I'll Pay You Later: Backloading to Sustain Opportunistic Relationships

Elena Paltseva, Gerhard Toews and Marta Troya-Martinez*

January 27, 2023

Abstract

In 1967, a decline in the use of military interventions by major world powers undermined international contract enforcement and increased the expropriation risk in many developing countries. Using data from the oil and gas industry, we document that this change caused backloading - a delay in investment, production and taxation - just as predicted by the theory of self-enforcing agreements. The delay peaked at five years right after 1967 and vanished as the firm-government relationship matured.

Keywords: Dynamic Incentives, Political Economy, Institutions, Oil.

JEL Classification: D86, L14, O13, H20, P48.

*Paltseva: SITE, Stockholm School of Economics, (email:elena.paltseva@hhs.se), Toews: New Economic School (email: gerhardtoews@gmail.com) and Troya-Martinez: New Economic School and CEPR (email: mtroya@nes.ru). We are grateful to Jørgen J Andersen, Joyee Deb, Georgy Egorov, Matthias Fahn, Leonardo Felli, Dana Foarta, Bob Gibbons, Jonathan Greenacre, Charles Hodgson, Alberto Iozzi, Namrata Kala, Francine Lafontaine, Rocco Macchiavello, Pepita Miquel-Florensa, Guido Friebel, Jim Malcomson, Ameet Morjaria, Debraj Ray, Léo Reitzmann, Anna Sanktjohanser, Daniel Spiro, Pierre-Louis Vezina, Liam Wren-Lewis, Giorgio Zanarone, Kuncheng Zheng and the participants of the ES World Congress, IIOC, SIOE, Norwegian Virtual Political Economy Workshop, 7th Workshop on Relational Contracts, EALE, CEPR-IMO, EWMES, NOITS, NEUDC, Org. Econ. NBER meeting, CASBS-CJBS Conference on Shared Governance, IOEA, CEPR-IO, NASMES, IBEO, JEI and the seminars at City, Erasmus, NES, Nottingham and SITE for many insightful comments. We thank Anton Didenko, Alina Gafanova, Maria Loskutnikova, Anastasia Nebolsina, Kira Silvestrovich, Alexander Tonis, Dmitrii Urentsov and Mikhail Zhokhov for excellent research assistance. Paltseva's work on this project was partially funded by The Research Council of Norway, Grant 275387. Any remaining errors are our own.

"Perhaps decolonization and the general postwar weakening of the OECD members as political and military actors is an experiment where expropriation is first viewed as impossible and then becomes possible."

— Eaton, Gersovitz and Herring (1983)

1 Introduction

The international commercial relations had traditionally been upheld by the implicit or explicit backing of open warfare. By the late 1960s, a decline in the military interventions by major powers weakened the international contract enforcement triggering the largest expropriation wave in recent history (Kobrin, 1980; Minor, 1994; Hajzler, 2012). Adverse outcomes resulting from imperfect contract enforcement are common in a wide range of contexts (North, 1991; Greif, 1993; Djankov et al., 2003). However, this problem is particularly salient in contracts with the government since it often has the power to undermine the rule of law. Weak institutions further exacerbate contracting frictions ((Acemoglu, 2006; Rigobon, 2010; Guriev, Kolotilin and Sonin, 2011)), making resource-rich economies unable to exploit their natural resources and move out of poverty (Van der Ploeg, 2011; Venables, 2016).

Despite the deterioration in international contract enforcement, expropriation of foreign assets has remained rare. Even during the aforementioned largest expropriation wave, less than 5% of all foreign-owned firms were expropriated in developing countries (Kobrin, 1980). Moreover, the share of global foreign direct investment going to the developing world has been on an upward trend since the 1970s, exceeding 52% in 2021 (UNCTAD, 2022). How have firms and governments managed to avoid the fate of expropriation while keeping cross-country investments flowing?

In this paper, we argue that firms and governments mitigate these expropriation threats by establishing self-enforcing agreements (MacLeod and Malcomson, 1989; Baker, Gibbons and Murphy, 1994; Levin, 2003). In theory, in these agreements, the firm reduces the expropriation incentives by delaying investing and paying taxes ("backloading") to increase the government's future value from the relationship (e.g., see Ray (2002) for a general model). We exploit a historical natural experiment in the deterioration of international contract enforcement in combination with rich data from the oil and gas industry, to identify the emergence, and estimate the extent of contract backloading. Despite the existence of large theoretical literature (see literature review), empirical analysis of such contract dynamics has been challenging due to data unavailability and identification problems. Our paper is the first to overcome both issues.

To guide the empirical analysis, we present a model of an ongoing relationship between a government and a firm. Our model builds on a stylized version of Thomas and Worrall (1994) and explicitly introduces variation in formal contract enforcement. In the model, the government can attempt to expropriate, while the probability of success is determined by the strength of formal institutions. To avoid expropriations, the government's immediate expropriation profits need to be less valuable than the expected long-term gains from having the firm invest and pay taxes. We show that the government's incentive to expropriate, and the resulting contract backloading, increase as the quality of institutions deteriorates.

We test this prediction in an important sector, the oil & gas industry. We use data from Rystad Energy, an energy consultancy, which contains detailed information on the financial, geographical and geological characteristics of fields operated by the seven largest multinational firms, the so-called oil majors. Our dataset covers fields which started production between 1960 and 1999, adding up to 3494 fields, 124 country-firm combinations and 49 countries. We differentiate the quality of institutions across countries by using the *level of constraints imposed on the executives* from Polity IV, but our results are robust to a number of alternative institutional measures. The oil & gas sector is a particularly well-suited setting to study imperfect contract enforcement. First, it is the most capital intensive industry (Ross, 2012), making the expropriation threat particularly salient. Second, petro-rich economies vary greatly in the quality of their formal institutions, providing the necessary cross-sectional variation to evaluate the need for backloading.

Finally, relationships between oil firms and hosting states span decades, allowing us to study relationship dynamics over a long period of time.

We consistently measure backloading across fields, despite their different characteristics, by analyzing the accumulation of investment, production and tax payment over the first 35 years of a field's life. Specifically, we compare the time it takes to reach two thirds of these cumulative flows between countries with weak and strong institutions. Focusing on the subsample after the deterioration in contract enforcement (i.e. after 1974), we find that investment, production and tax payments in countries with weak institutions are backloaded by an average of two years relative to countries with strong institutions. A back-of-the-envelope calculation suggests that in present value terms, a country with weak institutions loses on average 120 Million US$ per year due to this delay.[1]

To establish that the delay is causally driven by the increased expropriation threat, rather than by the general difficulties of doing business in countries with weak institutions (such as poor infrastructure, red tape and corruption), we exploit the historical global change in international relations. From 1967 to 1973, the world experienced a transition, in which *"expropriation is first viewed as impossible and then becomes possible"* (Eaton, Gersovitz and Herring, 1983). Prior to 1967, major developed nations threatened, or simply used, their military power to enforce the contracts of their firms.[2] But during the 1967-1973 transition, the

[1] Fields in countries with weak institutions produce on average in 30 years the same amount as the fields in countries with strong institutions do in 28 years. Using group-specific production dynamics, we allocate total output to individual periods, accounting for the two-year difference in the lifetime. The price of the resource and the interest rate are assumed to be constant across space and time. With an assumed interest rate of 5%, 10% or 15%, the NPV of a field is 5%, 8% or 10% larger in countries with strong institutions. Since the average NPV of field level tax payments in countries with weak institutions is 1 billion US$, the delay implies that the country would have gained on average 80 Million US$ more per field without a delay. This translates into 120 Million US$ per country and year since oil majors start 1-2 fields per year in countries with weak institutions.

[2] Perhaps the most famous example is the coup d'etat against Iranian prime minister Mohammad Mossadegh, backed by the CIA, with the help of Britain's MI6, following his attempt to renegotiate the fiscal regime with the Anglo Persian Oil Company (nowadays BP) in 1953. As the British officials at the Ministry of Fuel and Power put it in September 1951: "If we reached settlement on Mussadiq's (sic) terms, we would jeopardize not only British but also American oil interests throughout the world. We would destroy prospects of the investments of foreign capital in backward countries. We would strike a fatal blow to international law. We have a duty to stay and use force to protect our interest" (Abrahamian, 2013). In response to the Iranian nationalization, the US and the UK used their political influence and military force to reduce

home governments of the multinational firms permanently reduced the use of their military power. Specifically, we document that the average number of military interventions by the US, the UK and France fell from 2.4 per year to 1 per year between 1966 and 1967. The reasons for this change are best summarized by Yergin (2011): *"The postwar petroleum order in the Middle East had been developed and sustained under American-British ascendancy. By the latter half of the 1960s, the power of both nations was in political recession, and that meant the political basis for the petroleum order was also weakening. [...] For some in the developing world [...] the dangers and costs of challenging the United States were less than they had been in the past, certainly nowhere near as high as they had been for Mossadegh, [the Iranian politician challenging UK and US before the coup d'etat in 1953], while the gains could be considerable"* (p.565).

In terms of our model, the use of military power can be thought of as an enforcement substitute for strong formal institutions. Thus, the decline in military coercion weakened enforcement and triggered the need for agreements to be backloaded to counteract the increased threat of expropriation. Driven by this reasoning, we compare oil and gas agreements in countries with weak institutions relative to countries with strong institutions between 1960 and 1980 using a Difference-in-Differences framework. We find that prior to 1967, backloading in financial and physical flows at the field level was similar in these two groups of countries. However, after 1967 they became delayed by 5 years in countries with weak institutions relative to their counterparts. Moreover, just after 1967, countries with weak institutions started lagging in the number of fields acquired by the oil majors and the time between awarding a field license and the start of production. These results are consistent with the idea that the oil majors adjusted to the increased threat of expropriation by backloading agreements. We support these findings with a battery of robustness checks and a number of case studies.

We also explore the long-term dynamics of firm-government relationships. Theoretically, backloading vanishes as the relationship matures. Eventually, the higher

the global uptake of Iranian oil, resulting in a loss in government revenues and eventually a coup d'etat.

future taxes need to be paid, giving the government enough rents that it no longer wants to expropriate. Our estimates are consistent with this prediction. Fields at the start of the relationship exhibit a delay of 4-5 years. As the relationship matures, backloading vanishes. In particular, after 25 years of the relationship, the initially significant difference in backloading disappears. Thus, the 2-year delay, reported as a stylized fact, represents a weighted average of mature and young relationships in our sample.

The findings of this paper contribute to three strands of literature. First, we contribute to the literature on self-enforcing contracts. Backloading has been found to be optimal in a variety of relationships without commitment and limited transferable payoffs (for instance, see Lazear (1981), Harris and Holmstrom (1982) and Fong and Li (2017) for wage backloading in a labor setting, Albuquerque and Hopenhayn (2004) and Fuchs, Green and Levine (forthcoming) for lending backloading a credit setting, Acemoglu, Golosov and Tsyvinski (2008) for rent backloading in a political economy setting and Thomas and Worrall (1994) for investment backloading an investment setting).[3] Yet, the progress of the empirical literature has been limited by the unavailability of transaction data in environments with limited or no formal contract enforcement (Antràs and Foley (2015), Macchiavello and Morjaria (2015, 2021), Gibbons and Henderson (2013), Blader et al. (2015) and Calzolari et al. (2021) - see Gil and Zanarone (2017) for a survey). To the best of our knowledge, we are the first to provide empirical evidence of contract backloading.[4]

The above literature has exclusively focused on inter and intra-firm relationships. We are the first to study relational contracting in the government-firm relationship. In this way, we contribute to the political economy literature where limited commitment plays an important role (Bulow and Rogoff (1989), Atkeson (1991), Aguiar and Amador (2011), Acemoglu, Golosov and Tsyvinski (2008)).

[3] There are alternative theories rationalizing contract backloading in settings with asymmetric information (see Ghosh and Ray (2022) for an overview). In section 4.2, we discuss why we believe those do not apply to our setting.

[4] Brugues (2020) finds backloading in linear-pricing contracts in Ecuador; however, the setting is different from ours because the sellers can commit to such contracts.

More specifically, we provide empirical evidence that firms can establish self-enforcing relationships with governments and backload taxes to overcome the lack of formal institutions (Acemoglu, 2006).

The third strand of literature explores the link between institutions and economic performance. While this literature is large and multifaceted (see Baland et al. (2020) for an overview), two groups of papers are particularly relevant.[5] The first group studies the implications of institutions for foreign investments and finds that strong executive constraints are correlated with lower risk for multinational investors. They are also associated with higher economic performance for the host country due to increased investment flows (Jensen, 2008; Papaioannou, 2009) and/or lower economic volatility (Besley and Mueller, 2018). The other group takes a more micro-based perspective, studying how the quality of institutions affects firms' decisions about their organization (Lafontaine, Perrigot and Wilson, 2017), their performance (Levy and Spiller, 1994) and their investment (Javorcik, 2004). A number of papers focus on the oil industry in particular. Cust and Harding (2020) document that explorations are less likely to take place in countries with weak institutions, while Mihalyi (2021) documents that it takes longer to develop fields in non-democracies. In Guriev, Kolotilin and Sonin (2011), the firm can renege on tax payments, in which case the government expropriates, while in Stroebel and Van Benthem (2013) the firm can insure the government against oil price volatility by smoothing tax flow. Both papers find that, in a stationary equilibrium, the expropriations are more likely to occur under weak institutions. Jaakkola, Spiro and Van Benthem (2019) assume that the government's commitment is limited to one period and that the company can return after an expropriation. They show that taxation and investment exhibit cycles and that such cycles are more persistent under strong institutions. We contribute to this

[5] The "institutional resource curse" literature is also concerned with the interaction between institutions, natural resources and (different measures of) economic performance. While our paper incorporates all three components, our paper deviates from this literature in an important dimension. In this literature, natural resources - such as oil - are an immanent part of the studied interplay. In our case, the oil sector serves as an illustration of contractual frictions arising from weak institutional enforcement. Similar frictions could arise in other sectors, as we discuss in the conclusion.

group of papers by studying the consequences of limited enforcement on agreements between multinationals and foreign governments. Unlike the above papers, our modeling approach analyses the (non-stationary) dynamics of the relationships in the absence of commitment. Our data allows us to analyze the dynamics of production, investment and tax payments of these agreements and estimate the economic costs associated with the institution-driven inability to commit.

In the next section, we set up the model and derive our main hypotheses. In section 3, we describe the data and present the stylized facts. In section 4, we present our empirical results before we conclude.

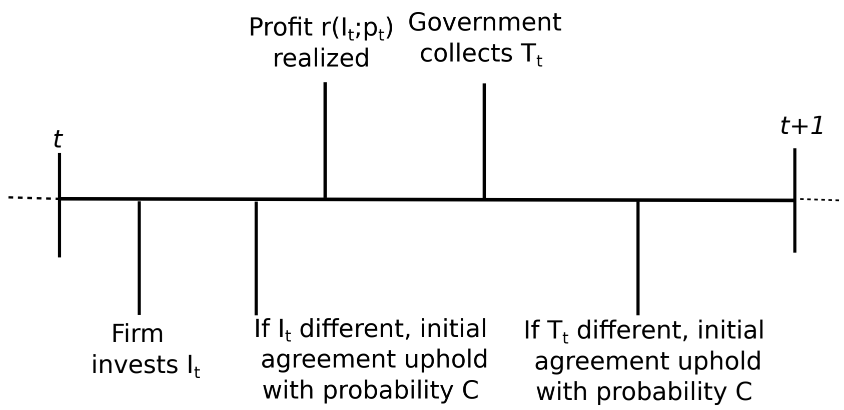
2 Theory

In this section, we present a stylized model of an ongoing informal relationship between a government and a firm, based on a version of Thomas and Worrall (1994). The firm invests and pays taxes, while the government decides whether to expropriate or not. In order to derive empirical predictions, we explicitly model legal constraints limiting the parties' ability to break the contract. The proofs of all results are relegated to Appendix A.

In the model, the government and the firm interact repeatedly over an infinite number of periods. The timeline for each period is shown in Figure 1. Every period, the government and the firm agree on an investment I_t and tax payment T_t. Then, the firm invests I_t which depreciates within one period.[6] When the firm does not invest as agreed, the legal constraints determined by the quality of institutions uphold the initial agreement with probability $C \in [0, 1]$ and, with probability $1-C$, the government expropriates the firm. Next, an *i.i.d.* price is realized whereby with equal probabilities the price can be low ($p = 0$) or high ($p = 1$). Jointly, the price and investment determine the revenues $r(I_t; p_t) = 4p_t\sqrt{I_t}$. Then the government chooses a tax payment T_t, leaving the firm a net profit of $r(I_t; p_t) - T_t$. If the government collects a different T_t from the one agreed, the initial agreement is

[6] Capital accumulation does not qualitatively change the nature of the game (Thomas and Worrall, 1994).

Figure 1: Timeline



upheld with probability C. After any deviation, we assume that the relationship ends.

The government and the firm have perfect information about each other actions. They both discount the future with δ, have zero outside options and are credit-constrained: $r(I_t; p_t) - T_t \geq 0$ and $T_t \geq 0$.[7] The expected value functions of the government V_t and the firm U_t are:

$$V_t = \mathbb{E}\left[T_t\right] + \delta\mathbb{E}\left[V_{t+1}\right]$$
$$U_t = -I_t + \mathbb{E}\left[r(I_t; p_t) - T_t\right] + \delta\mathbb{E}\left[U_{t+1}\right]$$

An agreement $A{=}(I_t, T_t)$ at time t depends on the history up to time $t-1$ and the current realization of the price. The agreement needs to be self-enforcing so that neither the government nor the firm have an incentive to violate it ex-post. The assumptions about the consequences of deviations imply that (1) the firm never deviates from investing the agreed amount, and (2) if the government deviates, it tries to expropriate all the profits.[8] As a result, A is self-enforcing if

[7] Unrestricted upfront transfers from the government ($T_t < 0$) eliminate the hold-up problem by subsidizing the cost of investment before it is incurred by the firm (i.e. the firm "sells" the company). In the oil & gas industry, upfront transfers are indeed very rare. Figure C.1 shows that the share of subsidies relative to the total cost of production (within the first seven years of production) is below 10%.

[8] The former follows from the observation that a deviation, if not upheld by court, leads to a complete expropriation, and the firm can always guarantee itself a zero payoff by not entering the

the government has incentives to honor the agreement. The following condition ensures this at time t, for a given p_t and C:

$$T_t + \delta V_{t+1} \geq C\, T_t + (1 - C)\, r(I_t; p_t) \tag{SE}$$

This constraint requires that the discounted future value of the relationship for the government δV_{t+1} (in terms of future taxes) be at least as large as what the government would expect to gain by expropriating today. If $C = 1$, the agreement is perfectly enforced by the courts and (SE) is slack. If $C = 0$, there is no legal enforcement, as in Thomas and Worrall (1994), and the agreement has to be self-enforced to be sustainable.

As a benchmark, consider the optimal contract under perfect enforcement. Define I^* as the efficient total surplus-maximizing level of investment. I^* solves the following FOC $E\left[r'(I^*; p_t)\right] = 1$, resulting in $I^* = 1$. If the quality of institutions is high enough such that (SE) is slack, the firm invests I^* every period. The tax payments determine how the surplus is shared but have no effect on the level of investment. We focus on the Pareto efficient equilibrium that maximizes the firm's payoff at the beginning of the game, as in Thomas and Worrall (1994)[9]. The contract that maximizes the firm's payoff features no transfers to the government which receives its outside option. Therefore, with perfect enforcement, the optimal agreement is stationary and gives the same value to the government and the firm every period.

If institutions are weak such that (SE) binds, the efficient level of investment is not reached immediately. Instead, the agreement A is "backloaded", that is, the government's future value from the relationship V_{t+1} increases over time. The firm achieves this by progressively increasing investment until I^* is reached.[10] The

country. The latter holds since the firm never invests again following the government's deviation.

[9]Concentrating on the equilibrium that is best from the point of view of the firm does not alter the characterization of the contract significantly. By doing so, we are selecting the most backloaded contract (Ray, 2002). In addition, for exposition purposes, we focus on a parameter range such that the efficient first best Pareto frontier is eventually reached with probability one. See the Appendix A for more details.

[10]When the price is low $p = 0$, there are no revenues to expropriate, the firm does not need to backload and the government's value of the agreement is constant $V_t = V_{t+1}$. Only under high

initial under-investment is driven by the profit-maximizing behavior of the firm. Note that (SE) could be satisfied by paying a sufficiently large tax from the first period onward. However, the firm can do better by using the promise of larger future taxes to deter expropriations at the beginning of the relationship. Thus, it is optimal not to have tax payments until the period before I^* is reached. Intuitively, delaying taxes and investments makes the threat of terminating the relationship more costly to the government and hence, more effective, which increases the government's credibility:

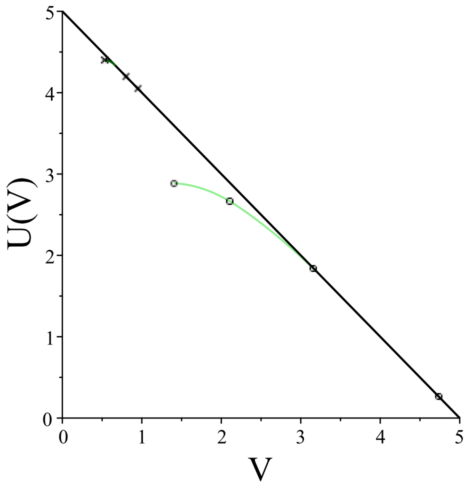
Proposition 1. *In institutional environments where the self-enforcing constraint (SE) binds, investment and production increase over time to reach the efficient steady-state value at which (SE) no longer binds. Tax payments are zero until the period before the efficient value of investment and production is attained.* [11]

The dynamic patterns of the agreement are illustrated in Figure 2 for different levels of institutional quality: $C \in \{1, 0.8, 0\}$. The figure depicts the firm's value $U(V)$ as a function of the government's value V. With perfect institutions $C = 1$, $U(V)$ is on the black solid line which represents the Pareto efficient frontier. While in theory any point on the frontier constitutes a stationary contract, the exact location depends on the outside option and the bargaining power of the government. The agreement that maximizes the firm's utility gives the government $V = 0$, while a larger V is needed to sustain the contract if the government has more bargaining power or a better outside option. With weaker institutions, $C = 0.8$ or $C = 0$, (SE) binds, which makes the upper part of the efficient frontier unattainable, as low V triggers expropriation. The initial underinvestment implies that the efficient frontier is achieved with a delay. As before, once the efficient frontier is reached, multiple equilibria are possible. The dynamics consistent with the maximization of the firm's profits are depicted by the dark green ($C = 0.8$) and light green ($C = 0$) lines. The crosses and dots on the feasible frontier indicate the path of the government/firm value over time.

prices, $p = 1$, we can observe the discussed dynamics and, thus, these are the periods to which we refer. See the Appendix A for more details.

[11] This proposition is akin to Proposition 1 in Thomas and Worrall (1994).

Figure 2: Value function ($\delta = 0.8$ & $C \in \{1, 0.8, 0\}$)



The left column of Figure 3 depicts the optimal investment, production and tax payment over time for $C = 0.8$ and $C = 0$. With strong institutions $C = 0.8$, investment and production reach I^* earlier, relative to settings with weaker institutions $C = 0$. This observation is generalized in the following Lemma:

Lemma 1. *The number of periods to achieve the efficient frontier in agreement A decreases with the quality of institutions C.*

With stronger institutions, tax payments start earlier, and their stationary levels are lower. This is because governments in countries with weak institutions need to eventually receive higher rents to prevent expropriation.

Empirically, the optimal levels of investment, production and tax payments greatly differ across fields for many other reasons beyond the quality of institutions. These reasons include geological, climatic and technological constraints. This suggests that the comparison of an over-time evolution of the *levels* of investment, production and taxes - as in the left panel of Figure 3 - may be biased and misleading. To reduce field-level heterogeneity and focus on the dynamics of our variables of interest, we use a more tractable measure of backloading which measures how fast these flows accumulate over time. That is, we study the evolution of their cumulative shares (CS):

$$CS_{\bar{p}} = \frac{\sum_{p=1}^{\bar{p}} X_p}{\sum_{p=1}^{P} X_p} = s \tag{1}$$

where $X \in \{Investment, Production, Taxes\}$, P is the exogenously set number of periods over which the cumulative share is calculated and $\bar{p} \in \{1, \ldots, P\}$ is the number of periods needed to reach a cumulative share of s.

