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A. Brausmann, E. Grieg

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Resource Discoveries and the Political Survival of Dictators

Alexandra Brausmann and Elise Grieg*

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Abstract

Empirical literature remains largely inconclusive as to whether resource abundance has significant political effects. In this paper we revisit the "political resource curse" by studying the effect of natural resource discoveries on the duration of autocratic leadership. We first present a dynamic stochastic model of a resource-driven coup. We extend the existing conflict models by considering both the timing of attack on the regime and the probability of its success. Both the incumbent and opposition invest in military arsenal which determines the probability of winning, while the opposition also strategically chooses when to stage a coup. We show that a random resource discovery allows the incumbent to stay in power longer by delaying the attack but also by reducing the probability of coup success under specific conditions. We test these hypotheses with a novel empirical analysis based on duration models and data on discoveries of giant oil and gas fields going back to as far as 1868. Our results show that a large hydrocarbon discovery lowers the hazard faced by an autocrat by 30 - 50%. The delay of the coup is the main driving force behind the stabilizing effect of discoveries in autocratic regimes.

JEL Classification: Q33, Q34, D74

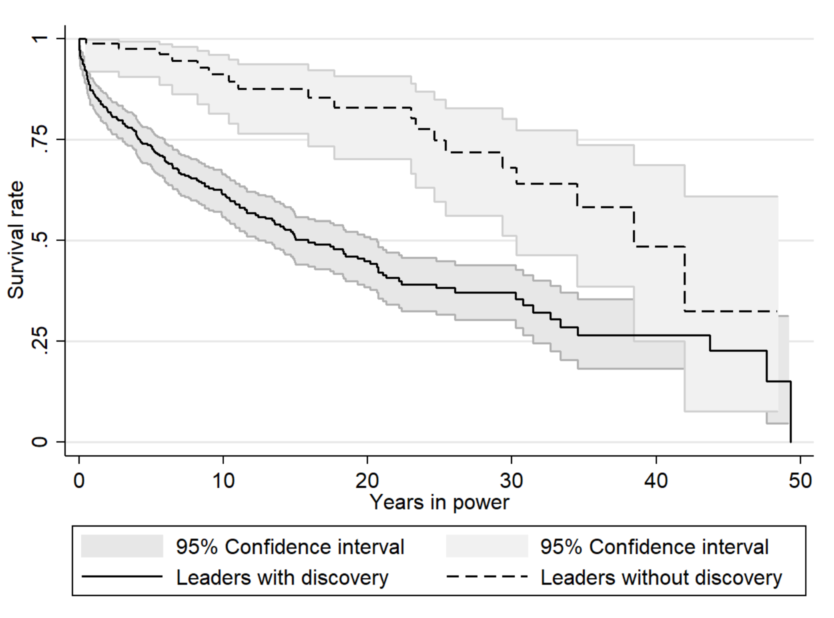
Key Words: Resource discoveries, Dictatorship, Leadership duration

*Center of Economic Research, CER-ETH, Zurich, Switzerland. Tel: +41-44-632-60-33, email: abrausmann@ethz.ch, egrieg@ethz.ch

1 Introduction

Clinging to power for as long as possible seems to be a hallmark of autocratic leaders. Dictatorial regimes have often been associated with self-enrichment, corruption, ethnic purging, repression, torture, and other forms of violation of human rights – usually with the goal of cementing the authority and supremacy of the leadership. 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). Is it coincidental that during the rule of Bongo, Bin Said and Qaddafi substantial discoveries of fossil resources have taken place, while during that of Pol Pot there have been none?

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



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). 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 stage a coup d'état, or induce an insurgency to create a revolution. 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. Our general finding is that the positive relationship between resource discoveries and political survival of dictatorial regimes, 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 under certain conditions. We also test the validity of these sub-hypotheses empirically and find that the delay in the timing of attack plays a more important role in the overall positive effect on regime survival.

Our theoretical model of a resource-driven coup builds on a large literature analyzing (resource) wars and conflicts in a setup with two players. Our 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 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 steaks for the rebel group. Van der Ploeg (2018) develops 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 also confirms that extraction is more rapacious if government instability is high and cohesiveness is weak.[1] 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 on regimes, 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.

