produced at a higher price—this is not always the case in the long run.[31]

The demand curve, for its part, bespeaks consumers' willingness to pay for a product or service. If there is no willingness to pay at prices at or above the marginal costs of production, the market will go missing. In the short run, the demand curve slopes downward. This implies that as the price of a good or service increases, the quantity demanded by consumers declines.[32]

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[31] Some firms may adopt new technologies or strategies to reduce their costs in ways that do not trickle out to rivals. This bespeaks an upward sloping supply curve over the long run—the dynamics of an increasing cost industry—that would otherwise be negated with perfect technology transfer across firms. Even in situations where information on best practices and technologies is available, firms may lag behind more productive firms for several reasons: e.g., if they possess outdated capital or make mistakes in learning new techniques. The latter may possess tacit knowhow and trade secrets that cannot be easily learned or replicated by rivals.

[32] One exception to this are positional goods, whose utility to a consumer is in part based on the status they confer because of their scarcity. Examples include luxury goods and diamonds. As the price decreases, demand may decrease for certain consumers (usually those with high incomes) instead of increasing (bespeaking a negative elasticity); as more individuals are able to

Given these building blocks, price theory attempts to explain the interface between consumer tastes and production costs.[33] The total value that can be created and distributed among the suppliers of inputs is circumscribed by the demand curve for the final product. The cumulative value across a supply chain equals the market price consumers are willing to pay for the final good or service. Each producer of the inputs that go into final goods therefore receives market prices determined by their contribution to satisfying this demand curve in light of whether there are substitutes for those inputs. When one firm purchases an input from another firm further up the supply chain to create an output consumed as a final good, that price reflects the former firm's willingness to pay, at the margin, which itself reflects the consumer's willingness to pay, at the margin.

What, therefore, is the value added by any particular input that occupies a node in the supply chain of a final product, what is its market or shadow price, and what determines the rents it earns, if any? If we want to find this out, the first thing we need to do is to understand the elasticity and functional form of the consumers' demand for the final product. This is because the demand curve circumscribes the remuneration made by intermediaries for all of the inputs across chain, including whatever rents they might command. Specifically, the pivotal consumer's willingness to pay at the margin—where the input's marginal cost intersects with the demand curve, conditioned by the potential substitutes for that input—determines the value that is added by any input.

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consume the good, it loses its cachet. Thus, the demand curve may slope upwards. Or, if demand is continuously pushed outwards over time the long run demand curve may slope upwards for a different reason. For example, Acemoglu (2002) argues that this is the case regarding the demand for skilled workers in the United States. According to Acemoglu, this shift in the demand curve is based on skill-biased technological change, which raises the premium for university education despite increases in the supply of skilled workers.

[33] This paragraph draws on Galetovic and Haber (2019).