Using this measure, X under agreement $A1$ is *backloaded* relative to agreement $A2$ if it accumulates slower under $A1$ than under $A2$. We illustrate this measure in the right column of Figure 3. Slower accumulation can be measured as a (positive) difference in the number of periods $\bar{p}$ to reach a given cumulative share of s under agreements $A1$ and $A2$, respectively.[12] It is easy to see in Figure 3 that under weak institutions, investment, production and taxes are backloaded, since it takes a larger number of periods (measured by the distance between the vertical lines) to reach 66% of the cumulative share indicated by the dashed horizontal line.[13] This relationship between institutions and backloading is proven in the following comparative statics result:

Proposition 2. *Investment and production are more backloaded with weaker institutions. It takes longer to start paying taxes under weaker institutions.*

This result allows us to form our first testable hypothesis:

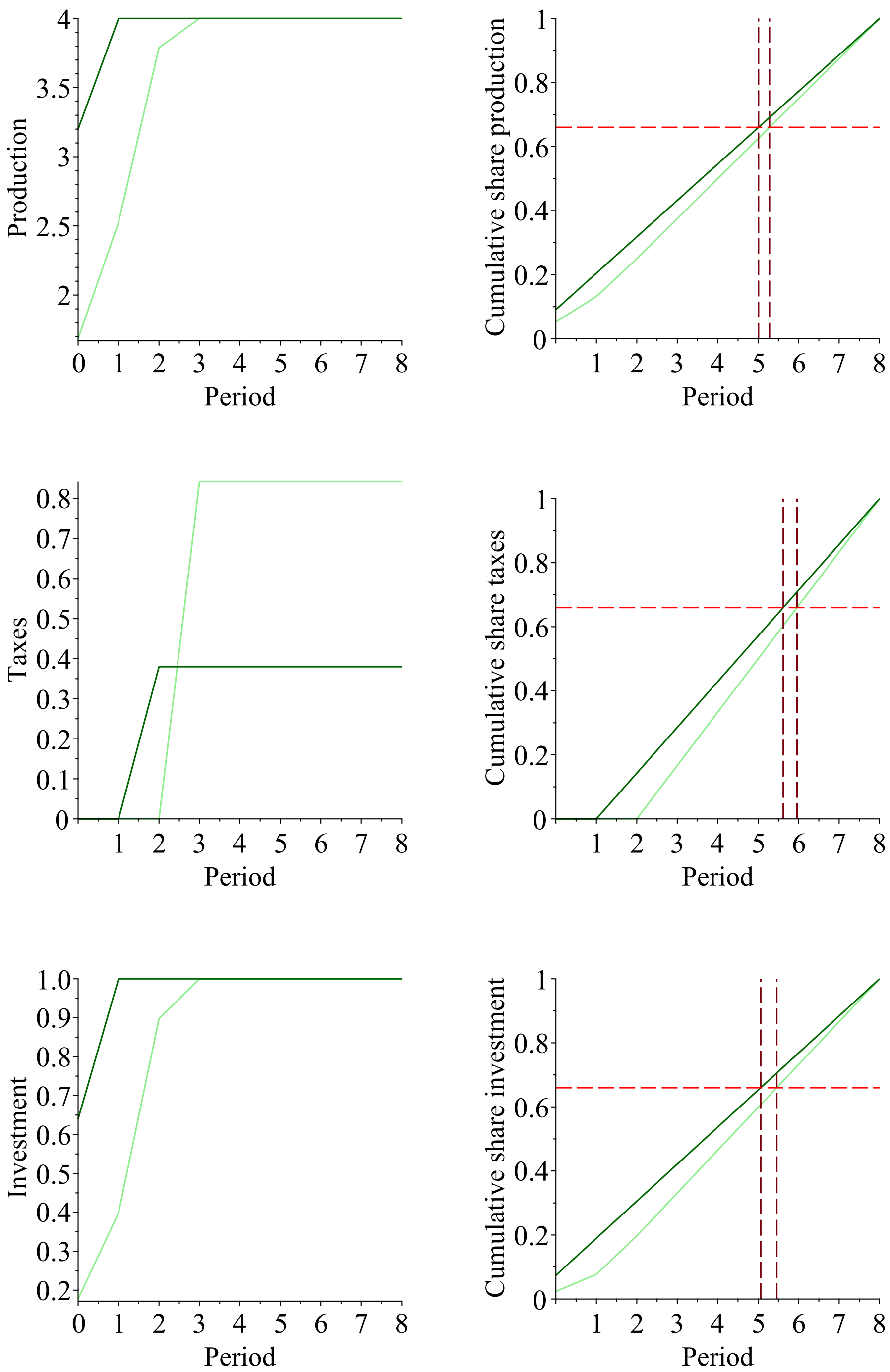
Hypothesis 1: *Consider a threshold* s *for the cumulative share of production/investment. It is reached faster in countries with strong institutions compared to those with weak institutions. For tax payments, it can be reached faster or slower.*

Our main empirical tests concentrate on s=66%, in line with the intuition suggested by Figure 3. We also test other values of s in robustness check exercises.

[12] Alternatively, a delay in accumulation can be measured on the y-axis as a difference in the cumulative share of X under two agreements reached by a given number of periods $\bar{p}$.

[13] Note, that once the efficient frontier has been reached, current taxes can theoretically be traded against future taxes without affecting the efficient level of investment. Thus, tax payments under weak institutions may be more or less backloaded after the efficient frontier has been reached.

Figure 3: Optimal agreement ($\delta = 0.8$ & $C \in \{0.8, 0\}$)



The above discussion also offers an insight into the dynamics of backloading. As the relationship evolves, the government's future value of the relationship increases. This undermines the expropriation incentives at the later periods of the relationship, and, as a consequence, the need to backload, so that backloading vanishes with time. In particular, for the levels of our variables of interest - production and investment, - there will be no backloading once the efficient frontier is reached. For our empirical, cumulative share-based measure, any backloading would be exhausted by period P as the share of X will reach 1 at that period independent of institutions. More generally, in the next Proposition, we show that the extent of (relative) backloading in shares between agreements with weaker and stronger institutions gradually decreases over time.

Proposition 3. *There exists a period $t < P$ after which the differences in investment and production backloading monotonously tends to zero.*

This result gives rise to our second testable hypothesis:

Hypothesis 2: The differences in investment and production backloading between countries with strong and weak institutions vanish over time as the relationship matures. For tax payments, the difference may or may not vanish.

3 Data and stylized facts

3.1 Data description

Oil and gas data. The micro-level data on oil & gas fields comes from Rystad Energy, an energy consultancy based in Norway. Its database contains current and historical data on physical, geological and financial features for the universe of oil & gas fields worldwide. Rystad collects the data from a wide range of sources, including company and government reports and expert interviews. In some cases, Rystad imputes observations. Asker, Collard-Wexler and De Loecker (2019) provide a very detailed description of the data construction process.[14] Our

[14] There is a growing multifaceted literature using the Rystad database. Asker, Collard-Wexler and De Loecker (2019) is among the earliest and most prominent examples of this literature.

discussions with Rystad representatives and researchers working with this dataset suggest that Rystad provides the highest quality data available in the industry and that the information on the physical production volumes and tax payments at the field level are particularly accurate.

Our sample contains all the fields worldwide owned by at least one oil major. A field may be thought of as containing *at least* one production well and be operated by *at least* one firm in *at least* one country. The oil majors are BP, Chevron, ConocoPhillips, Eni, ExxonMobil, Royal Dutch Shell and Total. Historically, these are the largest private firms in the industry. They have been active for a long time, and they own fields in many countries. Jointly, these two characteristics imply that we have sufficient spatial and time variation to capture dynamic patterns in long-term relationships. We restrict our analysis to those fields which began production between 1960 and 1999, and in order to measure the extent of backloading in the long run, we only use fields which have been in operation for at least 20 years.[15] In our backloading measure, we focus on the first 35 years of a field's life. Further, to construct our backloading measures, we need surplus generating fields which can be taxed. Thus, we only use fields which generate a surplus within a period of 35 years. In total, this implies that we are dropping around 3% of the cumulative production generated by the oil majors over the full sample period. Finally, for the presentation of the empirical facts, we focus on the sample from 1974 onward, while we extend the sample back to 1960 for the causal analysis.

For all fields, we observe the year in which exploration rights to a field have been acquired and the year in which production starts. We also observe the physical reserves, local climate conditions, type of commodity extracted (i.e. oil or gas), whether the field is located off- or onshore and the exact geographical location.

Their main research question deals with the allocative inefficiencies generated by the existence of OPEC (Organization of the Petroleum Exporting Countries), but they also offer perhaps one of the most detailed and precise descriptions of Rystad database content and methods.

[15]The quality of the data deteriorates when going back in time further than 1960. Also, we only use fields which have been in operation for at least 20 years since it is difficult to empirically capture backloading due to the large, geologically-driven field-level heterogeneity in investment and production during the early years of a field's production (Adelman, 1962). Finally, note that our data consists of realized contracts, i.e. we do not observe ex-ante agreements, and contracts which do not get to produce long enough.

Then, for every field, we have yearly data on the type of fiscal regime (i.e. concession, production sharing agreement (PSA) or service contract), ownership rights, physical production (in million barrels), different types of capital and operational expenditures, revenues, profits and different forms of taxes paid. All the financial flows are converted to millions of real 2018 USD. Appendix B provides a detailed description of all the variables.

The tax payment variable deserves a special mention. To construct it, we use information on tax payments under a variety of fiscal regimes. It captures the total amount of payments received by the government from a field. In the oil literature, such a measure is known as *government take*. It is the most common statistic used for the evaluation of contracts (Johnston (2007), Venables (2016)).[16] It consists of all cash flows destined for the authorities and land owners, including royalties, government oil profit (PSA equivalent to petroleum taxes), export duties, bonuses, income taxes and profit taxes. To match the assumptions of the modeling setup (which assumes absence of government subsidies), we need to abstract from subsidies (negative tax payments). We do this by considering two different measures: (1) royalties and profit taxes only, which do not contain any subsidies and, (2) all the tax payments, while setting the value of the income tax to zero in periods in which the reported government take is negative. This does not have a significant impact on our measure since the cumulative amount of subsidies received by the median field in our sample adds up to 2% of the total government take. For over 90% of all the observations in our sample, this share remained well below 10%.

Institutional measures. To differentiate countries by their institutional quality we rely on Polity IV. In particular, we use country-level annual information on executive constraints (XCONST), which measures the extent of institutional constraints on the decision-making powers of the chief executive, whether an individual or a collective executive.[17] To reduce the possibility that causality flows

[16] See Johnston (2007) for a discussion of the advantages and the disadvantages of such a measure.

[17] The country-specific median of this measure for the period 1974-2007 is negatively and significantly correlated with the number of expropriations in the oil and gas sector. Data on expropriations is taken from Guriev, Kolotilin and Sonin (2011), who extended the data set originally constructed by Stroebel and Van Benthem (2013).

Table 1: Descriptive statistics: fields starting operations in 1960-1999

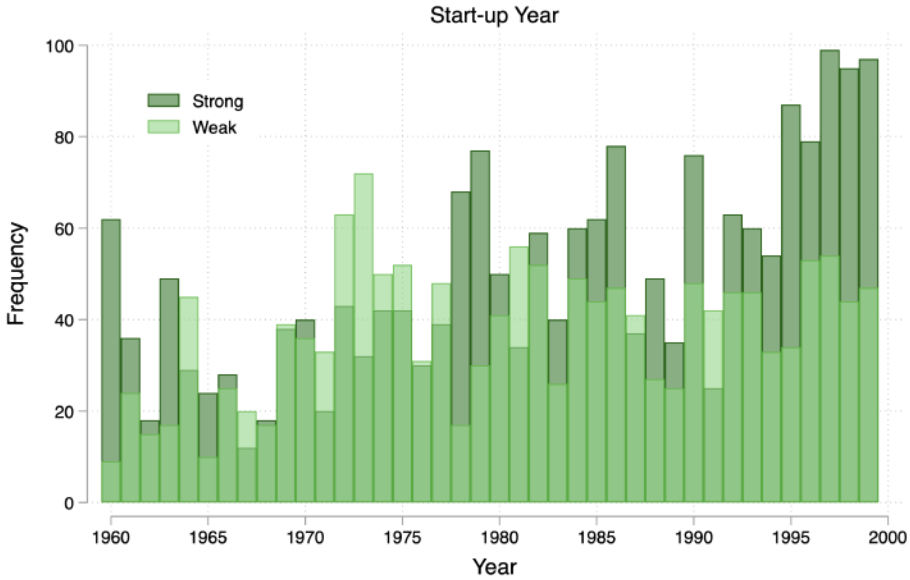
	Strong		Weak		Mean comparison	
	mean	sd	mean	sd	diff	p-value
Field Lifetime, years	33	0.2	35	0.3	-2	0.00
Cum. Production, MMbbl	42	4.4	41	2.8	1	0.89
Cum. Real Revenue, MUSD	1671	202	1883	142	-212	0.42
Cum. Real Cost, MUSD	644	72	456	30	188	0.03
Cum. Real Taxes, MUSD	698	92	1060	84	-362	0.00
Cum. Real Profit, MUSD	328	42	366	39	- 38	0.52
Number of fields	1986		1508			

Note: Monetary measures are in real 2018 US dollars. The lifetime of the fields (first row) is not restricted to 35 years. The other measures are restricted to fields which are in operation for at least 20 years and are calculated for the first 35 years of fields' lifetime. Extending the other measures to the full lifetime of the fields does not qualitatively change the results. A two sided t-test is used to calculate the p-values.

from oil wealth to institutions rather than the other way, we rely on the median score (above or below 5) received by a country over the period of 1950 to 1975. In the empirical section, we extend the number of groups to three by splitting the countries with weak institutions into two groups: the weak (XCONST of 3-5) and the very weak (XCONST of 1-2). Alternatively, we also use OECD membership before 1970 and during the early 1970s to differentiate between countries with strong and weak institutions. Our results remain robust to these changes and are available on request.

We present the descriptive statistics for our sample in Table 1 by distinguishing between countries with weak and strong institutions. Cumulative production and revenues do not differ significantly across groups of countries, while the average lifetime of a field is 2 years larger in countries with weak institutions relative to countries with strong institutions. This is in line with the presence of backloading in countries with weak institutions. Also, total cost of extraction per field is higher in developed countries, while the amount of taxes paid is lower. The former fact is well known and is typically attributed to the fact that the exploration of oil & gas has been taking place for much longer in developed countries, such that the easy-to-access fields have already been exhausted. On the other hand, the latter

Figure 4: Timing of the start of production



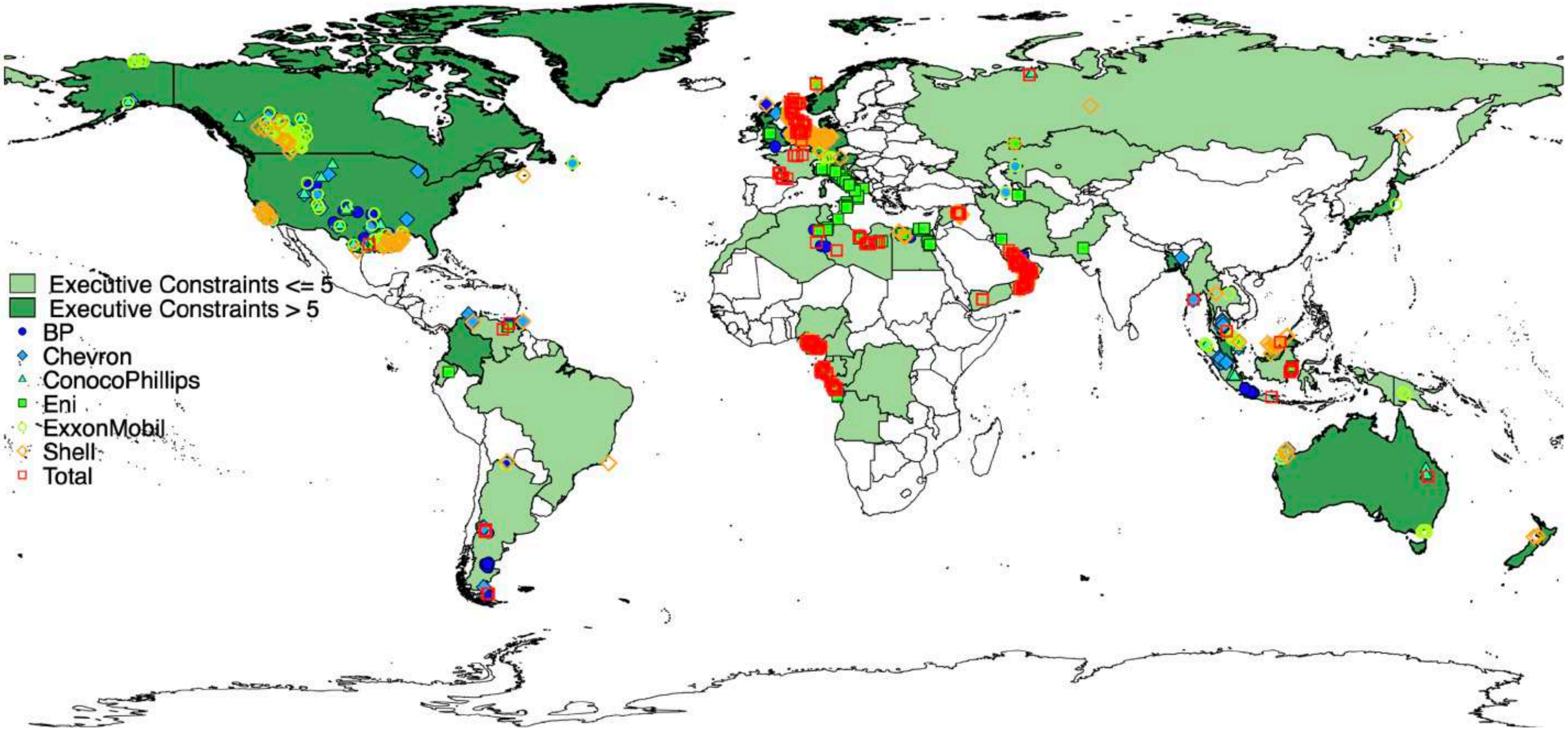
statement indicates that governments in developing countries are getting larger rents, which is consistent with the theory in section 2. Compensating higher taxes with lower extraction costs leaves the oil majors indifferent between investing in fields located in developing and developed countries, as the firms' profits do not differ significantly between groups of countries on average.[18] Figure 4 shows that there is a balanced frequency of fields starting production by group of country. Between 1960 and 1999, on average, 40 fields per year started production in countries with weak institutions, while the number of fields which started production in countries with strong institution was 50 per year. Figure 5 presents the spatial distribution of fields covering the majority of oil & gas rich countries.

3.2 Stylized facts on backloading

Before proceeding to the empirical analysis, we use field level data to document the presence of backloading graphically and to introduce our main dependent variable.

[18]Albeit they are slightly higher on average by approximately 40 MUSD, which may be rationalized by the pricing of risks the majors are exposed to in countries with weak institutions, including the risk of expropriation.

Figure 5: Spatial distribution of fields and institutional quality



Note: Longitude and latitude of individual fields is provided by Rystad. The executive constraint indicator is taken from PolityIV and we use the median from the period 1950 to 1975. The cut-off of 5 implies that roughly one third of the countries are defined as having strong institutions and roughly 50% of all the fields which started operation between 1960 and 2000 are located in countries with weak institutions.

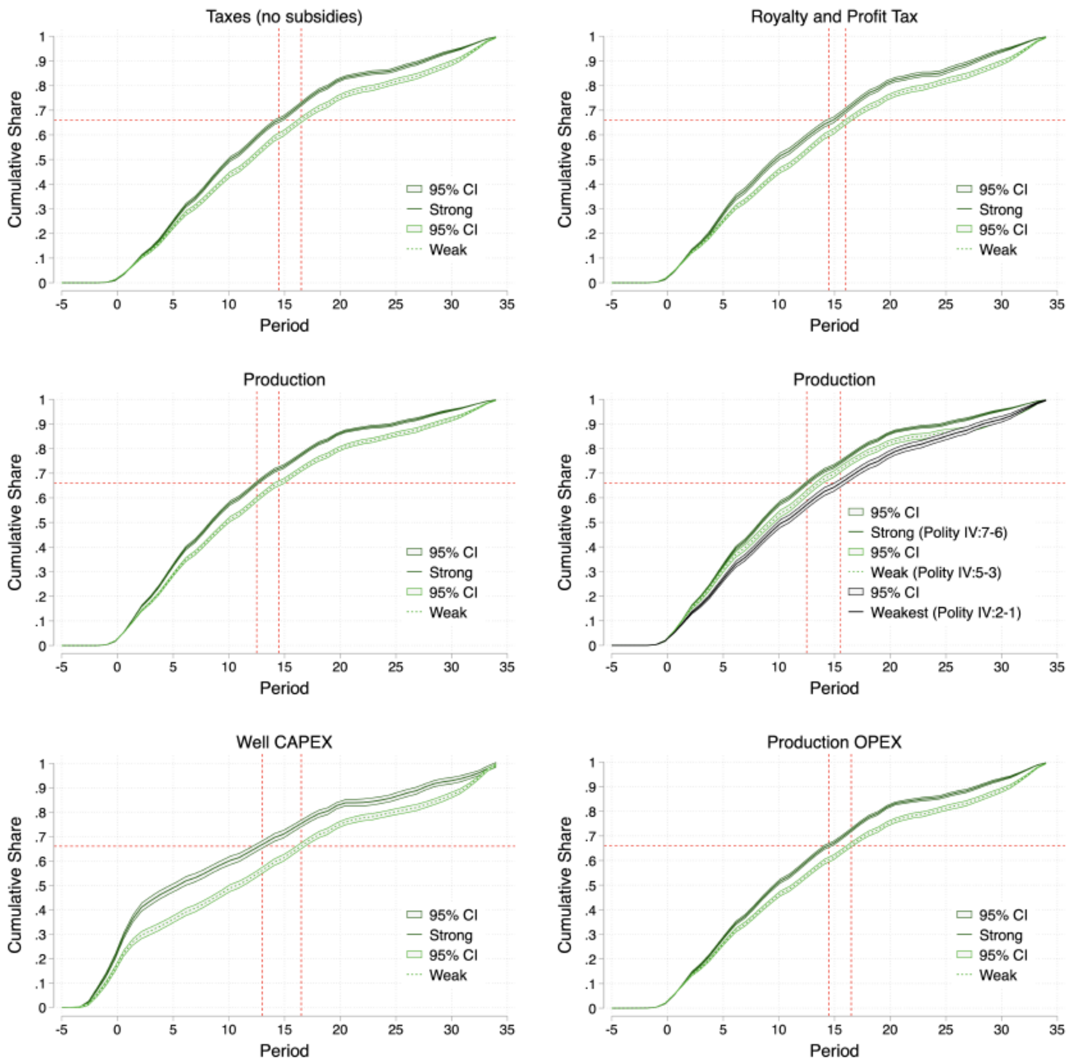
To this end, we use the following variables: well CAPEX and production OPEX, which proxy investment; physical production and the two alternative measures of tax payment, overall tax payment without subsidies and royalty & profit tax only. Production is our preferred variable since according to Rystad it has the highest quality and, in addition, it does not require any discounting over time. As discussed in the model in section 2, our measure of backloading is the *number of years needed to reach a value s of the cumulative share of investment, production and tax payments over the life cycle of the field.* We first construct the following measure for all the key variables with X indicating the *real* values of investment and tax payments as well as physical production of a field f in period p. Period p equals 1 in the year in which production starts, and we choose 35 years to be our baseline P. To control for investments potentially taking place prior to the start of production, we begin calculating the cumulative shares 5 years prior to beginning of production. Finally, $\bar{p}$ is the number of periods required for investment, production and tax payments to reach a particular cumulative share $CS_{f,\bar{p}}$ equal to s of the overall investment, production and tax payments over the chosen lifetime P, or more formally:

$$CS_{f,\bar{p}} = \frac{\sum_{p=-5}^{\bar{p}} X_{f,p}}{\sum_{p=-5}^{P} X_{f,p}} = s \tag{2}$$

Figure 6 depicts $CS_{f,\bar{p}}$ against $\bar{p}$ in countries with weak and strong institutions. Our main dependent variable in the empirical analysis, y_f, indicates the number of periods $\bar{p}$ which a field f needs to reach the threshold of $s = 66\%$ of cumulative share, and it is depicted by the two vertical red dashed lines (one per type of country).[19] For all the variables, oil majors need 1-3 years more in order to reach 66% in countries with weak institutions relative to countries with strong institutions. For our preferred measure, physical production, we extend the number of groups to three by splitting the countries with weak institutions into two groups: the weak (XCONST of 3-5) and the very weak (XCONST of 1-2) and illustrate the results

[19]Our results are robust to different choices of P and s as we document further below.