Similarly to the above-mentioned studies, in our theoretical framework one faction (the autocrat) enjoys the power of office and unilaterally decides on resource exploitation,[2] while a rival faction may try to gain control over office and resource rents by challenging the incumbent. We extend this standard incumbent-opposition framework in three dimensions. First, we propose a fully dynamic and stochastic model.[3] Second, 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. Moreover, we depart from exogenous contest-success probabilities (Tullock, 1975; Gallego & Pitchik, 2004; Jackson & Morelli, 2009; 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 current consumption has to be sacrificed in order to raise

[1] 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.

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

[3] One other study which also considers a dynamic and stochastic resource-war model is van der Ploeg (2018), although it does not look directly at how resources affect success probabilities but looks more closely at the effect of coups on exploration efforts.

self-preservation, i.e. "guns vs butter" choice, as in, e.g., Jackson & Morelli (2009) and Caselli & Tesei (2016). Third, we explore an additional link between natural resources and leadership duration working through stochastic resource discoveries.

Our theoretical model shows that a possibility of a discovery may entail either a more rapid or a more conservative extraction profile as compared to a benchmark without discovery. The outcome depends on the interplay between the oil demand elasticity and the elasticity of intertemporal consumption substitution. If extraction is more voracious and the discovered resources are relatively small, the leader is more likely to fail. If extraction is only mildly voracious while the discovery is large or occurs relatively early within the leader's tenure, he is more likely to persist. If extraction is conservationist, the leader is more likely to survive longer independently of the size or timing of discovery. 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) helps him accumulate more fighting power relative to the opposition and thus reduces the probability of coup success, provided that the elasticity of intertemporal substitution is relatively small.

The model thus gives us two main testable hypotheses: (1) Leaders face a lower hazard following a discovery; and (2) the earlier in his tenure the leader discovers oil, the larger the impact. Further, 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 analysis, 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 leaders 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 of the coup.

Many papers have attempted to estimate the effect of resource wealth on political outcomes, although results have been found to be sensitive to the specification choices in general, and to resource wealth in particular (see e.g. Brunnschweiler & Bulte, 2008; Horiuchi & Wagle, 2008; Herb, 2005; Gurses, 2011; Andersen & Aslaksen, 2013; Haber & Menaldo, 2011; Andersen & Ross, 2014; Nordvik, 2019).[4] 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, as the production and income levels could be strategic choices of the leader.[5] This is why a few studies have turned to the timing of oil

[4]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)

[5]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

and gas discoveries in an attempt to reduce the endogeneity in the link between resource wealth and democracy (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 randomness of oil discoveries and use 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 seem to lower democracy scores.

We also use resource discoveries in our empirical model in order to directly identify a causal relationship due to their inherent randomness. Discoveries of 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*, he cannot choose to *find*, nor 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 (see e.g. Lei & Michaels, 2014; Arezki *et al.*, 2017; Cotet & Tsui, 2013a,b; Van Der Ploeg & Poelhekke, 2017). 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 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.

In order to empirically assess the stability of autocratic leaders, we use survival analysis, as do a few earlier studies (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.

Our paper contributes to the literature by extending both theoretical and empirical research on the political implications of oil wealth. The 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. Our theoretical model elicits two channels through which resource discoveries prolong the leadership duration: timing of the coup and probability of success. Our empirical results confirm the importance of both channels and suggest that the effect of discoveries on the timing of the coup tends to be the main driving force.

The rest of the article is organized as follows. Section 2 introduces the theoretical model of a

producing countries (consider the Iranian revolution in 1979, and the effect it had on the oil price).

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 estimate the effect of discoveries on leadership durations in autocratic regimes. The final section 4 concludes.

