# Resource Discoveries and the Political Survival of Dictators

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**Abstract**

We study the effect of resource discoveries on dictator failure. We extend existing conflict literature by developing a dynamic stochastic model where timing of attack and probability of success are endogenous. Incumbent and opposition invest in military arsenals which determine success probability, while opposition also chooses when to stage a coup. A resource discovery delays the attack and reduces the probability of overthrow. We test these hypotheses using duration models and timing of giant oil and gas discoveries, finding that large discoveries more than double remaining time until failure and reduce hazard faced by an autocrat by 30 - 50%.

**Keywords**: resource discoveries; dictatorship; leadership duration; survival; resource curse

## 1 Introduction

Clinging to power for as long as possible is a hallmark of autocratic rulers. With the goal of cementing their authority and extending the duration of their regime, dictators have often resorted to repression, self-enrichment, corruption, ethnic purging, torture, and other forms of violation of human rights. However, not all were equally successful. Some of the world's most atrocious rulers remained in power for only a few years (Pol Pot in Cambodia), while others persisted for almost half a century (Omar Bongo in Gabon, Qabus Bin Said in Oman, Muammar Qaddafi in Libya).

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Coincidentally, substantial discoveries of fossil resources took place during the rule of Bongo, Bin Said and Qaddafi, while no discoveries occurred during Pol Pot's tenure.

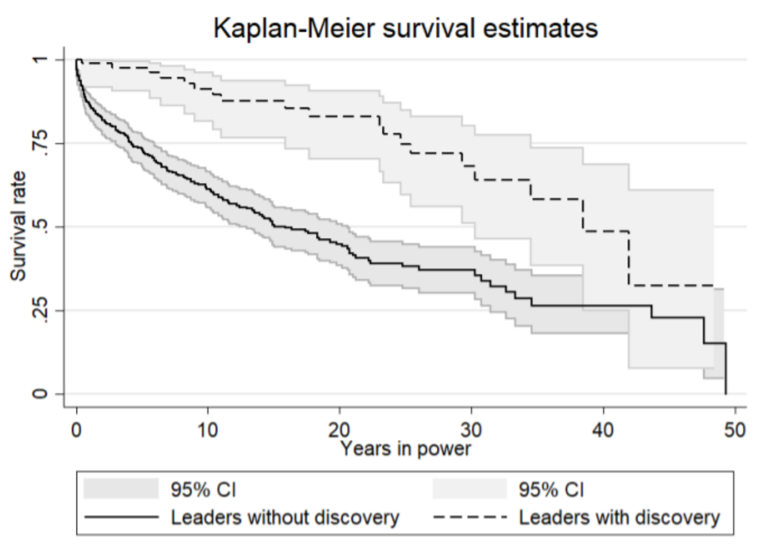
To explore the link between natural resource discoveries and autocratic leadership duration we plot Kaplan-Meier survival estimates (Figure 1) for leaders who experienced hydrocarbon discoveries (dashed line) vs those who have not (solid line).[1] The raw data indicate that leaders with discoveries indeed tend to remain in power, or "survive", longer. The survival estimates in Figure 1, however, are simple correlations and cannot tell us much about causality. It could be that unobserved characteristics make countries with discoveries more prone to having long-lasting autocratic regimes. Moreover, the basic intuition suggests that the relationship between discoveries and political survival is, if anything, ambiguous. On the one hand, the increase in resource wealth may allow the leader solidify and extend his rule. On the other hand, the promised future rents of resources may be enticing enough to induce an opposition to ignite an insurgency or even to stage a coup d'état. In the rest of the article we perform an in-depth investigation starting with the theoretical predictions from a dynamic stochastic model of a resource-driven coup and then moving to the empirical testing using the survival analysis and data on over 500 autocratic leaders.

We find that the positive relationship between resource discoveries and political survival of dictators, expressed in Figure 1, holds up to scrutiny. Our theoretical model elicits two channels via which this positive relationship may arise: a delay in the timing of attack on the regime and a reduction in the probability of success of such an attack. We also test the validity of these two sub-hypotheses empirically and find that the delay in the timing of attack plays a more important role in the overall positive effect on leader survival.

Our paper contributes to the literature by extending both theoretical and empirical research on the political implications of oil wealth. Our theoretical work draws primarily from the literature on resource wealth and international conflict (Acemoglu *et al.* , 2012; Caselli *et al.* , 2015; Caselli & Tesei, 2016) and civil war (Gallego & Pitchik, 2004; Cuaresma *et al.* , 2011; Van der Ploeg & Rohner, 2012; Van der Ploeg, 2018). Van der Ploeg & Rohner (2012) build a two-period

[1] When we refer to leadership duration, we have in mind duration of tenure of a dictator and not duration of dictatorial regime, which can span tenures of several consecutive dictators. For example, in 1997 Zair experienced a change in leadership when Mobutu Sese Seko was overthrown by Laurent Kabila but the nature of the regime remained dictatorial. In our analysis, we treat Mobutu and Kabila as separate "leaders".

**Figure 1:** Survival functions of leaders with and without hydrocarbon discoveries.




Leadership duration data from Archigos 4.1, oil discoveries from Horn & Myron (2011)

theoretical framework, which allows them to study endogenous conflict emergence together with endogenous resource exploitation. They show that a possibility of an armed conflict makes resource extraction more voracious, which reduces the fighting stakes for the rebel group. Van der Ploeg (2018) extends this analysis to an infinite-horizon dynamic model of civil resource wars linking the outcome of a conflict to constitutional cohesiveness, i.e. rent-sharing between competing factions, and partisan-in-office bias. He confirms that extraction is more rapacious if government instability is high and cohesiveness is weak.[2] Caselli & Tesei (2016) study how increases in resource windfalls can affect political regimes. Their model shows that changes in the price of the principal export commodity have a heterogeneous effect, depending on the initial state of the regime. In particular, democratic and strongly autocratic regimes see almost no change, while weakly autocratic regimes tend to become more autocratic as resource price increases.[3]

Similarly to the above-mentioned studies, in our theoretical framework one fac-

[2]The study, however, does not look directly at how resources affect success probabilities but examines instead the effect of fighting on exploration efforts.

[3]A model of military dictatorships presented by Acemoglu *et al.* (2010) shows that natural resources have an ambiguous effect on the probability of a *military* coup. Natural resources increase the value of leadership, thus increasing the incentive for staging a coup. However, they also increase the leader's preference for repression (he also sees the increased value of remaining in power) and his ability to "buy off" the military. Overall, the model does not resolve the dual impact which resource wealth may have on the probability of being overthrown.

tion (the autocrat) enjoys the power of office and unilaterally decides on resource exploitation.[4] The autocrat shares part of the rents with the other faction and engages in repressive activities. The rival faction may try to gain control over office and resource rents by staging a coup at some optimally-chosen time. From the perspective of the incumbent, however, the coup timing is a random variable until the coup is actually staged. We further extend the standard incumbent-opposition framework in two dimensions. First, we distinguish between the hazard of being attacked and the probability of the attack being successful. In other words, we allow for a possibility that a staged coup might fail.[5] Moreover, we depart from exogenous contest-success probabilities (Tullock, 1975; Gallego & Pitchik, 2004; Cuaresma *et al.* , 2011; Acemoglu *et al.* , 2012) by letting them be a function of (military) power which is endogenously determined. This modeling choice allows us to highlight the fact that consumption has to be sacrificed in order to raise self-preservation, i.e. "guns vs butter" choice, as in, e.g., Jackson & Morelli (2009) and Caselli & Tesei (2016). Second, we explore an additional link between natural resources and leadership duration working through random resource *discoveries*.

Our theoretical model shows that a possibility of a discovery may entail a more rapid extraction as compared to a situation without discovery. If, in addition, the newly-discovered resources are relatively small, the leader is more likely to fail. If, however, the discovery is large, he is more likely to persist. Moreover, if a large discovery occurs relatively early within the leader's tenure, the effect of discovery on survival is enhanced. In the two latter cases, a large resource discovery is beneficial for the incumbent because (i) it delays the optimal time of attack but also (ii) reduces the probability of coup success, thus increasing his average duration of tenure. Finally, we show that these effects are stronger, the higher the degree of repression of the regime.

The model thus gives us two main testable hypotheses: (1) Leaders face a lower hazard following a large discovery. (2) The earlier the leader discovers resources, the larger the impact. We test the mechanisms of hypothesis (1) through the two sub-hypotheses, which reflect the effect on: (1a) the time until the opposition stages a coup, and (1b) the probability of a coup succeeding. We test all these hypotheses using data on leadership duration until it ends in a domestic coup, and data on giant hydrocarbon discoveries. Hypotheses (1), (1a), and (2) are all tested with survival

[4] We have in mind non-lootable exhaustible resources, such as, for example, oil and gas.

[5] Our data reveal that 63% of coups end up failing, see Table 4.

analysis[6], and (1b) with a probability model. All hypotheses are consistent with the data: we find a negative statistically significant relationship between discoveries and the hazard of being overthrown, and discoveries earlier in the leader's tenure have a stronger effect. Results indicate that the lower political hazard is driven more by the opposition delaying the coup rather than by the decline in success probability.

Our empirical investigation contributes to the large literature which attempts to estimate the effect of resource wealth on political outcomes. The results of these empirical studies have been found sensitive to the specification choices in general, and to resource wealth in particular (see e.g. Brunnschweiler & Bulte, 2008; Herb, 2005; Gurses, 2011; Andersen & Aslaksen, 2013; Haber & Menaldo, 2011; Wright *et al.* , 2013; Andersen & Ross, 2014; Nordvik, 2019).[7] Most studies have tended to rely on variations of oil income (production or exports), often scaled by GDP. The main drawback of using these flow variables is that they are likely to be endogenous, particularly in autocracies (Wright *et al.* 2013), as the production and income levels could be strategic choices of the leader.[8] This is why a few recent studies have turned to the timing of oil and gas discoveries in an attempt to reduce the endogeneity in the link between resource wealth and political regimes (Van Der Ploeg & Poelhekke, 2017; Arezki *et al.* , 2017). In contrast to most flow variables, resource discoveries provide a quasi-random exogenous variation in the stock of resource wealth. Of particular interest to us are Cotet & Tsui (2013b), who exploit the timing of discoveries and initial oil endowments to find, contrary to much of the literature, that there is a modest positive relation between oil abundance and economic growth. Cotet & Tsui (2013a) use these data to look at the well-documented association between oil and internal armed conflicts, and find no link, while Tsui (2011) finds that oil discoveries tend to lower democracy scores.

We use large resource discoveries in our empirical model in order to directly

[6] See Smith (2004); Omgba (2009); De Mesquita & Smith (2010); Cuaresma *et al.* (2011); Andersen & Aslaksen (2013). These papers, however, focus on the flow of resource rents (e.g., oil rents, oil exports or oil income as percentage of GDP), rather than the less endogenous random stock increase that discoveries provide.

[7] When using measures of natural capital (a stock variable) instead of flow variables such as oil export as a share of GDP and similar, Brunnschweiler & Bulte 2008 find that "resources can be a blessing for both institutional and economic development - not a curse." (p. 250)

[8] For instance, a leader may choose not to diversify the economy away from the resource sector in an attempt to control the main source of income in his country, and thereby remain in power longer. While the oil price is typically assumed to follow a random walk, it can be influenced by instability in oil producing countries (see e.g. Hamilton, 2009a,b). Moreover, production rates may well be influenced by price changes. Further, while price shocks will be exogenous to most producers (as argued by e.g. Nordvik, 2019), they can be highly endogenous to the political situation in key producing countries (consider the Iranian revolution in 1979, and the effect it had on the oil price).

identify a causal relationship due to their inherent randomness. Discoveries of giant oil and gas fields, in particular, are near impossible to predict, and cannot be factored into the strategic choices of leaders ex ante. Fundamentally, a leader cannot choose to discover a giant oil or gas field tomorrow, regardless of how much he needs it. Although a leader can certainly choose to *look* (by engaging in exploration), he cannot choose to *find*, nor - importantly - choose exactly *when* to find. We assume that the chance of discovering a *giant* oil field is low enough for it to be considered reasonably random, as in Lei & Michaels (2014); Arezki *et al.* (2017); Cotet & Tsui (2013a,b); Van Der Ploeg & Poelhekke (2017). Yet, one may argue that exploration efforts increase the chances of making a discovery. The reccent study by Ahlvik & Torfinn (2019) shows, however, that a higher exploration intensity does not automatically lead to more discoveries.[9] Still, as discoveries do not constitute a perfect natural experiment, we condition on covariates, including exploration intensity. Our identification strategy thus relies on the fact that, conditional on exploration intensity and other covariates, a discovery of *giant* oil and gas fields, and especially its timing, can be viewed as exogenous, and estimates are causal. This novel specification lets us use over 500 autocratic leaders and oil and gas data from 1868 until 2011. Hence the data also allows us to test a much broader time range than most other studies that rely on flow measures of oil dependence which are only available from 1950 onwards. To the best of our knowledge, no study has used discoveries to assess the effect of resources on coups. Our results point to the stabilizing effect which natural resource wealth is sometimes argued to have on autocratic regimes: leadership durations increase when leaders find a giant oil or gas field.

The rest of the article is organized as follows. Section 2 introduces the theoretical model of a resource-driven coup and then examines how a discovery of additional stock of natural resources affects the conflict outcome. Section 3 presents our empirical investigation, where we use survival analysis to test the predictions of the model and discuss the implications of our results. The final section 4 concludes.

## 2 Theoretical Model

The first subsection presents a dynamic stochastic model of a resource-driven coup where both the timing of the coup and the probability of coup success/failure are

[9] We have also performed robustness checks to see whether it is the exploration itself (and not discoveries per se) that drives our results and found no evidence of that.

endogenous. The second subsection introduces a random oil discovery and shows how a discovery affects the equilibrium in terms of survival of the incumbent.

## 2.1 Dynamic Model of a Resource-driven Coup

We assume that time is continuous and is indexed by $t$. The resource stock at each moment $t$ is $S_t$ and the extraction rate is $R_t$. The initial resource endowment (think of oil) is denoted by $S_0$ and the resource demand function is given by $p_t = R_t^{-\varepsilon}$, where $p_t$ denotes the oil price and $1/\varepsilon > 1$ is the demand elasticity. The incumbent autocratic leader or Government (G) has full control over the natural resource. We assume that G shares a fraction of resource rents, $\theta \in (0, 1)$, with citizens. Citizens constitute a pool of potential Opposition (O). We refer to the competing faction as the opposition, although one may also think of an elite or even G's entourage which may decide to overthrow the leader at some future point in time in order to gain control over resources.[10]

It is reasonable to believe that leaders, especially in autocracies, try to maximize their chances of staying in power by taking some sort of a strategic action aimed at self-preservation. This may take a form of investing in secret police or ramping up military spending to build a loyal army or simply bribes for key supporters of the regime. It is also reasonable to suppose that abundance of natural resources plays an important role for such self-preservation activities (Cotet & Tsui, 2013a; Wright *et al.* , 2013). We denote by $m$ the resources that G devotes to self-preservation and assume that a larger $m$ increases G's chances of winning in the coup. There is, however, an associated cost, denoted by $C(m)$, such that $C(0) = 0$, $C'(m) > 0$, and $C''(m) \geqslant 0$.

The Opposition may decide to stage a coup at some future date $T$ in order to take control over resource rents. The coup timing, $T$, is of course not known to the incumbent from the outset and is treated by him as a random variable (clearly, G observes $T$ when the coup is actually staged), while $T$ is a choice variable of O. The Opposition also invests in military arsenal (or bribes her supporters) in order to in-

[10]Following Besley & Persson (2011) and Van der Ploeg (2018), we treat $\theta$ as a fixed parameter determined by culture or tradition or exogenous forces. Alternatively, one may think that $\theta$ can be a choice variable of G. By increasing the rent redistribution, essentially buying off the opposition, G can increase his chances of staying in power longer. However, one may also think of a counter-argument that an increase in rent sharing may improve the power of the opposition (or elite) and thus have a negative effect on leadership duration. Such a trade-off is similar to the one discussed by Acemoglu *et al.* (2010) in the context of military dictatorships. We show in the appendix that increasing $\theta$ in our model may indeed have a positive effect on duration but an ambiguous effect on the relationship between discoveries and duration.

crease her chances of success. We denote this amount by $m^o$ and the associated cost by $C^o(m^o)$ with $C^o(0) = 0$, $C^{o'}(m^o) > 0$, and $C^{o''}(m^o) \geqslant 0$. The variables pertaining to the Opposition are marked with the superscript "o" in order to distinguish them from those of G. If the coup is staged, there is a probability $\nu(m, m^o) \in [0, 1]$ that G remains in power, i.e. the coup fails, with $\frac{\partial \nu}{\partial m} > 0$, $\frac{\partial \nu}{\partial m^o} < 0$. If the coup is successful, O gains full control over the oil, while G receives a scrap value consumption (think of life in exile or jail). If the coup fails, O receives a scrap value consumption and does not attempt to stage another coup.[11] Both scrap values are assumed to be very small compared to the resource income and we shall ignore them in the rest of the analysis. The next two subsections describe the optimization problems of G and O, respectively.

### 2.1.1 Incumbent Government

The objective of the incumbent is to maximize the expected present discounted value of lifetime welfare knowing that a possibility of a coup exists but not knowing the exact time of the coup (until the coup does occur). We assume that the coup arrival follows the Poisson process with intensity $\psi$. G's objective function consists of the expected utility during the pre-coup phase, running from time 0 to $T$, and the expected utility during the post-coup phase running from $T$ onwards and weighted by the probability of staying in power $\nu$. G's decision variables are how much oil to extract in the first phase and, if he remains in power, in the second phase, and how much resources to allocate to self-preservation. Denoting the rate of time preference by a constant $\rho$, G's optimization problem may be written as:

$$\max_{R_t, m} \int_0^\infty \left\{ \int_0^T (1-\theta) p_t R_t e^{-\rho t} dt + \nu \int_T^\infty p_t R_t e^{-\rho t} dt - C(m) e^{-\rho T} \right\} \psi e^{-\psi T} dT \tag{1}$$

[11] Our model can be extended to multiple coup attempts in the same way as in Van der Ploeg (2018), although we believe that such a model is less suitable for the analysis of leadership duration (as opposed to regime duration). Such a model is also not supported by the data: in our sample of 527 autocratic leaders, only 2 returned to power after failing in a coup d'état. These were David Dacko in Central African Republic and Léon M'ba in Gabon. In both cases the return to power was not organized internally by the failed leaders themselves but by an outside ally, France. In the case of M'ba, his reinstallation in office occurred the day following the coup. This evidence suggests that switching power between the same leader and his opposition is very unlikely. Similarly, there are only a handful of leaders in our dataset which experienced multiple coup attempts. Easton & Siverson (2018) show that leaders who have retained power after a coup are less likely to experience more coup attempts (perhaps from a different opposition) because these leaders engage in severe purging of all known and potential rivals precisely in order to deter future overthrow attempts.

subject to the dynamic law for the stock of oil

$$\dot{S}_t = -R_t, \quad S_0 \text{ given} \tag{2}$$

and the oil demand function.[12]

The solution to the problem in (1) - (2) may be split in the pre-coup and post-coup phases. Since the post-coup phase is purely deterministic, we start by computing the optimal extraction trajectory in the post-coup phase and then we turn to the optimal extraction and self-preservation in the stochastic pre-coup phase.

POST-COUP PHASE

The post-coup phase is the standard deterministic Hotelling-extraction problem and has the following solution (see appendix):

$$\hat{R}_t = -\gamma, \quad R_T = \gamma S_T, \quad \gamma \equiv \frac{\rho}{\varepsilon} \tag{3}$$

where a hat over a variable denotes the growth rate.