Figure 6: Years to reach 66% of cumulative flows in 35 years



Source: We use the Epanechnikov kernel with a bandwidth of 0.5. We plot the cumulative production, investment, and tax payments over the 35 year life span of the field. As discussed in the text, we use only fields which have been in operation for at least 20 years. Countries are grouped according to their executive constraints as measured by Polity IV.

in the middle right panel of Figure 6. The "first order stochastic dominance" of the average CDF in countries with strong institutions relative to countries with weak institutions is consistent with the presence of backloading as predicted by the theory and which we emphasize here as a stylized empirical fact.

4 Identification and results

In this section, we present our main empirical results. First, motivated by the stylized facts presented in the previous section, we estimate the presence, and extent, of (relative) backloading in weak institution economies while controlling for a variety of observable field characteristics. That way, we rule out that those are driving the results. Then, we proceed to give the backloading a causal interpretation. To do this, we exploit the global change in contract enforcement through military interventions to show that backloading in weak institutional environments emerges around the time when such enforcement subsides. Thereafter, we focus on four case studies to explore cross-country heterogeneity in the timing and the intensity of contract backloading, before documenting that the backloading disappears as the relationship matures.

4.1 Backloading with controls

We estimate differences in the timing of contracts in weak and strong institutional environments. While doing so, we account for a number of geological, geographical and other field characteristics to rule out the possibility that the stylized facts presented in Figure 6 are driven by observable field-level characteristics that may be correlated with the quality of institutions across countries. The richness of our dataset allows us to control for a set of geographical characteristics that includes the exact location, whether the field is onshore or offshore and the climatic conditions as well as a set of geological characteristics that include the size of the reservoir and the type of fossil fuel extracted. To capture some basic relationship characteristics, we also account for the firm operating the field and the type of the fiscal regime associated with the field. Finally, we account for the year in which production started and the lifetime of the field, i.e. the total number of years for which we observe the fields since the beginning of production. Conditional on these controls, we estimate the following specification with y_f, indicating the field specific number of years $\bar{p}$ needed to reach 66 % of the cumulative flows of X (see equation 2):

$$y_f = \beta \text{Weak}_{c(f)} + \Omega'_f \gamma + \varepsilon_f \tag{3}$$

$Weak_{c(f)}$ is a dummy variable which is equal to 1 if the field is located in a country having weak institutions. Our coefficient of interest β thus provides an estimate for the difference in the number of years which are necessary to reach 66% of cumulative production, investment and tax payments between countries with strong and weak institutions. Ω_f is a vector of field specific characteristics for which we control. The standard errors are clustered by country, start-up year and the lifetime of the field. The estimates of β are presented in Table 2. To assess the effect of the controls, we present the results both with a limited number of controls (the year in which production starts and the field's lifetime) and with the full set of controls, in columns with odd and even numbers, respectively. Overall, the results in Table 2 are robust to the inclusion of all controls and suggest that it takes up to 2 more years in countries with weak institutions to reach the same level of cumulative investment, production and tax payments as in countries with strong institutions.

Our results are robust to different measures of institutional quality, alternative thresholds of cumulative share s and different cutoffs of the fields' lifetimes P. Tables 3 and 4 in Appendix C.2 summarize the results for alternative choices with all the controls in the former and with a limited set of controls in the latter.

4.2 Backloading and the end of military enforcement

While the above results with controls are encouraging, they could be driven by other factors present in countries with weak institutions that are not related to the government's ability to expropriate, such as poor infrastructure or corruption. In

TABLE 2: Years to reach 66% of cumulative flows in 35 years

	(1) Taxes	(2) Taxes	(3) R&P	(4) R&P	(5) Production	(6) Production	(7) CAPEX	(8) CAPEX	(9) OPEX	(10) OPEX
Weak (Polity IV)	1.341**	1.725**	1.577*	1.892**	1.528**	2.071***	4.418**	1.977**	1.505*	1.244*
	(0.625)	(0.677)	(0.890)	(0.834)	(0.592)	(0.504)	(1.825)	(0.891)	(0.797)	(0.705)
N	2620	2616	2046	2042	2620	2616	1463	1461	2620	2616
R-sq	0.27	0.33	0.25	0.32	0.30	0.37	0.19	0.49	0.21	0.27
Start-Up Year	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lifetime of the Field	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Location (Long. and Lat.)	N	Y	N	Y	N	Y	N	Y	N	Y
Onshore vs. Offshore	N	Y	N	Y	N	Y	N	Y	N	Y
Climatic Conditions	N	Y	N	Y	N	Y	N	Y	N	Y
Fossil Fuel Type	N	Y	N	Y	N	Y	N	Y	N	Y
Reservoir Size (logged)	N	Y	N	Y	N	Y	N	Y	N	Y
Fiscal Regime	N	Y	N	Y	N	Y	N	Y	N	Y
Firm	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: Year of Production Start-Up FE and the lifetime of the field are included in all regressions. In columns with even numbers, we also control for a large number of field-specific observable characteristics. The left-hand side variable is capturing the number of years until 66% of cumulative level of OPEX, well CAPEX, production and tax payments in 35 years is reached. SE in parentheses is clustered by country, start-up year and lifetime of the field. * stands for statistical significance at the 10% level, ** at the 5% level and *** at the 1% percent level.

this section, we establish a causal link between the enforcement of contracts and backloading. To do this, we exploit a historical period when the state's ability to expropriate increased (and, consequently, external enforcement of contracts recedes) to show that the backloading emerges at this point.

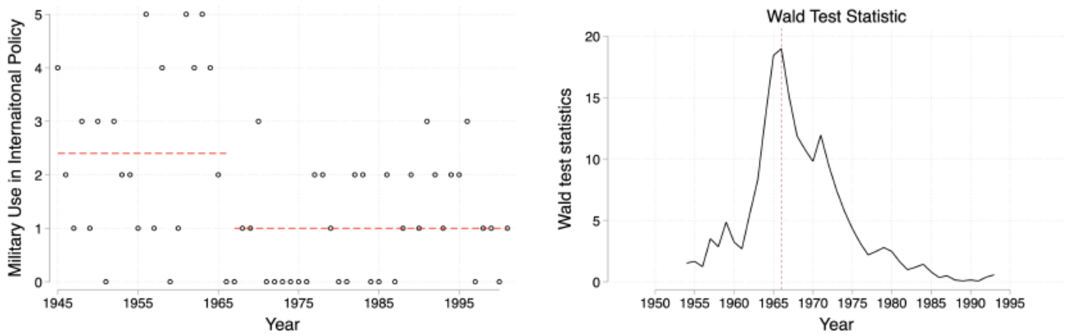
Traditionally, firms from developed countries have been backed by their countries of origin in their expansion into the developing world (Yergin, 2011). This has been particularly the case in the oil industry, where the US, the UK and France have used their military to make sure that contracts were not renegotiated. The most infamous case of US intervention followed the Iranian attempt to nationalize BP's oil fields in the early 1950s. It resulted in a coup d'etat and replacement of an initially democratic government with a monarchy until the Iranian revolution in 1979.[20] Scared by the Iranian example, only few oil rich economies attempted the renegotiation of oil deals with the big oil firms throughout the next decade.

In terms of the model in section 2, the governments in countries with weak institutions were facing the following adjusted self-enforcing constraint:

$$T_t + \delta V_{t+1} \geq CT_t + (1 - C)r(I_t; p_t) - K \qquad \text{(SE')}$$

[20] See footnote 8 for more details.

Figure 7: Break in military interventions



Notes: Data on military interventions is taken from Sullivan and Koch (2009). The left graph depicts the average number of military interventions by the US, UK and France between 1945 and 2000. The right graph documents the Wald Test for the endogenous structural break choice.

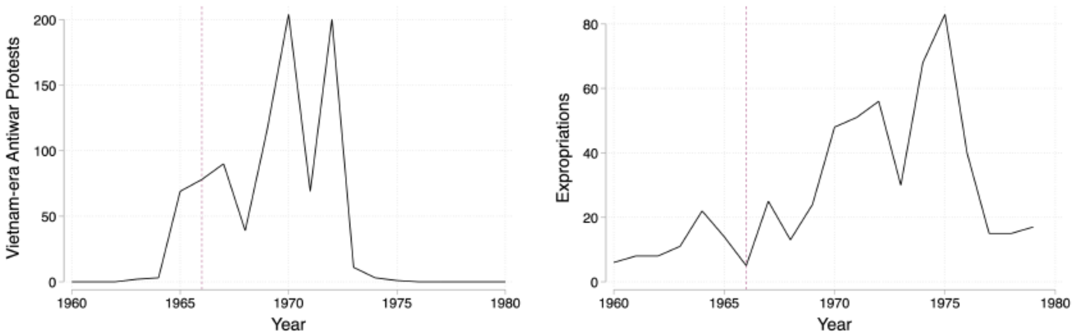
where K is the cost imposed on the country by military intervention inflicted by the firm's country of origin. For any C, if K is large enough, the constraint (SE') does not bind. In other words, an external threat of a military intervention acts as a substitute for strong rule of law and enforces agreements. Since the agreement is "military-enforced", it does not need to be backloaded.

However, as time passed, the use of military interventions lost momentum. Indeed, based on the data from Sullivan and Koch (2009), we document a pronounced decrease in the use of politically motivated military interventions in the second half of the 1960s, as illustrated by Figure 7. The Wald test statistic points to a single structural break in 1966, when the average number of military interventions dropped from around 2.4 to 1 per year.

This change in the use of military interventions was driven by both external and internal factors. First, the post-war decolonization wave brought about a change in the international economic system, bringing countries' sovereignty over natural resources into focus. While these attempts were not immediately successful, they eventually changed worldviews on the right of states over their natural resources. The resulting international pressure undermined the use of military interventions by the Western world.[21] This change was signified by the UN gen-

[21] A good illustration is the gradual retreat of Britain's military presence in the Middle East, beginning with the 1967 announcement of complete withdrawal of British forces deployed *"East of Suez"*, including from the Persian Gulf, by the end of 1971.

Figure 8: Pressure on military interventions



Notes: On the left, we plot the number of anti-war protest taking place in the US during the Vietnam war using data from Mapping American Social Movement. Data on expropriation in all industries is presented on the right and is taken from Kobrin (1984). Dotted line notifies 1966.

eral assembly granting resource rich economies permanent sovereignty over their natural resources and effectively legitimizing expropriations by 1974.[22]

Second, the use of military interventions also faced increasing domestic resistance in the counties relying on such practices. This was particularly apparent for the US, which at the time was involved in the Vietnam War. By 1964, over 20000 US soldiers would be deployed to Vietnam. As a response, the US government started facing a growing number of anti-war protests, as shown in the left panel of Figure 8. These developments triggered political changes, notably Lyndon Johnson being replaced by Richard Nixon as US president in 1968 (Lunch and Sperlich, 1979).[23] By 1973, increased dissatisfaction with the politically motivated use of military power resulted in a complete US withdrawal from Vietnam and the end of the war.

In the oil & gas sector, the changing paradigm can be illustrated by the creation and evolution of OPEC.[24] Created in 1960 with the intention of returning resource sovereignty to its owners, OPEC had very limited influence until the late 1960s.[25]

[22] The UN resolution 3201 (S-VI) explicitly established a New International Economic Order (Visser, 1988).

[23] The Vietnam War was the primary reason for the steep decline of President Johnson's popularity.

[24] OPEC was created by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. By 1971 this group of countries was joined by Algeria, Indonesia, Libya, Nigeria, Qatar and the UAE.

[25] In particular, the attempt of its Arab members to use "oil as a weapon" and initiate an oil embargo following the 1967 Six-Day War is largely considered a failure.

But in 1968, OPEC released the Declaratory Statement of Petroleum Policy in Member Countries, which emphasized the right of every nation to have complete sovereignty over their natural resources (OPEC, 2022; Dietrich (2017)). In the years following the declaration, several expropriations by OPEC members, such as in Libya and Algeria, were tolerated by the Western world. This was in clear contrast to the reactions by the same countries throughout the 1950s. Eventually, in 1973, the unwillingness of the oil consumer countries to use their military power to pursue their energy security goals was unambiguously revealed in the events surrounding the Yom Kippur War. The US and a few of their allies decided to support Israel during the war, to which the Arab members of OPEC responded by imposing a successful oil embargo against these countries (Vietor and Evans, 2003). But OPEC's costly cuts in oil supply did not trigger any military response from the US or any of its allies (Yergin, 2011).

In the framework of our model, this implies that after 1973, K in the constraint (SE') is set to zero, and the agreements between oil producing countries and oil companies need to be self-enforcing and hence backloaded. This structural change and its consequences for the threat of expropriation are also summarized by Kobrin (1984). *"[T]he success of Third Word countries in pressing for agreement on the issue of National Sovereignty of Natural Resources at the U. N., the ability of Vietnam to withstand US military action, and OPEC's achievement of control over pricing and participation, resulted in a climate that may have exacerbated tendencies toward direct and dramatic action such as expropriation,"*. Indeed, as shown in the right panel of Figure 8, there had been an escalating number of expropriations since 1967. Oil companies had to adjust to this new reality by devising self-enforcing agreements.

To test this hypothesis, we transform equation (3) into a Difference-in-Differences specification and estimate the following specification for the period 1960 to 1980:

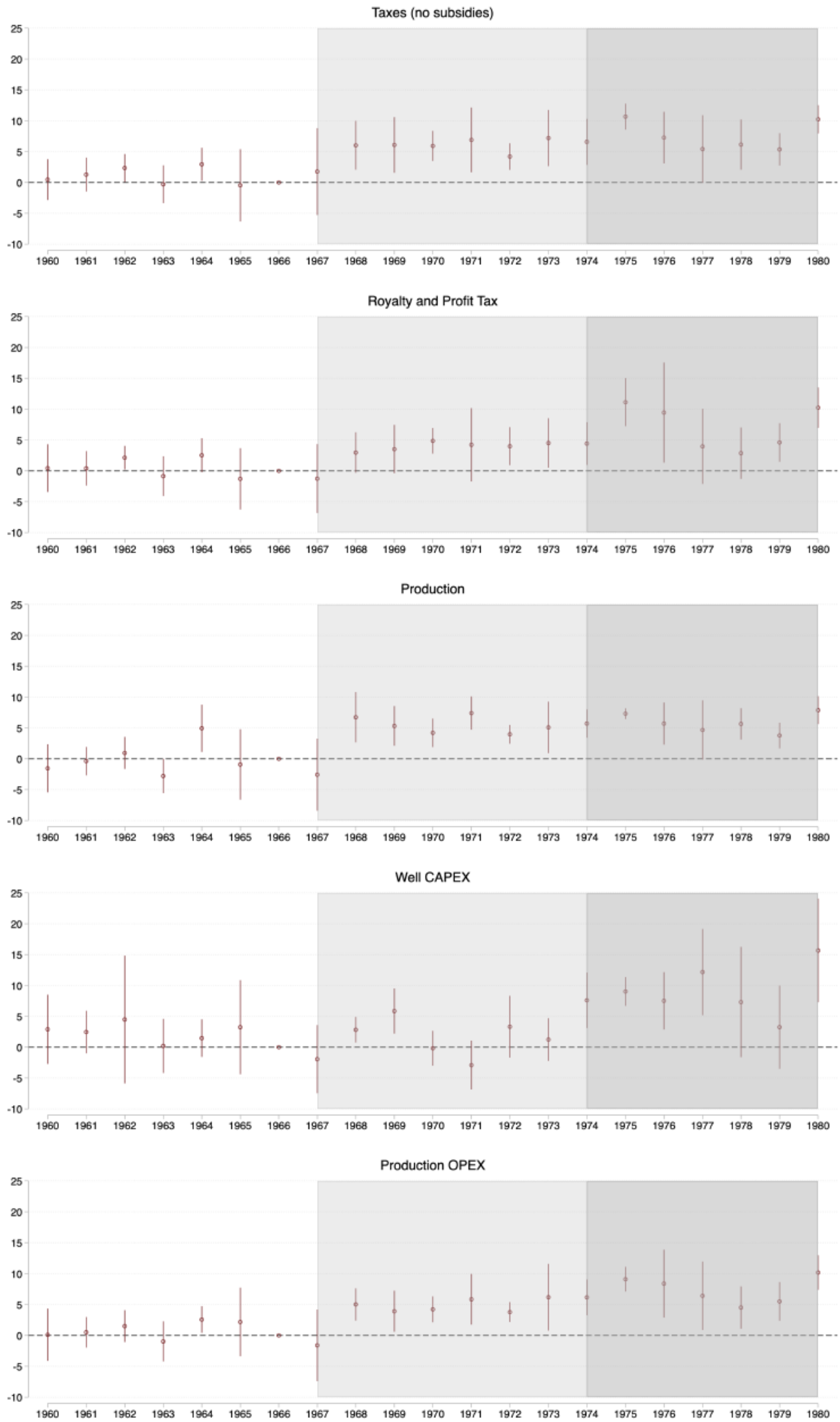
$$y_f = \sum_{j=1960, j\neq 1966}^{1980} \beta_j \times \text{Year}_j \times \text{Weak}_{c(f)} + \text{Weak}_{c(f)} + \text{Year}_{t(f)} + \Omega'_f \gamma + \varepsilon_f \quad (4)$$

As in equation (3), y_f captures the field-specific number of years $\bar{p}$ necessary to reach 66% of the cumulative flows of investment, production and tax payments. $Weak_{c(f)}$ is a dummy variable which is equal to 1 if the field is located in a country which is categorized as having weak institutions. Our coefficient of interest, β_j, measures the difference in the number of years needed to reach 66% of production, investment and tax payments in countries with weak institutions relative to countries with strong institutions between 1960 and 1980. Motivated by the results in Figure 7, we choose 1966 as our baseline. We carry our analysis forward until 1980 because of the absence of Investor-State Dispute Settlements in that period since international arbitration can be a substitute for local institutions. The first settlement case in the energy sector takes place shortly after 1980, and the number of cases starts picking up around 2000 (Delpeuch, 2022). As before, Ω_f is a vector of field-specific characteristics for which we control, and the standard errors are clustered by country, start-up year and the lifetime of the field. If our hypothesis is correct, the estimated β_j's should be around zero prior to 1966, but then gradually increase and turn positive thereafter.

The results are presented in Figure 9.[26] All estimates are conditional on country group dummies, the year in which production starts, the lifetime of a field, the exact location, the climatic conditions, the size of the reservoir, the type of fossil fuel and the operating firm. The identification assumption is that, conditional on the control variables, the evolution of outcomes in countries with weak institutions would have followed a similar path as the outcomes in countries with strong institutions, had the military enforcement of contracts continued. The results are consistent across measures and suggest that the number of years necessary to reach 66% of cumulative investment, production and tax payments increase in countries with weak institutions by approximately 5 years relative to the control group from 1968 onward. The 5-year delay is approximately 3 times larger than our results from the cross-sectional estimates in Table 2 and we discuss this dif-

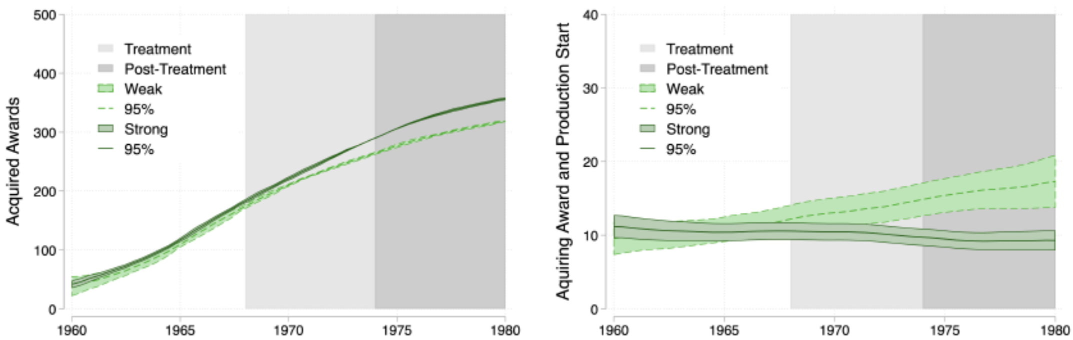
[26]In our preferred sample, we exclude countries which had received independence from colonizers after 1966 (Angola, Qatar, UAE,Yemen,Brunei and Papua New Guinea) but the results are robust to their inclusion.

Figure 9: Change in military enforcement of contracts



Notes: The outcome variable is the years to reach 66% of investment, production and tax payments over 35 years. Year of start up, country group FE and the field lifetime, location, climatic conditions, the size of the reservoir, the type of fossil fuel and the operating firm are included in all regressions. The shaded area marks the period of transition (1967-1973) and the period after 1974. The plotted interaction terms are on the year-level and the sample is limited to the period between 1960 and 1980, with 1966 being the baseline. SE are clustered by country, Start-up year and the lifetime of the field. We plot the 95% Confidence Intervals.

Figure 10: Active fields



Notes: We use the Epanechnikov kernel with a bandwidth of 2. In the top graph we plot the cumulative number for awards acquired in countries with weak and strong institutions. In the bottom graph we plot the distance in years between the year in which an Award is acquired in the year in which production starts.

ference in greater detail in section 4.4. At this point, we would just like to note that the transition to a new era resulted in the resetting of many relationships, such that the 5-year delay captures the extent of backloading at the beginning of the relationship, which we expect to vanish as the relationship matures.

The results in Figure 9 provide evidence for the appearance of backloading on the field level, the intensive margin. In Figure 10, we also confirm that this pattern translates to the extensive margin. In countries with weak institutions, the cumulative number of acquired awards, which are necessary to develop and start production, decreased relative to countries with strong institutions while being on the same trend until 1966. Similarly, the number of years needed to start production after an award is acquired increased in countries with weak institutions relative to the control group in the early 1970s, while being on the same level before 1966.

In Appendix C, we provide additional empirical evidence and discuss the influence of unobservable confounding factors in support of the causal interpretation of the results in Figure 9. First, we show the robustness of our results to the (reasonable) variation in the choice of the cumulative threshold at which the backloading is measured. Then we evaluate whether we find evidence for contract renegotiation after the start of production (see C.3). Comparing the production dynamics across countries of fields which start production around the year of the structural break, we do not find any evidence for ex-post renegotiation of contracts. The production dynamics seem to be, at least partly, predetermined by the year in which production starts. However, since we only observe the realized contracts and not the ex-ante contractual terms, our dataset does not allow us to conclusively answer this question. Second, the results presented in Figure 9 are robust to a variety of changes in the specification (see C.4). In particular, the results are robust to dropping observable field-level characteristics as controls (see Figure C.3) as well as the inclusion of country fixed effects (see Figure C.4). The results are robust to classifying countries as having weak institutions based on their OECD membership (see Figure C.5) and to the exclusion of OPEC member countries which joined OPEC before 1966 (see Figure C.6). In Figure C.7, we also show that the move to offshore drilling and the increased use of PSA, which represent "bad controls" (Angrist and Pischke, 2014),[27] since they could be used strategically by firms to reduce the risk of expropriations, did not develop differently in countries with weak and strong institutions during the transition. In Figure C.8, we document that operational and capital expenditures have been increasing in countries with strong and weak institutions alike, implying that the reallocation of capital to countries with strong institutions did not result in an increased capital scarcity in countries with weak institutions. Finally, we devote section C.5 of the Appendix to a detailed discussion of change in a country's borrowing costs and change in the government's bargaining power vis-a-vis the firms, which presumably went up for countries with weak institutions during the transition but remained unobserved. We also discuss the role of multilateral enforcement (Levin, 2002) and corruption (Troya-Martinez and Wren-Lewis, Forthcoming) in the relationships between governments and firms. We conclude these discussions by arguing that if these forces indeed have operated in the background and biased our estimates, that the bias should be negative such that our estimates reflect a lower-bound.