2 Theoretical Model

The first subsection presents a dynamic stochastic model of a resource-driven coup which augments the model of van der Ploeg (2018) by endogenizing the timing of the coup and by introducing a probability of coup success/failure, initially assumed exogenous. The second subsection endogenizes the success probability and describes the equilibrium. The third subsection introduces a random oil discovery, while the final subsection shows how a random 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 demand function is given by $p_t = R_t^{-\beta}$, where $1/\beta > 0$ is the resource demand elasticity. The incumbent autocratic leader or Government (G) has full control over the natural resource. 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. Following Besley & Persson (2011) and van der Ploeg (2018), we assume that G distributes a fixed fraction $\theta \in (0, 1)$ of the resource rents to the citizens. G's consumption at each point in time prior to a coup is thus $(1-\theta)p_t R_t$. Parameter θ may be viewed as redistribution in general, to the elite or population, and may be set, for example, by tradition. Adopting the interpretation of Besley & Persson (2011), it is an "institutionalized ability to make commitments not to expropriate the opposition." Importantly, we do not treat θ as a strategic choice of G because otherwise G will always be able to avoid a coup by choosing and committing to an appropriate redistribution policy. In order to avoid such a positive bias, we treat θ as fixed but we do take into account the incentive-compatibility constraint, such that it may indeed be optimal for the Opposition to eventually stage a coup. We discuss this in more detail in Section 2.1.2 and in the Appendix.

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 a random variable from the perspective of G but a choice variable of O. If the coup is staged, there is a probability $\nu \in (0, 1)$ that G remains in power, i.e. the coup fails. If the coup is successful, O gains full control over the oil, while G receives a scrap value consumption K per unit of time (think of life in exile or jail). If the coup fails, O receives a scrap value consumption K^o per unit of time and does not attempt to stage another coup.[6] Both scrap values are assumed to be relatively small compared to the resource income. In addition, we assume that $K \geq K^o$ on the presumption that the incumbent is able to secure a better post-coup fate for himself then the Opposition in case of failure. 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. We assume that coup arrival follows the Poisson process with intensity ψ. 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 ν. G's decision variable is how much oil to extract in the first phase and, if he remains in power, in the second phase. Denoting the instantaneous utility of consumption by $u(c)$, with $u'(c) > 0$, $u''(c) \leqslant 0$, and the rate of time preference by a constant ρ, G's optimization problem may be written as:

$$\max_{R_t} \int_0^\infty \left\{ \int_0^T u(c_t)e^{-\rho t}dt + \nu \int_T^\infty u(\tilde{c}_t)e^{-\rho t}dt + (1-\nu)\int_T^\infty u(K)e^{-\rho t}dt \right\} \psi e^{-\psi T}dT \tag{1}$$

subject to

$$c_t = (1-\theta)p_t R_t, \quad t \in [0,T), \quad \tilde{c}_t = p_t R_t, \quad t \geqslant T, \tag{2}$$

$$\dot{S}_t = -R_t, \quad S_0 \text{ given}, \tag{3}$$

$$p_t = R_t^{-\beta}, \;\; \beta > 0. \tag{4}$$

Eq. (2) describes the consumption functions: In the pre-coup phase G consumes the rents which remain after the constitutional payments; in the post-coup phase G consumes the entire oil rents, as there is no need to share them with O if the coup fails. Eq. (3) is the dynamic law for the stock of oil, while eq. (4) describes the oil demand.

The solution to the problem in (1) - (4) 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 the associated present value of welfare. Then, we compute the optimal extraction and welfare in the stochastic pre-coup phase. Let us assume for the rest of our analysis that the utility function of both players takes the iso-elastic form, $u(c) = \frac{c^{1-\varepsilon}}{1-\varepsilon}$, where ε is the inverse of the (constant) elasticity of intertemporal substitution (EIS).

[6] Our model can be easily extended to multiple coup attempts without changing the main insights. Recurring coups are studied in van der Ploeg (2018), although in that model coup is a random Poisson event for both factions and there is no distinction between coup arrival and success probability.

Post-coup Phase

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

$$\hat{R}_t = -\frac{\rho}{1-\eta} \equiv -\gamma, \quad R_T = \gamma S_T, \tag{5}$$

$$\hat{\tilde{c}}_t = -(1-\beta)\gamma, \quad \tilde{c}_T = (\gamma S_T)^{1-\beta} \tag{6}$$

where $\eta \equiv (1-\beta)(1-\varepsilon)$ and a hat over a variable denotes the growth rate. Thus the resource is depleted at the constant rate γ. In order to make sure that $\gamma > 0$, we need to impose the following restriction on parameter values: $\eta < 1$. This restriction is automatically satisfied if either (i) $\varepsilon \in [0,1]$ and $\beta \in [0,1]$ (but not both equal to 0 at the same time); or (ii) $\varepsilon > 1$ and $\beta \in [0,1]$; or (iii) $\varepsilon \in [0,1]$ and $\beta > 1$. Hence, the only case where the restriction is not automatically satisfied is $\varepsilon > 1$ and $\beta > 1$. For this case the necessary restriction is

$$1 < \beta < \frac{\varepsilon}{\varepsilon - 1} \quad \text{or} \quad 1 < \varepsilon < \frac{\beta}{\beta - 1}. \tag{7}$$