PRE-COUP PHASE

The problem in the pre-coup phase is stochastic due to the possibility of a coup. We show in the appendix that the pre-coup extraction rate, denoted by $\gamma^c$, can be either more rapacious or more conservationist than the post-coup extraction, depending on the relationship between the probability of staying in power, $\nu$, and rent sharing, $1 - \theta$. Formally,

$$\hat{R}_t = -\gamma^c, \quad R_0 = \gamma^c S_0, \tag{4}$$

$$\gamma^c = \frac{1}{\varepsilon}\left\{\rho + \psi\left[1 - \frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\right]\right\}. \tag{5}$$

If $\nu < 1-\theta$, i.e. staying in office is unlikely and rent sharing is relatively small, then extraction is more rapacious. If the incumbent always loses power when a coup is staged (i.e. $\nu = 0$), then the extraction is the most rapacious, which complies with the general intuition. In this case, the coup hazard increases the impatience rate one to one. If $\nu = 1 - \theta$ or if the risk of coup did not exist at all, i.e. $\psi = 0$, the extraction would proceed at the same rate $\gamma$ in both phases. Finally, if $\nu > 1-\theta$, the

[12]Note that we model the cost of self-preservation as a one-shot expenditure. This is done in order to simplify the derivations. Alternatively, the cost can be modelled as a per-period expenditure. We have explored this second approach and found that our main results are qualitatively the same in both cases. We therefore opted for the former case which allows for a more parsimonious analysis.

extraction proceeds more slowly than in the post-coup phase because the relatively large probability of staying in power makes it worthwhile to preserve the resource for the sole consumption of the incumbent after a failed coup. We summarize the effect of a stochastic coup on extraction in the following

**Result 1:** *For any given probability of coup success, the threat of a possible overthrow at some unknown future date makes extraction in the pre-coup phase more (resp., less) rapacious than under certainty if the probability of staying in power is relatively small compared to the percentage of appropriated rents.*

Certainty can be understood as either a situation without any threat at all or a situation where the date of the coup is known with certainty. A special case of the above result with $\nu = 0$ has been shown by Van der Ploeg (2018).[13]

We turn next to the optimal self-preservation which can be found by maximizing (1) with respect to $m$. The implicit solution is given by

$$\frac{\partial \nu}{\partial m}\left(\frac{\rho+\psi}{\beta+\psi}\right)\gamma^{-\varepsilon}S_0^{1-\varepsilon} = C'(m), \tag{6}$$

where we defined for convenience $\beta \equiv \gamma^c(1-\varepsilon)+\rho$. The right-hand side of (6) represents the marginal cost of self-preservation, while the left-hand side is the expected marginal gain in terms of increased probability of success and the associated benefit of enjoying the resource rents over the remaining planning horizon.

### 2.1.2 Opposition

The Opposition (O) receives a fraction of rents, $\theta p_t R_t$, per unit of time and is subject to repression from the autocratic regime, which we denote by a constant $\delta$. Thus, O faces two options: (1) collect a fraction of rents forever, suffering from repression at the same time, and refrain from staging a coup, or (2) stage a coup at some optimally chosen date, $T$, in order to attempt gaining office, escape from repression and take control over the oil stock. We show in the appendix that it is indeed welfare-improving for O to stage a coup at the optimally chosen time $T$, so that the incentive-compatibility constraint is satisfied.[14]

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[13] Note that if coups were recurring, with rent-sharing taking place for defeated party, then the extraction would decline at the rate $\gamma^c = \frac{1}{\varepsilon}\left[\rho+\psi(1-\nu)\right] > \gamma$ in both pre-coup and post-coup phases.

[14] By the incentive-compatibility constraint we mean that the net present value of welfare stemming from option (1), i.e. abstaining from staging a coup forever, is strictly lower than the net

If the coup is successful, with probability $1-\nu$, O stays in office for the remainder of the planning horizon. The objective of O is to maximize the present discounted value of welfare over the pre-coup and the post-coup phases with respect to the timing of the coup, $T$, military spending, $m^o$, and the extraction rate in the post-coup phase (if successful). As in the case of G, fighting is associated with a cost, denoted by $C^o(m^o)$. We focus on the Nash game in the sense that O does not observe the military spending of G and takes it as given.[15]

$$\max_{T,R_t,m^o} \quad \int_0^T (\theta p_t R_t - \delta)\, e^{-\rho t} dt + (1-\nu) \int_T^\infty p_t R_t e^{-\rho t} dt - C^o(m^o) e^{-\rho T} \tag{7}$$

subject to the oil demand function and the following oil-depletion constraint

$$\dot{S}_t = -R_t, \ \forall t > T, \ \ S_T = S_0 e^{-\gamma^c T}. \tag{8}$$

The extraction pace in the pre-coup phase is determined by G and proceeds at the rate $-\gamma^c$, while if O gains office, her post-coup extraction problem is identical to the problem of G discussed in the previous subsection. Hence, we can rewrite (7) as

$$\max_{T,m^o} \quad \theta(\gamma^c S_0)^{1-\varepsilon} \frac{1-e^{-\beta T}}{\beta} - \delta \frac{1-e^{-\rho T}}{\rho} + (1-\nu) e^{-\rho T} \gamma^{-\varepsilon} (S_T)^{1-\varepsilon} - C^o(m^o) e^{-\rho T}. \tag{9}$$

The first-order conditions (provided in the appendix) yield the following system which describes an implicit solution for $m^o$ and $T$:[16]

$$-\frac{\partial \nu}{\partial m^o} \gamma^{-\varepsilon} S_T^{1-\varepsilon} = C^{o'}(m^o), \tag{10}$$

$$\theta(\gamma^c)^{1-\varepsilon} S_T^{1-\varepsilon} + \rho C^o = (1-\nu)\beta \gamma^{-\varepsilon} S_T^{1-\varepsilon} + \delta. \tag{11}$$

The interpretation of these conditions is straightforward. Eq. (10) states that the optimal military spending is such that the marginal benefit in terms of increased probability of success, the left-hand side, is equal to the marginal cost, the right-hand side. Similarly, Eq. (11) states that the optimal time of attack is such that the marginal benefit of postponing the attack by one instant is equal to the marginal

present value of welfare stemming from option (2), i.e. staging a coup eventually at $T$, where $T$ is optimally chosen.

[15] This assumption is realistic in autocracies, where leaders control all the public apparatus and the media which makes it easy to conceal or misrepresent information.

[16] It can be verified that the second-order conditions are negative.

cost. The marginal benefit consists of the rents that O collects during this extra instant plus the reduced present value of the cost of fighting. The marginal cost is given by the value of resource rents which would be foregone had the attack been successful, with probability $(1-\nu)$, plus the repression suffered during the extra instant of delay. Using (10), the optimality condition (11) can be rewritten as

$$S_T^{1-\varepsilon}\left[\theta(\gamma^c)^{1-\varepsilon}+\rho\nu(1-\nu)\gamma^{-\varepsilon}\right]=(1-\nu)\beta\gamma^{-\varepsilon}S_T^{1-\varepsilon}+\delta, \tag{12}$$

which reveals the necessity of the following assumption.

**Assumption 1:** *Rent sharing is sufficiently generous relative to the disutility of repression, expressed in terms of the value of the initial oil endowment:*

$$\left[\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}(\beta-\rho\nu)\right]>\frac{\delta}{S_0^{1-\varepsilon}}$$

If Assumption 1 holds, condition (11) is guaranteed to have an interior solution (see appendix). If Assumption 1 is not met, in the sense that the value of collected rents is smaller than the disutility stemming from repression, then an immediate coup is optimal, i.e. a corner solution with $T=0$ will arise. For the rest of the analysis, we assume that Assumption 1 is satisfied.

### 2.1.3 Equilibrium

We solve for the Nash equilibrium of the model, in which G and O choose their best-response functions in terms of $m$ and $m^o$, respectively, taking the action of the other player as given.[17] In order to formalize the equilibrium, we will resort to the Tullock contest-success function which is often used in the literature on contests/wars to

[17] The assumption that G cannot observe the military power of O is realistic because it is reasonable to think that O will try to conceal the preparation of the coup. Also note that G cannot deduce the time of the coup without being able to observe $m^o$. The assumption that O cannot observe the military power of G can also be justified, see footnote 15, yet it may appear restrictive. On the one hand, G may also try to conceal his true army size or how much he spends on secret police. On the other hand, O may nonetheless be able to deduce the value of $m$ through publicly available sources, e.g. the share of yearly budget allocated to military spending, the extent of policing, etc. In order to take that into account, we also examine a Stakelberg version of our game, where O observes $m$ and internalizes the effect of her own choices on it. We present this extension of the model in Appendix A.5 and show that the predictions of the model do not change.

model success probabilities (Tullock, 1975):

$$\nu = \frac{\alpha m}{\alpha m + m^o},$$

where $\alpha > 0$ represents the relative military efficiency of G. As for the costs of self-preservation, we shall assume for simplicity that they are proportional to military arsenal[18]:

$$C(m) = cm, \;\; C^o(m^o) = cm^o, \;\; c > 0.$$

Then, dividing (6) by (10) yields the equilibrium ratio of military expenditure, which we denote by $\xi^*$:

$$\xi^* \equiv \frac{m^o}{m} = \frac{\beta + \psi}{\rho + \psi} e^{-(1-\varepsilon)\gamma^c T}, \tag{13}$$

The equilibrium success probabilities for G and O, respectively, become

$$\nu^* = \frac{\alpha}{\alpha + \xi^*}, \;\; 1 - \nu^* = \frac{\xi^*}{\alpha + \xi^*}. \tag{14}$$

Furthermore, in equilibrium, the arrival rate of the coup from the perspective of G, $\psi$, has to be consistent with the timing of attack, $T^*$. By the property of the Poisson process, we have:

$$\psi^* = \frac{1}{T^*}. \tag{15}$$

The Nash equilibrium of the model is characterized by the system of equations (5), (12) - (15).

### 2.2 Oil Discovery and Duration of Autocracy

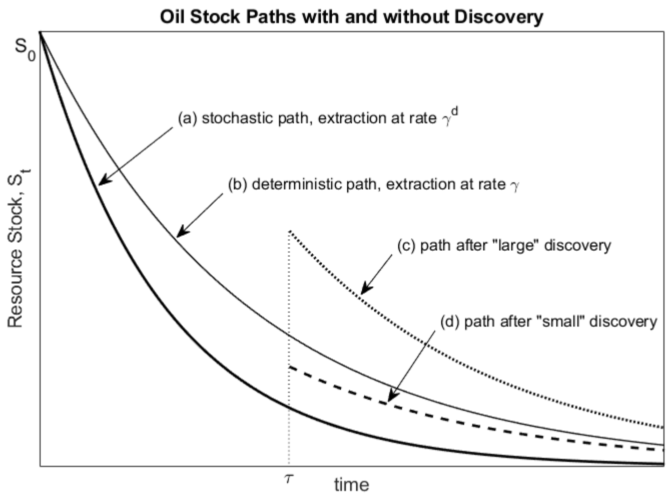
We focus on the sequence of events such that a resource discovery by a leader precedes a coup attempt on that leader.[19] Let us denote the time of discovery by $\tau$. From this point on, the resource-coup model of the previous subsection applies, with the only exception that the oil endowment is no longer $S_0$ but rather $S_\tau$, which also includes the newly discovered deposits.

Now we should pause for a moment and ask what the overall effect of a random

[18] One may simlpy think of a constant price of guns, bribes, policing, etc.

[19] The opposite case would mean that either (i) the leader has "survived" the first coup and experienced a discovery subsequently, with possibility of further coup attempts; or (ii) the leader has "not survived" the first coup and it is the new leader who experienced a discovery, with possible future coup attempts on the new leader.

**Figure 2:** Stochastic vs deterministic oil extraction with and without discovery.




Notes: Path (a) shows stochastic path of oil stock without discovery ever occurring. Path (b) corresponds to a deterministic path such that a discovery is not possible from the outset (and this is common knowledge). This path is more conservationist than the stochastic path. Paths (c) and (d) show the stock path when a discovery occurs at time $t = \tau$. Path (c) corresponds to a "large" discovery in the sense that it brings the stock path above the deterministic counterpart. Path (d) corresponds to a "small" discovery such that the stock remains below the deterministic path.

discovery on $S_\tau$ is. It turns out that the effect is two-fold: a random discovery (i) unsurprisingly increases the oil stock on date $\tau$ by the amount of the newly discovered deposits; but also (ii) changes the speed of extraction in the pre-discovery phase. We relegate the detailed analysis to the appendix and focus here only on the graphical illustration in Figure 2 and on two key insights: First, a possibility of a discovery may lead to a voracious extraction, illustrated by path (d) in Figure 2, such that $S_\tau$ may in fact end up being smaller than its counterpart in a deterministic scenario without a discovery (illustrated by path (b) in the figure). Intuitively, such rapacious extraction is the opposite of the precautionary saving behavior in anticipation of, for instance, a negative income shock. Second, such a case can be ruled out if the discovery is sufficiently large, so that the new deposits overcompensate for the rapacious extraction prior to discovery (path (c) in Figure 2). The exact condition for the latter case is

$$\ln(1 + \Delta) > (\gamma^d - \gamma)\tau, \tag{16}$$

where $\Delta$ represents the ratio of the newly discovered deposits to the existing stock, and $\gamma^d$ stands for the extraction speed before discovery (illustrated by path (a) in

Figure 2). Thus, if the discovery is large, i.e. $\Delta$ is large, and occurs relatively soon within a leader's tenure, i.e. $\tau$ is small, then even with rapacious extraction, in the sense of $\gamma^d > \gamma$, the condition above is likely to be satisfied. Because we focus only on giant oil and gas discoveries in our empirical investigation, we shall assume for the rest of our theoretical analysis that (16) holds. If that is the case, then a discovery always leads to a larger oil stock on date $\tau$, compared to a counterfactual no-discovery case.[20] We will explicitly refer to Eq. (16) in one of our main testable hypotheses in the next section.

**Remark:** *The effect of a random discovery on the equilibrium leadership duration is qualitatively equivalent to an increase in $S_0$ in our resource-coup model of the previous subsection.*

Let us define the average duration of leadership as $D = T^*/(1 - \nu^*)$, where $T^*$ and $(1 - \nu^*)$ are equilibrium time to coup and probability of coup success, respectively. If O succeeds with probability 1, i.e. $\nu = 0$, then the duration is simply the time until the coup is staged $T^*$. If the probability of success is one half, the average duration is $2T^*$ and so on. After substituting for $1 - \nu^*$ from (14), we obtain

$$D = T^* \left(1 + \frac{\alpha}{\xi^*}\right). \tag{17}$$

By differentiating (17) with respect to $S_0$ we may decompose the effect of discovery on $D$ into the effect on the timing, $\frac{dT^*}{dS_0}$, and the effect on the relative military power, $\frac{d\xi^*}{dS_0}$:

$$\frac{dD}{dS_0} = \left(1 + \frac{\alpha}{\xi^*}\right) \frac{dT^*}{dS_0} - \frac{T^* \alpha}{\xi^{*2}} \frac{d\xi^*}{dS_0}. \tag{18}$$

In order to find $\frac{dT^*}{dS_0}$ and $\frac{d\xi^*}{dS_0}$, we differentiate the system of equations (12) - (15) and obtain

**Lemma 1:** *If the degree of repression is sufficiently high, an increase in the resource endowment leads to (a) a higher equilibrium time to coup; (b) a lower equilibrium ratio of military spending, or equivalently, a lower probability of coup success.*

[20] Note that a "no discovery case" can occur in three scenarios: (i) There are resource deposits in the ground but the leader is "unlucky" and does not discover them (path $a$ in Figure 2); (ii) there are no more deposits in the ground and this is not known (also path $a$); (iii) there are no more deposits and this is known (path $b$). The first two scenarios correspond to stochastic extraction at rate $\gamma^d$, while the last scenario corresponds to a deterministic extraction at rate $\gamma < \gamma^d$.

**Proof:** provided in the Appendix.

The results in Lemma 1 imply that the overall effect of discovery on duration is positive. Furthermore, we know from Eq. (16) that the larger the newly discovered deposits and/or the sooner the discovery occurs within the leader's tenure, the larger the increase in $S_\tau$ and therefore the stronger the effect of discovery on duration. In light of this result and the Lemma, we obtain:

**Proposition 1:** *When a resource discovery is sufficiently large and/or it occurs relatively soon within a leader's tenure, it lengthens the expected leadership duration.*

**Proof:** follows from Lemma 1 and (18).

To understand the intuition behind Lemma 1 and Proposition 1, it is useful to return to eqs. (11) - (15) while keeping $\gamma^c$ constant for the moment. Eq. (11) shows that the optimal timing of the coup equates the marginal benefit of postponing the coup by an instant to the marginal cost of doing so. An increase in $S_0$ raises both the marginal benefit on the left-hand side and the marginal cost on the right-hand side. The increase in the marginal benefit is due to the increase in the value of shared rents, while the increase in the marginal cost is given by higher expected oil rents which would be forgone if the coup is delayed. Eq. (12) tells us that the marginal benefit from delaying the coup by an instant increases by more, following a rise in $S_0$, than the marginal cost, provided our Assumption 1 holds. Hence, an increase in oil endowment makes delaying the coup more desirable. Alternatively, one can see that an increase in $S_0$ also increases the present value of oil rents on the left-hand side of (12) and only by delaying the attack this present value can be reduced back to the one consistent with optimality of $T$.

Turning to eq. (13), we see that oil endowment has no direct effect on $\xi^*$. This occurs because the marginal benefit of military investment for both factions is proportional to the present value of post-coup oil rents. Thus, the influence of oil endowment on $\xi^*$ works only through its effect on $T^*$. We have just established that the coup will be delayed following an increase in $S_0$. By (13), a delay of the coup (higher $T$) reduces the marginal benefit of military investment on the left-hand side of (10), i.e. the stakes become lower, and calls for a reduction in $m^o$, thus reducing $\xi^*$. Overall, we obtain that a larger $S_0$ leads to a higher $T^*$ and a lower $\xi^*$ in equilibrium.

So far, however, we have kept $\gamma^c$ fixed but it too depends on $T$ and $\xi$ in equilibrium through $\psi$ and $\nu$ in eq. (5). It can be shown (see Appendix) that additional effects working through changes in $\gamma^c$ only alter the magnitudes of the effects described above but do not lead to changes in the sign of $\frac{dT^*}{dS_0}$ and $\frac{d\xi^*}{dS_0}$, provided that repression is sufficiently harsh, which should be expected to be the case in dictatorial regimes. Proposition 1 and Lemma 1 yield several testable implications which we explore empirically in the next Section.

## 3 Empirical Evidence

Our first testable hypothesis is based on our main result that a large discovery increases duration:

**Hypothesis 1**: *Ceteris paribus, an autocratic leader who discovers a giant oil or gas field faces a lower political hazard rate than a similar leader with no discovery.*

According to our theoretical model, there are two driving forces behind Hypothesis 1, reflected in Lemma 1. In order to test the two channels, we formulate our sub-hypotheses as

**Hypothesis 1a**: *A discovery delays the time until a coup is staged.*

**Hypothesis 1b**: *A discovery reduces the probability of coup success.*

Our second main hypothesis reflects Eq. (16) and reads

**Hypothesis 2**: *A discovery occurring early in the tenure of a leader has a stronger positive effect on survival than later discoveries.*

**Identification strategy:** Ideally, we would test these hypotheses by an experiment where autocratic leaders were randomly assigned increases in their oil reserves. Clearly, this is not feasible. Instead, we use observed discoveries, the measure of a change in resource wealth that most closely resembles such an experiment. The identification strategy relies on the fact that while leaders may to some extent be able to influence exploration, they cannot decide *when* a discovery is going to occur. That is, we assume that, conditional on exploration effort and other covariates, discovering a giant oil/gas field is exogenous to political outcomes. We cannot fully test for the exogeneity assumption, but a "placebo in time" discovery set 5 years prior to the observed discovery shows no effect.

We test hypotheses (H1) and (H2) with a Cox proportional hazards model, which estimates the change in the hazard of failing in a coup following an oil discovery. A lower hazard means that finding oil at time $t$ tends to increase the time the leader spends in office. We test hypothesis (H1a) with a Weibull accelerated failure model, which estimates how the remaining time until an event changes in response to a unit change in a covariate. We test hypothesis (H1b) with a logit probability model. Alternative specifications and robustness checks are provided in the appendix.