Finally, there are two other theories that predict contract backloading. First, backloading may arise in anonymous markets where relationships can start anew

[27] Variables that are themselves affected by the increased threat of expropriation (outcome variables) by affecting firms' choices.

after an opportunistic action has taken place and this opportunistic behavior is unobserved by new partners. Backloading emerges as a way to make switching to a new relationship more costly so that the incentives to behave opportunistically decrease (see Kranton (1996) and Fujiwara-Greve and Okuno-Fujiwara (2009)). We do not think this setting applies to the oil and gas industry since expropriations are public information. Second, backloading also arises in environments where there is asymmetric information about whether a player is opportunistic or not, as in Ghosh and Ray (1996). If the government can be opportunistic (i.e. always expropriates) or not, the firm wants to start the relationship small to use this first experimental period to screen out the government type. After that, opportunistic relationships terminate while non-opportunistic ones move to a fully cooperative level. One could imagine that the change in the world order created a situation in which the "type" of government starts mattering in countries with weak institutions. But in the oil & gas sectors, this type of screening has been documented to take place during or even before the exploration phase which precedes production (Cust and Harding, 2020). Once the exploration is finalized and productions starts, relationships are long-lasting. Thus, the mechanism of contract backloading is likely to have only marginal, if any, impact in our setting where we study producing fields. Moreover, once the type of government has been revealed as one who never expropriates, the firm has no reason to give rents to the government. Instead, we find in Table 5 that the rents given to the government increase over time, which is consistent with predictions of the model in Section 2.

4.3 Heterogeneity: case studies

The average estimates presented in Figure 9 are hiding vast country-specific heterogeneity which interacts with the appearance of backloading during the transition. To shed more light on the different mechanisms contributing to the extent of backloading, we present four case studies from different parts of the world, including Argentina, Indonesia, Libya and Nigeria. All these countries became independent by 1960.[28] None of these countries is a founding member of OPEC and three out of the four countries joined OPEC by 1971.[29] Only Argentina had a successfully operating National Oil Company (NOC) before 1960, while in the other countries, the creation of the NOC typically coincided with the transition to a new world order. Libya and Nigeria ended up expropriating some fields during and after the transition, while Argentina and Indonesia did not. Finally, all of these countries went through varying levels of political instability, interacting with and contributing to the appearance of backloading. In what follows, we use the augmented equation SE" to think about how country-specific circumstances, formally captured by X_c contributed to the heterogeneous response in backloading across countries:

$$T_t + \delta V_{t+1} \geq CT_t + (1 - C)r(I_t; p_t) + X_c \tag{SE"}$$

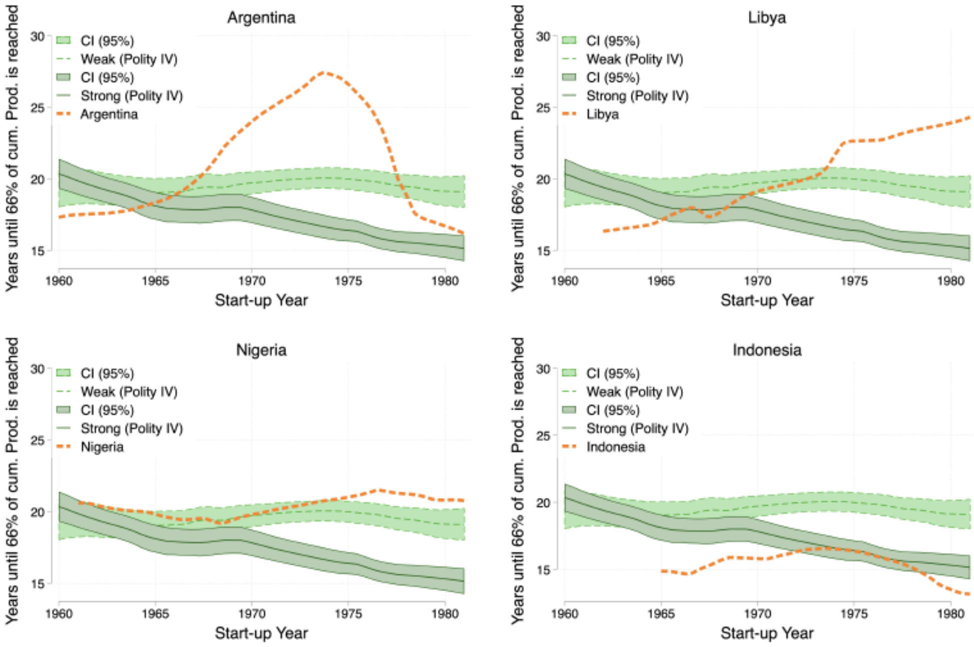
It is easy to see that, all else being equal, the constraint (SE") is more binding if $X_c > 0$ and less binding if $X_c < 0$. In Figure 11, we document the country-specific response in backloading (orange dashed line) in comparison to average patterns in weak- and strong-institutions countries. We plot the number of years which are necessary to reach the 66% threshold in production on the y-axis to depict the backloading dynamics over time. An increase in the number of years necessary to reach the threshold indicates an increase in backloading and vice versa.

ARGENTINA: Since the discovery of oil in 1907, Argentina's political elites were preoccupied with the idea that their vast oil reserves could be key to industrialization and economic independence (Buchanan, 1973). To this end, a NOC (Yacimientos Petrolíferos Fiscales) was created in 1922. When the NOC began negotiations with the Soviet Union, aimed at an increase in its oil imports, there was the fear that Argentina's oil industry would eventually be nationalized. The nationalization never occurred, and oil industry's share in national production surpassed 80% by 1955 (Solberg, 1979). Thus, Argentina is well suited for eval-

[28] Argentina in 1816, Indonesia in 1949, Libya in 1951 and Nigeria in 1960.

[29] Indonesia and Libya in 1962 and Nigeria in 1971.

Figure 11: Case studies



Notes: We use the Epanechnikov kernel with an optimal bandwidth. The dashed line in all the subfigures indicates the country-specific development of backloading. In the background of all the Figures, we also plot the average number of years necessary to reach the 66% threshold for countries with strong and weak institutions.

uating the impact of the transition to the new world oil order in the presence of an effective NOC that could run expropriated assets if needed. As we show in Figure 11, Argentina initially exhibits a particularly steep increase in backloading, greatly exceeding the average levels of backloading in countries with weak institutions. We attribute this to the presence of an efficient NOC and Argentina's ability to generate credible expropriation threats, formally captured by the future generated profits with expropriated assets $X_c > 0$. But by 1975, the extent of backloading drops sharply to previous levels. This U-turn is a direct consequence of Argentina's transformation into a military dictatorship in 1976. The new regime was politically and financially supported by the United States (National Security Archive, 2021). Hence, $X_c < 0$ turns negative after this point (since this support would stop in case of an expropriation), which greatly reduced the threat of expropriation, rendering backloading obsolete.

LIBYA: In 1959, Standard Oil of New Jersey (now ExxonMobile) made a huge oil discovery which catapulted Libya to one of the biggest oil producers in the world. Just a few years later, Libya was producing over three million barrels per day (Yergin, 2011). Since Libya's independence and during it's early years as an important oil producer, the relationship to the United States was generally described as being warm, focused on the considerable oil interests of the US backed oil majors and the operation of a strategically important airbase at the Mediterranean Sea, Wheelus Air Base (National Security Council Report, 1960). Such a relationship would be captured by $X_c < 0$ and consistent with a significantly lower level of backloading relative to other countries with weak institutions, as depicted in Figure 11. However, in 1969 a coup d'etat organized by a group of military officers, including Muammar Gaddafi, and the closure of the military base in 1970 contributed to an increased threat of expropriation, triggering the need for backloading. Following the creation of Libya's first NOC in 1970 and Libya's hard bargaining over the contract terms in the 1970's, the director of Standard Oil of New Jerseys branch in Libya was recorded saying that: "The oil industry as we had known it would not exist much longer" (Yergin (2011), p.580). The increased share in the profits captured by the Libyan government was subsequently accompanied by a sequence of expropriations in the early 1970s (Guriev, Kolotilin and Sonin, 2011). Jointly, the contract renegotiation as well as the successful expropriations forced the remaining majors to backload production, as is clearly visible in Figure 11. Thus, in the case of Libya, the subsequent switch to $X_c > 0$ captures the certainty in the regime's willingness to expropriate, events which in many other developing countries always represented a possibility but never materialized.

NIGERIA: Nigeria gained it's independence in 1960, only a few years after commercially viable oil fields were discovered by a consortium consisting of BP and Shell in 1956. The decolonization was accompanied by a complete withdrawal of the British military by 1966 (Barua, 2013). Within a few months after the last British soldier left the country, Nigeria was subject to two military coups. In this turmoil, Yakubu Gowon succeeded and stayed in power for the next nine years until he himself would be overthrown in 1975. Backed by the UK, he reigned throughout the Nigerian Civil War from 1967-1970 (Uche, 2008). The fact that this political regime was supported by the home countries of the majors positioned backloading well within the confidence bounds of the average country with weak institutions (see Figure 11). But towards the end of the war, the Nigerian relationship with the Soviet Union greatly improved, and the *New York Times* expressed the view in 1968 that "Ironically enough, it was one of the nations which Nigeria used to treat with fear and suspicion that has turned out to be her greatest friend in her most trying hours. This is the Soviet Union." Thus, by the end of the Civil War, the Nigerian army proved its effectiveness and gained a new friend and potential protector (Stent, 1973). Encouraged by its increased political independence from the Western colonizer, the Nigerian government created its NOC (Nigerian National Oil Corporation), joined OPEC and started a sequence of nationalizations (Genova, 2010; Guriev, Kolotilin and Sonin, 2011). By 1972, it was clear what the future would bring, as documented by an exchange among British Diplomats (Genova, 2007): "The growth of economic nationalism inevitably means that countries want to run their own industries and that foreign investment of the kind which has helped us prosper for so long will become increasingly exposed and in many cases will be taken from us with inadequate compensation." By 1974, over 50% of the oil fields were owned by the state (Genova, 2010), while the nationalization of the oil sector was complete by 1979. The increased political distance from the former colonizer as well as the realized expropriations indicate that $X_c > 0$ and are clearly reflected in increased backloading shown in Figure 11.

INDONESIA: The creation of Indonesia's oil industry dates back to the 1870s when Indonesia was under Dutch control and Royal Dutch Shell was created. Only in 1949, Indonesia successfully gained its independence from the Netherlands and conducted its economic decolonization throughout the 1950s. By 1957, the Indonesian NOC (Pertamina) was established, and in the following years, several of Shell's assets were nationalized (Sluyterman, 2020). But by the mid 1960s, two fundamental changes occurred which greatly decreased the threat of expropriation, $X_c < 0$, and kept the extent of backloading at low levels, as shown in Figure 11. First, backed by the US and the UK, Suharto would seize control over the country by 1967 and run the country for the next three decades (Bevins, 2017). While the primary reason for the involvement of the Western powers was political, (the plan was to eradicate the Communist tendencies in Indonesia,) the opening of Indonesian to foreign investment had additional economic benefits. Second, a new type of contractual relationship was pioneered by Indonesia in the late 1960s (Bindemann, 1999). Instead of being concessionaires and getting the ownership rights to the oil in the ground, the creation of production sharing contracts gave firms the rights to part of any stream of oil they discovered, while the government would keep part of the property right. The shift in terminology reflected the fact that the sovereignty of the country was recognized by both parties. Clearly, such agreements would naturally reduce the incentive to expropriate since part of the assets was already under the control of the government.

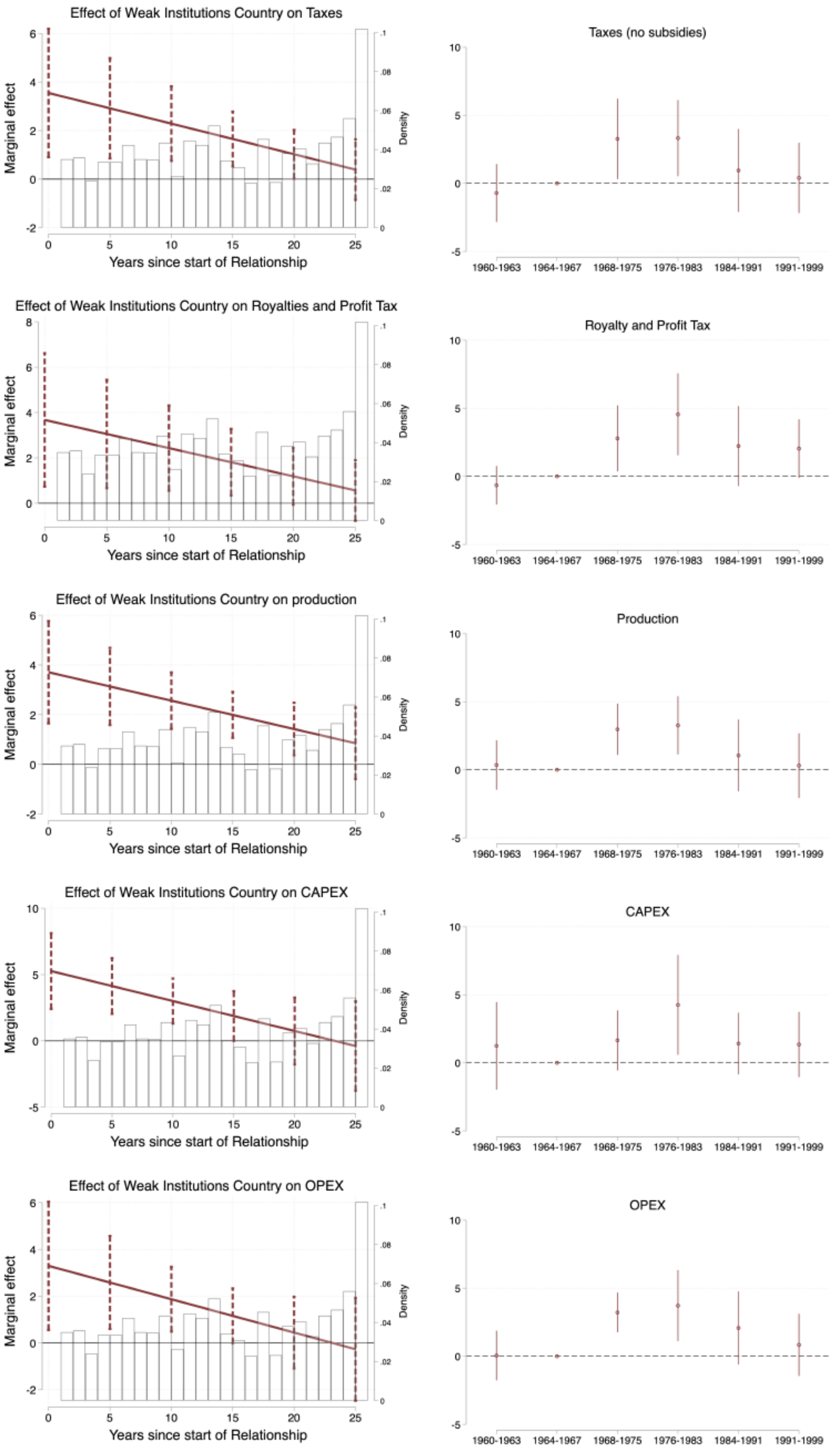
Jointly, these case studies suggest that strong political relationships between the host and home countries of foreign investments as well as contract designs which allow the host country to keep a share of the property rights reduce the need for backloading. On the other hand, nationalistic political movements, a well functioning NOC which makes expropriation feasible as well as contract negotiations and expropriations (perceived or realized) increase the need for backloading.

4.4 Long run dynamics

In the model of section 2, we discussed how investment, production and tax payments eventually approach the efficient frontier and backloading vanishes as emphasized in Hypothesis 2. In this section we put this hypothesis to an empirical test.

A relationship between the government and the firm starts in the year in which a firm is awarded a license for extraction for the first time in a particular coun-

Figure 12: Long-run dynamics



Notes: The left-hand side variable in all graphs is indicating the number of years until 66% of CAPEX, production and tax payments over 35 years is reached. The full set of controls is included in all results, identical to the set of controls used in the even columns of Table 2. In the left column, we document the estimated marginal effect from equation 5. In the right column, we present the results from estimating a specification which is akin to 4, but the interaction terms are aggregated in 5-year bins, the sample is extended to 1999 and the baseline is 1964-1967. The SE are clustered by country, start-up year and lifetime of the fields. We plot the 95% confidence interval.

try.[30] Treating the number of years since the beginning of a relationship as the relationship duration, we can evaluate how the number of years which are necessary to reach a certain cumulative threshold in investment, production and tax payments changes over the lifetime of the relationship. As before, we differentiate between countries with weak and strong institutions by expanding our baseline specification in equation (3) and interacting the $\text{Weak}_{c(f)}$ country dummy with $\text{Relation Duration}_{d(f)}$:

$$y_f = \beta \text{Weak}_{c(f)} + \alpha \text{RelationDuration}_{d(f)} + \gamma \text{Weak}_{c(f)} \times \text{RelationDuration}_{d(f)} + \Omega_f' \gamma + \varepsilon_f \tag{5}$$

As before, our unit of observation is an individual field, y_f captures the field-specific number of years which are necessary to reach 66 % of the cumulative flows of investment, production and tax payments. Ω_f is a vector of field specific characteristics for which we control, and the standard errors are clustered by country, start-up year as well as the lifetime of the fields. We are interested in the marginal effects ($\beta + \gamma \text{Relation Duration}_{d(f)}$) which are presented in the left column of Figure 12. All variables of interest exhibit the same pattern. In the first years of the relationship, the time to reach our 66% threshold in countries with weak institutions is 4-5 years above the number of years necessary to reach the same threshold in countries with strong institutions. Note that these estimates are close to the estimates presented in Figure 9. As relationships mature, however, the extent of backloading diminishes. On average, the level of backloading does not differ significantly between countries with strong and weak institutions approximately 20 to 25 years after the relationship starts.

To evaluate how the increased maturity of contracts in a world with a limited number of oil & gas rich economies effects the level of backloading on the global level in the long run, we slightly adjust and re-estimate our specification in equation 4. In particular, we extend the sample to cover the period 1960-1999, and for the sake of a simpler illustration, we aggregate the time fixed effects of the inter-

[30] And resetting the relationships to zero in 1973, due to the shift to a new world order which we documented above.

action terms to 8-years bins. The results in the right column of Figure 12 suggest that that the initially observed backloading on the global level also decreases in the long run, as we would expect.

5 Conclusion

Our dataset of oil & gas fields allows us to carefully study relational contracting between governments and oil & gas majors across a large number of resource rich economies, with weak and strong institutions, and over an extensive period of time. We show that since the early 1970s, investment, production and tax payments have been delayed in countries with weak institutions relative to countries with strong institutions. Exploiting a historical reduction in contract enforcement by military means, we show that physical and financial flows in the oil and gas industry reacted by becoming relatively more backloaded in countries with weak institutions. We also show that the backloading disappears as the relationship matures. These findings are consistent with a large body of theory, and to the best of our knowledge, we are the first to document such contract dynamics empirically.

While the oil & gas sector is particularly well suited for studying self-enforcing contracts, there are many industries, other than resource extracting ones, to which our insights apply and which are well suited to study long-term relationships between countries with a weak rule of law and multinational firms. For instance, Kobrin (1980, 1984) documents that firms in manufacturing and finance represented up to 40% of all the expropriated firms during the expropriation wave in the early 1970s. He argues that food and beverages, textile and construction material are particularly vulnerable to expropriations since they do not depend on advanced technologies to be operated and are typically self-sufficient with limited dependence on global supply chains. Understanding how changes in investment, production and the payment of taxes adjust to changes in the global order is very important since they have a direct and non-negligible effect on the gains from global trade (Findlay and O'Rourke, 2009).

Going further, we do think that the careful analysis of new datasets on international contracts between governments and firms as well as the use of alternative identification strategies which would allow us improve our understanding of the causal link between international investments and the ability to enforce or self-sustain international contracts would be of great value. More precisely, backloading is just one specific dimension in which contracts between firms and governments may adjust to deal with a lack of enforceability. Are there other mechanisms? If yes, it is important to understand how such mechanisms may affect and interact with the extent of backloading. For instance, our case study of Indonesia suggests that the use of PSA may have decreased the country's returns from expropriation, creating a downward pressure on observed backloading. Alternatively, political proximity between the home countries of the investing firm and the host countries seem to have contributed greatly to the drop in backloading, as we document for Argentina. However, studying these mechanisms in detail is beyond the scope of the paper, and much more careful studies are needed to understand them. In this regard, future research could study these channels by exploring the introduction of new formats of contractual agreements for the former or exploiting changes to geopolitical relationships for the latter.

Moreover, our identification strategy does not allow us to empirically differentiate between the effect of changing contract enforcement on the backloading of contracts and the simultaneous creation of NOCs and the increase in the price of oil. Theoretically, both of these can contribute to an increase in backloading. Unfortunately, both also coincide with the transition to a world order without the militarily enforcement of contracts, which does not allow us to carefully differentiate between the individual channels. This opens the door to future research, which could focus on differentiating between these mechanisms. Finally, our data set only allows us to observe realized investment, production and tax payments. Having access to the written contracts which are agreed upon ex-ante and being able to compare them to their realization ex-post, would certainly allow for many further insights about how international contracts react to changes in the global institutional environment.

References

Abrahamian, Ervand. 2013. *The coup: 1953, the CIA, and the roots of modern US-Iranian relations.* The New Press.

Acemoglu, Daron. 2006. "A simple model of inefficient institutions." *The Scandinavian Journal of Economics*, 108(4): 515–546.

Acemoglu, Daron, Michael Golosov, and Aleh Tsyvinski. 2008. "Political economy of mechanisms." *Econometrica*, 76(3): 619–641.

Adelman, MA. 1962. "Petroleum Production Costs in General." *Journal of Industrial Economics*, 3–24.

Aguiar, Mark, and Manuel Amador. 2011. "Growth in the Shadow of Expropriation." *The Quarterly Journal of Economics*, 126(2): 651–697.

Albuquerque, Rui, and Hugo A Hopenhayn. 2004. "Optimal lending contracts and firm dynamics." *The Review of Economic Studies*, 71(2): 285–315.

Andersen, Jørgen Juel, Frode Martin Nordvik, and Andrea Tesei. 2022. "Oil price shocks and conflict escalation: onshore versus offshore." *Journal of Conflict Resolution*, 66(2): 327–356.

Anderson, Soren T, Ryan Kellogg, and Stephen W Salant. 2018. "Hotelling under pressure." *Journal of Political Economy*, 126(3): 984–1026.

Angrist, Joshua D, and Jörn-Steffen Pischke. 2014. *Mastering'metrics: The path from cause to effect.* Princeton university press.

Antràs, Pol, and C. Fritz Foley. 2015. "Poultry in Motion: A Study of International Trade Finance Practices." *Journal of Political Economy*, 123(4): pp. 853–901.

Asker, John, Allan Collard-Wexler, and Jan De Loecker. 2019. "(Mis) allocation, market power, and global oil extraction." *American Economic Review*, 109(4): 1568–1615.

Atkeson, Andrew. 1991. "International lending with moral hazard and risk of repudiation." *Econometrica: Journal of the Econometric Society*, 1069–1089.

Baker, George, Robert Gibbons, and Kevin J Murphy. 1994. "Subjective Performance Measures in Optimal Incentive Contracts." *The Quarterly Journal of Economics*, 109(4): 1125–1156.

Baland, Jean-Marie, François Bourguignon, Jean-Philippe Platteau, and Thierry Verdier. 2020. *The Handbook of Economic Development and Institutions.* Princeton University Press.

Barua, Pradeep. 2013. *The military effectiveness of post-colonial states.* Brill.

Besley, Timothy, and Hannes Mueller. 2018. "Institutions, volatility, and investment." *Journal of the European Economic Association*, 16(3): 604–649.