However, this latter case will not be relevant for the equilibrium of our model (as shown in the appendix) because when $\beta > 1$ the Opposition will never want to stage a coup, in other words the ICC is not satisfied, as collecting the rents shared by G yields a larger expected welfare than venturing into a coup. Hence, for the rest of the analysis we will concentrate on the case where β is strictly less than unity.

Pre-coup Phase

The problem in the pre-coup phase is stochastic due to the possibility of a coup. The extraction and consumption feature growth rates which are larger in absolute value than those in (5) - (6) because the coup hazard essentially increases the impatience rate:

$$\hat{R}_t = -\gamma^c, \quad R_0 = \gamma^c S_0, \tag{8}$$

$$\hat{c}_t = -(1-\beta)\gamma^c, \quad c_0 = (1-\theta)R_0^{1-\beta}, \tag{9}$$

where γ^c is an implicit solution to the following equation

$$(1-\eta)\gamma^c = \rho + \psi\left[1 - \nu\left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}\right]. \tag{10}$$

In spite of the fact that an explicit solution is infeasible, we are still able to provide a clear relationship between γ^c and γ. If we rewrite the above equation as

$$\gamma^c = \frac{\rho}{1-\eta} + \frac{\psi}{1-\eta}\left[1 - \nu\left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}\right] = \gamma + \frac{\psi}{1-\eta}\left[1 - \nu\left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}\right], \tag{11}$$

we see that γ^c is equal to γ plus a term of a priori ambiguous sign. We show in the appendix that this extra term cannot be negative, so that $\gamma^c > \gamma$, implying that the pre-coup extraction is more rapacious. Moreover, how much more rapacious the extraction is depends on the coup arrival rate, on the probability of staying in power and on the extraction rate after the (failed) coup. If the risk of coup did not exist at all, i.e. $\psi = 0$, the extraction would proceed at the same rate γ in both phases. Hence, the presence of the coup risk is a precondition for rapacious extraction. If the incumbent would always lose 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 essentially increases the impatience rate one to one. On the other hand, if $\nu > 0$ and if, after a failed coup, the incumbent would again face the same coup risk, in other words the deterministic post-coup phase would never exist, then γ would be the same as γ^c in all phases and the term in the squared brackets would be equal to $1 - \nu > 1 - \nu \left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}$. In this case, the extraction is more rapacious than in (11) but less rapacious than under zero probability of remaining in power. Hence, it is possible to construct a ranking of the speed of extraction from the least voracious to the most voracious depending on the specific scenario. However, for our later analysis we will only need the following

Result 1: *The threat of a possible overthrow at some unknown future date makes extraction in the pre-coup phase more rapacious than under certainty. 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.*

Proof: provided in the appendix.

The above result is not new in the literature and has been shown by van der Ploeg (2018) in the context of a dynamic resource-war model. What has not been discussed in that paper, however, is the fact that a more rapacious extraction does not automatically imply smaller oil rents in the post-coup phase. The outcome depends on the magnitude of the oil demand elasticity.

Lemma 1: *A faster extraction in the pre-coup phase leads to a smaller oil stock which remains on the date of the coup, as compared to the certainty case, and results in a reduction (increase) in future oil rents if the oil demand elasticity is larger (smaller) than unity.*

Proof: The first statement of the Lemma is obvious, since, for a given initial oil stock, a faster extraction today means that there will be less oil in the ground tomorrow. Given that the remaining stock on date T is smaller, extraction rates on any future date $t > T$ will also be lower than under certainty. The oil rents per unit of time are given by the product of the price and the quantity extracted. With the oil demand function in (4), a change in rents due to a change in quantity is given by $p(1-\beta) \gtrless 0 \;\Leftrightarrow\; \beta \lessgtr 1$, where β is the inverse of the oil demand elasticity. Hence, if the elasticity is larger than unity (i.e. $\beta < 1$), oil rents decline in response to a decline in R and vice versa. ■

Result 1 and Lemma 1 will prove to be useful in our later discussion of the timing of the coup, which is a decision variable of the Opposition.