### 3.1 Data

Our main variable of interest is the duration of autocratic leadership. We use the ARCHIGOS 4.1 dataset on leadership durations for data on length of tenure for leaders (Goemans *et al.* , 2009). The dataset includes all leadership durations since 1875, and is not left-censored or truncated as the dataset includes the start date for the leadership tenures that started before 1875. We are only interested in internally motivated irregular failures of leaders, so we code as a failure only IRREGULAR turnover which is defined as the leadership ending in some sort of internal coup, assassination, or revolution – any other end to the leadership is treated as censored.[21] A leader that steps down voluntarily (e.g. new leaders within the Chinese communist party), even if it is due to pressure from the population (e.g. Pinochet in Chile), is thus not coded as a failure. We also exclude leaderships that end through international intervention (e.g. Saddam Hussain in Iraq), as we do not look at the effect of natural resources on international conflict. Only a leadership duration that ends in a successful internal power change (e.g. Mobuto in Zaire) is coded as a failure. Including regular turnovers as failures would likely bias our estimates downwards, and they would be uninformative about the effect resource wealth has on the *stability* of autocratic leaders.

For subhypotheses H1a and H1b, we require information on unsuccessful attempted coups. As the focus of ARCHIGOS dataset is on how a leadership transition happened, it does not include any information on attempted but failed coups. To test these, we use the data from Powell & Thyne (2011) which provide us with information on all attempted coups since 1950 but at a cost of reducing our time span to 1950-2010[22].

To create a variable for oil and gas discoveries during the tenure of a leader, we

[21] It is coded in the data as $numexit = 3$.

[22] We estimate hypotheses 1 and 2 with similarly restricted data in appendix B.8.4

use the Giant Oil and Gas Fields of the World database (Horn & Myron, 2011). The dataset includes the year, size and type of every giant oil and gas discovery since 1868.[23] Giant oil and gas fields are defined as those larger than 500 million barrels of ultimately recoverable oil or gas equivalent, so the dataset leaves out smaller discoveries. As the size estimates of oil fields can be unreliable, we code the discoveries as a dummy rather than using the size (see discussion in appendix B.7). Our dummy variable "turns on" for a leader when there is a discovery, meaning that it is coded as 1 for the year oil/gas is discovered, and remains 1 until the leader leaves office. This way we avoid potential size bias, as well as issues of autocorrelation when multiple discoveries occur within a short time period.

Following the literature, we use the Polity IV Project to restrict the datasets to leaders in autocracies (Marshall & Jaggers 2002). Polity2 is an index ranging from -10 to 10, where 10 is the most democratic and -10 is the most autocratic, and is a common measure of regime characteristics in the literature (see e.g. Cuaresma *et al.* , 2011; Andersen & Aslaksen, 2013). The Polity2 score reflects the extent to which a regime has certain attributes associated with democracies and autocracies, such as competitiveness and openness of the political process and executive recruitment, regulation of political participation and constraints on the chief executive (see POLITY IV codebook). Polity IV defines an autocracy as having a score of -6 or less, which we use here.[24] This leaves 527 leadership durations in 121 countries to work with, of which 79 find at least one giant oil or gas field.

In our robustness checks, we estimate our model with different definitions of autocracy by varying the cutoff and using a different dataset[25], compiled by Geddes

[23]Using several different sources for data over such a long time span creates some problems as the countries of the world have not been static since 1875. This becomes especially problematic for Russia, Germany, Vietnam and Yemen, as the Haber and Menaldo dataset considers these countries as unchanged for the entire period; i.e. there is no differentiation between Russia and the Soviet Union, between East and West Germany, North and South Vietnam, and North and South Yemen. Due to this difference, these countries are omitted from our sample during the periods when they were divided for the specifications where we use the Haber (2011) data. The Horn dataset uses only modern countries, but includes the coordinates for all the oil and gas fields. We could thus easily place the fields within the correct part of the country.

[24]One potential issue with using the Polity2 score as a cutoff is that this score is estimated yearly, and therefore varies within the leadership duration of many of the leaders. We choose to include all leaders who have ever had a polity score below our cutoff, to make sure that we include all leaders who have ever been considered autocratic. This means we include all leaders who transition from autocratic to intermediate or democratic, and all leaders who transition the other way as well. Not doing so would mean that we leave out leaders who choose to increase and/or decrease their level of repression - something that is likely to be done as a strategic action in order to increase the leadership duration, possibly as a response to the increases in resource wealth. We believe that leaving these leaders out would mean losing important information and limit our data unnecessarily.

[25]The dataset by Geddes *et al.* (2012) uses information on how a regime starts as the defining

*et al.* (2012), with largely similar results (see appendix B.8).

### Controls

The timing of a discovery is certainly subject to randomness, but the exploration effort could be an important determinant for the probability of discovery. This may not be an issue for our identification strategy as the leader typically has to rely on international companies to do the exploration, and cannot necessarily influence the probability of discovery this way. On the other hand, if oil companies are reluctant to engage in expensive explorations in countries with unstable regimes, the perceived stability of a leader may be an important determinant of the level of exploration in her country. We therefore include a series of controls to account for the perceived and real stability of the leader. We also control for exploration intensity using the number of wildcat wells drilled per year from the ASPO dataset in some specifications (from Cotet & Tsui, 2013a).

To improve accuracy, we control for other variables that may affect leadership durations. We include controls for the socio-economic situation such as GDP and GDP growth as a baseline, with additional controls for income from other resources, and oil already being discovered in the country (from Haber, 2011).

To control for the political situation in the country, we include the Polity2 score, and calculate the median duration of leaders prior to the leader in question from the ARCHIGOS data. Following Gleditsch & Ward (2006) and Haber & Menaldo (2011), we control for larger scale political trends by including diffusion of democracy in the world and in the region – measured as the percentage of countries that are considered democratic. We also include log of population to control for the size of the country (both from Haber, 2011). Finally, we include the age at entry for each leader from ARCHIGOS, as it is hypothesized that an older leader will be weaker than a younger leader (Andersen & Aslaksen, 2013; Cuaresma *et al.* , 2011; De Mesquita & Smith, 2010).[26]

Further, as argued by Andersen & Ross (2014), the nationalization movement, that for the most part occurred in the 1980s, may play an important role. Prior to the nationalization movement, most oil revenue went to large international companies that extracted the oil, rather than to the countries where the oil was found (see e.g.

feature of an autocracy and does not distinguish between individual leaders.

[26] One explanation, posited by De Mesquita & Smith (2010), argues that the power of an autocratic leader rests at least in part on his ability to provide future benefits for his followers, and a younger leader has a longer horizon for this provision.

Victor *et al.* 2011). We therefore include a dummy that indicates if a national oil company was ever set up in a given country prior to (or by) the leader in question. This allows us to control for this shift without reducing our sample size. The data comes from Ross & Mahdavi (2015). Using more detailed data on oil-companies' ownership structures, compiled by Brunnschweiler & Poelhekke (2021), does not change the results substantially. Further oil industry controls from ASPO through Cotet & Tsui (2013a) are incorporated in robustness checks in the appendix.

Note that while military spending plays a crucial role in the model, it is difficult to estimate and it is endogenous both in the model and in reality. We do not include it in the main specification, but explore it further in appendix B.3. Finally, we cluster all standard errors at the country level. The summary statistics are presented in Table 1.

**Table 1:** Summary statistics

| Variable | Mean | Std. Dev. | Min. | Max. | N |
|---|---|---|---|---|---|
| Duration, all | 10.246 | 11.06 | 0.005 | 49.314 | 529 |
| Duration, until failure | 8.197 | 10.022 | 0.005 | 49.314 | 529 |
| Oil/Gas discovery dummy | 0.173 | 0.379 | 0 | 1 | 529 |
| GDP per capita | 4.858 | 9.996 | 0.223 | 140.640 | 433 |
| GDP growth | 1.700 | 8.014 | -61.492 | 125.960 | 431 |
| Coal Income per capita | 16.755 | 74.101 | 0 | 1075.531 | 480 |
| Metals Income per capita | 32.562 | 108.329 | 0 | 1381.782 | 482 |
| Oil already disc. | 0.538 | 0.499 | 0 | 1 | 529 |
| Age at entry | 43.497 | 12.864 | 13 | 84 | 529 |
| Median duration of previous leaders | 2726.44 | 3063.662 | 41 | 17397 | 465 |
| Polity 2 | -6.777 | 2.867 | -10 | 10 | 529 |
| Population (log) | 15.832 | 1.524 | 11.712 | 20.993 | 467 |
| Nat'l oil company | 0.228 | 0.4195 | 0 | 1 | 529 |
| World democracy | 27.755 | 8.507 | 2.273 | 48.765 | 496 |
| Regional democracy | 12.582 | 16.615 | 0 | 90.909 | 496 |
| Military expenditure, 2016 USD | 3382.809 | 14697.95 | 1.619 | 250003 | 272 |
| Wildcats | 8.541 | 29.791 | 0 | 481 | 414 |

### 3.2 Econometric specifications

We use survival analysis to asses the impact of resource discoveries on leadership durations. Survival analysis has several advantages over other empirical strategies. First, it allows us to depart from the assumption of normally or symmetrically distributed error terms, which is not likely to hold on duration data (Cleves *et al.* , 2010). Second, survival analysis considers the timing of events, using more of the information in the data than other probability models. As the discovery variable is time-dependent, we cannot use non-parametric survival analysis to test our hypotheses. However, as this analysis helps us assess basic properties of the data, we explore it in appendix B.1. The semi-parametric and parametric regression models allow for time varying covariates, and we rely on these to test hypotheses H1, H1a, and H2.

The semi-parametric regression model, the Cox regression, takes the form

$$h_j(t|\boldsymbol{x_j}) = h_0(t)exp(\boldsymbol{x_j}\boldsymbol{\beta_x}), \tag{19}$$

where $h_0(t)$ is the baseline hazard and $h_j$ is the hazard faced by individual j. The baseline hazard is the hazard rate when all the covariates are zero. The results of the regression can be interpreted as "hazard ratios", i.e. the change in the hazard rate following a unit change in the independent variable.

The semi-parametric regression uses data to estimate the baseline hazard function, without imposing any restrictions on the shape of the hazard over time – except that it is assumed to be identical for all subjects. It is assumed that the covariates shift the hazard function multiplicatively.

The Parametric class models are written the same way as the Cox models, but require that we impose a functional form on $h_0(t)$. As Cleves *et al.* (2010) point out, these models use more of the available data, and are therefore more efficient than the semi-parametric models – but only if the baseline hazard is correctly specified. Based on Aikike's Information Criterion, the preferred baseline hazard function varies with the choice of covariates. We choose to rely on the results from the Cox regressions in the main analysis, as this does not require us to specify the shape of the baseline hazard function. For robustness, we include results using the parametric Weibull model.[27] Both models return very similar results.

As hypothesis H1a explicitly refers to the change in the time until a coup is staged, we use the accelerated failure time metric. This is only possible using parametric models, so here we rely only on the Weibull parametric model.

Hypothesis H1b is tested with a logit probability model, since the outcome of interest (i.e. success or failure of a coup) is a binary variable.

[27]We chose the Weibull model as it has a flexible form that allows time dependent and constant hazard.

### 3.2.1 Potential sources of bias

Our identification strategy rests on discoveries being exogenous conditional on covariates. If lower political risk makes oil companies more willing to participate in exploration, the exploration intensity – and by extension the chances of making a discovery – could be higher in more stable regimes. If this were the case, there would be an upward bias on the results.[28] We ran a series of checks to see whether political stability of a leader has any effect on drilling activity and did not find any statisitically significant results. We have also explored a possibility that drilling itself can drive our results (and not necessarily discoveries) and, again, did not find any evidence in support of that. If anything, more drilling is associated with higher, not lower, hazard. Even if the leader could influence exploration intensity one way or another, he could not know exactly when, where and how much oil/gas would be discovered. Moreover, as shown by Ahlvik & Torfinn (2019), more exploration effort does not necessarily lead to more discoveries, neither in terms of numbers nor in terms of size. Nonetheless, we include covariates to control for the political situation in the country. If these covariates capture the political situation as *perceived* by oil companies, the discovery variable is conditionally exogenous. We also control for the number of wildcat wells drilled – a proxy for exploration intensity – in some specifications, and find that this does not significantly alter the results (see also appendix B.5).

We do not include the discoveries of other resources, which potentially put a downward bias on the magnitude of the results. Leaving out other resource discoveries means that we are comparing autocratic leaders who find giant hydrocarbon reserves to a baseline that includes leaders who find no resources, and leaders who find resources other than oil and gas. This could bias the baseline hazard function upwards, and the difference to the hazard faced by discoverers will be lower than otherwise. However, Andersen & Aslaksen (2013) find that oil has the strongest effect on regimes. Thus it is likely that the bias is small, and if significant, it would reduce the magnitude of our estimates. We leave out small discoveries in the main specification, but including them does not change the main results (see appendix B.4).

The use of the dummy variable for discoveries makes the implicit assumption that the effect of a discovery does not depend on the size of the discovery. We do this

[28] Arezki *et al.* (2017) and Lei & Michaels (2014) argue that this potential bias is not a problem when using giant oil and gas discoveries.

to avoid the measurement error associated with the size of oil and gas fields, which could be large and non-random. Size estimates of oil discoveries are unreliable, and are typically only available with any level of certainty after production has started (see e.g. Laherrere, 2001; Owen *et al.* , 2010).[29] As we are not sure what the bias in the measurement of the size of the fields is, nor if it is a random bias (e.g. leaders could inflate/deflate the reported size of their reserves), we do not rely on size estimates in our main specification. Further, multiple discoveries often occur in a short time period, and by using the first discovery for each leader we avoid issues of autocorrelation. At the same time, using the dummy variable means we do not exploit all the information in the data. Based on our arguments we maintain that the dummy variable is the best choice for the estimation but we do explore the effect of discovery size in the appendix (section B.7).

Another issue could be that the extraction of oil usually begins on average 6-8 years after a discovery (Arezki *et al.* , 2017). One could thus argue that we should include the discoveries with a similar time lag, or that the discovery variable does not affect leadership duration through the increase in wealth. However, once an oil discovery has been made public, the leader will immediately have access to international credit using the future oil revenues as collateral. Indeed, Arezki *et al.* (2017) find that the Current Account of a country tends to go negative immediately after a discovery and a few years following, indicating that foreign funds are flowing into the country. If there is an inflow of foreign funds before production starts, the leader can start rent seeking and use the funds to counteract a coup immediately following a discovery.[30]

[29] Indeed, the size of the field reported in our data gives the size of the reserves as it is known *today*, not what it was initially estimated to be. Further, enhanced recovery methods have increased the amount of recoverable resources over time. Thus the difference between the currently estimated size of the field and the initially estimated size is another source of measurement error.

[30] Indeed, if the leader can use the funds from oil to lower the probability of a successful coup, the effect of the gap between discovery and extraction can be very important as the leader will have access to funds sooner than the opposition. While rebel leaders might appropriate resource flows once production has started, it seems unlikely that the international credit market will extend loans based on the possibility of a successful coup (see Ross, 2004), but note that this is not impossible. Ross (2005) provides case studies of rebel groups that have borrowed against their future leadership rents. If the incumbent is the only player that can rely on the added wealth from the discovery, he might gain an upper hand versus his opposition in a way that would not be possible with discoveries of other resources.

### 3.3 Results

This section presents the empirical results. First, we test hypothesis (H1) on the overall relationship between autocratic leadership duration and hydrocarbon discoveries. Then we provide results on sub-hypotheses (H1a) and (H1b), the two channels through which discoveries may affect leadership duration: (a) time to attack and (b) probability of coup success. Finally, we present the results on hypothesis (H2): an earlier discovery prolongs a leader's tenure more than a late discovery.

#### 3.3.1 Hypothesis 1: Discoveries and Political Survival

Table 2 reports the results of the semi-parametric estimation of Eq. (19). We report exponentiated coefficients which can be interpreted as hazard ratios; a value below (above) unity indicates that the variable in question decreases (increases) the hazard rate relative to the baseline hazard. We introduce economic controls in column 2, resource controls in column 3, political and leader controls in column 4, all the above controls in column 5, and finally exploration intensity in column 6. Column 7 shows the results of the parametric specification with a Weibull baseline hazard and the Accelerated Failure Time (AFT) metric.

The results show that the coefficient on the discovery dummy is below unity and significant at the 5% level or lower in every specification, suggesting that a discovery lowers the political hazard or increases the chance for an autocratic leader to stay in power. A giant oil/gas field discovery lowers the hazard rate faced by a leader by roughly 40% to 50%. The AFT specification (last column) shows that a discovery at time $\tau$ increases the remaining time to failure by a factor of 2.29: For example, if a leader, who would have been in power for 10 years, finds oil in year 5, his time to failure increases from 5 years to 11.45 years and his overall tenure from 10 years to 16.45 years. While the sign is as expected, the magnitude may be somewhat surprising. Note however, that the discovery variable indicates an increase in known stock of resources by at least 500 million barrels of oil equivalent, with the average discovery size being around 6 billion barrels (for context, Norway's total oil reserves are around 8 billion barrels today). Assessing the effect of increased oil production on leadership durations, Cuaresma *et al.* (2011) also find a large effect: increasing oil production by 1000 barrels/day leads to more than a 30% increase in duration.

Looking at the economic controls, we find that higher GDP per capita tends to be associated with lower hazard rates. However, the effect is small and not statistically significant. Increasing GDP growth by one percentage point lowers the hazard rate by 1-2%. These results are as expected and in line with previous research. Higher growth is likely to increase the opportunity cost of a coup by increasing the return to non-political employment. Of the other economic variables, only coal income has a statistically significant effect on failure (increasing income from coal per capita by 1000 USD lowers the hazard rate by 1-2%). The importance of coal is not surprising, as our sample includes periods where coal was a more important fuel source than oil. Income from metals does not appear to have a significant effect. This could indicate that fuels are more important than other resources when it comes to determining political outcomes (see e.g. Andersen & Aslaksen, 2013, for an analysis of different resources). Prior establishment of an oil company appears to have an ambiguous effect on hazard, and the effect is not statistically significant.

Age at entry has the expected sign and is significant: an older leader faces a higher hazard rate since they may be perceived as weaker than their younger counterparts. A longer median duration of previous leaders, which indicates a more stable country, unsurprisingly lowers hazard. While regional democracy remains insignificant, world democracy appears to significantly decrease hazard. It is somewhat surprising that a more democratic world helps autocratic rulers. This could mean that the democracy variable captures something more than just democratic trends. For instance, if increasing the level of democracy is associated with a more stable political climate, this could spill over to autocratic leaders as well. The coefficient on the Polity2 score is above 1, indicating that a lower level of repression increases hazard. Given that all the observations in the sample are autocratic, this means that changing from a very repressive to a slightly less repressive regime is associated with a higher hazard. This is in line with previous empirical research (e.g. Gates *et al.* , 2006) and with our theoretical model. However, the effect is not statistically significant.

Overall, these results indicate that discovering a giant oil or gas field lowers the political hazard of an autocratic leader, providing evidence in support of our first hypothesis (H1). An increase in oil wealth thus appears to have a stabilizing effect on autocracies. As the results hold for the whole sample, we conclude that oil does appear to influence politics, that it stabilizes and thus perpetuates autocracy, and that these properties have been present for a long time.

We conduct a series of robustness checks and report the results in appendix B: the effect of military spending and wildcat drilling, size and number of discoveries, and time; different definitions of autocracy and failure, different covariate selection, and different econometric models. The results are also robust to shared frailty models (analogous to random effects[31]) at the region, country and leader level. All these alternative specifications point to the same conclusion: discoveries tend to stabilize autocracies.