Bevins, Vincent. 2017. "What the United States Did in Indonesia." https://www.theatlantic.com/international/archive/2017/10/the-indonesia-documents-and-the-us-agenda/543534/, October 17, 2022.

Bindemann, Kirsten. 1999. *Production-sharing agreements: an economic analysis.* Oxford institute for energy studies.

Blader, Steven, Claudine Gartenberg, Rebecca Henderson, and Andrea Prat. 2015. "The Real Effects of Relational Contracts." *American Economic Review*, 105(5): 452–56.

Brown, Martin, Armin Falk, and Ernst Fehr. 2004. "Relational contracts and the nature of market interactions." *Econometrica*, 72(3): 747–780.

Brown, Martin, Armin Falk, and Ernst Fehr. 2012. "Competition and relational contracts: the role of unemployment as a disciplinary device." *Journal of the European Economic Association*, 10(4): 887–907.

Brugues, Felipe. 2020. "Take the Goods and Run: Contracting Frictions and Market Power in Supply Chains." Brown University mimeo.

Buchanan, James E. 1973. "Politics and petroleum development in Argentina, 1916-1930."

Bulow, Jeremy, and Kenneth Rogoff. 1989. "Sovereign Debt: ls to Forgive to Forget?" *The American Economic Review*, 79(1): 43–50.

Calzolari, Giacomo, Leonardo Felli, Johannes Koenen, Giancarlo Spagnolo, and Konrad O Stahl. 2021. "Relational Contracts and Trust in a High-Tech Industry."

Cust, James, and Torfinn Harding. 2020. "Institutions and the location of oil exploration." *Journal of the European Economic Association*, 18(3): 1321–1350.

Delpeuch, Samuel. 2022. "Investor-State Disputes and Tax Advantages in the Energy Sector." *Mimeo.*

Dietrich, Christopher RW. 2017. *Oil Revolution.* Cambridge University Press.

Djankov, Simeon, Rafael La Porta, Florencio Lopez-de Silanes, and Andrei Shleifer. 2003. "Courts." *The Quarterly Journal of Economics*, 118(2): 453–517.

Eaton, Jonathan, Mark Gersovitz, and RJ Herring. 1983. "Country risk: Economic aspects." *Managing international risk*, 75–108.

Findlay, Ronald, and Kevin H O'Rourke. 2009. "Power and plenty." In *Power and Plenty.* Princeton University Press.

Fong, Yuk-fai, and Jin Li. 2017. "Relational contracts, limited liability, and employment dynamics." *Journal of Economic Theory*, 169: 270–293.

Fuchs, William, Brett Green, and David Levine. forthcoming. "Optimal Arrangements for Distribution in Developing Markets: Theory and Evidence." *American Economic Journal: Microeconomics.*

Fujiwara-Greve, Takako, and Masahiro Okuno-Fujiwara. 2009. "Voluntarily separable repeated prisoner's dilemma." *The Review of Economic Studies*, 76(3): 993–1021.

Genova, Ann. 2007. "Oil and nationalism in Nigeria, 1970-1980." PhD diss. The University of Teaxs in Austin.

Genova, Ann. 2010. "Nigeria's nationalization of British Petroleum." *The International Journal of African Historical Studies*, 43(1): 115–136.

Ghosh, Parikshit, and Debraj Ray. 1996. "Cooperation in community interaction without information flows." *The Review of Economic Studies*, 63(3): 491–519.

Ghosh, Parikshit, and Debraj Ray. 2022. "The Social Equilibrium of Relational Arrangements." *Mimeo.*

Gibbons, Robert, and Rebecca Henderson. 2013. "What Do Managers Do? Exploring Persistent Performance Differences Among Seemingly Similar Enterprises." In *The Handbook of Organizational Economics.* , ed. Robert Gibbons and John Roberts, 680–731. Princeton University Press.

Gil, Ricard, and Giorgio Zanarone. 2017. "Formal and Informal Contracting: Theory and Evidence." *Annual Review of Law and Social Science*, 13(1).

Greif, Avner. 1993. "Contract enforceability and economic institutions in early trade: The Maghribi traders' coalition." *The American economic review*, 525–548.

Guriev, Sergei, Anton Kolotilin, and Konstantin Sonin. 2011. "Determinants of nationalization in the oil sector: A theory and evidence from panel data." *The Journal of Law, Economics, and Organization*, 27(2): 301–323.

Hajzler, Christopher. 2012. "Expropriation of foreign direct investments: sectoral patterns from 1993 to 2006." *Review of World Economics*, 148(1): 119–149.

Harris, Milton, and Bengt Holmstrom. 1982. "A theory of wage dynamics." *The Review of Economic Studies*, 49(3): 315–333.

Hotelling, Harold. 1931. "The economics of exhaustible resources." *Journal of political Economy*, 39(2): 137–175.

Jaakkola, Niko, Daniel Spiro, and Arthur A Van Benthem. 2019. "Finders, keepers?" *Journal of Public Economics*, 169: 17–33.

Javorcik, Beata Smarzynska. 2004. "The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies." *European economic review*, 48(1): 39–62.

Jensen, Nathan. 2008. "Political risk, democratic institutions, and foreign direct investment." *The Journal of Politics*, 70(4): 1040–1052.

Johnston, David. 2007. "How to evaluate the fiscal terms of oil contracts." *Escaping the resource curse*, 68.

Karl, Terry Lynn. 1997. *The paradox of plenty: Oil booms and petro-states.* Vol. 26, Univ of California Press.

Kobrin, Stephen J. 1980. "Foreign enterprise and forced divestment in LDCs." *International Organization*, 65–88.

Kobrin, Stephen J. 1984. "Expropriation as an attempt to control foreign firms in LDCs: trends from 1960 to 1979." *International Studies Quarterly*, 28(3): 329–348.

Kranton, Rachel E. 1996. "The formation of cooperative relationships." *The Journal of Law, Economics, and Organization*, 12(1): 214–233.

Krautkraemer, Jeffrey A. 1998. "Nonrenewable resource scarcity." *Journal of Economic literature*, 36(4): 2065–2107.

Kvaløy, Ola, and Trond E Olsen. 2009. "Endogenous verifiability and relational contracting." *American Economic Review*, 99(5): 2193–2208.

Lafontaine, Francine, Rozenn Perrigot, and Nathan E Wilson. 2017. "The quality of institutions and organizational form decisions: Evidence from within the firm." *Journal of Economics & Management Strategy*, 26(2): 375–402.

Lazear, Edward P. 1981. "Agency, earnings profiles, productivity, and hours restrictions." *The American Economic Review*, 71(4): 606–620.

Levin, Jonathan. 2002. "Multilateral contracting and the employment relationship." *The Quarterly Journal of Economics*, 117(3): 1075–1103.

Levin, Jonathan. 2003. "Relational incentive contracts." *American Economic Review*, 93(3): 835–857.

Levy, Brian, and Pablo T Spiller. 1994. "The institutional foundations of regulatory commitment: a comparative analysis of telecommunications regulation." *The Journal of Law, Economics, and Organization*, 10(2): 201–246.

Lunch, William L, and Peter W Sperlich. 1979. "American public opinion and the war in Vietnam." *Western Political Quarterly*, 32(1): 21–44.

Macchiavello, Rocco. 2021. "Relational contracts and development." *Annual Review of Economics*, 14.

Macchiavello, Rocco, and Ameet Morjaria. 2015. "The value of relationships: evidence from a supply shock to Kenyan rose exports." *American Economic Review*, 105(9): 2911–45.

Macchiavello, Rocco, and Ameet Morjaria. 2021. "Competition and relational contracts in the Rwanda coffee chain." *The Quarterly Journal of Economics*, 136(2): 1089–1143.

MacLeod, W Bentley, and James M Malcomson. 1989. "Implicit contracts, incentive compatibility, and involuntary unemployment." *Econometrica: Journal of the Econometric Society*, 447–480.

Mihalyi, David. 2021. "The Long Road to First Oil." *Available at SSRN 3719751*.

Minor, Michael S. 1994. "The demise of expropriation as an instrument of LDC policy 1980–1992." *Journal of International Business Studies*, 25(1): 177–188.

National Security Archive. 2021. "Argentina's Military Coup of 1976: What the U.S. Knew." https://nsarchive.gwu.edu/briefing-book/southern-cone/2021-03-23/argentinas-military-coup-what-us-knew,, August 17, 2022.

National Security Council Report. 1960. "STATEMENT OF U.S. POLICY TOWARD LIBYA." https://history.state.gov/historicaldocuments/frus1958-60v13/d339,, August 17, 2022.

Nordvik, Frode Martin. 2018. "Does Oil Promote or Prevent Coups? The Answer is Yes." *The Economic Journal*, 129(619): 1425–1456.

North, Douglass C. 1991. "Institutions." *Journal of economic perspectives*, 5(1): 97–112.

Papaioannou, Elias. 2009. "What drives international financial flows? Politics, institutions and other determinants." *Journal of Development economics*, 88(2): 269–281.

Ray, Debraj. 2002. "The time structure of self-enforcing agreements." *Econometrica*, 70(2): 547–582.

Rigobon, Roberto. 2010. "Dealing with expropriations: General guidelines for oil production contracts." *The Natural Resources Trap: Private Investment Without Public Commitment*, 227–254.

Rose-Ackerman, Susan. 2008. "Corruption and government." *International peacekeeping*, 15(3): 328–343.

Ross, Michael. 2012. *The oil curse: How petroleum wealth shapes the development of nations.* Princeton University Press.

Sluyterman, Keetie. 2020. "Decolonisation and the organisation of the international workforce: Dutch multinationals in Indonesia, 1945–1967." *Business History*, 62(7): 1182–1201.

Solberg, Carl E. 1979. "Oil and nationalism in Argentina: a history."

Stent, Angela. 1973. "The Soviet Union and the Nigerian Civil War: A Triumph of Realism." *African Issues*, 3(2): 43–48.

Stroebel, Johannes, and Arthur Van Benthem. 2013. "Resource extraction contracts under threat of expropriation: Theory and evidence." *Review of Economics and Statistics*, 95(5): 1622–1639.

Sullivan, Patricia L, and Michael T Koch. 2009. "Military Intervention by Powerful States, 1945—2003." *Journal of Peace Research*, 46(5): 707–718.

Thomas, Jonathan, and Tim Worrall. 1994. "Foreign direct investment and the risk of expropriation." *The Review of Economic Studies*, 61(1): 81–108.

Troya-Martinez, Marta, and Liam Wren-Lewis. Forthcoming. "Managing Relational Contracts." *Journal of the European Economic Association.*

Uche, Chibuike. 2008. "Oil, British interests and the Nigerian civil war." *The Journal of African History*, 49(1): 111–135.

Van der Ploeg, Frederick. 2011. "Natural resources: curse or blessing?" *Journal of Economic literature*, 49(2): 366–420.

Venables, Anthony J. 2016. "Using natural resources for development: why has it proven so difficult?" *Journal of Economic Perspectives*, 30(1): 161–84.

Vietor, Richard HK, and Rebecca Susan Evans. 2003. *World Oil Markets.* Harvard Business School.

Visser, Fritz. 1988. "The principle of permanent sovereignty over natural resources and the nationalisation of foreign interests." *Comparative and International Law Journal of Southern Africa*, 21(1): 76–91.

Yergin, Daniel. 2011. *The prize: The epic quest for oil, money & power.* Simon and Schuster.

APPENDIX FOR ONLINE PUBLICATION

A. PROOFS OF SECTION 2

Proof of Proposition 1

This proof characterizes the equilibrium and establishes its properties as stated in the Proposition. Let U and V be the discounted values of the firm and the government, respectively. We focus on the Subgame Perfect Equilibrium (SPE) that maximizes the firm's profits at the start of the game and that lies on the Pareto optimal frontier $\{V, U(V)\}|V \in [V_{\min}, V_{\max}]$ depicted in Figure 2. $V_{\min}$ and $V_{\max}$ are the minimum and maximum discounted values obtained by the government. After price p is realized, let T_p be the taxes paid by the firm and V_p the government's continuation value. The firm's problem is to maximize:

$$U(V) = \max_{I,\{V_p\},\{T_p\}} \{-I + \mathbb{E}[r(I,p) - T_p + \delta U(V_p)]\} \tag{6}$$

subject to the following set of constraints:
– the government's promise-keeping equation

$$V = \mathbb{E}[T_p + \delta V_p], \tag{PK}$$

– the government's self-enforcing constraint

$$\delta V_p \geq (1 - C)\left(r(I,p) - T_p\right), \tag{SE}$$

– the limited liability constraint

$$0 \leq T_p \leq r(I,p), \tag{LL}$$

– the firm's participation constraint

$$U(V_p) \geq 0. \tag{PC}$$

The government's participation constraint and the firm's self-enforcing constraint never bind and are omitted.[31] To simplify the problem, note that when $p = 1$ the right hand side of (LL) cannot bind $T_1 < r(I,1)$ - otherwise the firm incurs losses since it pays I and keeps no revenue. When $p = 0$, (SE) is slack since by (LL) $T_0 = r(I,0) = 0$ and there are no profits to be expropriated. We ignore (PC) for $p = 0$ and show later that it does not bind since we focus on the Pareto frontier and $V_1 \geq V_0$. Finally, using (PK), we find an expression for T_1:

$$T_1 = 2V - \delta V_0 - \delta V_1, \tag{7}$$

[31] To see this, note that the government can always ensure itself a non-negative payoff because of (LL). Moreover, if the firm does not invest the agreed amount, the government expropriates the firm unless the courts uphold the initial contract with probability C. In any case, the relationship is terminated following a deviation. Given these assumptions, the best possible deviation is not to invest. The resulting self-enforcing constraint is:

$$-I + \mathbb{E}\left[r(I;p) - T_p + \delta U(V_p)\right] \geq C(-I + \mathbb{E}\left[r(I;p) - T_p\right])$$

which is equivalent to $U(V) \geq \frac{-C\delta}{1-C}\mathbb{E}\left[U(V_p)\right]$. Since the firm has a 0 outside option, this constraint never binds.

These observations allow us to rewrite equations (6)–(PC) as follows:

$$U(V) = \max_{I,V_0,V_1} \left\{ 2\sqrt{I} - I - V + \frac{\delta}{2}\left(V_0 + V_1 + U(V_0) + U(V_1)\right) \right\} \tag{8}$$

subject to

$$\delta V_1 - (1-C)\left(4\sqrt{I} - 2V + \delta V_0 + \delta V_1\right) \geq 0, \tag{9}$$

$$2V - \delta V_0 - \delta V_1 \geq 0, \tag{10}$$

$$U(V_1) \geq 0. \tag{11}$$

We are now ready to solve this simplified problem. Let $\lambda, \mu, \nu \geq 0$ be the Lagrange multipliers for (9), (10) and (11), respectively. Then the first-order conditions for (8)–(11) are

$$I = (1 - 2\lambda(1-C))^2, \tag{12}$$

$$U'(V_0) = -1 + 2\lambda(1-C) + 2\mu, \tag{13}$$

$$U'(V_1) = \frac{-1 - 2\lambda C + 2\mu}{1 + 2\frac{\nu}{\delta}}. \tag{14}$$

The envelope theorem applied to the problem (8)–(11) give us:

$$U'(V) = -1 + 2\lambda(1-C) + 2\mu = U'(V_0). \tag{15}$$

Thus, $-1 \leq U'(V) \leq 0$ for all relevant V.

The Pareto frontier can be divided into two parts. In the first-best part, $V \in FB$, the constraint (9) does not bind (for instance, when $C = 1$) while in the second-best part, $V \in SB$, it binds. When $V \in FB$, the investment is set at the first-best level:

$$U(V) = V^{\#} - V, \text{ where } V^{\#} = V_{\max} = \frac{1}{1-\delta}, \quad I = I^* = 1. \tag{16}$$

For concreteness, we assume that $\delta < \dfrac{2-2C}{3-2C}$ to guarantee a non-empty FB.[32]

When $\lambda > 0$, then $V \in SB$ and the investment level is suboptimal, $I < I^*$, and

$$U'(V_0) = U'(V) > -1. \tag{17}$$

Assuming the function $U(\cdot)$ is strictly concave, it follows from (8)–(15) that $U'(V)$ is decreasing in V for $V \in SB$. Hence,

$$V_0 = V \leq V_1 \leq \frac{V}{\beta} \quad \text{where } \beta = \frac{\delta}{2-\delta}. \tag{18}$$

where the last inequality follows from (10) and the condition that $V_0 = V$. Moreover, note that it is not possible to have $\mu = \nu = 0$ for $V \in SB$ as long as $C > 0$, since constraints (14) and (17) need to be satisfied. Hence, if $C > 0$ then either (10) or (11) must bind. If (10) binds, then $V_1 = V/\beta$. Otherwise, $V_1 = V^{\#}$. In contrast with Thomas and Worrall (1994), whenever there are formal institutions,

[32] For the case where the FB is empty, please see Case 2 in Thomas and Worrall (1994).

a strict incentive to increase V_1 makes it necessary to bound V_1. To see why, consider an increase in V_1. By (7), it will be accompanied by a reduction in T_1 such that the government still gets V. An increase in V_1 relaxes (9), but also tightens it, since the reduction in T_1 increases the expected expropriated profits. When $C = 0$, these two effects cancel out resulting in (9) being unaffected by V_1. However, when $C > 0$, because expropriation does not happen with probability 1, the benefit of increasing V_1 dominates.

When $\lambda = 0$, then $V \in FB$ and by (14), we have that $\mu = \nu = 0$ (otherwise, the inequality $U'(V) \geq -1$ would not hold). Hence $U'(V) = U'(V_0) = U'(V_1) = -1$ and $U(V)$ is given by (16). Plugging (16) to the right-hand side of (8), we see that (16) indeed holds if (9)–(11) hold. There are multiple solutions[33] to the maximization problem (8)–(11). The set of solutions (V_0, V_1) for a given $V \in [\bar{V}, V^{\#}]$ is described by the following inequality system:

$$\begin{aligned} &V_1 - (1-C)\,(4 - 2V + \delta V_0 + \delta V_1) \geq 0,\\ &2V - \delta V_0 - \delta V_1 \geq 0\\ &V, V_0, V_1 \in [\bar{V}, V^{\#}]. \end{aligned} \tag{19}$$

We solve for minimal $\bar{V}$ satisfying (19) to define the broadest set of V such that $I = I^*$. Notice that for such a minimal V the first inequality in (19) is more likely to hold for a small V_0, so we can set $V = V_0 = \bar{V}$. This, combined with (10), implies that $V_1 \leq V/\beta$. As a result, if $\bar{V} \geq \beta V^{\#}$ then only (10) binds and the solution is found by setting highest possible $V_1 = V^{\#}$. If instead $\bar{V} < \beta V^{\#}$, then only (11) binds and to solve (19) we take $V_1 = V/\beta$. This inequality system defines the following two sub-cases:

$$\bar{V} = \max(\tilde{V}, V^*), \quad \tilde{V} = \frac{4(1-C)}{2-\delta}, \quad V^* = \frac{4(1-C) - (4-3C)\delta}{(1-C)(1-\delta)(2-\delta)}. \tag{20}$$

Case 1.1 involves $\bar{V} = \tilde{V}$ and takes place when $\delta \geq \dfrac{4-4C}{5-4C}$. In this case, the first-best part of the Pareto frontier needs more than one step to cross from the left to the right. Then the segment of the Pareto set neighboring from the left to its first-best part is determined by equalizing (9) with $V_1 = V/\beta$, $V_0 = V$ and $U(V_1) = V^{\#} - V_1$. Solving (8) for $U(V)$, we obtain

$$U(V) = aV^2 + bV + c \tag{21}$$

where

$$a = -\frac{2-\delta}{8(1-C)^2}, \quad b = \frac{C}{1-C}, \quad c = \frac{\beta}{1-\delta}. \tag{22}$$

The level of investment is

$$I(V) = \left(\frac{2-\delta}{4(1-C)}V\right)^2 = \left(\frac{V}{\tilde{V}}\right)^2. \tag{23}$$

Equations (21)–(23) are valid for $V \in [\beta\tilde{V}, \tilde{V}]$. To the right of this segment, that is for $V \in [\tilde{V}, V^{\#}]$, we have the solution in (16). The solution to the left of this

[33] Note that $U'(V_0) = U'(V)$ regardless of which constraints bind. This does not imply $V_0 = V$ if $V \in FB$ because then $U'(V) = -1$ everywhere.

segment, will be described later.

When $\frac{2-2C}{3-2C} \leq \delta < \frac{4-4C}{5-4C}$, we have Case 1.2 and hence $\bar{V} = V^*$. The first-best part of the Pareto frontier needs less than one step to be crossed. There are $V \in SB$ such that (11) binds and we jump to $V_1 = V^{\#}$ following $p = 1$. Then the segment of the Pareto set neighboring from the left to its first-best part is determined by equalizing (9) with $V_1 = \min(V/\beta, V^{\#})$,[34] $V_0 = V$ and $U(V_1) = V^{\#} - V_1$. Solving (8) for $U(V)$, we obtain

$$U(V) = aV^2 + bV + c \tag{24}$$

where a, b, c are given by

$$a = -\frac{2-\delta}{8}, \quad b = -\frac{C}{4(1-C)}\frac{\delta}{1-\delta}, \quad c = \frac{\beta}{(1-C)(1-\delta)}\left(1 - \frac{\delta}{1-\delta}\frac{C^2}{8(1-C)}\right), \tag{25}$$

with the level of investment given by

$$I(V) = \left(\frac{C}{4(1-C)}\frac{\delta}{1-\delta} + \frac{2-\delta}{4}V\right)^2 \tag{26}$$

for $V \in [\beta V^{\#}, V^*]$ and by (22), with investment given by (23), for $V \in [\beta V^*, \beta V^{\#}]$.

For lower V (i.e. to the left of the segments considered above: to the left of $\beta\tilde{V}$ in Case 1.1 and βV^* in Case 1.2) both, (9) and (10), bind. Then

$$V_1 = \frac{V}{\beta}, \quad I = \left(\frac{(2-\delta)V}{4(1-C)}\right)^2 \tag{27}$$

and the formula for $U(V)$ depends on k, the number of steps needed to reach the first best part when $p = 1$, $k \geq 2$:

$$U(V) = a_k V^2 + b_k V + c_k \tag{28}$$

where a_k, b_k, c_k can be determined recursively from the Bellman equation (8):

$$a_k = \frac{a_{k-1}}{\beta} - \frac{2-\delta}{8(1-C)^2}, \quad b_k = b_{k-1} + \frac{1}{1-C}, \quad c_k = \beta c_{k-1}, \quad a_1 = a, \quad b_1 = b, \quad c_1 = c, \tag{29}$$

where a, b, c are defined in (22) or (25), depending on the case (1.1 or 1.2). This allows us to compute the coefficients a_k, b_k, c_k recursively

$$a_k = \beta^{1-k}a - \frac{\beta^{1-k}-1}{\beta^{-1}-1}\frac{2-\delta}{8(1-C)^2}, \quad b_k = b + \frac{k-1}{1-C}, \quad c_k = \beta^{k-1}c. \tag{30}$$

In general, k is given by:

$$k = \left\lceil \frac{\ln\left(V_{\min}/\bar{V}\right)}{\ln \beta} \right\rceil \tag{31}$$

[34] We include V/β to get the full-length segment $[\beta V^*, V^*]$. Hence (10) binds and (11) is slack in the left part of the segment where $V \leq \beta V^{\#}$.

where (31) is determined by $\bar{V} = \tilde{V}$ for Case 1.1 and $\bar{V} = V^*$ for Case 1.2.

The left bound of the Pareto frontier $V_{\min}$ is reached at the maximum of $U(V)$, when $U'(V) = 0$ i.e.

$$V_{\min} = \frac{b_k}{-2a_k} \tag{32}$$

where k is such that $V_{\min}$ is between $\beta^k \bar{V}$ and $\beta^{k-1}\bar{V}$ where $\bar{V}$ depends on the case as before. Note that $V_{\min}$ is positive since $b_k > 0$. At this point, the firm gets the largest profits.