2.1.2 Opposition

The Opposition faces two options: (1) collect the rents offered by G forever and refrain from staging a coup, or (2) stage a coup at some optimally chosen date, T, in order to attempt gaining office and control over the oil stock. In the appendix we specify the exact incentive-compatibility constraint (ICC) such that it is optimal for O to eventually stage a coup, and we proceed below under the assumption that the ICC holds. In a nutshell, the sufficient conditions for ICC to hold state that θ should not be too large, otherwise it would be optimal to safely collect the constitutional payments.

If the coup is successful, with probability $\mu \equiv 1 - \nu$, O stays in office for the remainder of the planning horizon, while G receives the scrap consumption K per unit of time. 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, and the extraction rate in the post-coup phase (if successful). Consumption and welfare of the Opposition are denoted with the superscript "o" in order to distinguish them from those of G.

$$\max_{T,R_t} \quad \int_0^T u(c_t^o)e^{-\rho t}dt + \mu \int_T^\infty u(\tilde{c}_t^o)e^{-\rho t}dt + (1-\mu)\int_T^\infty u(K^o)e^{-\rho t}dt \tag{12}$$

subject to

$$c_t^o = \theta R_0^{1-\beta} e^{-\gamma^c(1-\beta)t}, \quad t \in [0,T), \quad \tilde{c}_t^o = p_t R_t, \quad t \geqslant T, \tag{13}$$

$$\dot{S}_t = -R_t, \quad p_t = R_t^{-\beta}, \; \forall t > T. \tag{14}$$

The choice of the optimal program proceeds backwards. Since the post-coup extraction problem is identical to the problem of G (discussed in the previous subsection), we already know the solution from eqs. (5) - (6). We may therefore write directly the post-coup welfare under success as

$$W_{II}^o \equiv \int_T^\infty u(\tilde{c}_t^o)e^{-\rho t}dt = \frac{u(\tilde{c}_T^o)e^{-\rho T}}{\gamma}, \quad \tilde{c}_T^o = (\gamma S_T)^{1-\beta}. \tag{15}$$

In the pre-coup phase, O simply collects the constitutional payments from G. Thus, the discounted welfare in the first phase is given by:[7]

$$W_I^o = \int_0^T u(c_t^o)e^{-\rho t}dt = u(c_0^o)\frac{1-e^{-(\gamma^c\eta+\rho)T}}{\gamma^c\eta+\rho}, \quad c_0^o = \theta(\gamma^c S_0)^{1-\beta}, \quad \gamma^c\eta+\rho > 0. \tag{16}$$

The total expected lifetime welfare of O is then

$$W^o \equiv W_I^o + \mu W_{II}^o + (1-\mu)\frac{u(K^o)e^{-\rho T}}{\rho}. \tag{17}$$

[7]For the integral to converge, we require that $\gamma^c\eta + \rho > 0$.

The objective of O is to choose the optimal time of attack, T. Delaying the coup by one unit of time increases the pre-coup marginal welfare as O gets to consume with certainty the oil rents shared by G. However, delaying the coup causes an expected marginal welfare loss in the post-coup phase because O will enjoy the post-coup rents over a shorter period of time and she will end up controlling a smaller oil stock (the latter follows from Result 1). In addition, if the coup fails, O's consumption will drop to a tiny scrap value. By totally differentiating the lifetime welfare with respect to T we obtain the first-order condition

$$\frac{dW^o}{dT} = \frac{dW_I^o}{dT} + \mu\frac{dW_{II}^o}{dT} + (1-\mu)\frac{d}{dT}\left(\frac{u(K^o)e^{-\rho T}}{\rho}\right) = 0, \tag{18}$$

which can be written as

$$\frac{\theta^{1-\varepsilon}(\gamma^c S_0 e^{-\gamma^c T})^\eta}{1-\varepsilon} = \mu\frac{(\gamma S_0 e^{-\gamma^c T})^\eta}{\gamma(1-\varepsilon)}\rho + \mu\frac{(\gamma S_0 e^{-\gamma^c T})^\eta}{\gamma}(1-\beta)\gamma^c + (1-\mu)u(K^o), \tag{19}$$