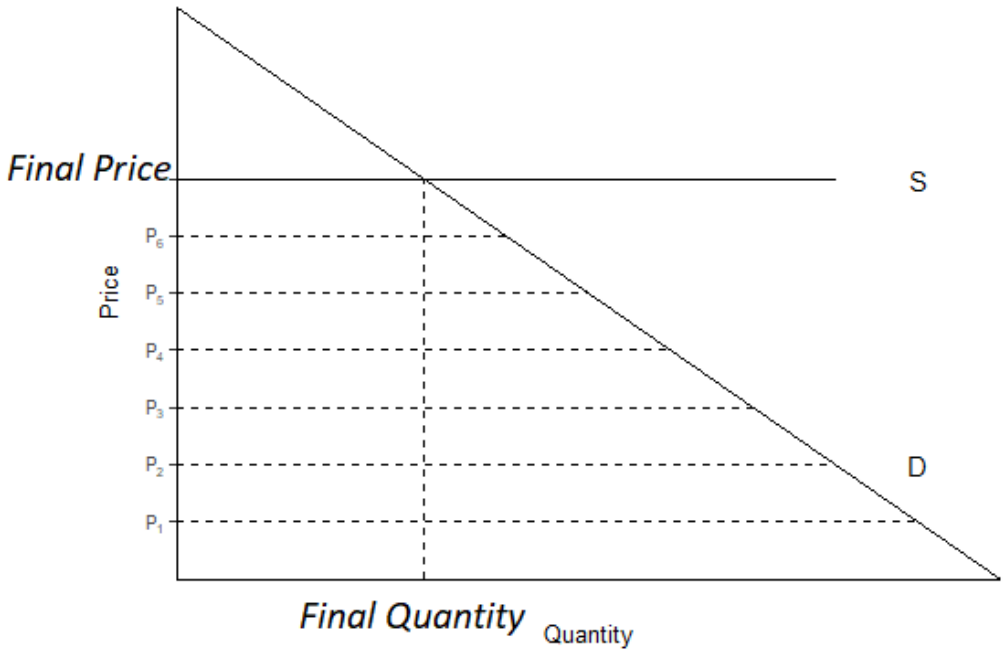

Figure A1.1: Final price determined by marginal costs of inputs to product

Notes: the supply curve is flat, which bespeaks the price over the long run. In the case of this product, there are zero economic rents earned because the final price reflects the cumulation of marginal costs across a supply chain characterized by competitive markets.

Figure A1.1 is a visual representation of the final price ($P_{Final\ Price}$) as the sum of the marginal costs of each input (P_1-P_6) of production. The latter might represent raw materials, refining and machining, assembly, packaging and transportation, marketing, and any additional retail costs that culminate in final point of sale price. Each horizontal line represents the value added by each firm in the supply chain and, thus, their market price or shadow price.

By extension, the potential rents earned by a firm situated in this chain is also bounded by the demand curve. All of this holds whatever the firm's location in the production chain: whether it provides intermediary inputs to a downstream assembler or whether it is completely vertically integrated. In Figure A1.1 we have assumed a flat supply curve and zero economic rents.

We now relax this assumption. We turn to an exploration of what rents mean in general, the broad implications this has for firms—and, by extension, the governments that tax them—and the different sources of rents: Ricardian, Market Power, and Quasi.

WHAT ARE RENTS IN GENERAL?

Recall from the discussion above about price theory that the market price received by an input into the production of a final good compensates for the opportunity cost of providing it (and also reflects its substitutes). Therefore, any revenue above that input's market price—by definition exceeding its opportunity cost—represents an economic rent to its owner. In other words, rents are a pecuniary return to a factor of production—and, more broadly, an input—in excess of what it would accept to remain in a given market. These factors of production include land, natural resources, labor, machinery, ideas, knowhow, and money.

Opportunity costs encompass three things: the alternative uses of capital, alternative uses of the "business power" needed to manage it, and the alternative uses of the organization that concatenates these and brings them into production (Marshall, 1920: 596). By extension, rents that accrue to labor are "supra-normal" wages, those above a laborer's reservation wage; rents that accrue to land, natural resources, and machinery beyond their opportunity cost are fittingly called "rents"; rents associated with an idea beyond the opportunity costs to think of it are called "royalties"; and rents for the use of money beyond its opportunity cost is called "interest" (see Alchian 1987). In the case of producers, in general, rents are any increment it receives above the product's marginal cost (which subsumes the opportunity costs of labor, land, natural resources, machinery, and money).

All of these types of rents differ from normal accounting profits. The latter are essentially payment for the factor's opportunity cost: the minimum return required to guarantee that the inputs will be directed toward their current use.

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APPENDIX 2

MARKET POWER RENTS

Market Power Rents are when firms price above marginal cost by constraining quantity. That means that the cross-elasticity of demand between its products and potential substitutes is inelastic enough that they enjoy the luxury of constraining supply and the room to increase price. Monopoly power is the extreme of this situation, where producers are able to reduce quantity by half and maximize revenues where their own marginal revenues intersect with the marginal cost curve. In this situation, the cross-elasticity of demand between its products and potential substitutes is fully inelastic (it faces no substitutes). After laying out the microeconomic logic behind Market Power Rents in general, we discuss the mixed evidence for Market Power Rents in the oil industry, focusing first on the infamous case of Standard Oil before its breakup by the U.S. government and the OPEC cartel.