**Table 2:** Results, Hypothesis 1: Discoveries and leader survival

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| VARIABLES | Hazard ratio | Hazard ratio | Hazard ratio | Hazard ratio | Hazard ratio | Hazard ratio | Parametric Time Ratio (Weibull) (see note) |
| Oil/Gas discovery | 0.562*** | 0.501*** | 0.484*** | 0.522** | 0.507** | 0.325*** | 2.291* |
| | (0.120) | (0.110) | (0.117) | (0.152) | (0.148) | (0.122) | (1.043) |
| GDP per capita | | 0.992 | 0.995 | 0.957* | 0.978 | 0.975 | 1.031 |
| | | (0.0148) | (0.0122) | (0.0232) | (0.0152) | (0.0167) | (0.022) |
| GDP growth | | 0.973*** | 0.975*** | 0.974** | 0.973** | 0.968** | 1.044*** |
| | | (0.00909) | (0.00899) | (0.0103) | (0.0104) | (0.0122) | (0.0161) |
| Coal Income per capita | | | 0.990** | | 0.989* | 0.917** | 1.016* |
| | | | (0.00474) | | (0.00584) | (0.0386) | (0.00935) |
| Metals Income per capita | | | 1.000 | | 1.000 | 1.000 | 1.000 |
| | | | (0.000818) | | (0.000913) | (0.000851) | (0.00137) |
| Oil already disc. | | | 0.828 | | 0.720 | 1.193 | 1.574 |
| | | | (0.160) | | (0.154) | (0.408) | (0.501) |
| Age at entry | | | | 1.001*** | 1.001*** | 1.001*** | 0.998*** |
| | | | | (0.000357) | (0.000332) | (0.000372) | (0.000591) |
| Median duration | | | | 1.000** | 1.000** | 1.000** | 1.000** |
| | | | | (4.11e-05) | (4.59e-05) | (5.55e-05) | (6.82e-05) |
| Polity 2 | | | | 0.984 | 1.004 | 1.014 | 1.006 |
| | | | | (0.0267) | (0.0261) | (0.0292) | (0.0407) |
| Population (log) | | | | 0.938 | 1.005 | 0.948 | 0.994 |
| | | | | (0.0643) | (0.0739) | (0.0824) | (0.108) |
| Nat'l oil company | | | | 1.117 | 1.279 | 0.958 | 0.790 |
| | | | | (0.288) | (0.367) | (0.349) | (0.361) |
| World democracy | | | | | 0.967*** | 0.965** | 1.045** |
| | | | | | (0.0111) | (0.0161) | (0.0190) |
| Regional democracy | | | | | 0.999 | 1.002 | 1.000 |
| | | | | | (0.00529) | (0.00564) | (0.00772) |
| Exploration intensity (Wildcats) | | | | | | 1.011* | |
| | | | | | | (0.00620) | (0.00670) |
| Constant | | | | | | | 1.065 |
| | | | | | | | (1.436) |
| p | | | | | | | 0.658*** |
| | | | | | | | (0.0534) |
| Leaders | 527 | 429 | 426 | 383 | 382 | 273 | 382 |
| Failures | 207 | 170 | 169 | 149 | 149 | 105 | 149 |

Standard errors clustered on the country level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### 3.3.2 Sub-hypothesis 1a: Time to Attack

Our theoretical model predicts that an oil discovery will increase the time until a coup is staged. A parametric Weibull model allows us to use the accelerated failure metric, i.e. estimate if a change in a variable speeds up or slows down the time until an event. We specify the event in this case as the first staged coup regardless of its success status and we do not consider subsequent coups. If no coups are staged over the whole tenure of a leader (i.e. he leaves the sample voluntarily, or is removed by

[31] Shared frailty allows for multiplicative heterogeneity of baseline hazard functions (Gutierrez, 2002)

external forces/death), he is considered censored. We include the same controls as for (H1).

The results are reported in Table 3. A positive coefficient indicates a slowing down of time until the event. Our results show that there is a large, statistically significant impact on the time until the first coup is staged: following an oil discovery, the time of the coup is increased by a factor of 3 to 4 relative to no discovery. For example, if the opposition plans a coup in year 5 and a discovery occurs in year 4, the coup will be postponed to year 7 or 8. The data thus supports Hypothesis 1a.

**Table 3:** Results, Hypothesis 1a: Time to any coup ($T$)

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| VARIABLES | Time Ratio | Time ratio | Time ratio | Time ratio | Time ratio |
| Oil/Gas discovery | 4.761*** | 3.805** | 4.319** | 2.680** | 3.156** |
| | (2.768) | (2.434) | (2.639) | (1.338) | (1.501) |
| Exploration intensity (wildcats) | | | | | 0.994 |
| | | | | | (0.0102) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | ✓ | ✓ |
| Pol. controls | | | | ✓ | ✓ |
| Constant | 9.604*** | 6.894*** | 5.618*** | 0.114 | 0.0520 |
| | (1.814) | (1.468) | (1.327) | (0.386) | (0.135) |
| p | 0.522*** | 0.510*** | 0.514*** | 0.568*** | 0.668*** |
| | (0.0203) | (0.0211) | (0.0220) | (0.0495) | (0.0586) |
| Leaders | 366 | 343 | 343 | 123 | 105 |
| Failures | 283 | 269 | 269 | 101 | 88 |

Standard errors clustered on the country level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### 3.3.3 Sub-hypothesis 1b: Probability of Success

In order to test the sub-hypothesis (H1b), we use the Powell & Thyne (2011) data on coup attempts. This gives us a sample of 186 coup attempts, of which 118 failed. We can see from the raw data in Table 4 that fewer coups appear to succeed if the leader has had an oil discovery.

We test this formally using a logit model with lagged control variables, following De Bruin (2018). Results are reported in Table 5. The estimated coefficients indicate that the probability of a coup succeeding is lower if a leader has had a discovery but the coefficients are not statistically significant in any specification. Using a Heckman selection model to control for selection into coup attempt returns similar results (not reported). The lack of statistical significance of the discovery estimate may be due to our rather small sample. On the other hand, it may also be interpreted as evidence suggesting that the coup was not a complete surprise for the leader, in which case the effect should be nil according to our theoretical model. Overall, we may conclude that the main driving force behind the increase in political survival is the delay of the coup following a discovery, while the decline in the success rate plays a secondary role.

**Table 4:** Summary statistics, Hypothesis 1b: Coup success $(1 - \nu)$

| | Total | Leader had no discovery | Leader had discovery |
|---|---|---|---|
| Total obs | 4159 | 3301 | 858 |
| No coup attempt | 3973 | 3138 | 835 |
| % years with attempts | 4.5% | 4.9% | 2.6% |
| Coup attempts | 186 | 163 | 23 |
| Failed | 118 | 100 | 18 |
| Successful | 68 | 63 | 5 |
| % successful coups | 36.6% | 38.7% | 21.7% |

**Table 5:** Results, Hypothesis 1b: Logistic regression on coup success

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| VARIABLES | Coup outcome | Coup outcome | Coup outcome | Coup outcome |
| Oil/Gas discovery | -0.992 | -0.669 | -0.783 | -0.190 |
| | (0.730) | (0.873) | (0.873) | (0.905) |
| Econ. controls | | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | ✓ |
| Pol. controls | | | | ✓ |
| Constant | -0.618*** | -0.718*** | -0.718** | -8.381** |
| | (0.185) | (0.213) | (0.293) | (3.760) |
| Observations | 175 | 153 | 153 | 142 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### 3.3.4 Hypothesis 2: Time of Discovery

The second prediction of the model is that an earlier discovery tends to have a larger effect on leader survival. In order to test this hypothesis, we proceed in two ways: (i) We split the discoveries into those that occur in the first 3 or 5 years of rule and those that occur later; (ii) we introduce a control variable $\tau$ defined as the number of years between the leader assumed power and discovered oil. The results of the first procedure are reported in columns (1) and (2) of Table 6. The coefficient on the early discovery variable is below 1, indicating that hazard falls by more than 60% if a discovery occurs within the first few years of tenure, and is statistically significant. Discoveries after three or five years also reduce hazard, but these are not statistically significant when early discoveries are accounted for. Similarly, including the variable $\tau$ in the regression indicates that a discovery lowers hazard, and as $\tau$ increases,

**Table 6:** Results, Hypothesis 2: Timing of discovery ($\tau$)

| VARIABLES | (1)<br>Hazard ratio<br>split at 3 years | (2)<br>Hazard ratio<br>split at 5 years | (3)<br>Hazard ratio<br>Tau |
|---|---|---|---|
| Early disc. | 0.333** | 0.394** | |
| | (0.143) | (0.150) | |
| Late disc. | 0.697 | 0.715 | |
| | (0.277) | (0.316) | |
| Oil/Gas discovery | | | 0.428** |
| | | | (0.169) |
| Tau | | | 1.025 |
| | | | (0.0345) |
| Econ. controls | ✓ | ✓ | ✓ |
| Res. controls | ✓ | ✓ | ✓ |
| Pol. controls | ✓ | ✓ | ✓ |
| Leaders | 382 | 382 | 382 |
| Failures | 149 | 149 | 149 |

Standard errors clustered on the country level in parentheses
*** p<0.01, ** p<0.05, * p<0.1

so does the hazard (column (3) of Table 6). The coefficient on $\tau$ is not statistically significant, however. Taken together, these results support the model's prediction that an earlier discovery has a stronger stabilizing effect on autocratic regimes than later discoveries.

### 3.4 Implications

What do our results tell us about the political properties of resource discoveries? The clear conclusions to be drawn are that (1) there is a statistically significant political effect of increasing resource wealth, and (2) this effect is positive for autocratic regimes, as large hydrocarbon discoveries tend to "help" dictators stay in power longer.

Thus it appears that resource wealth has a stabilizing effect in autocratic regimes. Does this mean that these results disprove the destabilizing effect of resource wealth that is shown in the conflict literature? Not necessarily. First, the effect of a resource endowment vs a resource discovery, i.e. of a stock vs a random increase in the stock, can be quite different. While Ross (2008) argues that the "blood barrels" of oil wealth fuel civil conflicts and ethnic grievances, Cotet & Tsui (2013a) find that oil *discoveries* have no statistically significant effect on civil conflict. Second, access to natural resources may decrease the chances of a leader failing in a coup, and at the same time increase the incidence and duration of conflict. It may be the case that long lasting autocratic regimes prevail centrally, while resource-fueled conflicts occur at the periphery. For instance, Berman *et al.* (2017) find that the location of mines increase local conflicts. Further, Le Billon (2012) points out that the location of oil fields relative to opposition groups and ethnic minority areas can drive conflicts. However, research indicates that civil war is more prevalent in less autocratic regimes (see Hegre, 2001). Further, as Cabrales & Hauk (2011) point out, scholars tend to find heterogeneous effects of resources across countries. It may well be the case that an increase in resource wealth leads to conflicts in some countries, while leading to stable regimes in others. Finally, we do not consider interstate conflicts, and Caselli *et al.* (2015) show that interstate conflicts are more likely to occur when resource deposits are located close to the border or when they are asymmetrically distributed vis-a-vis the border between two resource-endowed countries. Thus, while our work points to discoveries increasing one type of stability, it does not exclude that other types of destabilizing effects can be present as well.

While we find that discoveries are a boon for the dictators in power, we remain agnostic on the impact on the population. Our results do not directly support a resource *curse* hypothesis in a broader sense. Stable regimes may be preferable to unstable regimes, even if they happen to be autocratic. If oil discoveries also slow down democratic transition, then a stronger and longer autocratic regime may be undesirable insofar as democracy is a goal in itself. Using the Geddes *et al.* (2012) dataset, we tested the effect of discoveries on democratic transition in appendix B.9 and did not find strong evidence to support this hypothesis. Moreover, the population of a country may still prefer a stable autocratic regime that contributes positively to economic outcomes to a less repressive but *unstable* regime. Indeed, some countries have experienced very high growth rates under stable autocratic rulers (e.g. China and South Korea). On the other hand, some stable autocratic regimes have had devastating impacts on the economy of their country (e.g. Zimbabwe and the former Zaire). Certainly, unstable autocratic regimes have also seen poor economic outcomes (e.g. Nigeria). Recently, a question has emerged on whether autocracies are better than democracies at combating climate change (The Economist, 2019). Indeed, scholars have debated what the effect of autocratic leadership is on economic growth without arriving at a clear consensus (see e.g. Carden & James, 2013; Easterly, 2011).

Further, our empirical results add to the debate regarding the Haber & Menaldo (2011) analysis. Contrary to Haber & Menaldo, who find no evidence that increases in oil windfalls (measured by percent of resource rents in total government revenues or resource income per capita, i.e. flow variables) are associated with authoritarianism over a time span of over 200 years (1800-2006), our results indicate that hydrocarbon resources do have a strong political effect in autocratic regimes. Importantly, we find this effect to hold over a long time period as well, going back to before 1875 in some cases. Andersen & Ross (2014) argued that assuming the effect of oil wealth on political outcomes was constant over the 200 years is a weakness in Haber & Menaldo's approach. When allowing for a structural break around 1980 in the data of Haber & Menaldo, Andersen & Ross (2014) find a statistically significant effect of oil wealth on polity2 scores. Our results differ from both of these, as we show a statistically significant effect over almost the whole period considered by Haber & Menaldo, a much larger time period than in Andersen & Ross. However, our sample is different from both of these papers (we leave out several countries, and, perhaps crucially, only start including colonies after they are independent), and we use a different measure of the political outcome. Our results therefore complement the two papers by showing that (i) there is evidence of a political effect of resources in autocracies, and that (ii) this effect holds over a large time period.

While we remain confident that we have found evidence of a political effect of oil discoveries, our empirical results might not be generalizable to other resources (e.g. minerals or renewables). Andersen & Aslaksen (2013) find an effect only of oil, and we do not have access to data on other resource discoveries. Oil might be special, e.g. if the other resources do not have the same gap between discovery and production. Further, oil and gas are what Le Billon (2001) classifies as "point source" resources. He argues that the benefits of resources like oil (particularly offshore oil) that have easily controllable points of extraction, fall more directly to the elites of a country than "diffuse" resources like agriculture etc. The results shown in this paper are thus more likely to apply only to point source resources.

# 4 Conclusion

In this paper, we have investigated the question of whether resource discoveries influence duration of leadership in autocratic regimes. Autocratic leaders are well known for their reluctance to redeem power. Often, the only way to make them leave office is to stage a coup d'état or a revolution. A revolt is an even more attractive endeavor when the country is - or suddenly becomes - rich in natural resources. A large resource discovery may thus prompt an attack on the regime but it also enables the leader to improve her chances of staying in power by relaxing her budget constraint.

We have presented a dynamic stochastic model of a resource-driven coup shedding light on the two mechanisms which may influence leadership duration, namely the timing of the coup and probability of a successful overturn. We have shown that a large resource discovery induces the opposition to delay the attack and it reduces the chances of coup success. Thus the overall effect of the discovery is to prolong leadership duration. Moreover, we have shown that an earlier discovery reinforces this effect.

We have tested the model's predictions empirically using a long dataset on autocratic leaders and giant oil and gas discoveries starting from 1868. The empirical results largely confirm our hypotheses. On average, a giant discovery more than doubles remaining time to failure and lowers the hazard faced by a leader by 30 -50%. Following a discovery, the time of attack is pushed back by a factor of 3 to 4 relative to no discovery. We also find that the probability of coup success is reduced if a leader has had a discovery, although the estimated coefficient is not significant at conventional levels. We interpret this result as the evidence suggesting that the overall negative effect on hazard is driven by the delay of the coup rather than by the reduced chances of success.

The empirical results are consistent across time, holding for the entire period between 1868 and 2010. We can conclude that oil and gas discoveries tend to be beneficial for the stability of autocratic leaders. Depending on the extent to which our results are general to all resources, it means that increasing resource wealth in a country will stabilize and strengthen an autocratic regime. This points to the anti-democratic properties of resources, although our results do not directly support the resource-curse hypothesis.

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# Online Appendix

## A Appendix to Section 2

### A.1 Resource-driven Coup

**Incumbent**

The objective function of the incumbent is

$$\max_{R_t,m} \int_0^\infty \left\{ \int_0^T (1-\theta)p_t R_t e^{-\rho t} dt + \nu \int_T^\infty p_t R_t e^{-\rho t} dt - C(m)e^{-\rho T} \right\} \psi e^{-\psi T} dT \tag{A.1}$$

subject to the dynamic law for the stock of oil

$$\dot{S}_t = -R_t, \;\; S_0 \text{ given} \tag{A.2}$$

and the the oil demand funciton.

The post-coup problem is purely deterministic and the extraction follows the standard Hotelling path. To see this, consider the Hamiltonian associated with the post-coup problem when the coup fails:

$$H = pR - \lambda R, \tag{A.3}$$

where $\lambda$ is the co-state associated with the resource depletion constraint. The optimality conditions are:

$$R: \qquad p'R + p - \lambda = 0, \tag{A.4}$$

$$S: \qquad 0 = \rho\lambda - \dot{\lambda}. \tag{A.5}$$

From the first condition, combined with the oil demand function, we obtain

$$(1-\varepsilon)R^{-\varepsilon} = \lambda,$$

which yields, by log differentiation, $\hat{\lambda} = -\varepsilon \hat{R}$. The second optimality condition tells us that the growth rate of the shadow value of the resource must be equal to the rate of time preference, $\hat{\lambda} = \rho$. Combining both results we finally obtain:

$$-\varepsilon \hat{R} = \rho \;\text{ or }\; \hat{R} = -\frac{\rho}{\varepsilon}. \tag{A.6}$$

Defining $\gamma \equiv \frac{\rho}{\varepsilon}$, eq. (A.6) implies that $R_t = R_T e^{-\gamma(t-T)}$. Using this in $\dot{S}_t = -R_t$, along with $\lim_{t\to\infty} \lambda_t S_t e^{-\rho t} = 0$, yields $R_T = \gamma S_T$ and $S_t = S_T e^{-\gamma(t-T)}$, $\forall t > T$. The current value of the post-coup problem is then given by

$$V(S_t) = \int_t^\infty p_s R_s e^{-\rho(s-t)} ds = \frac{(\gamma S_t)^{1-\varepsilon}}{\gamma}. \tag{A.7}$$

The pre-coup problem can be analyzed with the aid of the HJB equation, given by

$$\rho V(S) = \max_R \left\{ (1-\theta)pR - V_S R + \psi \left[ \nu[\tilde{V}(S) - V(S)] + (1-\nu)[-V(S)] \right] \right\}, \tag{A.8}$$

where $\tilde{V}(S) = \frac{(\gamma S)^{1-\varepsilon}}{\gamma}$ by (A.7). The optimality conditions are

$$R: \quad (1-\theta)(p'R + p) - V_S = 0, \tag{A.9}$$

$$S: \quad \rho V_S = -V_{SS} R + \psi \left[ \nu \left( \frac{d\tilde{V}(S)}{dS} - V_S \right) - (1-\nu) V_S \right]. \tag{A.10}$$

These conditions can be rewritten as

$$V_S = (1-\theta)(1-\varepsilon)R^{-\varepsilon}, \tag{A.11}$$

$$\begin{aligned} \rho &= -\frac{V_{SS} R}{V_S} + \psi \left[ \nu \left( \frac{\frac{d\tilde{V}(S)}{dS}}{V_S} - 1 \right) - (1-\nu) \right] \\ &= -\varepsilon \hat{R} + \psi \left[ \nu \left( \frac{\frac{d\tilde{V}(S)}{dS}}{V_S} - 1 \right) - (1-\nu) \right], \end{aligned} \tag{A.12}$$

where the last equality follows from $-V_{SS}R = V_{SS}\dot{S} = dV_S/dt = -(1-\theta)(1-\varepsilon)\varepsilon R^{-\varepsilon}\hat{R}$.

Exploiting (A.7), we can make the following guess of the value function: $V(S) = \frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c} + X$, where $\gamma^c$ and $X$ are unknown constants. With this guess, $V_S = (1-\theta)(1-\varepsilon)(\gamma^c S)^{-\varepsilon}$. Substituting this into (A.11) yields $R = \gamma^c S$, so that

$\hat{R} = -\gamma^c$. In the meantime, eq. (A.12) becomes:

$$\rho = -\varepsilon\hat{R} + \psi\left[\nu\left[\frac{1}{1-\theta}\left(\frac{\gamma S}{\gamma^c S}\right)^{-\varepsilon} - 1\right] - (1-\nu)\right]$$
$$\rho = \varepsilon\gamma^c + \psi\left[\frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon} - 1\right]$$
$$\gamma^c = \frac{1}{\varepsilon}\left\{\rho + \psi\left[1 - \frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\right]\right\}, \tag{A.13}$$

which is an implicit equation in $\gamma^c$. This equation has a unique solution because (i) the LHS is a strictly increasing function of $\gamma^c$, while the RHS is a monotone decreasing and convex function of $\gamma^c$, and (ii) LHS evaluated at zero is zero and lies below the RHS evaluated at zero (which is equal to $(\rho + \psi)/\varepsilon > 0$).