where the marginal gain is represented by the expression on the left-hand side and the marginal loss is on the right-hand side. The last term on the RHS is straightforward and refers to the case of coup failure. The first two terms on the RHS represent the "duration" and the "rents" effect, respectively, and apply to the case of coup success (hence, weighted by μ). The "duration" effect refers to a shorter period of time over which the oil rents can be enjoyed if the coup is delayed. Moreover, the present discounted value of rents stemming from the smaller oil stock is lower, the higher the discount rate. Hence, a higher ρ on the RHS increases the marginal loss. The "rents" effect is given by the middle term which shows that if the oil demand elasticity is larger than unity, i.e. $\beta < 1$, delaying the coup by one unit of time will result in smaller future oil rents and thus a welfare loss. If, however, the elasticity is below unity, i.e. $\beta > 1$, delaying the coup will in fact lead to an increase in rents and thus a marginal welfare gain, all else equal. At the optimum, the marginal gain in the pre-coup phase must coincide with the expected marginal loss in the post-coup phase, such that

$$T = \frac{1}{\eta\gamma^c}\ln\left[\frac{\Omega(\gamma^c S_0)^\eta}{(1-\mu)(K^o)^{1-\varepsilon}}\right], \tag{20}$$

where $\Omega \equiv \theta^{1-\varepsilon} - \frac{\mu}{\gamma}\left(\frac{\gamma}{\gamma^c}\right)^\eta(\rho + \eta\gamma^c)$ must be positive for an interior solution to exist.

Result 2: The optimal timing of the coup is an increasing function of the initial oil stock.

Proof: By differentiation of (20), $\frac{dT}{dS_0} = \frac{1}{\gamma^c S_0} > 0$.

Result 2 will prove to be useful in our later analysis once we introduce a possibility of a discovery into our resource-coup model.

In the next step we wish to introduce another useful element into the model. It is reasonable to believe that leaders, especially autocratic ones, try to maximize their chances of staying in power by taking some sort of a strategic action aimed at self-preservation, for instance investing in secret police or a loyal army. It is also reasonable to suppose that abundance of natural resources will play an important role for such an investment (Cotet & Tsui, 2013a; Wright *et al.*, 2013). In the context of our model, this implies that G's probability of staying in power, ν, and O's probability of coup success, μ, are endogenous. We endogenize these probabilities in the next subsection by assuming that they are functions of expenditure on self-preservation, which we refer to, for simplicity, as military spending and denote them by m and m^o for G and O, respectively.

2.1.3 Endogenous Success Probability

In order to focus on the role of resource abundance in determining the probability of remaining in power, we now treat T as common knowledge. Treating T as a deterministic variable will allow us to isolate the pure effect of oil wealth from the combined effect of wealth and coup risk. We already know from the previous discussion and, in particular, from Result 1, that the only effect of T being stochastic is that the incumbent extracts the resource at a faster rate. The case where T is stochastic from the view point of G is presented in the appendix. When T is known, oil extraction proceeds at the rate γ in both the pre-coup and post-coup phases, that is, extraction is less rapacious in the first phase. Hence, in contrast to the stochastic model of sections 2.1.1 - 2.1.2, the oil stock which remains in the ground on date T is larger.

The objective function of G is now modified to include the cost of military spending, denoted by $C(m)$:

$$\max_{R,m} \int_0^T u(c_t)e^{-\rho t}dt + \nu(m)\int_T^\infty u(\tilde{c}_t)e^{-\rho t}dt + \Big(1-\nu(m)\Big)\int_T^\infty u(K)e^{-\rho t}dt - C(m), \tag{21}$$

subject to (2) - (4), where $C(0) = 0$, $C'(m) > 0$, $C''(m) \geq 0$, and $\nu'(m) > 0$, $\nu''(m) \leq 0$.