The extreme of Market Power Rents are Monopoly Rents. The monopolist earns Monopoly Rents when it prices its product at Lerner Margins, whereby the price cost margin is equal to $P - c/P = 1/\eta$ where η = the elasticity of demand (the percent change in price if there is a percent change in quantity). It follows that, the more inelastic the demand curve (notice we are speaking about the demand curve for the firm's product now, not the cross-elasticity of demand between products), the bigger the wedge. What does this mean in practice? At an elasticity equal to 1, the margin/rent as percent of price will be 90; at an elasticity equal to 2, it will be 50; at an elasticity equal to 4, it will be slightly south of 30.[34]

[34] This discussion draws heavily on Galetovic (2017).

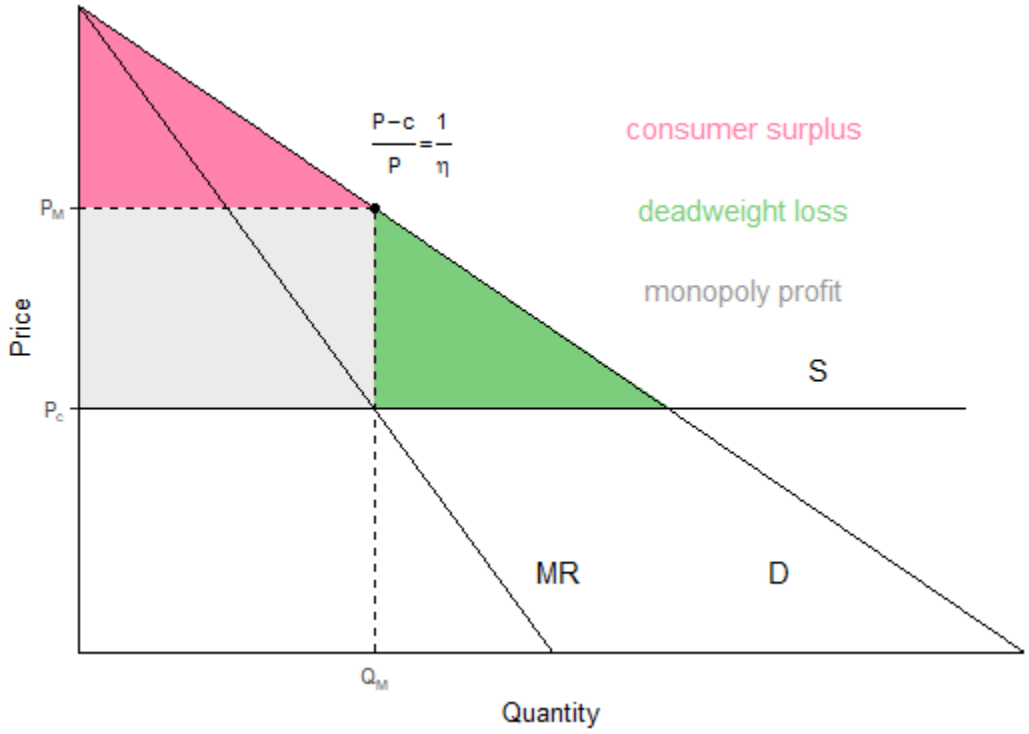

Figure A2.1. The Rents Earned from Monopoly Power

Notes: the supply curve is flat, which bespeaks the price over the long run. In the case of this product, a single firm earns Lerner Margin economic rents (the gray rectangle) because the final price reflects its ability to equate its marginal costs with its marginal revenues, which in turn intersects the demand curve at the point illustrated by the black dot. Horizontal to that dot on the Y-axis is the price at which $P - c/P = 1/\eta$.