In spite of the unavailability of an analytical solution for $\gamma^c$, we can nonetheless say something about the relationship between $\gamma^c$ and $\gamma$. Let us rewrite (A.13), recalling the definition of $\gamma$, as:

$$\gamma^c = \gamma + \frac{\psi}{\varepsilon}\left[1 - \frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\right]$$

Note that the term in the square brackets can be in general of ambiguous sign. First, suppose that $\theta = 0$ and that $\gamma^c < \gamma$. If this were true, then the above equation implies that the term in the square brackets must be negative. However, when $\gamma^c < \gamma$, the term $\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}$ is clearly less than unity, so that $1 - \nu\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}$ is unambiguously positive. Hence, $\gamma^c < \gamma$ cannot be true. Suppose next that $\gamma^c = \gamma$. Then the above equation implies that the term in the square brackets is zero. However, when $\gamma = \gamma^c$, this term becomes $(1-\nu) > 0$, hence the equality is violated. Therefore the only possibility is that $\gamma^c > \gamma$ when $\theta = 0$. Next, suppose that $\theta = 1 - \nu$ and do the same thought experiment as above. The result is that the only possibility is that $\gamma^c = \gamma$. Finally, if $\theta > 1 - \nu$, then the only constellation consistent with this is $\gamma^c < \gamma$.

In order to ensure that our value-function guess is correct, we need to verify the

HJB equation. We substitute our guess into eq. (A.8):

$$\rho\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}+\rho X=(1-\theta)R^{1-\varepsilon}-R(1-\theta)(1-\varepsilon)(\gamma^c S)^{-\varepsilon}+$$
$$+\psi\left\{\nu\left[\frac{(\gamma S)^{1-\varepsilon}}{\gamma}-\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}-X\right]+(1-\nu)\left[-\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}-X\right]\right\} \tag{A.14}$$

$$\rho\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}+\rho X=(1-\theta)(\gamma^c S)^{1-\varepsilon}-(1-\theta)(1-\varepsilon)(\gamma^c S)^{1-\varepsilon}+$$
$$+\psi\left\{\nu\left[\frac{(\gamma S)^{1-\varepsilon}}{\gamma}-\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}-X\right]+(1-\nu)\left[-\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}-X\right]\right\} \tag{A.15}$$

$$\rho\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}+\rho X=\varepsilon(1-\theta)(\gamma^c S)^{1-\varepsilon}+$$
$$+\psi\left\{\nu\left[S^{1-\varepsilon}(\gamma^{-\varepsilon}-(1-\theta)(\gamma^c)^{-\varepsilon})\right]-\nu X\right]+(1-\nu)\left[-\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}-X\right]\right\} \tag{A.16}$$

The next step is to look at the terms involving $S$ on both sides of the equation in order to solve for the unknown constant $\gamma^c$ and to compare it to our solution (A.13). Then we will equate the constant terms and solve for $X$. Starting with the terms in $S$ and dividing both sides by $\frac{(1-\theta)(\gamma^c S)^{1-\varepsilon}}{\gamma^c}$:

$$\rho=\varepsilon\gamma^c+\psi\left\{\nu\left[\frac{1}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}-1\right]-(1-\nu)\right\} \quad \text{or}$$
$$\gamma^c=\frac{1}{\varepsilon}\left\{\rho+\psi\left[1-\frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\right]\right\} \tag{A.17}$$

This expression is exactly our equation (A.13). Now we collect the constant terms:

$$\rho X=-\psi\nu X+\psi(1-\nu)(-X)$$
$$X(\rho+\psi\nu+\psi(1-\nu))=0$$
$$X=0. \tag{A.18}$$

To find the optimal military spending, we differentiate the objective (A.1) with respect to $m$:

$$
\begin{aligned}
&\int_0^\infty \left\{ \frac{\partial \nu}{\partial m} \left[ \int_T^\infty p_t R_t e^{-\rho t} dt \right] \right\} \psi e^{-\psi T} dT - C'(m)\psi \int_0^\infty e^{-(\rho+\psi)T} dT = 0 \\
&\int_0^\infty \left\{ \frac{\partial \nu}{\partial m} \left[ R_T^{1-\varepsilon} \frac{e^{-\rho T}}{\gamma} \right] \right\} \psi e^{-\psi T} dT - C'(m) \frac{\psi}{\rho+\psi} = 0 \\
&\int_0^\infty \left\{ \frac{\partial \nu}{\partial m} \left[ R_T^{1-\varepsilon} \frac{e^{-\rho T}}{\gamma} \right] \right\} e^{-\psi T} dT - \frac{C'(m)}{\rho+\psi} = 0 \\
&\frac{\partial \nu}{\partial m} \int_0^\infty \left\{ R_T^{1-\varepsilon} \frac{e^{-\rho T}}{\gamma} \right\} e^{-\psi T} dT - \frac{C'(m)}{\rho+\psi} = 0 \\
&\frac{\partial \nu}{\partial m} \int_0^\infty \left\{ (\gamma S_0 e^{-\gamma^c T})^{1-\varepsilon} \frac{e^{-\rho T}}{\gamma} \right\} e^{-\psi T} dT - \frac{C'(m)}{\rho+\psi} = 0 \\
&\frac{\partial \nu}{\partial m} \gamma^{-\varepsilon} S_0^{1-\varepsilon} \int_0^\infty e^{-[\gamma^c(1-\varepsilon)+\rho+\psi]T} dT - \frac{C'(m)}{\rho+\psi} = 0 \\
&\frac{\partial \nu}{\partial m} \left[ \frac{(\rho+\psi)\gamma^{-\varepsilon} S_0^{1-\varepsilon}}{\gamma^c(1-\varepsilon)+\rho+\psi} \right] = C'(m) \qquad \text{(A.19)}
\end{aligned}
$$

### A.1.1 Opposition

The objective function of O is

$$
\max_{T,m^o} \quad \theta(\gamma^c S_0)^{1-\varepsilon} \frac{1-e^{-\beta T}}{\beta} - \delta \frac{1-e^{-\rho T}}{\rho} + (1-\nu) e^{-\rho T} \gamma^{-\varepsilon} (S_T)^{1-\varepsilon} - C^o(m^o) e^{-\rho T} \qquad \text{(A.20)}
$$

Defining $\beta \equiv \gamma^c(1-\varepsilon) + \rho$, the first-order conditions read:

$$
\begin{aligned}
m^o: &\quad -\frac{\partial \nu}{\partial m^o} \left[ e^{-\rho T} \gamma^{-\varepsilon} S_T^{1-\varepsilon} \right] - C^{o'}(m^o) e^{-\rho T} = 0 \qquad \text{(A.21)} \\
T: &\quad \theta(\gamma^c S_0)^{1-\varepsilon} \frac{-e^{-\beta T}(-\beta)}{\beta} - \delta \frac{e^{-\rho T}\rho}{\rho} + (1-\nu)\gamma^{-\varepsilon} \times \\
&\quad \times [-S_0^{1-\varepsilon} e^{-\gamma^c(1-\varepsilon)T} \gamma^c(1-\varepsilon) + (-\rho) S_T^{1-\varepsilon}] e^{-\rho T} + \rho C^o e^{-\rho T} = 0. \qquad \text{(A.22)}
\end{aligned}
$$

The first condition yields Eq. (10) in the text:

$$
-\frac{\partial \nu}{\partial m^o} \left[ \gamma^{-\varepsilon} S_T^{1-\varepsilon} \right] = C^{o'}(m^o), \qquad \text{(A.23)}
$$

which can also be written as

$$
\frac{\nu(1-\nu)}{m^o} \gamma^{-\varepsilon} S_T^{1-\varepsilon} = c \;\text{ or }\; C^o = \nu(1-\nu)\gamma^{-\varepsilon} S_T^{1-\varepsilon}.
$$

The second-order condition is given by

$$\gamma^{-\varepsilon}S_T^{1-\varepsilon}\frac{\partial\nu}{\partial m^o}(1-2\nu)-c=-2\nu c<0.$$

Multiplying both sides of (A.22) by $e^{-\rho T}$, we obtain

$$\theta(\gamma^c S_0)^{1-\varepsilon}e^{-(1-\varepsilon)\gamma^c T}-\delta-(1-\nu)\gamma^{-\varepsilon}\beta S_0^{1-\varepsilon}e^{-\gamma^c(1-\varepsilon)T}+\rho C^o=0$$
$$S_0^{1-\varepsilon}e^{-(1-\varepsilon)\gamma^c T}\left[\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}\beta\right]-\delta+\rho C^o=0, \tag{A.24}$$

which is the same as Eq. (11) in the text. The second-order condition is given by

$$-(1-\varepsilon)\gamma^c S_T^{1-\varepsilon}\left[\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}\beta\right]<0\Leftrightarrow\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}\beta>0.$$

The last inequality also implies that $\delta>\rho C^o$.

Inserting the expression for $C^o$ into (A.24), yields:

$$S_0^{1-\varepsilon}e^{-(1-\varepsilon)\gamma^c T}\left[\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}\beta+\rho\nu(1-\nu)\gamma^{-\varepsilon}\right]=\delta.$$

Because the left-hand side is a decreasing convex function of $T$, while the right-hand side is constant, an interior solution exists if and only if the left-hand side evaluated at zero lies above $\delta$, i.e. $S_0^{1-\varepsilon}\left[\theta(\gamma^c)^{1-\varepsilon}-(1-\nu)\gamma^{-\varepsilon}(\beta-\rho\nu)\right]>\delta$.

### A.1.2 Incentive-compatibility Constraint

If O refrains from staging a coup, her lifetime welfare is given by

$$W_{nc}^o=\int_0^\infty(\theta p_t R_t-\delta)e^{-\rho t}dt=\theta(\gamma^c S_0)^{1-\varepsilon}\frac{1}{\beta}-\frac{\delta}{\rho}.$$

If she does stage a coup at the optimally chosen time $T$, her expected lifetime welfare is

$$W_c^o=\theta(\gamma^c S_0)^{1-\varepsilon}\frac{1-e^{-\beta T}}{\beta}+(1-\nu)\gamma^{-\varepsilon}S_T^{1-\varepsilon}e^{-\rho T}-\delta\frac{1-e^{-\rho T}}{\rho}-C^o e^{-\rho T}.$$

Comparing $W_c^o$ with $W_{nc}^o$, we obtain:

$$\begin{aligned}
\theta(\gamma^c S_0)^{1-\varepsilon}\frac{1-e^{-\beta T}}{\beta} + (1-\nu)\gamma^{-\varepsilon} S_T^{1-\varepsilon} e^{-\rho T} - \delta\frac{1-e^{-\rho T}}{\rho} - C^o e^{-\rho T} &\sim \theta(\gamma^c S_0)^{1-\varepsilon}\frac{1}{\beta} - \frac{\delta}{\rho} \\
-\theta(\gamma^c S_0)^{1-\varepsilon}\frac{e^{-\beta T}}{\beta} + (1-\nu)\gamma^{-\varepsilon} S_T^{1-\varepsilon} e^{-\rho T} + \delta\frac{e^{-\rho T}}{\rho} - C^o e^{-\rho T} &\sim 0 \\
-\theta(\gamma^c)^{1-\varepsilon}\frac{S_T^{1-\varepsilon}}{\beta} + (1-\nu)\gamma^{-\varepsilon} S_T^{1-\varepsilon} + \frac{\delta}{\rho} - C^o &\sim 0 \\
S_T^{1-\varepsilon}\frac{\rho}{\beta}\left[-\theta(\gamma^c)^{1-\varepsilon} + (1-\nu)\gamma^{-\varepsilon}\beta\right] + \delta - \rho C^o &\sim 0 \\
-S_T^{1-\varepsilon}\frac{\rho}{\beta}\left[\theta(\gamma^c)^{1-\varepsilon} - (1-\nu)\gamma^{-\varepsilon}\beta\right] &\sim -(\delta - \rho C^o) \\
-\frac{\rho}{\beta}(\delta - \rho C^o) &\sim -(\delta - \rho C^o) \\
-\frac{\rho}{\beta} &> -1,
\end{aligned}$$

where we used the first-order condition with respect to $T$ and the fact that $\rho < \beta$, since $\beta \equiv (1-\varepsilon)\gamma^c + \rho$.

### A.2 Equilibrium

Given the functional form of $\nu$, we have

$$\frac{\partial \nu}{\partial m} = \frac{m^o}{\alpha m + m^o} \times \frac{\alpha m}{\alpha m + m^o} \times \frac{1}{m} = \frac{\nu(1-\nu)}{m}$$

$$\frac{\partial \nu}{\partial m^o} = -\frac{m^o}{\alpha m + m^o} \times \frac{\alpha m}{\alpha m + m^o} \times \frac{1}{m^o} = -\frac{\nu(1-\nu)}{m^o}.$$

Thus, $-\frac{\partial \nu/\partial m}{\partial \nu/\partial m^o} = \frac{m^o}{m} \equiv \xi$. Dividing (A.19) by (A.23) we obtain:

$$\xi \frac{\frac{(\rho+\psi)\gamma^{-\varepsilon} S_0^{1-\varepsilon}}{\gamma^c(1-\varepsilon)+\rho+\psi}}{\gamma^{-\varepsilon} S_T^{1-\varepsilon}} = 1$$

or

$$\xi^* = \frac{\beta+\psi}{\psi+\rho} e^{-(1-\varepsilon)\gamma^c T^*}. \tag{A.25}$$

Using the last equilibrium condition $\psi = 1/T^*$, we obtain

$$\xi^* = \frac{\beta + 1/T^*}{1/T^* + \rho} e^{-(1-\varepsilon)\gamma^c T^*}. \tag{A.26}$$

### A.3 Effect of Discovery on Extraction Path

Consider the simplest extraction problem with a stochastic discovery. Assume that discovery follows the Poisson process with a constant intensity $\lambda$ and increment $dq_t$, so that the oil stock satisfies:

$$dS_t = -R_t dt + \bar{S} dq_t, \tag{A.27}$$

where $\bar{S}$ stands for the newly discovered deposits.

The objective is

$$\max_{R_t} \left\{ \int_0^\tau p_t R_t e^{-\rho t} dt + \int_\tau^\infty p_t R_t e^{-\rho t} dt \right\} \lambda e^{-\lambda \tau} d\tau$$

subject to the dynamic stochastic law of $S$ and the oil demand function. The extraction in the post-discovery phase proceeds at the rate $-\gamma$, derived earlier. We can write the HJB equation for the pre-discovery phase as:

$$\rho V(S) = \max \left\{ p_t R_t + V_S[-R_t] + \lambda \left[ V(\tilde{S}) - V(S) \right] \right\}$$

where $\tilde{S} = S + \bar{S}$ is the new oil stock after the discovery.

The optimality conditions are given by:

$$R : p'R + p - V_S = 0 \tag{A.28}$$

$$\rho V_S = -R V_{SS} + \lambda \left[ V_{\tilde{S}} \frac{d\tilde{S}}{dS} - V_S \right]. \tag{A.29}$$

Using the demand function in (A.28) and dividing both sides of (A.29) by $V_S$, yields:

$$R : (1 - \varepsilon) R^{-\varepsilon} = V_S \tag{A.30}$$

$$\rho = -\frac{R V_{SS}}{V_S} + \lambda \left[ \frac{V_{\tilde{S}}}{V_S} \frac{d\tilde{S}}{dS} - 1 \right]. \tag{A.31}$$

We can rewrite the term $-\frac{RV_{SS}}{V_S} = \frac{\dot{V}_S}{V_S} = \frac{-\varepsilon(1-\varepsilon)R^{-\varepsilon-1}\dot{R}}{(1-\varepsilon)R^{-\varepsilon}} = -\varepsilon \hat{R} = \varepsilon \gamma^d$, where we defined $\hat{R} \equiv \gamma^d$. Since we know the post-discovery solution and the associated value function $V(\tilde{S}) = \frac{(\gamma\tilde{S})^{1-\varepsilon}}{\gamma}$, we can write

$$\rho = \varepsilon\gamma^d + \lambda\left[\left(\frac{\gamma(S+\bar{S})}{R}\right)^{-\varepsilon} - 1\right]. \tag{A.32}$$

By rewriting the above expression, recalling that $\gamma = \rho/\varepsilon$, as

$$\left(\gamma^d - \gamma\right)\frac{\varepsilon}{\lambda} = 1 - \left(\frac{R}{\gamma(S+\bar{S})}\right)^{\varepsilon}$$

we see that the term on the right-hand side is likely to be positive because the ratio $\frac{R}{\gamma(S+\bar{S})}$ is likely to be less than unity. If this is the case, then $\gamma^d > \gamma$, i.e. the extraction in anticipation of discovery proceeds faster than in post-discovery phase.

In order to arrive at an explicit solution, we consider a variant of eq. (A.27) such that $\bar{S} = \Delta S$, i.e. the discovery is proportional to existing reserves (Pindyck 1987, Lafforgue 2004). Such an assumption can be justified by the observation that new discoveries typically occur near the existing deposits or near places where recent discoveries have been made. In addition, income from existing reserves can support investment in exploration. Furthermore, we consider a more general version of the instantaneous payoff of the CRRA form: $u(c) = \frac{c^{1-\eta}}{1-\eta}$, $\eta \geqslant 0$, $\eta \neq 1$, $c = pR$. With these modifications, eq. (A.32) becomes:

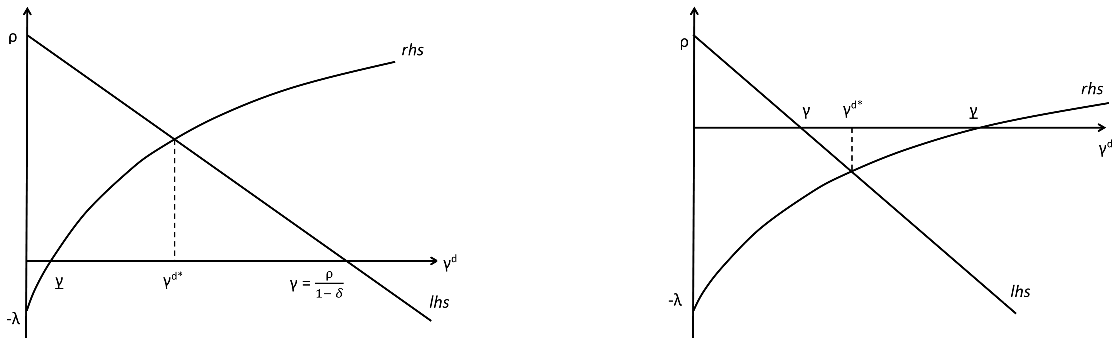
$$\rho = (1-\delta)\gamma^d + \lambda\left[\left(\frac{\gamma^d}{\gamma}\right)^{1-\delta}(1+\Delta)^{\delta} - 1\right], \tag{A.33}$$

where we defined for convenience $\delta \equiv (1-\varepsilon)(1-\eta)$. Rewrite this equation as:

$$\rho - \gamma^d(1-\delta) = \lambda\left[\left(\frac{\gamma^d}{\gamma}\right)^{1-\delta}(1+\Delta)^{\delta} - 1\right]. \tag{A.34}$$

The solution for $\gamma^d$ may be represented graphically as the intersection of the left-hand side, $lhs(\gamma^d) = \rho - \gamma(1-\delta)$, and the right-hand side $rhs(\gamma^d) = \lambda\left[\left(\frac{\gamma^d}{\gamma}\right)^{1-\delta}(1+\Delta)^{\delta} - 1\right]$. The function $lhs(\gamma^d)$ is decreasing and linear in $\gamma^d$ with the slope $-(1-\delta) < 0$ and the intercept with the vertical axes at $\rho > 0$ and with the horizontal axes at $\frac{\rho}{1-\delta} > 0$. The post-discovery extraction proceeds at the rate $-\gamma$, such that $\gamma = \frac{\rho}{1-\delta} > 0$. Thus the function $lhs$ intersects with the horizontal axes at $\gamma^d = \gamma$. The function $rhs$ is increasing and concave in $\gamma^d$ with the intercept with the vertical axes at $-\lambda < 0$ and with the horizontal axes at $\underline{\gamma} = \gamma \left[\frac{1}{(1+\Delta)^{\delta}}\right]^{\frac{1}{1-\delta}} > 0.$

**Figure 3:** Graphical solution of Eq. (A.34).




(a) (b)

If both $\eta$ and $\varepsilon$ lie between zero and unity or both lie above unity, i.e. $\delta > 0$, then $\underline{\gamma} < \gamma$, as shown in figure 3 (a). To see this, rewrite $\underline{\gamma}$ as $\underline{\gamma} = \gamma(1+\Delta)^{-\frac{\delta}{1-\delta}}$. Since $1+\Delta > 1$, the term $(1+\Delta)^{-\frac{\delta}{1-\delta}} \gtreqless 1 \Leftrightarrow \delta \lesseqgtr 0$. Therefore, the value of $\gamma^d$ which corresponds to the intersection between $lhs$ with $rhs$ is such that $\underline{\gamma} < \gamma^d < \gamma$. If, however, either $\eta$ or $\varepsilon$ exceed unity, while the value of the other parameter lies between zero and unity, i.e. $\delta < 0$, then we have the opposite case, depicted in figure 3 (b): $\gamma^d > \gamma$. To summarize, a possibility of oil discovery induces (i) a <u>faster</u> extraction in the pre-discovery phase, if either oil demand is elastic ($\varepsilon \in (0,1)$) and EIS is small ($\eta > 1$) or oil demand is inelastic ($\varepsilon > 1$) and EIS is large ($\eta \in (0,1)$) but (ii) a <u>slower</u> extraction if oil demand is elastic ($\varepsilon \in (0,1)$) and EIS is large ($\eta \in [0,1)$).