The optimal paths of extraction and consumption in the post-coup phase remain as those described in eqs. (5) - (6). The growth rate of extraction in the pre-coup phase is equal to γ, as has already been shown in Result 1. The optimal military spending must satisfy the following first-order condition[8]: the present discounted value (PDV) of the expected marginal welfare gain from an extra unit of military spending must be equal to the marginal cost,

$$\nu'(m)\left[W_{II} - \frac{u(K)e^{-\rho T}}{\rho}\right] - C'(m) = 0,$$

where $W_{II} = \frac{(\gamma S_T)^\eta e^{-\rho T}}{\gamma(1-\varepsilon)}$, which yields the following implicit equation in m:

$$\nu'(m)e^{-\rho T}\left[\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K)}{\rho}\right] = C'(m). \tag{22}$$

The right-hand side of (22) represents the present value of the marginal welfare loss due to a marginal unit of rents being spent on military power instead of on current consumption. The

[8]It can be shown that the second-order condition is negative.

left-hand side represents the present value of the expected marginal welfare gain in the post-coup phase, which is equal to a marginal increase in the probability of staying in power multiplied by the welfare gain. The latter is simply the welfare difference between scenarios where the coup succeeds and where it fails.

The optimization problem of O is modified in a similar way. The optimal military spending of O, m^o, must satisfy the following first-order condition:

$$\mu'(m^o)e^{-\rho T}\left[\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K^o)}{\rho}\right] = C'(m^o), \tag{23}$$

The interpretation of eq. (23) is similar to that of eq. (22). Note that the optimal time to stage a coup, T, is still given by (20), except that γ^c is now equal to γ and μ is endogenous. These optimal values, however, are not yet the equilibrium solutions of the dynamic resource-coup model.

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 model success probabilities (Tullock, 1975):

$$\nu = \frac{\alpha m}{\alpha m + m^o}, \quad \mu = \frac{m^o}{\alpha m + m^o} = 1 - \nu, \tag{24}$$

where $\alpha > 0$ represents the relative military efficiency of G. We will also assume for simplicity that the cost function of military spending is linear, so that $C(x) = x$, $x = m, m^o$.[9] Then, dividing (22) by (23) yields the equilibrium ratio of military expenditure, which we denote by ξ:

$$\xi \equiv \frac{m^o}{m} = \frac{\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K^o)}{\rho}}{\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K)}{\rho}} \tag{25}$$

and the equilibrium success probabilities for G and O, respectively,

$$\nu^* = \frac{\alpha}{\alpha + \xi}, \quad \mu^* = \frac{\xi}{\alpha + \xi}. \tag{26}$$

The equilibrium of the model is characterized by the system of equations (20), (25), and (26). Note that μ in eq. (20) is now endogenous and depends on T, as well as on the parameters of the model, through the variable ξ. To anticipate the discussion on the role of oil discovery in the next subsection, we note the following

Result 3: The equilibrium timing of the coup is an increasing function of the initial oil wealth, while the equilibrium probability of coup success or, equivalently, the incumbent's equilibrium probability of remaining in power, is independent of oil wealth.

Proof: Provided in the Appendix.

The result that the equilibrium success probability is independent of oil wealth, S_0, is somewhat

[9] A quadratic cost function gives qualitatively the same results.

surprising, as one would expect that access to oil rents should facilitate self-preservation. Indeed, if we simply look at the effect of S_0 on ξ in eq. (25), we find that $\partial\xi/\partial S_0 < 0$, so that the oil wealth increases the chances of winning for the incumbent. However, this is only the partial equilibrium effect which ignores the effect of S_0 on T and the fact that T itself depends on ξ. Once we consider all the interactions among ξ, T, and S_0 in general equilibrium, we find that the overall effect of oil wealth on the military ratio is nil (as shown in the appendix). The intuition is the following: Since the timing of the coup is known to both factions, extraction is efficient and the post-coup oil rents are identical for both G and O, if they win. Hence, access to future oil rents affects the equilibrium military spending symmetrically. Therefore, the equilibrium *ratio* of military spending is not affected by the rents. Since the initial oil wealth is relevant for the players insofar as it determines future oil rents, it has no impact on the equilibrium ratio of military spending. This can be seen very clearly in a special case, where the two players receive identical scrap consumption, $K = K^o$. In this case, $m^o = m$ and $\xi = 1$. The success probabilities become constant and depend only in the relative military efficiency parameter α (as in Van der Ploeg & Rohner, 2012).

By contrast, when coup arrival is stochastic, the symmetry breaks down because G makes its optimal choice of m on the basis of the *expected* welfare, which is generally not equal to the deterministic welfare. In this case, the effect of oil wealth on ξ becomes either positive or negative, depending on the magnitude of ε. Because the derivations of the stochastic case are more involved, we relegate them to the appendix. Depending on whether the time of the coup is a random variable or not from the perspective of G, oil wealth will have an ambiguous effect on the success probability. If the Opposition is not able to effectively conceal the coup, it turns out that the oil wealth is not relevant at all for the chances of success of either parties. The effect of oil wealth on coup success rate is then an empirical question which we will address in Section 3.