Figure A2.1 outlines the basic features of a market with a single producer over the long run, which implies persistent barriers to entry. A monopolist faces the entire demand curve and optimizes as described above. On the one hand, if it were to produce any greater quantity it would sacrifice a higher price, therefore reducing its rents. On the other hand, if it would increase the price further, it would sacrifice quantity and reduce its rents accordingly. The Lerner margin, by contrast, generates the largest amount of rents possible with a price that remains appreciably greater than marginal costs. The social costs are a reduction in consumer surplus and

the existence of deadweight losses; the magnitude of the latter is determined by the elasticity of the demand curve.[35]

APPLYING MARKET POWER RENTS TO THE OIL INDUSTRY

We will examine the theory and evidence for Market Power Rents in the oil industry. We will first look at the infamous Standard Oil case. Standard's supposed cartelization of the petroleum refining industry in the United States at the turn of the 19th Century remains an iconic example of the American government suing a large company for violating the Sherman Antitrust Act. We will then turn to the logic and evidence for Market Power Rents in the international oil industry by focusing on OPEC (the Organization of Petroleum Exporting Countries).

Standard Oil: Was it a Monopoly or Not?

There is considerable ambiguity about the possibility of market power rents in the case of the early oil industry in the United States most famously represented by Standard Oil and its supposed monopoly in the late 19th and early 20th Centuries.

Granitz & Klein (1996) argue that Standard Oil developed considerable market power in US oil refining beginning in the 1870s. Rather than attempting to dominate the refining stage of oil production, where entry was relatively easy, they suggest that Standard instead put a chokehold on the rail transportation of refined oil (there were no significant oil pipelines transporting oil within the United States at the time). Granitz & Klein argue that by exploiting the fact that only three railroads transported oil in 1870, Standard could successfully collude with each of the railroad companies by threatening to reallocate its transportation business from one

[35] When the elasticity of demand is high, the deadweight losses are bigger; relatively inelastic demand means smaller deadweight losses.

competitor to another. They also show that Standard shared the revenues it collected from the sale of refined oil with these railroads. The railroads reciprocated by setting higher rates for the transportation of non-Standard oil. This helped Standard grow its market share from 4 percent of US refining capacity to almost 90 percent in under a decade.

Yet, as Granitz & Klein themselves argue, while there is evidence Standard's market power contributed to anticompetitive behavior, it is less clear that this also resulted in monopoly pricing of oil; furthermore, the collusive relationship between Standard and the railways was prone to breaking down, weakening Standard's ability to sell at a monopoly price. Along these lines, Wienberger (2018) reports several noteworthy facts. In 1870, Standard Oil owned 4 percent of the petroleum market. By 1874, this share jumped to 25 percent. By 1880, it was 85 percent. However, higher market concentration did not translate into higher prices for gasoline. The price of gasoline was reduced from 30 cents per gallon in 1869 to eight cents in 1885. And, in any event, on the eve of Standard Oil's breakup by the US government in 1911 under the auspices of the Sherman Antitrust Act, its market share was back down to 65 percent.

This suggests that Standard Oil did not charge Lerner Margins whereby it reduced the quantity of refined petroleum available for sale by half, which would have been passed onto consumers as very high prices for gasoline sold at the pump due to Standard Oil's markup: its exorbitant price minus cost to price ratio. Let us think about this carefully. First, consider the relatively inelastic, contemporarily accurate, price elasticity of demand for gasoline equal to -0.04, which is representative of consumer behavior circa 2014 (Morris 2014). This translates into gasoline consumption increasing by 1 percent when the price of gasoline decreases by 50 percent. Using the Lerner Margin formula, $P - c/P = 1/\eta$, this would entail that Standard's rent

margin as percent of price should have been a markup over cost of 2,500 percent if Standard Oil was charging monopoly prices for gasoline!

While the price elasticity of demand for gasoline in the United States has become more inelastic over time (see Morris 2014), even if we disregard this historical fact and assume the price elasticity of demand for gasoline was 1.1 in the late 19th Century/early 20th Century, this means Standard's rent margin as percent of price should have been a markup over cost of 90 percent if Standard Oil was charging monopoly prices for gasoline. Indeed, even if we assume the price elasticity of demand for gasoline during this time period was a completely unrealistic 4, then Standard's rent margin as percent of price should have been a markup over cost of 25 percent if Standard Oil was charging monopoly prices for gasoline. However, no matter what price elasticity of demand we assume, according to Weinberger (2018), the price of gasoline as a share of the company's refining costs kept decreasing in the United States over this time period because Standard Oil reduced costs continuously by vertically integrating and achieving economies of scale. Indeed, the American courts ruled in favor of breaking up Standard Oil not because of fewer gasoline for sale at the pump nor rising gas prices, but because Standard Oil had consolidated about 30 divisions under a single management structure (see Weinberger 2018).