The Pareto optimal path for an initial $V_{\min}$ looks as follows: at the first $k-1$ periods where a high price is realized (low-price periods are not taken into account since the investment stays constant and $T_0 = 0$), $T_1 = 0$ and the investment increases exponentially at the rate $\frac{1}{\beta^2}$. Then the k-th high-price period follows. Case 1.1 has the same pattern as in previous $k-1$ periods, while in Case 1.2 the investment may grow at a decreased rate and some positive taxes may occur. Finally, from period $k+1$ the investment stabilizes at its maximal, first-best optimal level $I = 1$ and remains constant forever. The taxes T_1 are defined by (7) in all possible segments. It is zero up until the equilibrium path reaches the first best segment. Once the first best is reached, the evolution of T is not uniquely defined; since the (9) constraint no longer binds, today's T can be traded against tomorrow's value of V_1 as illustrated by equation (7). As a result, there are many possible paths for T_1.

Proof of Lemma 1 For expositional clarity, we limit the analysis of this section and of Proof of Proposition 2 to Case 1.1. Most of the results of this section extend to Case 1.2 and the proofs are available on request. The only result that we could not establish for case 1.2 so far is the existence of an equilibrium with more backloading of taxes under weaker institutions.

In this Lemma, we want to establish that k, the number periods with a high price realization needed to reach the first best part of Pareto frontier, is decreasing in C. The value of k is determined by the inequalities

$$\beta^k \le \frac{V_{\min}}{\tilde{V}} < \beta^{k-1}. \tag{33}$$

Remember that $V_{\min}$ is in (32), with a_k and b_k given by (30) and with a and b given by (22). As follows from these formulas, $V_{\min}$ is given by

$$V_{\min} = \frac{2(k-1+C)(1-C)(1-\beta^2)}{\beta(\beta^{-k}-1)} \text{ if } C_k \le C \le C_{k-1} \tag{34}$$

where

$$C_k = \sum_{i=0}^{k} \beta^i - k = \frac{1-\beta^{k+1}}{1-\beta} - k. \tag{35}$$

Here $[C_k, C_{k-1}]$ is the segment of C values satisfying $\beta^k \tilde{V} \le V_{\min} \le \beta^{k-1}\tilde{V}$.

Using (34)–(35), we obtain

$$\frac{V_{\min}}{\tilde{V}} = -\frac{(2-\delta)b_k}{8(1-C)a_k} = \frac{\beta^{-1}-1}{\beta^{-k}-1}(C+k-1) \tag{36}$$

We need to show that k as determined by conditions (33) and (36)

$$\beta^k \leq \frac{\beta^{-1}-1}{\beta^{-k}-1}(C+k-1) < \beta^{k-1} \tag{37}$$

is decreasing in C.

Consider an auxiliary implicit equation defining a continuous variable $x \geq 0$ as a function of $C \in [0,1]$

$$\frac{\beta^{-1}-1}{\beta^{-x}-1}(C+x-1) - \beta^x = 0. \tag{38}$$

Note that this equation is a continuous version of the condition (37) which (step-wise) defines a natural number k as a function of C. Thus, if we can show that x is decreasing in C in equation (38), k is decreasing in C. Equation (37) can be rewritten as

$$\beta^x(\frac{\beta^{-1}-1}{1-\beta^x}(C+x-1) - 1) = 0. \tag{39}$$

Define

$$F(C,x) \equiv \frac{\beta^{-1}-1}{1-\beta^x}(C+x-1),$$

then equation (38) is equivalent to

$$F(C,x) - 1 = 0. \tag{40}$$

Taking full derivative of this equation we get

$$\frac{dx}{dC} = -\frac{F_C(C,x)}{F_x(C,x)}$$

Partial derivatives of its LHS with respect to C and x are positive

$$F_C(C,x) = \partial\frac{\frac{\beta^{-1}-1}{1-\beta^x}(C+x-1)-1}{\partial C} = \frac{\beta^{-1}-1}{1-\beta^x} > 0$$

$$\begin{aligned}
F_x(C,x) &= \partial\frac{\frac{\beta^{-1}-1}{1-\beta^x}(C+x-1)-1}{\partial x} \\
&= \frac{\beta^{-1}-1}{(\beta^x-1)^2}\left(C\beta^x\ln\beta - \beta^x\ln\beta - \beta^x + x\beta^x\ln\beta + 1\right) \\
&\geq \frac{\beta^{-1}-1}{(\beta^x-1)^2}\left(\beta^x\ln\beta - \beta^x\ln\beta - \beta^x + x\beta^x\ln\beta + 1\right) \\
&= \frac{\beta^{-1}-1}{(\beta^x-1)^2}\left(1 - \beta^x(1-\ln\beta^x)\right) \geq 0
\end{aligned}$$

as $\beta < 1$ and, thus, the maximum of the expression $\beta^x(1-\ln\beta^x)$ is achieved at $\beta^x = 1$ and is equal to 1. As a result, x is a decreasing function of C as defined by implicit equation (38), which completes the proof.

Proof of Proposition 2

Recall the definition of the cumulative share of investment/production/taxes after n high-price periods as:

$$CS_n^I = \frac{\sum_{p=1}^{n} X_p}{\sum_{p=1}^{P} X_p} \tag{41}$$

where $n \in \{1, \ldots, P\}$, P is exogenously given, and X may stand for investment I, production $r(I)$, or taxes T. The proof of this proposition is composed by three Lemmas.

Lemma 2. *Cumulative share of investment CS_n^I is increasing in C for any fixed n, P, and δ.*

Proof. Firstly note that if both, the self-enforcing constraint (9) and the feasibility constraint (10), bind then the level of investment I is given by (23): $I = \left(V/\tilde{V}\right)^2$. This means that for all $V \in [0, V^{\#}]$

$$I = \min\left\{\left(V/\tilde{V}\right)^2, 1\right\}. \tag{42}$$

Consider the evolution of V starting from $V = V_{\min}$ where $V_{\min}$ is given by (32). If $p \leq k$ then the value of I is given by

$$I_p = \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2. \tag{43}$$

Hence the cumulative share of investment CS_n^I defined by (41) is given by

$$CS_n^I = \frac{e\left(V_{\min}/\tilde{V}\right)^2 + f}{\sum_{p=1}^{k} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + P - k} \tag{44}$$

where

$$\begin{cases} e = \sum_{p=1}^{n} \beta^{-2(p-1)}, \ f = 0, & \text{if } n \leq k, \\ e = \sum_{p=1}^{k} \beta^{-2(p-1)}, \ f = n - k, & \text{if } n > k. \end{cases}$$

In both ranges of n,

$$e(P - k) > f \sum_{p=1}^{k} \beta^{-2(p-1)}$$

for all $n = 1, \ldots, P - 1$, so CS_n^I is increasing in $V_{\min}/\tilde{V}$. □

Let's now prove that $V_{\min}/\tilde{V}$ is increasing in C. Recall from the proof of

Lemma 1 that

$$\frac{V_{\min}}{\tilde{V}} = -\frac{(2-\delta)b_k}{8(1-C)a_k} = \frac{\beta^{-1}-1}{\beta^{-k}-1}(C+k-1) \text{ if } C_k \le C \le C_{k-1} \quad (45)$$

where

$$C_k = \sum_{i=0}^{k} \beta^i - k = \frac{1-\beta^{k+1}}{1-\beta} - k. \quad (46)$$

Here $[C_k, C_{k-1}]$ is the segment of C values satisfying $\beta^k \tilde{V} \le V_{\min} \le \beta^{k-1}\tilde{V}$. Note that $V_{\min}$ is continuous in C on each such segment.

From this expression it is easy to see that $V_{\min}/\tilde{V}$ is increasing in C for any particular k (or, equivalently, on each segment $[C_k, C_{k-1}]$). We are left to establish that $V_{\min}/\tilde{V}$ is continuous in C also at C_k for each k. As a result we would obtain that $V_{\min}/\tilde{V}$ is increasing in C, and, consequently, CS_n^I is increasing in C.

Let's show that both the numerator and denominator of CS_n^I are continuous at the threshold C_k for any k. Start with the denominator, and show that the difference between the values of it to the left and to the right of C_k is zero

$$\begin{aligned}
&\left(\sum_{p=1}^{k+1} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + P - k - 1\right) - \left(\sum_{p=1}^{k} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + P - k\right) \\
= \; & \beta^{-2k} \left(V_{\min}/\tilde{V}\right)^2 - 1 = \beta^{-2k} \left(\frac{\beta^{-1}-1}{\beta^{-k}-1}(C_k + k - 1)\right)^2 - 1 \\
= \; & \beta^{-2k} \left(\frac{\beta^{-1}-1}{\beta^{-k}-1}\left(\frac{1-\beta^{k+1}}{1-\beta} - 1\right)\right)^2 - 1 = 0
\end{aligned}$$

Now turn to the numerator. If $n < k$, the difference between the values of the numerator to the left and to the right of C_k is trivially zero. If $n \ge k$, this difference is

$$\begin{aligned}
&\left(\sum_{p=1}^{k+1} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + n - k - 1\right) - \left(\sum_{p=1}^{k} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + n - k\right) \\
= \; & \beta^{-2k} \left(V_{\min}/\tilde{V}\right)^2 - 1 = 0
\end{aligned}$$

by the proof above. Thus we have proven that CS_n^I is continuous at C_k for any k, and that CS_n^I is increasing in C.

Lemma 3. *Cumulative share of production CS_n^r is increasing in C for any fixed n, P, and δ.*

Proof. The proof that CS_n^r is increasing in C for any fixed n, P, and δ closely parallels the one for the investment. Indeed, it is enough to note that $r(I,1) = 4\sqrt{I}$, and $r(I,0) = 0$. As a result, the cumulative share of production CS_n^r is given by

$$CS_n^r = \frac{\sum_{p=1}^{n} r_p}{\sum_{p=1}^{P} r_p} = \frac{\sum_{p=1}^{n} 4\sqrt{I_p}}{\sum_{p=1}^{P} 4\sqrt{I_p}} = \frac{\widetilde{e}\left(V_{\min}/\tilde{V}\right) + f}{\sum_{p=1}^{k} \beta^{-(p-1)}\left(V_{\min}/\tilde{V}\right) + P - k} \tag{47}$$

where

$$\begin{cases} \widetilde{e} = \sum_{p=1}^{n} \beta^{-(p-1)}, \ f = 0, & \text{if } n \leq k, \\ \widetilde{e} = \sum_{p=1}^{k} \beta^{-(p-1)}, \ f = n - k, & \text{if } n > k. \end{cases}$$

Just as above, $\widetilde{e}\,(P-k) > f \sum_{p=1}^{k} \beta^{-(p-1)}$ for all $n = 1, \ldots, P-1$, so CS_n^r is increasing in $V_{\min}/\tilde{V}$ for any k, and we have proven above that $V_{\min}/\tilde{V}$ is increasing in C.

We need to prove the continuity of CS_n^r in C. We show that both the numerator and denominator of CS_n^r are continuous at the threshold C_k for any k. We start with the denominator, and show that the difference between the values of it to the left and to the right of C_k is zero

$$\begin{aligned} &\left(\sum_{p=1}^{k+1} \beta^{-(p-1)}\left(V_{\min}/\tilde{V}\right) + P - k - 1\right) - \left(\sum_{p=1}^{k} \beta^{-(p-1)}\left(V_{\min}/\tilde{V}\right) + P - k\right) \\ = \ & \beta^{-k}\left(V_{\min}/\tilde{V}\right) - 1 = \beta^{-k}\left(\frac{\beta^{-1}-1}{\beta^{-k}-1}(C_k + k - 1)\right) - 1 = 0 \end{aligned}$$

The result for the numerator follows in the similar fashion. Thus we have proven that CS_n^r is continuous at C_k for any k, and that CS_n^r is increasing in C.

□

Lemma 4. *(a) The number of periods with zero taxes is decreasing in C.*

(b) Cumulative share of Taxes CS_n^T may be increasing in C for any fixed n, P, and δ.

Proof. Result (a) follows from the proof of Lemma 1. Let us establish result (b). As discussed earlier, unlike investment or production, the tax schedule may depend on the choice among multiple solutions in the first-best segment. To be specific, let us consider the equilibrium that originates at $V_{\min}$, reaches efficient frontier at $\tilde{V}$, then proceeds to $\tilde{V}/\beta$ and stays there stationary.[35]

[35] Two comments are necessary concerning this equilibrium construction. First, notice that a stationary equilibrium satisfying (SE) constraint implies

$$\delta V - (1-C)\,(4 - 2V + 2\delta V) \geq 0$$

or equivalently

$$V \geq \frac{4(1-C)}{2 - \delta - 2C(1-\delta)}.$$

Then T_p is zero in periods $p \leq k+1$, and for $p > k+1$ it is given by

$$T_k = 2(1-\delta)\frac{\tilde{V}}{\beta}.$$

As a result, $CS_n^T = 0$ if $n \leq k+1$, while for $n > k+1$ it is given by

$$CS_n^{GT} = \frac{(n-k+1)2(1-\delta)\frac{\tilde{V}}{\beta}}{(P-k+1)2(1-\delta)\frac{\tilde{V}}{\beta}} \tag{50}$$

$$= 1 - \frac{(P-n)}{(P-k+1)} \tag{51}$$

Since k is decreasing in C by result in (a), CS_n^T is increasing in C which completes the proof.[36] □

Proof of Proposition 3 To prove this result, it is sufficient to note that after the period efficient frontier is reached the cumulative share of investment/production is increasing by the same amount each period, and this incremental increase is decreasing in the institutional quality. For example, for investment

$$\Delta CS_n^I = CS_{n+1}^I - CS_n^I = \frac{1}{\sum_{p=1}^{k} \beta^{-2(p-1)} \left(V_{\min}/\tilde{V}\right)^2 + P - k}$$

for any n such that $k \leq n < P$. We have shown in the proof of Lemma 2 that the denominator of this expression is increasing in C, so the expression is decreasing in C. Now, consider two levels of institutions, $C_{weak} < C_{strong}$. By Lemma 1 from period $\kappa = k_{weak}$ investment is efficient for either institutional level. Then for any $n \geq \kappa$, the incremental increase in the cumulative share of investment for C_{weak} will be higher than for C_{strong}. This means, that the cumulative share of investment under weak institutions is catching up with the one under strong institutions, or equivalently, that investment backloading decreases over time. The proof for production is fully analogous.

This implies that in presence of imperfect enforcement $C > 0$ a stationary equilibrium is impossible at $\tilde{V} = \frac{4(1-C)}{2-\delta}$, but can take place at $\tilde{V}/\beta$.

Second, the individual rationality constraint for the firm (IR) is satisfied at the constructed equilibrium, as $\frac{\tilde{V}}{\beta} \leq V^{\#}$. Indeed

$$\frac{\tilde{V}}{\beta} - V^{\#} = \frac{4(1-C)}{\delta} - \frac{1}{1-\delta} \tag{48}$$

$$= \frac{4(1-C) - \delta(5-C)}{\delta(1-\delta)} \leq 0 \tag{49}$$

where the last inequality follows from the parameter restrictions for Case 1.1. That is, this equilibrium is indeed feasible.

[36] Note that this result may depend on equilibrium selection. For example, it can be shown that the reverse is true in an equilibrium that originates at $V_{\min}$, reaches efficient frontier at $\tilde{V}$, then proceeds so that $V_1 = V/\beta$ and $V_0 = V$ until it reaches (and stabilizes at) $V^{\#}$, the allocation that yields zero payoff to the firm.

B. DATA DESCRIPTION

In this Appendix, we provide a detailed description of the variables used in the empirical analysis:

YEAR OF AWARD AND START OF PRODUCTION: Years in which the exploration license is granted and production starts, respectively. A field discovery takes place after the award of a license and it is followed by the development of the field and production.

OWNERSHIP: All the fields in our sample are at least partially owned by at least one major (BP, Chevron, ConocoPhilips, Eni, ExxonMobile, Shell, Total). For almost all of our fields, a major is also the company that started production. We exclude the fields which were not discovered and initially operated by majors.

PHYSICAL PRODUCTION AND REVENUES: For each field, we observe yearly physical production, revenues and profits. Production is given in thousands of barrels for liquids, or barrels of oil equivalent for gas, per day. Revenue is the physical amount produced on the field level multiplied by the price for which the hydrocarbon is sold. Note that prices can vary due to the heterogeneity in the type as well as the quality of the hydrocarbon which is extracted. Thus, equality in the amounts produced, does not imply equality in generated revenues. Revenues are documented in millions current USD. To make them comparable across time, we use the US CPI and transform the nominal values into real 2018 USD. If the field is jointly operated by several companies, we observe their levels of production, revenues and profits from this field separately.

OPERATIONAL AND CAPITAL EXPENDITURE: On the field level we observe well CAPEX (CAPital EXpenditure), which is defined as capitalized costs related to well construction, including drilling costs, rig lease, well completion, well stimulation, steel costs and the purchase of a variety of necessary materials. We also observe OPEX (OPerational EXpenditure), which contains costs related to materials, tools, maintenance, equipment leases as well as salaries. Both are denominated in millions real 2018 US dollars.

TAX PAYMENTS (GOVERNMENT TAKE): Using the available information on tax payments under a variety of fiscal regimes in every point in time, we construct the tax payment variable. It consists of all cash flows destined to the authorities and land owners, including royalties, government profit oil (PSA equivalent to petroleum taxes), export duties, bonuses, income taxes and profit taxes. In practice, the total amount and the structure of payments received by the government in the framework of an agreement are typically referred to as a fiscal regime. See the Global oil & gas Tax Guide 2021 for examples. It is denominated in millions of real 2018 US dollars.

FISCAL REGIME: There are three different types of ownership. Concession: the firm is granted 100% ownership of the product extracted; Service Contract: the firm is granted 0% ownership; Production Sharing Agreement: the firm is granted between 0% and 100% ownership. Such agreements imply that at least a share of the produced fossil fuel is owned by the government of the country in which the firm is operating. In general, fiscal regimes and the exact share of the revenues and profits received by both parties vary greatly across and within countries, and depend on a country's petroleum laws and regulations as well as the geological features of the fields.

RESERVES, TYPES, LOCATION AND CLIMATE: Reserves are defined in the data as the remaining economically recoverable physical quantities of fossil fuels. We use reserves at the beginning of field's production as a measure for field size. We also have information on the type of hydrocarbon (oil or gas,) as well as the exact location of the field and the climatic conditions in which the field is located.

EXECUTIVE CONSTRAINTS: We use country level annual information on the executive constraints (XCONST) from Polity IV. We consider a country to have strong institutions if the median score from 1950 to 1975 was 6 or 7, while countries that had a median score of 5 or less are defined as countries with weak institutions.[37] Choosing the cut-off between 5 and 6 implies that roughly one third of the countries, or 17 out of 49, are defined as having strong institutions and around 43% of all the fields which started production between 1960 and 2000 are located in countries with weak institutions.

C. ADDITIONAL RESULTS AND ROBUSTNESS

C.1 SUBSIDIES IN THE OIL & GAS INDUSTRY

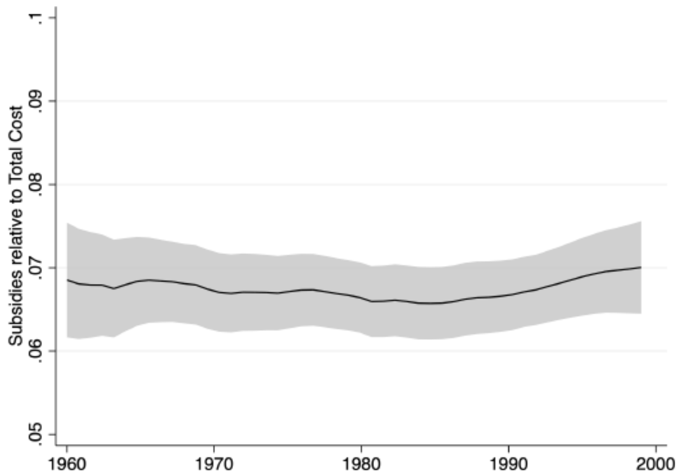
In Table C.1, we show the average share of subsidies over total production cost since 1960. We focus on the *upfront* subsidies that are made within the first seven years of production. It is apparent from Figure C.1 that the share of upfront subsidies in the total cost of production has been relatively small (below 10%) in the oil & gas industry throughout our sample period.

C.2 ROBUSTNESS OF MEASURES

In Table 3 and Table 4 we document the results for the estimates of β in specification 3, while allowing for different choices of the cumulative threshold (50% and 75%, instead of 66%), different truncation of the fields' lifetimes (truncating the lifetime at 25 and 30 years, instead of 35 years) and an alternative institutional quality measure (OECD membership, instead of Polity IV). In Table 3, all results are reported conditional on our standard set of controls, as employed in the even columns of Table 2. In Table 4, we present the results which are only conditional on the Start-up year and the lifetime of the field, as in the uneven columns of of Table 2. In the individual Panels of both Tables, we report the results for our five measures: Taxes or Government Take without subsidies (Panel A), Royalties and Profit Taxes (Panel B), physical Production (Panle C), Capital Expenditure or CAPEX (Panel D) and Operational Expenditure or OPEX (Panel E). In the

[37] A few remarks are in order. The countries which have a median score of 6 or 7 consist of countries which joined the OECD by the early 1970s, as well as Bangladesh, Brunei, Colombia, Malaysia, and Trinidad and Tobago. Surprisingly, France is below this threshold which we attribute to the extraordinary power Charles de Gaulle received during his presidency. But since only 12 fields are operated by the majors in France during our sample period, adding France to either of the groups barely affects the results. Since Brunei remained part of the UK until 1984 and since it is completely surrounded by Malaysia, we classify Brunei as a country with strong institutions. In our baseline specification all the remaining countries are classified as having weak institutions. But note that for some countries only a few observations are used to determine the median score, since they became independent after 1960 with the number in parentheses indicating the exact year: Angola (1975), Bangladesh (1971), Papua New Guinea (1975), Qatar (1971), UAE (1971). We also use the median score of the USSR for all the former Soviet Union countries as well as the median score of Yugoslavia for all the former Yugoslavian countries. And we use the score of West Germany for Germany, while we use the median score of North and South Yemen (which are the same) for Yemen. Finally, some of the wells are jointly managed by several countries. We drop the 284 observations assigned to such wells. To the best of our knowledge, none of these choices significantly impacts our results.

Figure C.1: SHARE OF SUBSIDES IN TOTAL COSTS



Note: We use the Epanechnikov kernel with a bandwidth of 1.

top row of every Panel we rely on our preferred institutional measure, which we take from Polity IV, while in the bottom row of every Panel we rely on the OECD dummy to differentiate between countries with weak and strong institutions. The OECD dummy defines countries as being governed by strong institutions if the country became part of the OECD by the early 1970s. In column 6 of the top row of every Panel we reproduce the results from Table 2, relative to which the other measures can be compared. The different choices with regards to the different truncation of the fields' lifetimes as well as the different cumulative thresholds to be reached are indicated above the individual estimates. The percentages in brackets indicate the cumulative threshold to be reached and the numbers preceding the letter Y(ears) indicate the years at which the lifetime of the fields is truncated. The results suggest that our estimates of β for our preferred outcome variables on taxation and production are particularly robust to the different choices.

C.3 RENEGOTIATION OF CONTRACTS

In Figure 6 we document a 5 years delay in reaching 66% of cumulative production in fields which start production in countries with weak institutions after 1967. To better grasp the contract dynamics and understand the parties' abilities to renegotiate contracts we unwrap our cumulative share measure by plotting the cumulative production shares against the period of production in Figure C.2. Just like in Figure 6, the number of periods since the start of production is depicted on the x-axis. On the y-axis we plot the cumulative production shares and the 66% threshold is indicated by the red horizontal line. Unlike the presentation of results in Figure 6, we split the sample into distinct time intervals.