The analysis above implies that if extraction is more rapacious in the pre-discovery phase and the amount of discovered reserves is small, then the oil stock on the date of discovery, $t = \tau$, may be lower than in a determinisitc case without a possibility of discovery. We know that in the latter scenario extraction proceeds at the rate $\gamma$. Such a case can be ruled out if the newly-discovered deposits are sufficiently large, i.e. if

$$(1+\Delta)S_0 e^{-\gamma^d \tau} > S_0 e^{-\gamma \tau}$$

or

$$\ln(1+\Delta) > (\gamma^d - \gamma)\tau.$$

## A.4 Effect of Discovery on Leadership Duration

Consider average leadership duration defined as $D \equiv T^*/(1-\nu^*)$. The effect of discovery on average duration is equivalent to the effect of an increase in $S_0$ on $D$. Consider the system of equations (A.26) and (A.24) rewritten as:

$$A = \xi - \frac{\beta + 1/T}{1/T + \rho} e^{-(1-\varepsilon)\gamma^c T} = 0 \quad \text{(A.35)}$$

$$B = S_0^{1-\varepsilon} e^{-(1-\varepsilon)\gamma^c T} \left[\theta(\gamma^c)^{1-\varepsilon} - (1-\nu)\gamma^{-\varepsilon}\beta\right] - \delta + \rho C^o = 0. \quad \text{(A.36)}$$

Define for convenience $a \equiv \theta(\gamma^c)^{1-\varepsilon} - (1-\nu)\gamma^{-\varepsilon}\beta > 0$. Then totally differentiate the system, first keeping $\gamma^c$ fixed:

$$A = d\xi + \xi(1-\varepsilon)\gamma^c \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] dT = 0 \quad \text{(A.37)}$$

$$\begin{aligned} B = & \left[-aS_T(1-\varepsilon)\gamma^c + \rho C^{o'} \frac{\partial m^o}{\partial T}\right] dT + \left[\rho C^{o'} \frac{\partial m^o}{\partial \xi} + \beta\gamma^{-\varepsilon} S_T^{1-\varepsilon} \frac{\partial \nu}{\partial \xi}\right] d\xi + \\ & + \left[a(1-\varepsilon) S_0^{-\varepsilon} e^{-(1-\varepsilon)\gamma^c T} + \rho C^{o'} \frac{\partial m^o}{\partial S_0}\right] dS_0 = 0. \end{aligned} \quad \text{(A.38)}$$

Defining the partial derivatives by $\Delta_{i,j}$, $i = A, B$, $j = \xi, T, S_0, \theta$, we can rewrite the system in a simpler form as

$$\begin{bmatrix} \Delta_{A\xi} & \Delta_{AT} \\ \Delta_{B\xi} & \Delta_{BT} \end{bmatrix} \times \begin{bmatrix} d\xi \\ dT \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ -\Delta_{BS_0} & -\Delta_{B\theta} \end{bmatrix} \times \begin{bmatrix} dS_0 \\ d\theta \end{bmatrix}$$

where

$$\begin{aligned}
&\Delta_{A\xi} = 1 > 0, \\
&\Delta_{AT} = \xi(1-\varepsilon)\gamma^c \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] > 0, \\
&\Delta_{B\xi} = \rho C^{o'} \frac{\partial m^o}{\partial \xi} + \beta\gamma^{-\varepsilon} S_T^{1-\varepsilon} \frac{\partial \nu}{\partial \xi} = -\frac{1}{\xi}(1-\varepsilon)\gamma^c C^o < 0, \\
&\Delta_{BT} = -aS_T(1-\varepsilon)\gamma^c + \rho C^{o'} \frac{\partial m^o}{\partial T} < 0, \\
&\Delta_{BS_0} = a(1-\varepsilon) S_0^{-\varepsilon} e^{-(1-\varepsilon)\gamma^c T} + \rho C^{o'} \frac{\partial m^o}{\partial S_0} > 0, \\
&\Delta_{B\theta} = S_0^{1-\varepsilon} e^{-(1-\varepsilon)\gamma^c T} (\gamma^c)^{1-\varepsilon} > 0 \\
&M \equiv \begin{vmatrix} \Delta_{A\xi} & \Delta_{AT} \\ \Delta_{B\xi} & \Delta_{BT} \end{vmatrix} = \Delta_{A\xi}\Delta_{BT} - \Delta_{AT}\Delta_{B\xi}.
\end{aligned}$$

From Eq. (10) we can express $m^o$ as

$$m^o = \nu(1-\nu)\gamma^{-\varepsilon} S_T^{1-\varepsilon} \frac{1}{c}$$

and get

$$\begin{aligned}
\frac{\partial m^o}{\partial T} &= -m^o(1-\varepsilon)\gamma^c < 0, \\
\frac{\partial m^o}{\partial \xi} &= m = \frac{m^o}{\xi} > 0, \\
\frac{\partial m^o}{\partial S_0} &= \frac{(1-\varepsilon)m^o}{S_0} > 0.
\end{aligned}$$

In order to sign the expression for $M$, we write:

$$\begin{aligned}
M \quad &= -aS_T(1-\varepsilon)\gamma^c - \rho c m^o(1-\varepsilon)\gamma^c - \xi(1-\varepsilon)\gamma^c \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] \times \\
&\quad \times \left[\rho C^{o\prime} \frac{m^o}{\xi} - \beta\gamma^{-\varepsilon} S_T^{1-\varepsilon} \frac{\alpha}{(\alpha+\xi)^2}\right] \\
&= (1-\varepsilon)\gamma^c \left\{ -aS_T - \rho C^o - \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] \times \left[\rho C^o - \beta\gamma^{-\varepsilon} S_T^{1-\varepsilon} \frac{\alpha\xi}{(\alpha+\xi)^2}\right] \right\} \\
&= (1-\varepsilon)\gamma^c \left\{ -aS_T - \rho C^o - \left[1 - \frac{\psi^2}{\beta+\psi}\right] \times \left[\rho C^o - \beta\gamma^{-\varepsilon} S_T^{1-\varepsilon} \nu(1-\nu)\right] \right\} \\
&= (1-\varepsilon)\gamma^c \left\{ -aS_T - \rho C^o - \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] \times \left[\rho C^o - \beta c m^o\right] \right\} \\
&= (1-\varepsilon)\gamma^c \left\{ -aS_T - \rho C^o - \left[1 - \frac{\psi^2}{\beta+\psi}\right] \times \left[\rho C^o - \beta C^o\right] \right\} \\
&= (1-\varepsilon)\gamma^c \left\{ \rho C^o - \delta - \rho C^o - \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] C^o(\rho-\beta) \right\} \\
&= -(1-\varepsilon)\gamma^c \left\{ \delta + \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] C^o(\rho-\beta) \right\}
\end{aligned}$$

The sign of $M$ is determined by the sign of the expression in the curly braces. In particular, $M < 0$ when

$$\delta + \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] C^o(\rho-\beta) > 0$$

or equivalently

$$\delta > \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right] C^o(1-\varepsilon)\gamma^c.$$

Hence, when the repression is sufficiently harsh, $M < 0$. We know that since $\delta > \rho C^o$ by the first-order condition with respect to $T$, the condition above is likely to hold for reasonable parameter values, in particular if $\rho > \left[1 - \frac{\psi^2}{(\beta+\psi)(\rho+\psi)}\right](1 - \varepsilon)\gamma^c$.

**Proof of Lemma 1:**
Using Cramer's rule, we obtain:

$$\frac{d\xi}{dS_0} = \frac{1}{M}\begin{vmatrix} 0 & \Delta_{AT} \\ -\Delta_{BS_0} & \Delta_{BT} \end{vmatrix} = \frac{\Delta_{AT}\Delta_{BS_0}}{M} < 0, \tag{A.39}$$

$$\frac{dT}{dS_0} = \frac{1}{M}\begin{vmatrix} \Delta_{A\xi} & 0 \\ \Delta_{B\xi} & -\Delta_{BS_0} \end{vmatrix} = \frac{-\Delta_{A\xi}\Delta_{BS_0}}{M} > 0. \tag{A.40}$$

Since the sign of $\Delta_{B\theta}$ is the same as of $\Delta_{BS_0}$, the comparative statics with respect to $\theta$ are:

$$\frac{d\xi}{d\theta} < 0, \quad \frac{dT}{d\theta} > 0,$$

so that more generous rent sharing improves leadership duration.

In the next step, we introduce the effects of $\gamma^c$ because it too depends on $T$ and $\xi$. Equations (A.37) - (A.38) are modified as follows:

$$\left[\Delta_{A\xi} + \frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi}\right]d\xi + \left[\Delta_{AT} + \frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T}\right]dT = 0 \tag{A.41}$$

$$\left[\Delta_{B\xi} + \frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi}\right]d\xi + \left[\Delta_{BT} + \frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T}\right]dT = \Delta_{BS_0}dS_0.$$

where

$$\frac{\partial \gamma^c}{\partial \xi} = -\frac{\psi\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\frac{\partial \nu}{\partial \xi}}{\varepsilon(1-\theta)\left[1 + \frac{\psi\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\frac{1}{\gamma^c}\right]} > 0 \tag{A.42}$$

$$\frac{\partial \gamma^c}{\partial T} = \frac{1 - \frac{\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}}{\varepsilon\left[1 + \frac{\psi\nu}{1-\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon}\frac{1}{\gamma^c}\right]} \times \left(-\frac{1}{T^2}\right) \gtrless 0 \Leftrightarrow \theta \gtrless 1 - \nu \tag{A.43}$$

$$\frac{\partial A}{\partial \gamma^c} = (1-\varepsilon)\frac{\beta}{\psi(\rho+\psi)}e^{-(1-\varepsilon)\gamma^c T} > 0 \tag{A.44}$$

$$\frac{\partial B}{\partial \gamma^c} = -S_T^{1-\varepsilon}(1-\varepsilon)\left\{aT + \theta(\gamma^c)^{-\varepsilon}\left[\frac{1-\nu}{\theta}\left(\frac{\gamma^c}{\gamma}\right)^{\varepsilon} - 1\right] + \rho\nu(1-\nu)\gamma^{-\varepsilon}T\right\} < 0$$
$$\Leftrightarrow \theta < 1 - \nu \text{ (i.e. } \gamma^c > \gamma). \tag{A.45}$$

The new system can be rewritten as

$$\begin{bmatrix} \tilde{\Delta}_{A\xi} & \tilde{\Delta}_{AT} \\ \tilde{\Delta}_{B\xi} & \tilde{\Delta}_{BT} \end{bmatrix} \times \begin{bmatrix} d\xi \\ dT \end{bmatrix} = \begin{bmatrix} 0 \\ \Delta_{BS_0} \end{bmatrix} dS_0$$

where $\tilde{\Delta}_{A\xi} = \Delta_{A\xi} + \frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi} > 0$, $\tilde{\Delta}_{AT} = \Delta_{AT} + \frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T} > 0$, $\tilde{\Delta}_{B\xi} = \Delta_{B\xi} + \frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi}$, $\tilde{\Delta}_{BT} = \Delta_{BT} + \frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T}$. Hence, the effects of $S_0$ on $T$ and $\xi$ maintain their signs for as long as the determinant of the first matrix on the left-hand side, which we denote by $\tilde{M}$, remains negative. This determinant can be expressed in terms of $M$ as follows:

$$\tilde{M} = M + \Delta_{A\xi}\frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T} + \Delta_{BT}\frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi} - \Delta_{AT}\frac{\partial B}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial \xi} - \Delta_{B\xi}\frac{\partial A}{\partial \gamma^c}\frac{\partial \gamma^c}{\partial T}.$$

By writing out all the terms and using the first-order conditions from O's optimization problem, one can show that $\tilde{M} < 0$ for sufficiently harsh repression, similar to the condition for $M < 0$.

### A.5 Stakelberg Case

We explore the implications of an alternative game structure, where G chooses his ammunition level first and O can observe this choice. We continue to assume that G cannot observe the arms level of O because of the secrecy surrounding the coup. This setup corresponds to a Stakelberg game with G being the first mover.

The Stakelberg game structure does not affect the maximization problem of G but it does affect the first-order condition of O with respect to $m^o$. This condition reads

$$-\frac{d\nu}{dm^o}\gamma^{-\varepsilon}S_T^{1-\varepsilon} = C^{o'}(m^o), \tag{A.46}$$

with

$$\frac{d\nu}{dm^o} = \frac{\partial \nu}{\partial m^o} + \frac{\partial \nu}{\partial m}\frac{dm}{dm^o} = -\frac{\nu(1-\nu)}{m^o} + \frac{\nu(1-\nu)}{m}\frac{dm}{dm^o},$$

where the latter new term reflects the fact that O internalizes the effect of her choice of $m^o$ on $m$ and thus on the probability of success. The term $\frac{dm}{dm^o}$ can be found by totally differentiating (6):

$$\frac{dm}{dm^o} = \frac{\frac{\alpha m}{m^o} - 1}{2\alpha} = \frac{\frac{\alpha}{\xi} - 1}{2\alpha} \gtrless 0 \Leftrightarrow \alpha \gtrless \xi,$$

and therefore

$$\frac{d\nu}{dm^o} = \frac{\nu(1-\nu)}{m^o}\left(\frac{dm}{dm^o}\frac{m^o}{m} - 1\right) = \frac{\nu(1-\nu)}{m^o}\left(\frac{\alpha-\xi}{2\alpha} - 1\right) = -\frac{\nu(1-\nu)}{m^o}\left(\frac{\alpha+\xi}{2\alpha}\right) < 0.$$

The latter result implies that if $\xi \gtrless \alpha$, then the left-hand side of (A.46) is smaller (resp., larger) than the left-hand side of (10) and thus O chooses a larger (resp., smaller) arsenal under Stakelberg than under Nash.

The new equilibrium condition for the relative military power becomes:

$$\xi - \frac{\beta + 1/T}{1/T + \rho} e^{-(1-\varepsilon)\gamma^c T} \frac{\alpha + \xi}{2\alpha} = 0$$

or

$$A' = \xi - \frac{\alpha \xi^{Nash}}{2\alpha - \xi^{Nash}} = 0,$$

where $\xi^{Nash}$ is given by the condition (A.35).

Finally, the effect on the leadership duration in the Stakelberg game is computed in a similar way as in the Nash game, with the only difference that the term $\Delta_{AT}$ is now replaced by $\Delta'_{AT}$:

$$\Delta'_{AT} \equiv \frac{\partial A'}{\partial T} = \frac{\partial A'}{\partial \xi^{Nash}} \frac{\partial \xi^{Nash}}{\partial T} = \frac{2\alpha^2}{(2\alpha - \xi^{Nash})^2} \times \Delta_{AT} > 0.$$

Because the sign of $\Delta'_{AT}$ is the same as that of $\Delta_{AT}$, the comparative statics results for $\frac{dT}{dS_0}$ and $\frac{d\xi}{dS_0}$ do not change qualitatively.

# B Appendix to Section 3

## B.1 Non-Parametric analysis

The non-parametric class of survival models are the simplest of the survival models, as they put no restrictions on the data. Non-parametric analysis does not rely on parameters to shape the hazard/survival functions, instead simply uses information on failures to construct hazard- and survival functions. The effect of a variable can be gauged by splitting the sample into subgroups and comparing the subgroups' survival functions.

With a perfectly exogenous variable, the non-parametric model can be quite informative. However, it cannot account for time-varying variables. Thus, while the oil discovery variable would be a good candidate due to its quasi-exogeneity, its time varying nature makes it less suitable for non-parametric analysis. Specifically, the likelihood of being placed in the group of leaders who discover a field will increase with the time spent in power. We will therefore by construction see fewer leaders with short leadership durations in the group of discoverers.

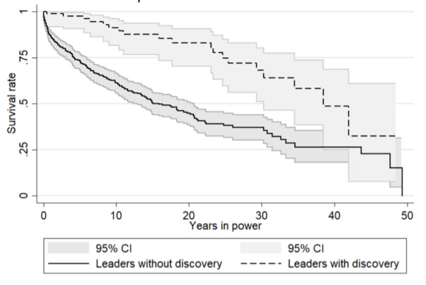
However, we assess the basic properties of the hazard- and survival functions by looking at the shape of the non-parametric models and using them to see if the raw data indicates any effect of resource discoveries and endowments (Cleves *et al.* , 2010).

We show the Kaplan-Meyer function and the Nelson-Aalen hazard functions, dividing the observations into dictators who find at least one giant oil or gas field during their tenure, and those who find none. We also divide our sample into leaders before and after the first discovery in the country.

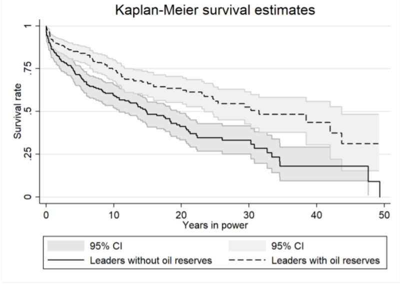
The Kaplan-Meyer survival functions (figure 4) and the Nelson-Aalen hazard functions (figure 5) imply that there is a statistically significant difference in the survival of the leaders who discover a giant oil field and those who do not. As can be seen in figure 4, the survival function is higher when the leader sees an increase in the resource wealth (left panel) or if the country of the leader has oil reserves (right panel). That is, more leaders survive past any given time $t$ when they get more oil/gas and if they have oil reserves, relative to the ones without. Hypothesis tests for equality of survivor functions confirm that the survivor functions are not equal (results not reported).

The hazard functions reveal a similar effect; at any time $t$, leaders that have discoveries or oil reserves face a lower hazard, indicating that they are less likely to fail than leaders without oil. These preliminary results support our hypothesis - there is a positive (negative) correlation between resource wealth/discoveries and political survival (hazard rates) of autocratic leaders.