But perhaps these reductions in gasoline prices were part of a long con on Standard Oil's part, however? Did Standard Oil engage in predatory pricing by charging lower prices in the short run, below its marginal cost to drive out competitors? This would enable it to then turn around and charge higher retail prices for refined oil once its rivals had exited the market due to their inability to compete with Standard's artificially lower prices. However, McGee (1958) does not find any evidence to that effect. And a vast theoretical literature has shown that a predatory

pricing strategy of this sort is almost impossible to actually pull off successfully (see Henderson 2017) .

OPEC: Does Cartelization Deliver Monopoly Pricing for Oil?

OPEC is a cartel that, theoretically, reduces quantity and is involved therefore in price fixing. But this is ultimately an empirical question and there are reasons to question whether OPEC actually earns Lerner margins. There are geopolitical reasons why, as the swing producer, Saudi Arabia may leave big bills on the sidewalk and not push this policy and, indeed, there have been several episodes where the opposite is true: Saudi Arabia floods the market with oil to push down the price. Plus, there is always the issue of defections from the arrangement—in other words, how well the collusion between OPEC members to restrict the quantity of oil supplied actually works in practice and under what conditions?[36] A few attempts have been made to assess the degree to which OPEC wields market power in the oil industry, a topic of much interest since the oil crisis of 1973.[37]

There is no clear academic consensus. Huppman & Holz (2012) use price data from 2005-2009 and find that Saudi Arabia acted as a Stackelberg price leader prior to 2008 with a non-cooperative OPEC, but in 2008-9 prices were much closer to what we would expect in a competitive market. Griffin (1985), using data from 1971-83, finds mixed evidence, some in favor of true cartel-like behavior from OPEC, and some in favor of a competitive market quantity and price. Lin (2009) finds competitive market behavior from OPEC prior to 1973 and evidence of monopoly pricing afterwards until 1990, while Hansen and Lindholt (2008) observe behavior that falls somewhere short of an outright pure profit-maximizing dominant producer.

[36] See Smith (2005) for a review.
[37] Al-Qahtani et al. (2008) have a useful review on the literature in energy economics on the market structure of the oil industry and OPEC's role within the market.

Nakov and Nuño (2013) model Saudi Arabia as a dominant producer, showing evidence that the country consistently has higher rates of spare, unused production capacity than its fellow OPEC members or non-OPEC producers. They take this as an indication that Saudi Arabia is restricting supply in order to create monopolistic rents. Golombek et al. (2018) have the latest take on the data, finding dominant firm behavior on the part of OPEC between 1986 and 2016.

Other scholars focus on the strategic behavior of OPEC members with each other, and especially Saudi Arabia versus the rest. Alhajji & Huettner (1998), for example, are skeptical of OPEC's classification as a cartel, suggesting that most of the organization's power resides with Saudi Arabia, while the other members fall into groups whose behavior is not well modeled using a dominant firm framework. Dibooglu & Al Gudhea (2007) study OPEC's quota system, introduced in 1982, to look for whether members cheat on these quotas, and if they face any consequences. They find that members do in fact cheat on their production quotas, typically by overproducing, and other members do not absorb this cheating by changing their own production levels. However, when there is a large real oil price shock, Saudi Arabia takes the lead in punishing cheating. Kaufmann et al. (2008) find a mix of competitive and market power behavior by OPEC members, and evidence that Saudi Arabia does *not* follow a tit-for-tat strategy as Dibooglu & Al Gudhea suggest, or that the threat that they might is enough to enforce production quotas most of the time.