In the top row of Figure C.2 we do not see a statistically significant difference in the accumulation of production shares and both groups of countries reach the 66% threshold equally fast. The absence of changes in the production dynamics during and after the transition to a new world oil order is consistent with the idea that ex-post adjustments to these relationships are difficult after the start of

TABLE 3
ROBUSTNESS WITH CONTROLS

Panel A: Taxes (Government Take without Subsidies)

	(1) GT 25Y (50%)	(2) GT 30Y (50%)	(3) GT 35Y (50%)	(4) GT 30Y (66%)	(5) GT 30Y (66%)	(6) GT 35Y (66%)	(7) GT 30Y (75%)	(8) GT 30Y (75%)	(9) GT 35Y (75%)
Weak (Polity IV)	0.745**	1.300***	1.695***	0.885**	1.437***	1.725**	0.954*	1.433**	1.609**
	(0.322)	(0.379)	(0.527)	(0.402)	(0.501)	(0.677)	(0.477)	(0.600)	(0.741)
N	2600	2613	2616	2600	2613	2616	2600	2613	2616
R-sq	0.25	0.26	0.28	0.27	0.29	0.33	0.28	0.31	0.36

	(1) GT 25Y (50%)	(2) GT 30Y (50%)	(3) GT 35Y (50%)	(4) GT 30Y (66%)	(5) GT 30Y (66%)	(6) GT 35Y (66%)	(7) GT 30Y (75%)	(8) GT 30Y (75%)	(9) GT 35Y (75%)
Weak (OECD)	0.912***	1.694***	2.131***	1.142***	1.911***	2.232**	1.233**	1.892**	2.092**
	(0.239)	(0.445)	(0.677)	(0.356)	(0.580)	(0.803)	(0.456)	(0.691)	(0.870)
N	2600	2613	2616	2600	2613	2616	2600	2613	2616
R-sq	0.25	0.26	0.28	0.27	0.29	0.33	0.28	0.32	0.37

Panel B: Royalties and Profit Taxes

	(1) R&P 25Y (50%)	(2) R&P 30Y (50%)	(3) R&P 35Y (50%)	(4) R&P 25Y (66%)	(5) R&P 30Y (66%)	(6) R&P 35Y (66%)	(7) R&P 25Y (75%)	(8) R&P 30Y (75%)	(9) R&P 35Y (75%)
Weak (Polity IV)	0.555	1.073**	1.483**	0.849	1.330**	1.892**	0.896	1.460**	1.860**
	(0.446)	(0.482)	(0.643)	(0.529)	(0.598)	(0.834)	(0.542)	(0.670)	(0.864)
N	2028	2041	2042	2028	2041	2042	2028	2041	2042
R-sq	0.24	0.25	0.27	0.26	0.28	0.32	0.25	0.30	0.35

	(1) R&P 25Y (50%)	(2) R&P 30Y (50%)	(3) R&P 35Y (50%)	(4) R&P 25Y (66%)	(5) R&P 30Y (66%)	(6) R&P 35Y (66%)	(7) R&P 25Y (75%)	(8) R&P 30Y (75%)	(9) R&P 35Y (75%)
Weak (OECD)	0.758	1.489**	2.020**	1.090*	1.816**	2.495**	1.190*	1.942**	2.470**
	(0.518)	(0.653)	(0.929)	(0.604)	(0.801)	(1.110)	(0.623)	(0.874)	(1.145)
N	2028	2041	2042	2028	2041	2042	2028	2041	2042
R-sq	0.24	0.25	0.27	0.26	0.28	0.32	0.26	0.30	0.35

Panel C: Production (Physical)

	(1) Prod 25Y (50%)	(2) Prod 30Y (50%)	(3) Prod 35Y (50%)	(4) Prod 25Y (66%)	(5) Prod 30Y (66%)	(6) Prod 35Y (66%)	(7) Prod 25Y (75%)	(8) Prod 30Y (75%)	(9) Prod 35Y (75%)
Weak (Polity IV)	1.090***	1.767***	1.997***	1.228***	1.801***	2.071***	1.090***	1.658***	1.885***
	(0.353)	(0.410)	(0.480)	(0.387)	(0.426)	(0.504)	(0.372)	(0.431)	(0.493)
N	2600	2615	2616	2600	2615	2616	2600	2615	2616
R-sq	0.24	0.30	0.33	0.25	0.32	0.37	0.27	0.35	0.40

	(1) Prod 25Y (50%)	(2) Prod 30Y (50%)	(3) Prod 35Y (50%)	(4) Prod 25Y (66%)	(5) Prod 30Y (66%)	(6) Prod 35Y (66%)	(7) Prod 25Y (75%)	(8) Prod 30Y (75%)	(9) Prod 35Y (75%)
Weak (OECD)	1.231***	2.023***	2.225***	1.344***	2.072***	2.326***	1.194***	1.905***	2.086***
	(0.356)	(0.543)	(0.623)	(0.378)	(0.487)	(0.588)	(0.359)	(0.504)	(0.576)
N	2600	2615	2616	2600	2615	2616	2600	2615	2616
R-sq	0.24	0.30	0.33	0.25	0.33	0.37	0.27	0.35	0.40

Panel D: Investment (CAPEX)

	(1) CAPEX 25Y (50%)	(2) CAPEX 30Y (50%)	(3) CAPEX 35Y (50%)	(4) CAPEX 25Y (66%)	(5) CAPEX 30Y (66%)	(6) CAPEX 35Y (66%)	(7) CAPEX 25Y (75%)	(8) CAPEX 30Y (75%)	(9) CAPEX 35Y (75%)
Weak (Polity IV)	0.881	0.570	1.535*	0.805	0.844	1.977**	0.771	0.992	1.997*
	(0.752)	(0.760)	(0.810)	(0.712)	(0.654)	(0.891)	(0.739)	(0.868)	(0.992)
N	1445	1453	1461	1445	1453	1461	1445	1453	1461
R-sq	0.49	0.48	0.49	0.48	0.47	0.49	0.46	0.44	0.46

	(1) CAPEX 25Y (50%)	(2) CAPEX 30Y (50%)	(3) CAPEX 35Y (50%)	(4) CAPEX 25Y (66%)	(5) CAPEX 30Y (66%)	(6) CAPEX 35Y (66%)	(7) CAPEX 25Y (75%)	(8) CAPEX 30Y (75%)	(9) CAPEX 35Y (75%)
Weak (OECD)	0.351	0.482	1.336	-0.025	0.462	1.412	0.063	0.325	1.129
	(0.866)	(0.951)	(1.105)	(0.841)	(0.891)	(1.200)	(0.841)	(1.011)	(1.214)
N	1445	1453	1461	1445	1453	1461	1445	1453	1461
R-sq	0.49	0.47	0.49	0.48	0.47	0.49	0.45	0.44	0.46

Panel E: Investment (OPEX)

	(1) OPEX 25Y (50%)	(2) OPEX 30Y (50%)	(3) OPEX 35Y (50%)	(4) OPEX 25Y (66%)	(5) OPEX 30Y (66%)	(6) OPEX 35Y (66%)	(7) OPEX 25Y (75%)	(8) OPEX 30Y (75%)	(9) OPEX 35Y (75%)
Weak (Polity IV)	0.036	0.705	1.049	0.189	0.913*	1.244*	0.341	0.921*	1.144
	(0.481)	(0.503)	(0.633)	(0.436)	(0.479)	(0.705)	(0.396)	(0.487)	(0.686)
N	2600	2615	2616	2600	2615	2616	2600	2615	2616
R-sq	0.18	0.19	0.21	0.20	0.23	0.27	0.21	0.25	0.31

	(1) OPEX 25Y (50%)	(2) OPEX 30Y (50%)	(3) OPEX 35Y (50%)	(4) OPEX 25Y (66%)	(5) OPEX 30Y (66%)	(6) OPEX 35Y (66%)	(7) OPEX 25Y (75%)	(8) OPEX 30Y (75%)	(9) OPEX 35Y (75%)
Weak (OECD)	-0.150	0.562	1.008	0.020	0.851	1.281	0.233	0.969	1.283
	(0.492)	(0.594)	(0.777)	(0.463)	(0.620)	(0.874)	(0.462)	(0.650)	(0.875)
N	2600	2615	2616	2600	2615	2616	2600	2615	2616
R-sq	0.18	0.19	0.21	0.20	0.23	0.27	0.21	0.25	0.31

Notes: Notes: Left hand side variable is capturing the number of years until 50%, 66% or 75% of the cumulative level of OPEX, Well CAPEX , production and tax payments after 25, 30 or 35 years is reached. The fulls set of controls is included in all regressions, identical to the results presented in the even columns of Table 2. Our baseline dummy $Weak_c(a)$ differentiates between countries with strong and weak institutions. SE in parenthesis is clustered by country and Start Up Year as well as the lifetime of the field. * stands for statistical significance at the 10% level, ** at the 5% level and *** at the 1% percent level.

TABLE 4
ROBUSTNESS WITHOUT CONTROLS

Panel A: Taxes (Government Take without Subsidies)

	(1) GT 25Y (50%)	(2) GT 30Y (50%)	(3) GT 35Y (50%)	(4) GT 30Y (66%)	(5) GT 30Y (66%)	(6) GT 35Y (66%)	(7) GT 30Y (75%)	(8) GT 30Y (75%)	(9) GT 35Y (75%)
Weak (Polity IV)	0.579	0.834	1.180*	0.726*	1.047*	1.341**	0.874**	1.178**	1.384**
	(0.410)	(0.532)	(0.635)	(0.407)	(0.527)	(0.625)	(0.411)	(0.518)	(0.592)
N	2604	2617	2620	2604	2617	2620	2604	2617	2620
R-sq	0.17	0.18	0.20	0.20	0.23	0.27	0.21	0.26	0.31

	(1) GT 25Y (50%)	(2) GT 30Y (50%)	(3) GT 35Y (50%)	(4) GT 30Y (66%)	(5) GT 30Y (66%)	(6) GT 35Y (66%)	(7) GT 30Y (75%)	(8) GT 30Y (75%)	(9) GT 35Y (75%)
Weak (OECD)	0.597	0.874	1.207*	0.789*	1.121**	1.414**	0.934**	1.258**	1.464**
	(0.408)	(0.517)	(0.621)	(0.401)	(0.516)	(0.617)	(0.396)	(0.509)	(0.581)
N	2604	2617	2620	2604	2617	2620	2604	2617	2620
R-sq	0.17	0.18	0.20	0.20	0.23	0.27	0.22	0.26	0.32

Panel B: Royalties and Profit Taxes

	(1) R&P 25Y (50%)	(2) R&P 30Y (50%)	(3) R&P 35Y (50%)	(4) R&P 25Y (66%)	(5) R&P 30Y (66%)	(6) R&P 35Y (66%)	(7) R&P 25Y (75%)	(8) R&P 30Y (75%)	(9) R&P 35Y (75%)
Weak (Polity IV)	0.359	0.639	1.112	0.691	1.018	1.577*	0.841	1.241	1.752*
	(0.567)	(0.721)	(0.862)	(0.597)	(0.733)	(0.890)	(0.588)	(0.737)	(0.872)
N	2032	2045	2046	2032	2045	2046	2032	2045	2046
R-sq	0.15	0.16	0.18	0.18	0.21	0.25	0.19	0.24	0.29

	(1) R&P 25Y (50%)	(2) R&P 30Y (50%)	(3) R&P 35Y (50%)	(4) R&P 25Y (66%)	(5) R&P 30Y (66%)	(6) R&P 35Y (66%)	(7) R&P 25Y (75%)	(8) R&P 30Y (75%)	(9) R&P 35Y (75%)
Weak (OECD)	0.478	0.775	1.265	0.817	1.176	1.733*	0.985	1.403*	1.937**
	(0.580)	(0.733)	(0.872)	(0.600)	(0.737)	(0.898)	(0.581)	(0.742)	(0.887)
N	2032	2045	2046	2032	2045	2046	2032	2045	2046
R-sq	0.15	0.16	0.18	0.18	0.21	0.25	0.19	0.24	0.30

Panel C: Production (Physical)

	(1) Prod 25Y (50%)	(2) Prod 30Y (50%)	(3) Prod 35Y (50%)	(4) Prod 25Y (66%)	(5) Prod 30Y (66%)	(6) Prod 35Y (66%)	(7) Prod 25Y (75%)	(8) Prod 30Y (75%)	(9) Prod 35Y (75%)
Weak (Polity IV)	0.645	0.951*	1.162*	1.025**	1.290**	1.528**	1.066**	1.346**	1.598***
	(0.422)	(0.535)	(0.600)	(0.449)	(0.523)	(0.592)	(0.423)	(0.513)	(0.572)
N	2604	2619	2620	2604	2619	2620	2604	2619	2620
R-sq	0.15	0.22	0.25	0.18	0.25	0.30	0.19	0.28	0.33

	(1) Prod 25Y (50%)	(2) Prod 30Y (50%)	(3) Prod 35Y (50%)	(4) Prod 25Y (66%)	(5) Prod 30Y (66%)	(6) Prod 35Y (66%)	(7) Prod 25Y (75%)	(8) Prod 30Y (75%)	(9) Prod 35Y (75%)
Weak (OECD)	0.659	0.959*	1.150*	1.038**	1.314**	1.530**	1.088**	1.375**	1.606***
	(0.416)	(0.525)	(0.581)	(0.437)	(0.509)	(0.569)	(0.412)	(0.502)	(0.552)
N	2604	2619	2620	2604	2619	2620	2604	2619	2620
R-sq	0.15	0.22	0.25	0.18	0.26	0.30	0.19	0.28	0.34

Panel D: Investment (CAPEX)

	(1) CAPEX 25Y (50%)	(2) CAPEX 30Y (50%)	(3) CAPEX 35Y (50%)	(4) CAPEX 25Y (66%)	(5) CAPEX 30Y (66%)	(6) CAPEX 35Y (66%)	(7) CAPEX 25Y (75%)	(8) CAPEX 30Y (75%)	(9) CAPEX 35Y (75%)
Weak (Polity IV)	2.654**	2.875*	3.952**	2.558*	3.198**	4.418**	2.655*	3.379**	4.394**
	(1.272)	(1.462)	(1.685)	(1.414)	(1.548)	(1.825)	(1.398)	(1.524)	(1.778)
N	1447	1455	1463	1447	1455	1463	1447	1455	1463
R-sq	0.16	0.12	0.15	0.14	0.13	0.19	0.12	0.13	0.19

	(1) CAPEX 25Y (50%)	(2) CAPEX 30Y (50%)	(3) CAPEX 35Y (50%)	(4) CAPEX 25Y (66%)	(5) CAPEX 30Y (66%)	(6) CAPEX 35Y (66%)	(7) CAPEX 25Y (75%)	(8) CAPEX 30Y (75%)	(9) CAPEX 35Y (75%)
Weak (OECD)	1.918	2.175	3.083*	1.663	2.333	3.388*	1.763	2.413	3.298*
	(1.318)	(1.518)	(1.773)	(1.477)	(1.619)	(1.909)	(1.452)	(1.600)	(1.864)
N	1447	1455	1463	1447	1455	1463	1447	1455	1463
R-sq	0.14	0.11	0.14	0.12	0.11	0.17	0.10	0.11	0.17

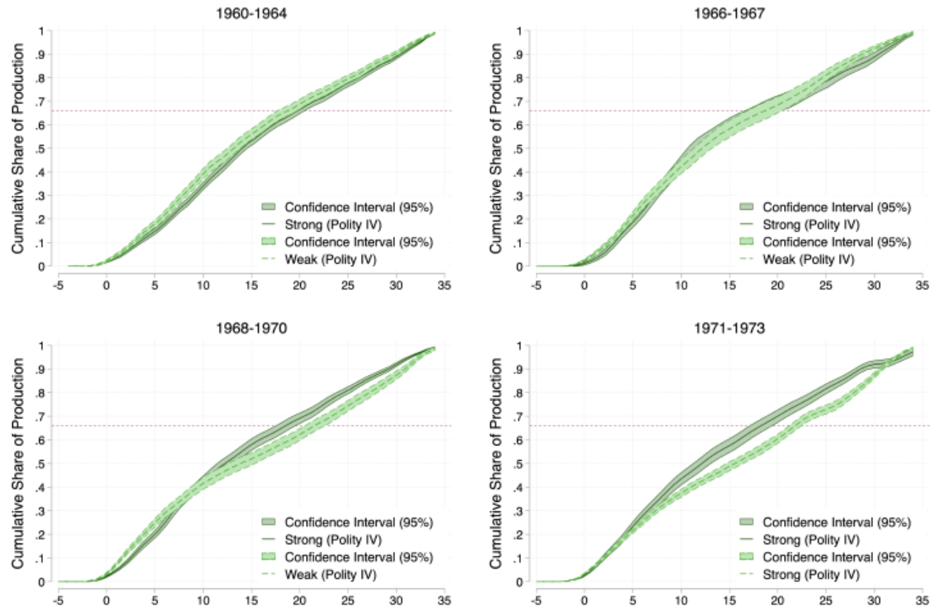
Panel E: Investment (OPEX)

	(1) OPEX 25Y (50%)	(2) OPEX 30Y (50%)	(3) OPEX 35Y (50%)	(4) OPEX 25Y (66%)	(5) OPEX 30Y (66%)	(6) OPEX 35Y (66%)	(7) OPEX 25Y (75%)	(8) OPEX 30Y (75%)	(9) OPEX 35Y (75%)
Weak (Polity IV)	0.473	0.918	1.228	0.729	1.140	1.505*	0.863	1.285*	1.577*
	(0.521)	(0.666)	(0.762)	(0.511)	(0.679)	(0.797)	(0.517)	(0.647)	(0.768)
N	2604	2619	2620	2604	2619	2620	2604	2619	2620
R-sq	0.12	0.13	0.15	0.14	0.17	0.21	0.15	0.19	0.26

	(1) OPEX 25Y (50%)	(2) OPEX 30Y (50%)	(3) OPEX 35Y (50%)	(4) OPEX 25Y (66%)	(5) OPEX 30Y (66%)	(6) OPEX 35Y (66%)	(7) OPEX 25Y (75%)	(8) OPEX 30Y (75%)	(9) OPEX 35Y (75%)
Weak (OECD)	0.476	0.897	1.235	0.745	1.176*	1.586**	0.897*	1.366**	1.704**
	(0.523)	(0.655)	(0.735)	(0.502)	(0.657)	(0.765)	(0.509)	(0.628)	(0.746)
N	2604	2619	2620	2604	2619	2620	2604	2619	2620
R-sq	0.12	0.13	0.15	0.14	0.17	0.22	0.15	0.20	0.26

Notes: Left hand side variable is capturing the number of years until 50%, 66% or 75% of the cumulative level of OPEX, Well CAPEX , production and tax payments after 25, 30 or 35 years is reached. Year of Start-Up FE and the life time of the field are included in all regressions, identical to the results presented in the uneven columns of Table 2. Our baseline dummy $Weak_c(a)$ differentiates between countries with strong and weak institutions. SE in parenthesis is clustered by country and Start Up Year as well as the lifetime of the field. * stands for statistical significance at the 10% level, ** at the 5% level and *** at the 1% percent level.

Figure C.2: RENEGOTIATION



Notes: We use the Epanechnikov kernel with a bandwidth of 1.

production, due to physical as well as institutional rigidities. On the other hand, in the second row of Figure C.2 we see that for the fields which start production between 1968 and 1970 the production of fields located in countries with strong institutions initially appear to be relatively more backloaded, but the opposite is the case by the time the production shares reached the 66% threshold. Such dynamics are consistent with the idea that fields located in countries with weak institutions started producing as quickly as fields located in countries with strong institutions, but then slowed down several years after the start of production, once the transition to a new world oil order became apparent and the price of oil increased. For the fields which started production after and including 1970 we clearly observe that the transition to a relational contract with backloading occurred.

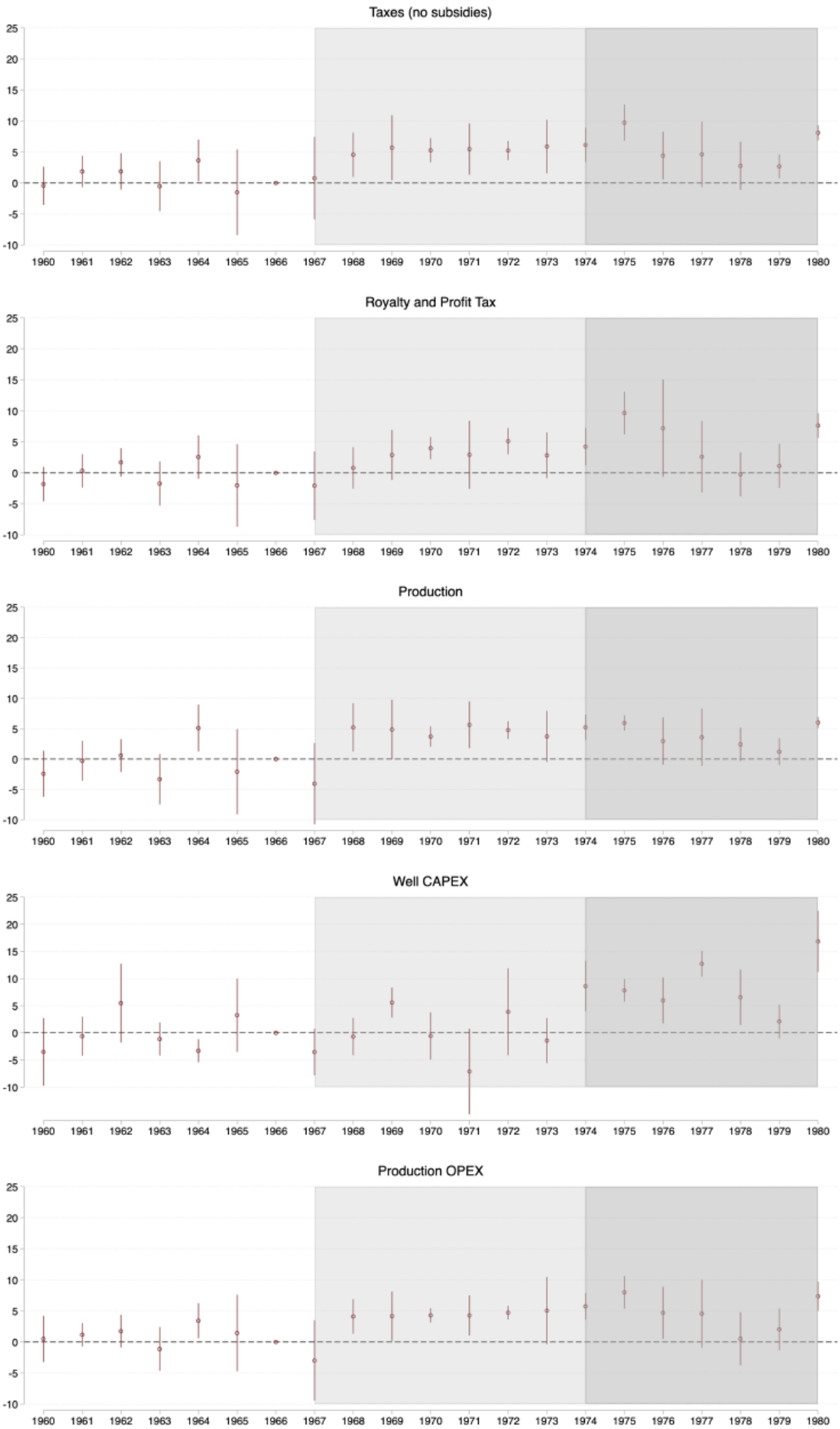
However, since we only observe the realized contracts, we cannot conclusively answer the question whether the changes in backloading have been predetermined or have been the result of ex-post adjustments. Thus, while the evidence towards renegotiation of contracts is weak, its presence cannot be ruled out.

C.4 ACCOUNTING FOR OBSERVABLE CONFOUNDERS

The results presented in Figure 9 are robust to changes in the specification. In particular, they are robust to the inclusion of country fixed effects (see Figure C.4), as well as the dropping of observable field level characteristics as controls (see Figure C.3). The results do not depend on the inclusion of countries which joined OPEC throughout the 1960s (see Figure C.6) and the results are robust to classifying countries to have weak institutions based on their OECD membership (see Figure C.5).