**Figure 4:** Survival functions of leaders with and without oil reserves and discoveries

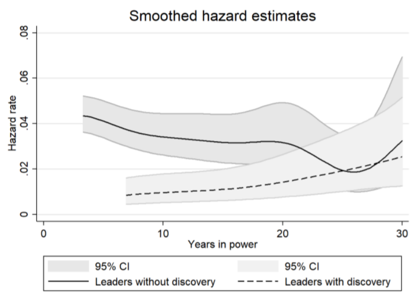


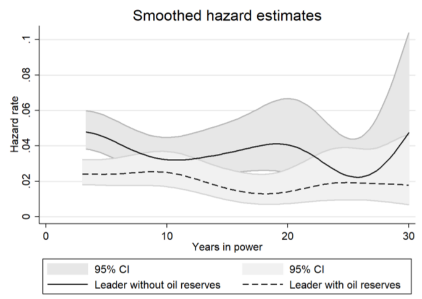

Hydrocarbon discoveries




Oil reserves

**Figure 5:** Political hazard rate




Hydrocarbon discoveries　　　Oil reserves

Leadership duration data from Archigos 4.1, oil discoveries from Horn & Myron (2011). Hazard rates smoothed with Gaussian kernel, bandwith 3.

### B.2 Parametric Analysis

While the semi-parametric analysis is less efficient than the parametric *if the baseline hazard is correctly specified*, it is the better choice if we have no idea what the baseline hazard function looks like. If the baseline hazard of the parametric model is correctly specified, the parametric and semiparametric regressions should return very similar results. If the results are different, one should conclude that the parametric model is misspecified (Cleves *et al.* , 2010). Thus we rely on the semi-parametric for the baseline results, and run robustness checks with the parametric regressions.

In our model, we assume an exogenous, constant hazard rate. The model thus does not inform which parametrization of the hazard we should use. We therefore rely on Aikike's Information Criterion (AIC) to determine the best fitting model, and find that the Weibull distribution has the most consistently good fit (when the Gamma model converges, it tends to have a lower AIC, but for several specifications it does not converge). Further, Weibull nests the exponential model. The exponential model has constant hazard, and thus fits our theoretical model the best. The Weibull model is commonly used in the literature to model political hazard (De Mesquita & Smith, 2005). Based on this, we consider Weibull the best fit for the parametric analysis. Results of other parametric models return very similar results to the Weibull model (albeit with some variation in statistical significance), and are not reported.

Results of the parametric model are shown in table 7.

**Table 7:** Results, Weibull regression

| VARIABLES | (1) Hazard ratio | (2) Hazard ratio | (3) Hazard ratio | (4) Hazard ratio | (5) Hazard ratio | (6) Hazard ratio |
|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.595** | 0.532*** | 0.541** | 0.582* | 0.580* | 0.405** |
| | (0.129) | (0.116) | (0.131) | (0.169) | (0.171) | (0.153) |
| GDP per capita | | 0.991 | 0.995 | 0.962* | 0.980 | 0.976 |
| | | (0.0142) | (0.0116) | (0.0211) | (0.0138) | (0.0149) |
| GDP growth | | 0.973*** | 0.974*** | 0.972*** | 0.972*** | 0.967*** |
| | | (0.00903) | (0.00898) | (0.0101) | (0.0103) | (0.0119) |
| Coal Income per capita | | | 0.990** | | 0.989* | 0.922** |
| | | | (0.00460) | | (0.00586) | (0.0371) |
| Metals Income per capita | | | 1.000 | | 1.000 | 1.000 |
| | | | (0.000800) | | (0.000899) | (0.000855) |
| Oil already disc. | | | 0.831 | | 0.742 | 1.273 |
| | | | (0.158) | | (0.153) | (0.424) |
| Age at entry | | | | 1.001*** | 1.001*** | 1.001** |
| | | | | (0.000416) | (0.000404) | (0.000453) |
| Median duration | | | | 1.000*** | 1.000** | 1.000** |
| | | | | (4.01e-05) | (4.43e-05) | (5.06e-05) |
| Polity 2 | | | | 0.980 | 0.996 | 1.004 |
| | | | | (0.0267) | (0.0265) | (0.0294) |
| Population (log) | | | | 0.941 | 1.004 | 0.936 |
| | | | | (0.0630) | (0.0720) | (0.0762) |
| Nat'l oil company | | | | 1.040 | 1.168 | 0.849 |
| | | | | (0.276) | (0.349) | (0.314) |
| World democracy | | | | | 0.971** | 0.968* |
| | | | | | (0.0118) | (0.0163) |
| Regional democracy | | | | | 1.000 | 1.003 |
| | | | | | (0.00508) | (0.00565) |
| Exploration intensity (Wildcats) | | | | | | 1.011 |
| | | | | | | (0.00670) |
| p | 0.635*** | 0.630*** | 0.639*** | 0.639*** | 0.658*** | 0.728*** |
| | (0.0424) | (0.0504) | (0.0517) | (0.0507) | (0.0534) | (0.0589) |
| Constant | 0.110*** | 0.140*** | 0.162*** | 0.401 | 0.413 | 1.065 |
| | (0.0183) | (0.0260) | (0.0314) | (0.457) | (0.509) | (1.436) |
| Leaders | 527 | 429 | 426 | 383 | 382 | 273 |
| Failures | 207 | 170 | 169 | 149 | 149 | 105 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## B.3 Military spending

Our theoretical model emphasizes expenditure on self-preservation (or military) as one of the possible channels which allows the leader to control the office. We would like to test if oil discoveries do affect leadership duration through such spending, but it is not straightforward. While Stockholm International Peace Research Institute (SIPRI) provides data on defence burden (also used by Cotet & Tsui 2013a), the data only covers certain countries over a limited time period. Further, as we have limited our analysis to autocratic countries that by definition have low transparency surrounding governance, the countries we are interested in tend to have the least reliable data.[32]

[32] Polity2 scores are based in part on transparency. In SIPRI Frequently Asked Questions on the Military Expenditure Database: How reliable is SIPRI military expenditure data?,

More importantly, spending on the military is not the only way a leader can invest in self-preservation or fighting efforts. For many leaders, the military is one of the greatest threats to their leadership (Acemoglu *et al.* 2010), making the data on military spending more complex than a proxy for self-preservation spending. In some countries, military spending may proxy our investment in the stock of arms variable well, whereas in other countries the military would be better thought of as the Opposition, and spending on, e.g., secret police, would be more representative of the investment the leader undertakes in order to secure the office. It is therefore unlikely that the SIPRI military spending variable would fully capture the resources the leader dedicates to remaining in power. Further, military spending is endogenous both in the model and in reality. For these reasons, we do not include military spending in the main analysis.

Here, we include a variable on military spending from the SIPRI dataset. Results are reported in Table 8. The results show that the coefficient on military spending is insignificant in almost every specification, including the simple regression of military spending on leadership duration (not reported). It is not clear whether this is due to data problems or the complex effect of military spending on leadership durations, or whether military spending actually does not affect leadership durations at all, although the latter seems unlikely. When controlling for exploration intensity, military spending appears to increase the hazard of a leader. This could be due to the inherently endogenous nature of the spending variable: a leader will increase military spending in response to an increased threat level. However, the effect is small in absolute terms; for the hazard to increase by about 7% requires an additional 1 billion USD in spending. An interesting note is that this relationship disappears when removing military coups from counting as a failure (results not reported): increased military spending then appears to decrease the threat of a non-military coup. This situation is likely the one in which military spending mimics preservation spending the most, thus, to the extent that these results can be considered reliable, they are consistent with our model.

### B.4 Effect of small discoveries

The model indicates that while large discoveries increase duration, smaller discoveries have an ambiguous effect on the hazard. We test this prediction by using the ASPO dataset on small discoveries, using a dummy variable constructed the same

https://www.sipri.org/databases/milex/frequently-asked-questions, it is pointed out that since the data is based on official estimates, the less transparent the country, the less reliable the data.

**Table 8:** Results, Military expenditure

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| Military spending (bn USD 2016) | 0.980 | 1.005 | 1.012 | 1.005 | 1.010 | 1.068** |
| | (0.0231) | (0.0229) | (0.0204) | (0.0216) | (0.0222) | (0.0348) |
| Oil/Gas discovery | 0.424** | 0.399** | 0.408* | 0.400* | 0.387* | 0.267** |
| | (0.163) | (0.165) | (0.187) | (0.204) | (0.210) | (0.151) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. Controls | | | | ✓ | ✓ | ✓ |
| Exporation intensity (Wildcats) | | | | | | 1.011* |
| | | | | | | (0.00551) |
| Observations | 2,403 | 2,108 | 2,106 | 1,833 | 1,833 | 1,270 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 9:** Results, Small discoveries

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| ASPO small discoveries | 1.193 | 1.085 | 1.557 | 1.249 | 1.621 | 1.627 |
| | (0.297) | (0.266) | (0.516) | (0.389) | (0.584) | (0.564) |
| Exploration intensity (Wildcats) | | | 1.008 | | 1.008 | 1.012* |
| | | | (0.00569) | | (0.00654) | (0.00613) |
| Oil/Gas discovery | | | | | | 0.353*** |
| | | | | | | (0.126) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. controls | | | ✓ | ✓ | ✓ | ✓ |
| Leaders | 322 | 304 | 304 | 267 | 267 | 267 |
| Failures | 128 | 119 | 119 | 103 | 103 | 103 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

way as for the large discoveries. Results are reported in table 9. The point estimates indicate that a small discovery may increase hazard but the coefficient is not statistically significant. It thus appears that smaller discoveries indeed have an ambiguous effect.

### B.5 Wildcat drilling

We try to address the concern that there is reverse causality in play, i.e. the stability of a leader increases the probability of a large oil discovery. If the stability of the leader affects the oil industry, it should first and foremost affect *drilling activity*, as that is something an oil company or a leader actually can control. We therefore include the number of wildcats drilled in a country in a given year. The results are given in table 10 and show that including wildcat drilling does not significantly alter the baseline results. Rather, holding drilling activity constant increases the effect of the discovery. Further, the results indicate that drilling activity tends to *increase* hazard. We therefore feel confident in our conclusion that it is *discoveries* rather than drilling activity that drive our results.

**Table 10:** Results, Wildcat drilling

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.366*** | 0.357*** | 0.310*** | 0.191** | 0.237** | 0.334*** |
| | (0.112) | (0.111) | (0.106) | (0.137) | (0.149) | (0.125) |
| # Wildcats drilled | 1.004** | 1.010* | 1.013** | 1.029*** | 1.027*** | 1.012* |
| | (0.00199) | (0.00568) | (0.00504) | (0.00977) | (0.00982) | (0.00634) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. Controls | | | | ✓ | ✓ | ✓ |
| Leaders | 341 | 314 | 314 | 93 | 93 | 274 |
| Failures | 134 | 123 | 123 | 32 | 32 | 106 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### B.6 Oil price

As variations in the oil price can cause large fluctuations in the value of resource stocks, we want to control for their effect. We include the yearly average spot price of West Texas Intermediate (Federal Reserve Bank of St. Louis, 2013). However, as standardized oil prices are only available from 1946, this reduces our sample size. We therefore only include them in this robustness check. Results are reported in table 11 and show that the magnitude of the impact of the oil price is small, the sign varies with the specification, and the variable is only significant in the most parsimonious specification. From these results it appears that inclusion of the oil price has no impact on our main results and the price has little impact on the duration of leadership.

### B.7 Size and number of discoveries

In the main analysis we use a dummy for the discovery variable. We do this because the size estimates of the fields are not reliable and generally not known with any precision at the time of the discovery. Further, multiple discoveries tend to happen in rapid succession, so this also helps avoid issues of serial correlation. Still, the size estimates contain some information that we ignore in the main specification. In this section we attempt to use this information and we explore the effect of the size and number of discoveries.

**Table 11:** Results, Oil price

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.506*** | 0.480*** | 0.492*** | 0.518* | 0.374** | 0.454* |
| | (0.121) | (0.115) | (0.128) | (0.177) | (0.151) | (0.194) |
| Oil price (WTI Spot USD/barrel) | 0.989** | 0.991 | 0.990 | 1.005 | 1.012 | 1.011 |
| | (0.00488) | (0.00731) | (0.00716) | (0.00879) | (0.0109) | (0.0106) |
| Drilling intensity (Wildcats) | | | | | 1.012** | 1.011 |
| | | | | (0.00597) | (0.00667) | |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. Controls | | | | ✓ | ✓ | ✓ |
| P | | | | | | 0.741*** |
| | | | | | (0.0644) | |
| Constant | | | | | | 1.815 |
| | | | | | | (2.661) |
| Leaders | 414 | 377 | 377 | 335 | 243 | 243 |
| Failures | 165 | 152 | 152 | 133 | 95 | 95 |

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

We define a variable for number of discoveries as the cumulative count of discoveries of giant fields (i.e. when the first discovery happens, the variable goes from 0 to 1 and remains 1 until the second discovery happens, when it goes to 2 and so on). Results reported in columns 7-8 of table 12 show that more discoveries lower hazard, but that the effect is not statistically significant. Adding a squared term makes the model fit better, and a hazard ratio above unity indicates that at some point the effect will switch and additional discoveries increase hazard.

Further, using the size of the oil discoveries shows an ambiguous effect. Using the size of the first discovery (column 1 and 2 of table 12)seems to indicate increased hazard with a bigger discovery, but the effect is not significant when we add controls. We also use the cumulative size of discoveries, results reported in columns 3-4. The results indicate an increase in hazard; however, they lose significance when a square term is added (columns 5-6).

However, very few leaders discover many giant oil and gas fields: less than 50 discover two or more, and less than 20 discover more than five. The results are thus driven by a small number of observations. We check if the results are driven by outliers (by the DFBETA method, comparing the distance between the estimated coefficient $\hat{\beta}_x$ to the estimated coefficient $\hat{\beta}_x^{(i)}$ when dropping observation $i$ - a large distance indicates a highly influential observation). We identify two extreme outliers, King Faisal of Saudi Arabia and Prime Minister Mohammad Mosaddegh of Iran[33]. We redo the previous analysis without these two outliers, and report the

[33]King Faisal was assassinated by his nephew, whose motives for the assassination were unclear

results in table 13. Without the outliers, all the full models return coefficients below 1, or statistically insignificant results above 1, except the simple model of only the size of the first discovery. Overall, the count and size results do not lead us to revise the conclusion of the main analysis, and we remain convinced that oil discoveries lower the hazard rate faced by autocratic leaders.

(see e.g. de Onis, 1975; Hirst, 2010, for journalistic accounts). Prime Minister Mosaddegh was overthrown in a coup that the CIA has later admitted to orchestrating. Both of these are borderline cases for being counted as failures regardless of their outsized influence

**Table 12:** Different specifications of size and number of discoveries

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio | (7)<br>Hazard ratio | (8)<br>Hazard ratio | (9)<br>Hazard ratio | (10)<br>Hazard ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Size of first disc. | 1.012*** | 1.002 | | | | | | | | |
| | (0.00348) | (0.0105) | | | | | | | | |
| Cumulative size | | | 1.025 | 1.076** | 1.017 | 0.683 | | | | |
| | | | (0.0339) | (0.0376) | (0.0835) | (0.341) | | | | |
| Cumulative size$^2$ | | | | | 1.000 | 1.000 | | | | |
| | | | | | (3.73e-07) | (2.70e-06) | | | | |
| Count disc. | | | | | | | 0.998 | 0.970 | 0.802** | 0.601** |
| | | | | | | | (0.0571) | (0.140) | (0.0880) | (0.137) |
| Count disc.$^2$ | | | | | | | | | 1.021*** | 1.041*** |
| | | | | | | | | | (0.00806) | (0.0143) |
| Exploration intensity (Wildcats) | | 1.007 | | 1.007 | | 1.008 | | 1.007 | | 1.012** |
| | | (0.00653) | | (0.00668) | | (0.00617) | | (0.00694) | | (0.00584) |
| Econ. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Res. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Pol. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Leader years | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 13:** Different specifications of size and number of discoveries, without outliers

| VARIABLES | (1) Hazard ratio | (2) Hazard ratio | (3) Hazard ratio | (4) Hazard ratio | (5) Hazard ratio | (6) Hazard ratio | (7) Hazard ratio | (8) Hazard ratio | (9) Hazard ratio | (10) Hazard ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| Size of first disc. | 1.012*** | 0.954 | | | | | | | | |
| | (0.00390) | (0.146) | | | | | | | | |
| Cumulative size | | | 0.989 | 0.299 | 0.920 | 0.230 | | | | |
| | | | (0.0689) | (0.247) | (0.185) | (0.241) | | | | |
| Cumulative size$^2$ | | | | | 1.000 | 1.000 | | | | |
| | | | | | (7.16e-07) | (1.50e-05) | | | | |
| Count disc. | | | | | | | 0.923 | 0.654** | 0.808* | 0.577* |
| | | | | | | | (0.0826) | (0.118) | (0.0958) | (0.191) |
| Count disc.$^2$ | | | | | | | | | 1.018** | 1.029 |
| | | | | | | | | | (0.00861) | (0.0447) |
| Exploration intensity (Wildcats) | | 1.007 | | 1.007 | | 1.008 | | 1.007 | | 1.012** |
| | | (0.00653) | | (0.00668) | | (0.00617) | | (0.00694) | | (0.00584) |
| Econ. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Res. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Pol. controls | | ✓ | | ✓ | | ✓ | | ✓ | | ✓ |
| Leader years | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 | 5,687 | 2,236 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### B.8 Different specifications

#### B.8.1 Varying the definition of autocracy

Restricting the data to dictatorships then requires a cut-off point. This will inevitably lead to a somewhat arbitrary dichotomy between autocratic and intermediate/democratic regimes. While Andersen & Aslaksen (2013) use -5 as a cutoff, Polity IV recommends -6, which is also used by Cuaresma *et al.* (2011). We choose to use the latter, setting this cut-off point to -6. Varying the cutoff values of polity score for inclusion returns largely the same results, with some variation in statistical significance. The results point towards a stronger effect in more repressive regimes, as lowering the cutoff lowers the hazard ratio and increases the statistical significance of the results. See table 14 for cutoff value of -5 and table 15 for cutoff value of -7.

**Table 14:** Cutoff, Polity 2 <-5

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.594*** | 0.583*** | 0.562** | 0.445* | 0.470 | 0.637* |
| | (0.118) | (0.119) | (0.127) | (0.211) | (0.233) | (0.166) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. Controls | | | | ✓ | ✓ | ✓ |
| Leader years | 6,069 | 4,252 | 4,120 | 1,259 | 1,251 | 3,491 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 15:** Cutoff, Polity 2 <-7

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio | (6)<br>Hazard ratio |
|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.563*** | 0.561** | 0.517*** | 0.372* | 0.341* | 0.565* |
| | (0.124) | (0.135) | (0.129) | (0.202) | (0.198) | (0.170) |
| Econ. controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | | ✓ | ✓ |
| Pol. Controls | | | | ✓ | ✓ | ✓ |
| Leader years | 4,822 | 3,566 | 3,490 | 1,061 | 1,061 | 2,937 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to test whether our results are robust to a different definition of autocratic regimes, we also run the analysis using the data complied by Geddes *et al.* (2012). This data focuses on regimes rather than individual leaders, and classifies the regime type based on how it started rather than how it behaves. Using this definition, we also find very similar results to our main specification. Results are reported in table 16.