The relative ambiguity of these empirical findings is striking given OPEC's status as a textbook example of a cartel that wields significant market power. If anything, these studies suggest that market power rents are both difficult to appropriate—in the case of OPEC because of the collective action problems inherent in the group—and, even when they are available, are to some degree fleeting, given the industry's sensitivity to global demand shocks.

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APPENDIX 3

VENEZUELA AND QUASI-RENTS

Oil production is a pillar of Venezuela's economy, constituting nearly 90 percent of its exports and 61 percent of government revenue (Rodriguez et al. 2012). Estimated reserves total nearly 300 billion barrels, the most of any country. Venezuela's national oil company, PDVSA, is responsible for most investment in the sector, and has been a majority owner of all joint ventures in the country since its creation in 1976.

Despite the historical importance of the sector for the Venezuelan economy, the past decade has witnessed a decline in production, a lack of investment in future production, and a decline in reserves. This is due in part to the substantial subsidies on gasoline for the domestic market[38], as well as the fact that about 60 percent of Venezuela's reserves are extra-heavy oil (e.g. in the Orinoco Belt), which require a relatively high oil price to be profitable. This is a remarkable fall for an organization that, through the 1980s and 90s, was considered one of the best-run and most technologically advanced NOCs in the world (Hults 2011).

More important are the ways in which the government taxes oil production. PDVSA pays an assortment of royalties and taxes to the government, with gross taxes totaling 38 percent of the cost of oil production, or roughly US$10.48 per barrel in 2016 (Hernandez & Monaldi 2016). PDVSA also is required by law to contribute to social development programs, and to the off-budget National Development Fund (Fonden), over which the executive branch wields almost unchecked discretion. Contributions to these obligations rose from $14 million in 2002 to almost $14 billion in 2007 (PDVSA 2009, as cited by Hults 2011).

[38] Venezuelans paid $0.015 dollars in 2014 per liter of gasoline, the least of any country (see Hernandez & Monaldi 2016).

This level of state appropriation of Quasi-rents is a relatively recent phenomenon in the history of Venezuela's oil industry: PDVSA was hamstrung in 2003 when President Hugo Chavez fired most of its managerial staff and technical experts who had taken part in a strike (Hernandez & Monaldi 2016: 7). Hults (2011) estimates that PDVSA production is roughly 25 percent off pre-strike levels. The Chavez administration also took advantage of being the sole shareholder in PDVSA to receive some of their net profits through dividends, money which normally would be used for reinvestment (Hults 2011: 447).

Plummeting oil prices, a global pandemic, and U.S. sanctions on its oil sector has forced the Venezuelan government into a position where reform is necessary if PDVSA is to continue operating. A special committee appointed by President Nicolas Maduro has recommended reducing many of PDVSA's oil projects and stripping it of its non-oil sector duties (Vyas 2020b). Oil production is currently 300,000 barrels per day, a far cry from the 3.5 million bpd that was produced before Chavez took office in 1998 (Vyas & Gonzalez 2020). This will leave Venezuela with about US$4 billion in annual oil revenue, an amount that was collected every two weeks during the boom of 2012 (Vyas & Gonzalez 2020) Lifting the tax burden on PDVSA may signal a genuine commitment to reform; yet at the same time, Maduro has also appointed a close ally (and alleged drug trafficker) Tareck El Aissami to revamp the ailing energy sector, leaving doubt as to the future of PDVSA (Vsay 2020a).

Venezuela's situation differs from Mexico's in a few respects. The state's aggressive appropriation of rents is a more recent phenomenon than in Mexico, at least at levels that hamper long term investment. PDVSA also has a history of successful operations and engagement with IOCs along with technical expertise, contrary to the experience of PEMEX. Yet the recent history of state-NOC relations in both countries is characterized by short-term tax and

management strategies based on siphoning off Quasi-rents, underpinned by political incentives that make reform difficult or even undesirable from the state's perspective.

Therefore, the Mexican and Venezuelan cases demonstrate that the type of resource rent being produced is not the same as the structure of a country's oil sector. The Mexican state appropriates Quasi-rents from a state-owned firm that has essentially no competition domestically, while the Venezuelan state allows joint ventures with IOCs while garnering similar rents.

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