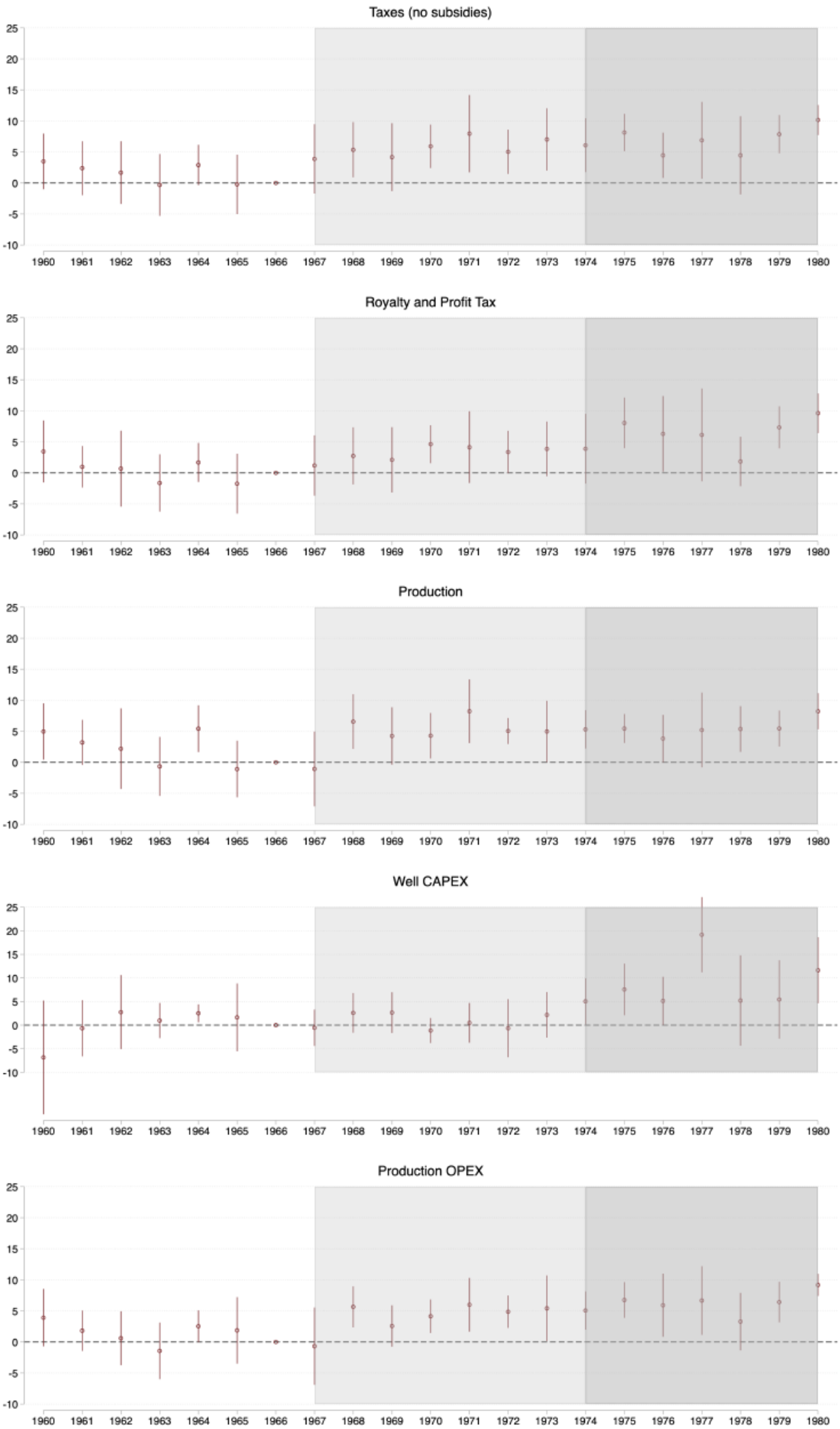
While we use a variety of controls in our baseline regression presented in Figure

Figure C.3: CHANGE IN MILITARY ENFORCEMENT OF CONTRACTS (no Controls)



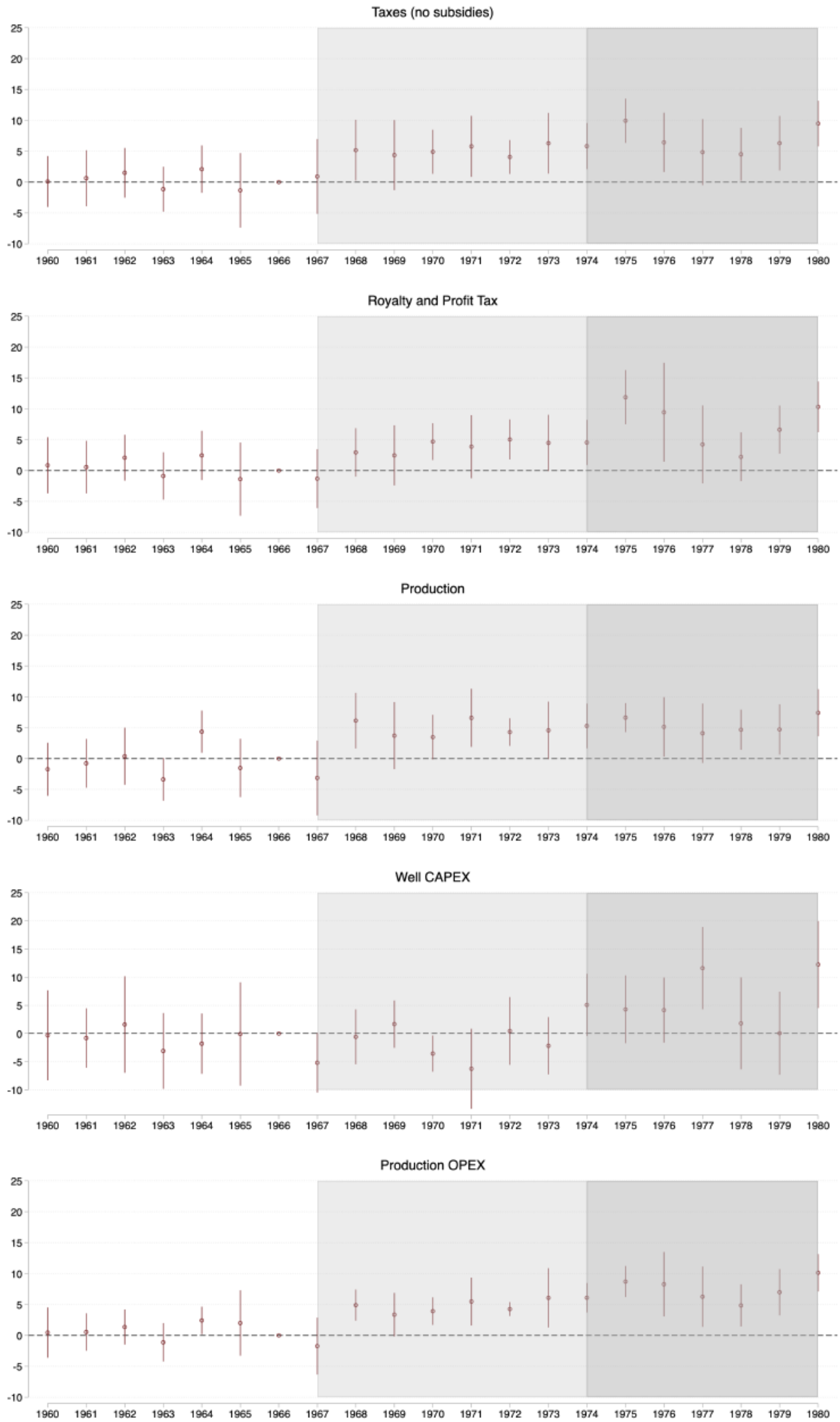
Notes: The outcome variable is the number of years which are necessary to reach 66% of investment, production and tax payments over 35 years. Year of Start Up, country group FE and the life time of a field are included in the regressions. The shaded area marks the period of transition between 1967 and 1974 as well as the period after 1974. The plotted interaction terms are on the yearly level and the sample is limited to the period between 1960 and 1980, with 1966 being the baseline. SE are clustered by country, Start-up year and the life time of the field. We plot the 95% Confidence Intervals.

Figure C.4: CHANGE IN MILITARY ENFORCEMENT OF CONTRACTS (Country FE)



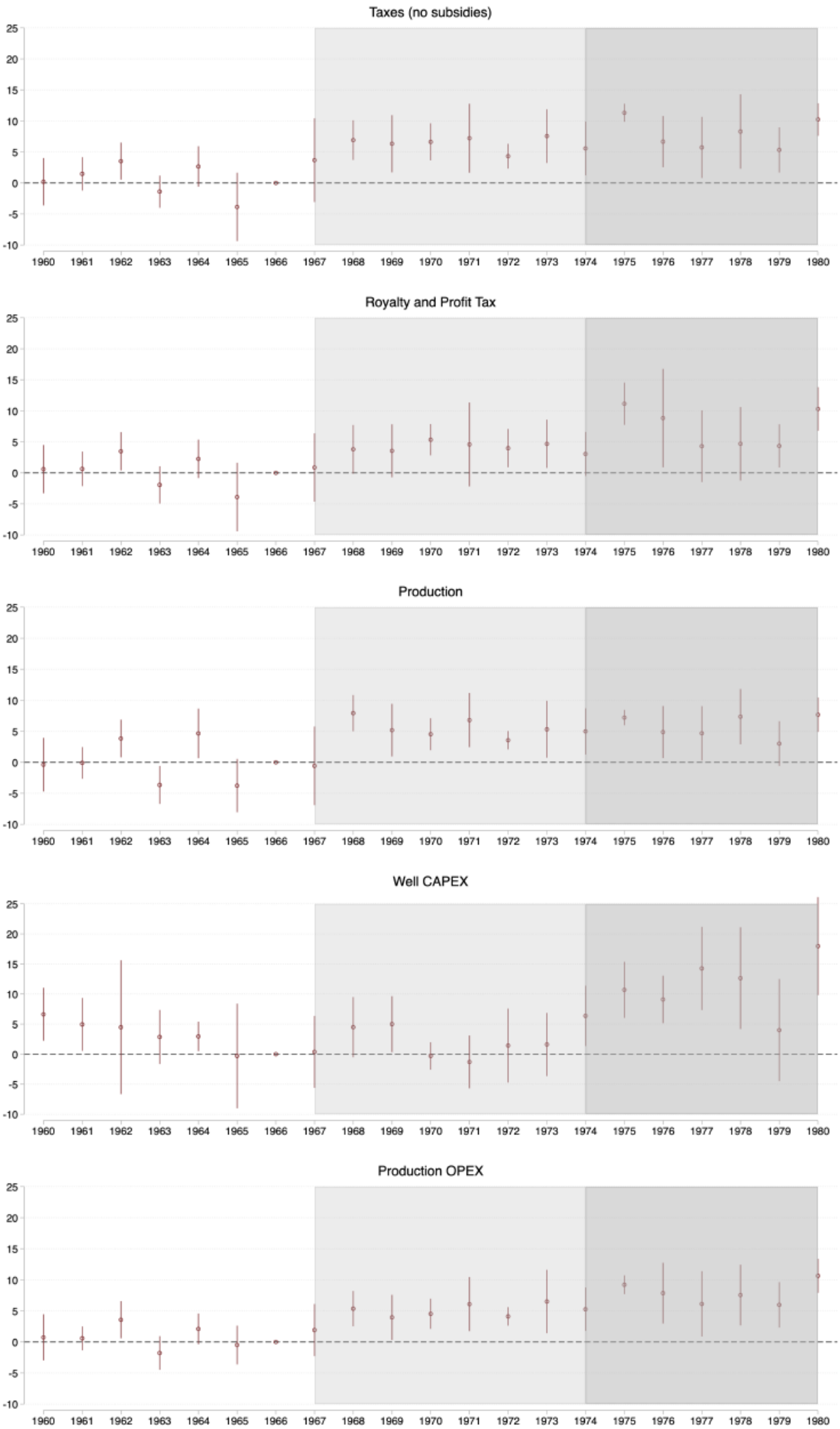
Notes: The outcome variable is the years to reach 66% of investment, production and tax payments over 35 years. Year of start-up, country group FE and the field life-time, location, climatic conditions, the size of the reservoir, the type of fossil fuel and the operating firm are included in the regressions. The shaded area marks the period of transition (1967-1974) and the period after 1974. The plotted interaction terms are on the yearly level and the sample is limited to the period 1960-1980, with 1966 as the baseline. SE are clustered by country, start-up year and the field life-time. We plot the 95% Confidence Intervals.

Figure C.5: CHANGE IN MILITARY ENFORCEMENT OF CONTRACTS (OECD dummy)



Notes: The outcome variable is the number of years which are necessary to reach 66% of investment, production and tax payments over 35 years. Year of Start Up, country group FE and the life time of a field are included in the regressions. The shaded area marks the period of transition between 1967 and 1974 as well as the period after 1974. The plotted interaction terms are on the yearly level and the sample is limited to the period between 1960 and 1980, with 1966 being the baseline. SE are clustered by country, Start-up year and the life time of the field. We plot the 95% Confidence Intervals.

Figure C.6: CHANGE IN MILITARY ENFORCEMENT OF CONTRACTS (no OPEC)



Notes: The outcome variable is the years to reach 66% of investment, production and tax payments over 35 years. Year of start up, country group FE and the field lifetime, location, climatic conditions, the size of the reservoir, the type of fossil fuel and the operating firm are included in the regressions. The shaded area marks the period of transition (1967-1974) and the period after 1974. The plotted interaction terms are on the yearly level and the sample is limited to the period 1960-1980, with 1966 as the baseline. SE are clustered by country, start-up year and the lifetime of the field. We plot the 95% Confidence Intervals.

9, there are some economic and technological advances that took place during the considered time period and which may bias our results. These advances include the introduction of Production Sharing Agreements (PSAs), the development of offshore oil extraction as well as new oil discoveries in developed countries. Their important common feature is that they are difficult to account for directly, as the decision to uptake them may be part of firm's strategic response to an increased threat of expropriation and, thus, they represent bad controls (Angrist and Pischke, 2014). In this section we argue that our results are unlikely to be driven by these factors.

Traditionally, oil & gas fields have been developed under concessions, whereby property rights to the subsoil assets are completely transferred to the firm. But in the 1960s, Production Sharing Agreements (PSAs) appeared as an alternative to concessions, representing around 10% of all fields. PSAs allow the resource rich economy, the initial owner of the resource, to keep a share of the field's value and property rights are not completely transferred to the firm. The use of such agreements keeps the country involved in the production process and mechanically reduces the government's gains from expropriating. Thus, the use of PSAs may have been triggered by the strategic reactions of firms with the aim to avoid expropriations. In such a case, a differential use of PSAs in countries with weak institutions relative to countries with strong institution during the transition could bias our results downwards.

Similarly, in the 1960s technological progress allowed the expansion of offshore field developments. According to our sample, the share of offshore fields started increasing in the late 1940s and early 1950s, represented 50% of all field developments by the majors in the early 1980s and exceeded the number of onshore fields by the mid 1990s.[38] Offshore fields are less prone to hold-up problems since they are naturally protected by the sea.[39] If oil majors are more likely to develop offshore fields in countries with weak institutions to reduce the risk of expropriation, we would underestimate the extent of backloading.

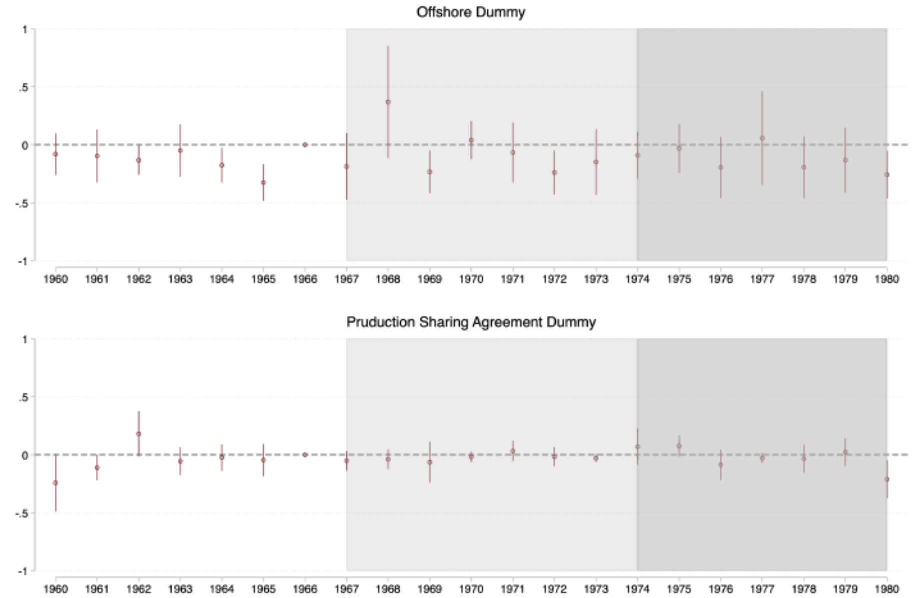
We proceed to argue that if the oil majors chose any of the measures above to reduce the probability of expropriation, they would be more frequently observed in weaker institutional environments. To test this, we construct a dummy indicating the use of Concessions versus PSAs, with the latter being coded as zero, and a dummy indicating offshore fields versus onshore fields, with the latter being coded as zero. Using these measures as our left hand side variable we reestimate the βs in a specification akin to equation (4), controlling for country, start-up year and field lifetime FEs. The results are presented in Figure C.7 and suggest that these factors are not more likely to take place in counties with weak institutions relative to strong ones so they are unlikely to bias our results. Note, the inclusion of the variables into our baseline regressions does not significantly effect our results.

Finally, this period coincides with a reallocation of investment from developing to developed countries, most prominently the developments of fields in the North Sea and Alaska. Theoretically, if the oil majors operate under capacity constraints, the expansion of new fields in the North may have resulted in temporary under investments in developing countries. In Figure C.8 we document that this argument is inconsistent with the upward trending operational and capital expenditures in countries with weak and strong institutions.

[38] See also a A Brief History of Offshore Oil Drilling.

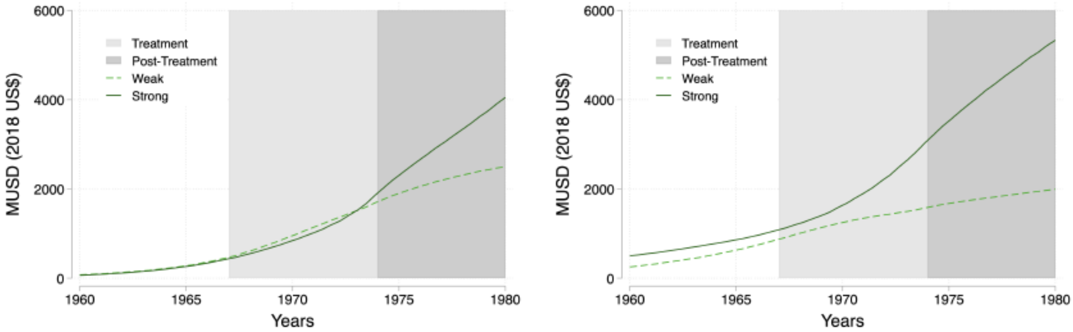
[39] Andersen, Nordvik and Tesei (2022) and Nordvik (2018) argue that offshore fields are more difficult to attack and loot for the rebel groups, and, thus, they are less likely to be associated with a conflict and need less defense.

Figure C.7: CONFOUNDERS



Notes: At the top, the left hand side is a dummy indicating offshore fields versus onshore fields, with the latter being coded as zero. At the bottom, the left hand side variable is a dummy indicating the use of Production Sharing Agreements versus Concessions, with the former being coded as zero. Year of Start Up and country FE and life time of the field are included in all regressions. The plotted interaction terms are on the yearly level and the sample is limited to the period between 1959 and 1980, with 1966 being the baseline. SE are clustered by country and Start Up Year and the lifetime of the fields.

Figure C.8: CAPITAL CONSTRAINTS



Notes: We use the Epanechnikov kernel with a bandwidth of 2. In the top, we plot OPEX by group of country. In the bottom, we plot CAPEX by group of country.

Table 5: EVOLUTION IN GOVERNMENT'S PROFIT SHARES

	Pre-Treatment (1960-1966)	Treatment (1967-1973)	Post-Treatment (1974-1980)
strong institutions	32 %	43 %	59 %
weak institutions	23 %	45 %	68 %

Note: Median profit shares of the governments are calculated by collapsing the raw data to Country-Year level for the three periods indicated in the column titles: pre-treatment, treatment and post-treatment. The data sample used to calculate the reported medians is restricted to observations of fields which started production between 1960 and 1980 and which did not gain independence during this time period.

C.5 ACCOUNTING FOR UNOBSERVABLE CONFOUNDERS

HIGH INTEREST RATE: According to Hotelling's Rule, a larger interest rate should lead to a faster extraction of a scarce resource with a corresponding adjustment to the resource price reflecting the increase in scarcity (Hotelling, 1931; Krautkraemer, 1998; Anderson, Kellogg and Salant, 2018). Intuitively, this is because the owner of the resource should be indifferent between the following two options: Extract the resource today, deposit the generated resource rents at the bank and collect the interest in the next period. Or keep the resource below the ground for one more period to benefit from the additional gain in the price of the extracted resource. If the interest rate is large relative to the changes in the price of the resource, its owners have an incentive to speed up extraction and vice versa.

Interest rates represent a confounding factor since they are country-specific and can change over time. Also, and beyond Hotelling's logic, we do have some evidence that newly independent and resource rich economies may be particularly interested in extracting the resource as quickly as possible to avoid borrowing from international markets at a higher interest rate. This issue is explicitly emphasized by Yergin (2011) when discussing the post-WWII petroleum order: "Royalties on oil were or would soon be the major source of revenues for the countries of the Gulf. As a result, those countries would put continuing pressure — augmented by threats, veiled or otherwise — on the companies to increase production, in order to increase royalty revenues." Hence, while we may expect that a country specific interest rate (either to save or to borrow) may have an effect on the dynamics of investment, production and tax payment, it should lead to a front loading if we expect that countries with weaker institutions may be subject to higher country-specific interest rates. Thus, our results may be thought of representing a lower bound.[40]

CHANGE IN BARGAINING POWER: In Section 2, we assumed that the firm has all the bargaining power vis-a-vis the government. Under this assumption, we have shown that weaker institutions lead to relatively more backloaded agreements. Instead, if the government were to hold all the bargaining power, weaker institutions would not be associated with contract backloading since the government is already keeping all the profits and would not gain from expropriating the firm. In reality, the bargaining power may be shared by both parties

[40] Unfortunately, we are not aware of a qualitative dataset containing information on country specific interest rates and going back sufficiently far in time, which would allow us to address this issue empirically.

and the relative bargaining power may change over time. In particular, during the transition to a new world oil order, the government's bargaining power may have increased translating into larger government's profit shares in countries with weak institutions. Theoretically, this would imply less backloading (see Ray (2002) and footnote 9). Hence, in this case, we estimate the lower bound of the backloading triggered by the transition to a new world oil order. The extent of the estimated backloading would have been even more severe if the bargaining power of the countries with weak institutions would have remained unaffected.

In Table 5, we document the median profit share received by governments with weak and strong institutions from fields which started production between 1960 and 1980, by differentiating between the periods before, during and after the treatment. The median profit share received by the government in countries with weak institutions increased from 23% in the pre-treatment period to 45% in the treatment period and then up to 68% in the periods after 1974. At the same time, the gains in the median profit share received by countries with strong institutions moved from around 32% in the pre-treatment to 43% in the treatment period and eventually to 59% in the post-treatment period. Overall, the results suggest that the bargaining power of the countries with weak institutions increased from a lower level in the pre-treatment period and eventually caught up and acceded the bargaining power of the countries with strong institutions. This pattern is consistent with an increase in the government's bargaining power. It is also consistent with the result of backloading, since the model predicts that the governments in countries with weak institutions end up receiving larger taxes (see Figure 3).

CORRUPTION: Since corruption is more present in countries with weak institutions than in countries with strong institutions (Rose-Ackerman, 2008), one may wonder about the role of corruption in the relationship between the government and the firm. If oil firms pay bribes to the government, Troya-Martinez and Wren-Lewis (Forthcoming) show that the commitment problem of the government gets relaxed. Indeed, the government is less willing to expropriate for fear of loosing the future stream of bribes from the firms. As a result, we expect the backloading to be less pronounced and hence, our results represent a lower bound.

MULTILATERAL ENFORCEMENT: In reality, there are usually more than one oil firm operating in a given country. In such conditions, firms which have not been expropriated, may react to an expropriation of another firm by leaving the country. For such cases, Levin (2002) shows that this kind of informal multilateral enforcement increases the government's commitment not to expropriate since the punishment following a firm's expropriation is larger. Hence, again, our estimate represents a lower-bound.