**Table 16:** Using Geddes *et al.* (2012) dataset

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio |
|---|---|---|---|---|---|
| Oil/Gas discovery | 0.368** | 0.480* | 0.442* | 0.347* | 0.316 |
| | (0.150) | (0.183) | (0.195) | (0.223) | (0.238) |
| GDP per capita | | 1.000 | 1.000 | 1.000* | 1.000 |
| | | (6.61e-05) | (3.90e-05) | (0.000102) | (9.56e-05) |
| GDP growth | | 0.961** | 0.964** | 0.954*** | 0.952*** |
| | | (0.0151) | (0.0156) | (0.0121) | (0.0121) |
| Coal Income per capita | | | 0.806* | | 0.853 |
| | | | (0.0941) | | (0.0879) |
| Metals Income per capita | | | 1.000 | | 1.000 |
| | | | (0.00105) | | (0.00103) |
| Oil already discovered | | | 0.851 | | 0.953 |
| | | | (0.265) | | (0.391) |
| Polity 2 | | | | 1.014 | 1.031 |
| | | | | (0.0304) | (0.0330) |
| Population (log) | | | | 0.790** | 0.874 |
| | | | | (0.0901) | (0.117) |
| World democracy | | | | | 0.965* |
| | | | | | (0.0198) |
| Regional democracy | | | | | 1.002 |
| | | | | | (0.00936) |
| Regime years | 5,442 | 4,076 | 4,070 | 3,400 | 3,399 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### B.8.2 Using only the first discovery

We argue as Arezki *et al.* (2017), Cotet & Tsui (2013a) and Cotet & Tsui (2013b) that using the discoveries of new oil and gas fields offer a more exogenous measure of variation in resource wealth than the standard measures. However, as we have explained, discoveries are not perfect natural experiments. Possibly, a better variable would be only the first discovery in each country, as the first discovery may be harder to anticipate than subsequent discoveries and thus more random to the leader. On the other hand, the endogeneity issue discussed in section 3.2.1 may actually be stronger when looking at the first discovery. It seems likely that continuing exploration in an area where oil is already found depends less on the stability of the leader than starting exploration in a completely new area. Potentially, the costs involved in oil exploration make such uncertain exploration an even larger gamble. Still, we check if the results hold for the first discovery.

We attempt to run the regressions on a subsample that compares leaders in power when oil is first discovered to leaders who never find oil. This specification reduces the sample size significantly, and, importantly, leaves very few leaders with a discovery. The results show a lower hazard, but they are not statistically significant (see table 17). Thus we cannot say whether the loss of significance is due to having such a small "treatment group", if the first discovery is special, or if this type of unexpected increase in oil wealth is simply unimportant for leadership duration. However, as the size and sign of the coefficient is consistent with our main analysis, the results do not lead us to revise our previous conclusion.

**Table 17:** Using only the first discovery

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio |
|---|---|---|---|---|
| Dummy=1 if the first leader in the country to find oilgas | 0.635 | 0.618 | 0.672 | 0.710 |
| | (0.332) | (0.395) | (0.391) | (0.434) |
| Econ. controls | | ✓ | ✓ | ✓ |
| Res. controls | | | ✓ | ✓ |
| Pol. controls | | | | ✓ |
| Leader years | 5,692 | 4,008 | 3,882 | 3,272 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### B.8.3 Using different definitions of failure

Using the Powell & Thyne (2011) dataset, we check if the results are robust to different types of turnover in table 18. Regular turnover is not significantly affected (column 6), and the other definitions of coups appear to show the same direction of the effect. Generally, the results are somewhat less precise relative to the main results, likely due to the reduction in sample size (the Powell & Thyne (2011) dataset starts in 1950). Notably, excluding military coups renders the estimates insignificant (column 8), but this definition reduces the number of failures. Using only overthrows by rebel groups leaves too few failures to estimate the effect of the discovery. The evidence is overall consistent with our previous conclusions.

**Table 18:** Different failure definitions

| VARIABLES | (1) Irregular turnover no natural death | (2) Successful coup | (3) Attempted & successful coups | (4) Rebels overthrow | (5) Any turnover | (6) Regular turnover | (7) Military coup | (8) No military | (9) No assassinations |
|---|---|---|---|---|---|---|---|---|---|
| Oil/Gas discovery | 0.546** | 0.572* | 0.444*** | x | 1.052 | 1.464 | 0.196* | 0.759 | 0.573* |
| | (0.158) | (0.189) | (0.133) | | (0.222) | (0.411) | (0.193) | (0.289) | (0.189) |
| GDP per capita | 0.982 | 0.969* | 0.991 | 0.986 | 0.980* | 0.978 | 0.971 | 0.967** | 0.969* |
| | (0.0142) | (0.0158) | (0.0102) | (0.0819) | (0.0120) | (0.0206) | (0.0294) | (0.0157) | (0.0158) |
| GDP growth | 0.976** | 0.973** | 0.984 | 0.927*** | 0.978** | 0.984 | 0.990 | 0.963** | 0.973** |
| | (0.0102) | (0.0126) | (0.0101) | (0.0247) | (0.00873) | (0.0122) | (0.0177) | (0.0165) | (0.0127) |
| Age at entry | 1.001*** | 1.001*** | 1.001*** | 1.001* | 1.001*** | 1.001*** | 1.001*** | 1.001*** | 1.001*** |
| | (0.000312) | (0.000133) | (0.000137) | (0.000585) | (0.000173) | (0.000163) | (0.000297) | (0.000209) | (0.000133) |
| World democracy | 0.956*** | 0.916*** | 0.955*** | 0.989 | 0.991 | 1.027 | 0.981 | 0.874*** | 0.915*** |
| | (0.0106) | (0.0125) | (0.0113) | (0.0359) | (0.0136) | (0.0244) | (0.0171) | (0.0155) | (0.0120) |
| Regional democracy | 0.999 | 1.005 | 0.998 | 1.004 | 1.003 | 1.002 | 1.000 | 1.009 | 1.005 |
| | (0.00519) | (0.00520) | (0.00426) | (0.0119) | (0.00363) | (0.00507) | (0.00990) | (0.00565) | (0.00520) |
| Median duration | 1.000** | 1.000** | 1.000*** | 1.000 | 1.000*** | 1.000 | 1.000 | 1.000** | 1.000** |
| | (4.61e-05) | (5.21e-05) | (3.80e-05) | (0.000155) | (3.24e-05) | (4.99e-05) | (0.000104) | (4.93e-05) | (5.20e-05) |
| Polity 2 | 1.091*** | 1.078** | 0.963* | 1.156** | 1.108*** | 1.124*** | 1.071* | 1.088** | 1.079** |
| | (0.0295) | (0.0323) | (0.0214) | (0.0693) | (0.0224) | (0.0320) | (0.0403) | (0.0403) | (0.0326) |
| Population (log) | 0.971 | 0.866* | 1.019 | 1.377* | 0.942 | 0.935 | 1.007 | 0.767*** | 0.865* |
| | (0.0714) | (0.0655) | (0.0538) | (0.262) | (0.0571) | (0.107) | (0.105) | (0.0671) | (0.0657) |
| Coal Income per capita | 0.989* | 0.976** | 0.974** | 0.959 | 1.000 | 1.002*** | 0.938 | 0.983** | 0.976** |
| | (0.00589) | (0.0117) | (0.0102) | (0.0321) | (0.000475) | (0.000606) | (0.0451) | (0.00785) | (0.0117) |
| Metals Income per capita | 1.000 | 0.998* | 0.999 | 0.996 | 0.999 | 1.000 | 0.999 | 0.997* | 0.998 |
| | (0.000925) | (0.00122) | (0.000609) | (0.00318) | (0.000738) | (0.00104) | (0.00135) | (0.00139) | (0.00121) |
| Oil already disc. | 0.734 | 1.205 | 1.010 | 0.335** | 0.760 | 0.854 | 0.924 | 1.508 | 1.221 |
| | (0.152) | (0.308) | (0.164) | (0.180) | (0.131) | (0.233) | (0.320) | (0.433) | (0.308) |
| Nat'l oil company | 1.350 | 0.998 | 0.825 | 0.716 | 1.485 | 1.482 | 0.765 | 1.217 | 0.999 |
| | (0.403) | (0.352) | (0.187) | (0.750) | (0.362) | (0.472) | (0.292) | (0.489) | (0.352) |
| Leader years | 3,272 | 3,272 | 1,475 | 3,272 | 3,272 | 3,272 | 3,272 | 3,272 | 3,272 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
x too few observations to estimate

### B.8.4 Controlling for time

The full sample covers a large time period, and thus different eras of the importance of oil. As we indicated in the literature review, there are reasons to believe that the relationship between oil and political outcomes has changed over the time span that we consider. In particular, the long time period covered by our sample means that several of our leaders ruled during times when coal was a much more important fuel source than oil. We therefore conduct a more thorough check of the effect of different time periods.

The first time control is including year fixed effects. Survival analysis compares

**Table 19:** Hypothesis 1, controlling for time

| VARIABLES | (1)<br>Year FE | (2)<br>From 1950 | (3)<br>From 1960 | (4)<br>From 1970 | (5)<br>From 1980 |
|---|---|---|---|---|---|
| Oil/Gas discovery | 0.567* | 0.557* | 0.530 | 0.526 | x |
| | (0.177) | (0.194) | (0.208) | (0.335) | |
| GDP per capita | 0.978 | 0.979 | 0.976 | 0.985 | 0.984 |
| | (0.0148) | (0.0163) | (0.0179) | (0.0141) | (0.0434) |
| GDP growth | 0.977** | 0.977* | 0.980 | 0.970** | 0.965* |
| | (0.0109) | (0.0123) | (0.0125) | (0.0140) | (0.0202) |
| Age at entry | 1.001*** | 1.001*** | 1.001*** | 1.027** | 1.037** |
| | (0.000365) | (0.000355) | (0.000378) | (0.0112) | (0.0172) |
| World democracy | 2.027*** | 0.944*** | 0.934*** | 0.922*** | 0.886*** |
| | (0.0766) | (0.0165) | (0.0170) | (0.0196) | (0.0343) |
| Regional democracy | 1.005 | 1.009 | 1.013** | 1.008 | 1.008 |
| | (0.00583) | (0.00747) | (0.00646) | (0.0123) | (0.0152) |
| Median duration | 1.000** | 1.000* | 1.000** | 1.000 | 1.000 |
| | (4.59e-05) | (5.70e-05) | (6.34e-05) | (7.50e-05) | (9.17e-05) |
| Polity 2 | 1.106*** | 1.076** | 1.069** | 1.073* | 1.042 |
| | (0.0279) | (0.0338) | (0.0338) | (0.0404) | (0.0596) |
| Population (log) | 0.957 | 1.005 | 0.971 | 1.065 | 1.098 |
| | (0.0666) | (0.0764) | (0.0736) | (0.0978) | (0.139) |
| Coal Income per capita | 0.989* | 0.991** | 0.990* | 0.888 | 0.924* |
| | (0.00575) | (0.00416) | (0.00572) | (0.0768) | (0.0395) |
| Metals Income per capita | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| | (0.000861) | (0.000892) | (0.000869) | (0.00107) | (0.00186) |
| Oil already disc. | 0.731 | 0.767 | 0.834 | 0.925 | 0.794 |
| | (0.148) | (0.162) | (0.165) | (0.251) | (0.337) |
| Nat'l oil company | 1.448 | 1.306 | 1.097 | 0.711 | 1.108 |
| | (0.414) | (0.418) | (0.361) | (0.302) | (0.551) |
| Leader years | 3,272 | 2,640 | 2,160 | 1,488 | 809 |

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$
x: not enough observations with discoveries to estimate the effect

leaders in the same year of their reign. Controlling for the real world year would remove any worldwide trends affecting the results. The results are reported in column 1 of table 19, and reveal no significant change.

**Table 20:** Hypothesis 2, controlling for time

| VARIABLES | (1) Year FE | (2) From 1950 | (3) From 1960 |
|---|---|---|---|
| Early disc. (3 years) | 0.336** | 0.348** | 0.417** |
| | (0.150) | (0.153) | (0.176) |
| Late disc. | 0.709 | 0.830 | 0.660 |
| | (0.307) | (0.400) | (0.418) |
| GDP per capita | 0.976 | 0.977 | 0.972 |
| | (0.0150) | (0.0157) | (0.0182) |
| GDP growth | 0.974** | 0.975** | 0.978* |
| | (0.0114) | (0.0126) | (0.0129) |
| Age at entry | 1.001*** | 1.001** | 1.001*** |
| | (0.000405) | (0.000369) | (0.000391) |
| World democracy | 2.052*** | 0.954*** | 0.944*** |
| | (0.0802) | (0.0172) | (0.0179) |
| Regional democracy | 1.004 | 1.007 | 1.012* |
| | (0.00571) | (0.00734) | (0.00622) |
| Median duration | 1.000** | 1.000** | 1.000** |
| | (4.43e-05) | (5.46e-05) | (6.13e-05) |
| Polity 2 | 1.006 | 1.006 | 0.995 |
| | (0.0288) | (0.0283) | (0.0303) |
| Population (log) | 0.999 | 1.032 | 0.993 |
| | (0.0696) | (0.0788) | (0.0753) |
| Coal Income per capita | 0.989* | 0.992** | 0.991* |
| | (0.00562) | (0.00410) | (0.00540) |
| Metals Income per capita | 1.000 | 1.000 | 1.000 |
| | (0.000862) | (0.000873) | (0.000858) |
| Oil already disc. | 0.712* | 0.749 | 0.804 |
| | (0.147) | (0.157) | (0.161) |
| Nat'l oil company | 1.362 | 1.263 | 1.061 |
| | (0.364) | (0.383) | (0.338) |
| Leaders | 382 | 304 | 266 |
| Failures | 149 | 121 | 109 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We also check whether using subperiods of the data affects the result (columns 2 - 5 of table 19). Dropping observations from before 1950, 1960, 1970, and 1980 reveals largely similar results to the full sample, albeit with some reduction in precision. Using only data after 1980 removes too much of the sample for meaningful analysis; only two leaders have a discovery and a failure. Thus we conclude that the results are not significantly changed by looking at different time periods. The results of a similar check with respect to our Hypothesis 2 are reported in table 20. There are not enough observations with discoveries to estimate the effect from 1970 and 1980.

### B.8.5 Alternative control variables

While our main analysis follows the literature on the choice of covariates, some are what Angrist & Pischke describe as "bad controls" (2008, pp. 64-68). We run the same analysis using variables that cannot be affected by the discovery: we replace GDP and GDP growth by GDP in the last year of the previous ruler, all the resource variables with the oil reserves in the last year of the previous ruler, and keep age at entry, world and regional democracy, median duration of leadership, population, and the nationalized oil company dummy as in the main analysis. The results are reported in table 21, and are very similar to the main analysis both in terms of magnitude and statistical significance.

**Table 21:** No "bad" controls

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio |
|---|---|---|---|---|---|
| Oil/Gas discovery | 0.562*** | 0.485*** | 0.583* | 0.486** | 0.487** |
| | (0.120) | (0.129) | (0.167) | (0.161) | (0.158) |
| Prev. ruler GDP | | 0.987 | 0.999 | 0.996 | 0.996 |
| | | (0.0185) | (0.00548) | (0.00738) | (0.00742) |
| Prev. ruler reserves | | | 0.981** | 0.984* | 0.984* |
| | | | (0.00810) | (0.00945) | (0.00939) |
| Age at entry | | | | 1.001** | 1.001** |
| | | | | (0.000394) | (0.000385) |
| Median duration | | | | 1.000** | 1.000** |
| | | | | (4.64e-05) | (4.64e-05) |
| Population (log) | | | | 0.996 | 0.994 |
| | | | | (0.0704) | (0.0717) |
| World democracy | | | | | 0.979* |
| | | | | | (0.0125) |
| Regional democracy | | | | | 1.000 |
| | | | | | (0.00555) |
| Nat'l oil company | | | | 1.077 | 1.105 |
| | | | | (0.272) | (0.279) |
| Leader years | 5,687 | 3,296 | 3,005 | 2,727 | 2,718 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### B.8.6 Other models & further robustness checks

We test the robustness of our results by applying binary outcome models. Both the probit and the linear probability model indicate that discoveries lower the probability of irregular turnover.

Results are robust to one-by-one exclusion of countries. No effect is detected from a "placebo-in-time" discovery 5 years before an actual discovery.

## B.9 Transition to democracy

While our model does not consider what happens following a coup, the Geddes *et al.* (2012) dataset includes regime type following a regime ending. We run the same analysis using transition to democracy as the failure event. The results are reported in table 22. The estimated coefficients show that a discovery lowers the hazard of a democratic transition, but that the effect is not statistically significant.

**Table 22:** Transition to democracy

| VARIABLES | (1)<br>Hazard ratio | (2)<br>Hazard ratio | (3)<br>Hazard ratio | (4)<br>Hazard ratio | (5)<br>Hazard ratio |
|---|---|---|---|---|---|
| Oil/Gas discovery | 0.735 | 0.704 | 0.612 | 0.934 | 0.965 |
| | (0.253) | (0.272) | (0.251) | (0.392) | (0.391) |
| GDP per capita | | 1.000 | 1.000 | 1.000 | 1.000* |
| | | (1.59e-05) | (1.75e-05) | (3.01e-05) | (4.78e-05) |
| GDP growth | | 0.969** | 0.969** | 0.947*** | 0.948*** |
| | | (0.0142) | (0.0143) | (0.0144) | (0.0137) |
| Coal Income per capita | | | 1.001 | | 1.005*** |
| | | | (0.000804) | | (0.00182) |
| Metals Income per capita | | | 1.000 | | 0.999 |
| | | | (0.000682) | | (0.00126) |
| Oil already discovered | | | 1.419 | | 1.951** |
| | | | (0.355) | | (0.662) |
| Polity 2 | | | | 1.228*** | 1.235*** |
| | | | | (0.0326) | (0.0354) |
| Population (log) | | | | 1.203 | 1.002 |
| | | | | (0.149) | (0.134) |
| World democracy | | | | | 0.991 |
| | | | | | (0.0229) |
| Regional democracy | | | | | 1.018*** |
| | | | | | (0.00700) |
| Regime years | 5,442 | 4,076 | 4,070 | 3,400 | 3,399 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## B.10 Data sources

Data sources are reported in table 23.

**Table 23:** Data sources

| Variable | measured in | source | available at |
|---|---|---|---|
| Leadership duration | Days | ARCHIGOS 4.1 | https://www.rochester.edu/college/faculty/hgoemans/data.htm |
| Age of leader at entry | Years | ARCHIGOS 4.1 | |
| Giant oil and gas discovery | Dummy | Giant Oil and Gas Fields of the World | https://worldmap.harvard.edu/data/ |
| Giant oil and gas discovery size | Est. ultimately recoverable barrels of oil equivalent | Giant Oil and Gas Fields of the World | geonode:giant_oil_and_gas_fields_of_the_world_co_yxz |
| Polity2 | Index, -10 to 10 | Marshall & Jaggers (2002) | https://www.systemicpeace.org/polityproject.html |
| Total oil reserves | proven oil reserves in billions bbls | Haber (2011) APSR Dataset | https://stephen-haber.com/data/ |
| Coal Income PC | Real Value of Coal Produced Per Capita | Haber (2011) APSR Dataset | |
| metals income PC | Real Value of Metal Minerals Produced Per Capita | Haber (2011) APSR Dataset | |
| GDP per capita | Real Per Capita GDP | Haber (2011) APSR Dataset | |
| Population | | Haber (2011) APSR Dataset | |
| REGION DEM DIFFUSE | Percent Democracies in Region | Haber (2011) APSR Dataset | |
| WORLD DEM DIFFUSE | Percent Democracies in World | Haber (2011) APSR Dataset | |
| Dependency ratio | Age dependency ratio (% of working-age population) | World Bank | https://data.worldbank.org/indicator/SP.POP.DPND |
| National oil company ever | Dummy | Ross & Mahdavi (2015) "Oil and Gas Data, 1932-2014", | https://doi.org/10.7910/DVN/ZTPW0Y, |
| Military spending | current US $ | SIPRI | https://www.sipri.org/databases/milex |
| Wildcats drilled | Number per year | ASPO, through Cotet & Tsui (2011) | DOI: 10.1257/mac.5.1.49 |
| Small discoveries | Est. ultimately recoverable barrels of oil equivalent | | |
| Coup attempts | Dummy | Powell & Thyne (2011) | https://www.jonathanmpowell.com/coup-detat-dataset.html |
| Coup types | Dummy/type | Powell & Thyne (2011) | |
| Autocratic regime duration | Years | Geddes et al (2012) | https://xmarquez.github.io/democracyData/reference/gwf_all.html |
| Oil sector ownership | Dummy | Brunnschweiler & Poelhekke (2019) | (not published) |
| Oil price | USD/barrel | Federal Reserve Bank of St. Louis (2013) | https://fred.stlouisfed.org/series/WTISPLC |