Next we introduce the stochastic oil discovery into our resource-coup model. We assume that the time of the discovery is not known to either faction.[10]

2.2 Introducing Oil Discovery

Let us assume that an arrival of a discovery follows the Poisson process with an increment dq_t and a constant intensity λ. Then the time of discovery, denoted by τ, follows an exponential distribution with density $f_\tau = \lambda e^{-\lambda\tau}$. If a discovery occurs, the current resource stock is augmented by a factor $\Delta > 1$. We assume for simplicity that there may be only one discovery while G is in office.[11]

We focus on the sequence of events where the discovery precedes the coup (the opposite case would be irrelevant). We assume that the initial resource endowment is relatively small, so that staging a coup does not pay off initially, in other words, ICC is not satisfied. Fighting for the resource only becomes attractive once a relatively large discovery occurs. G learns about a possibility

[10] The role of exploration efforts in a resource-war model are analyzed by van der Ploeg (2018).

[11] Our data on autocratic leaders and giant oil/gas discoveries, going back to 1868, shows that it is most common for leaders to have only one discovery, and few have more than two.

of a coup once the (large) discovery has taken place. This also guarantees consistency with our empirical investigation later in the paper.

2.2.1 Optimal Extraction in Anticipation of Discovery

If a possibility of a discovery did not exist, G would operate in a deterministic environment and would extract the resource at the rate γ, defined in (5). By time τ the amount $S_\tau = S_0 e^{-\gamma\tau}$ would still remain in the ground. The simple existence of a *possibility* of a discovery (but not an actual occurrence of a discovery) introduces a distortion into G's extraction profile by changing the speed of extraction. The key question is how the possibility of a discovery affects the oil stock that prevails on the date of the discovery, which we denote by S^d_τ in order to distinguish it from the deterministic S_τ. In particular, the stochastic stock just before discovery is denoted by $S^d_{\tau-}$ and just after by $S^d_{\tau+}$. The amount of oil remaining on date τ is determined by (i) the speed of extraction prior to discovery, denoted by γ^d, and (ii) the size of the discovery, Δ, so that $S^d_{\tau+} = \Delta S_0 e^{-\gamma^d\tau}$. If the speed of extraction prior to discovery is lower than γ, then the oil stock is unambiguously larger. This is not only because of the newly discovered deposits but also because less has been extracted over the period from 0 to τ. If, however, the extraction is more rapacious, $\gamma^d > \gamma$, then the remaining oil stock just before discovery, $S^d_{\tau-}$, is lower than S_τ. If the new deposit is relatively small, it may not be sufficient to compensate for the fast extraction and the reduction in the stock prior to discovery. Only if the additional stock is large enough, will the total stock on the discovery date exceed its deterministic counterpart. Our next task is to determine the optimal stochastic growth rate of extraction, γ^d, and to compare the oil stocks in the two scenarios.

The optimal speed of extraction in anticipation of a discovery is given by the solution to the following implicit equation (see Appendix)

$$\gamma^d = \frac{\rho}{\beta} - \frac{\lambda}{\beta}\left[\left(\frac{\gamma^d}{\gamma}\right)^\beta \Delta^{1-\beta} - 1\right]. \tag{27}$$

Comparison of (27) and (5) reveals that γ^d may in general be either greater or smaller than γ (detailed analysis in the appendix). On the one hand, the prospect of making a discovery of additional reserves relaxes the resource constraint and may induce a faster depletion of the current stock. On the other hand, since the discovery is not certain and may even never occur, it might be optimal to deplete the current stock taking precautionary considerations into account - and thus deplete more slowly, while raising consumption only when the new reserves become available with certainty. Whether the depletion proceeds more quickly or more slowly depends on the magnitude of the oil demand elasticity and the elasticity of intertemporal substitution (EIS). We refer to the oil demand as elastic (inelastic) if the oil demand elasticity is above (below) unity, i.e. $0 < \beta < 1$ ($\beta > 1$). Similarly, we refer to EIS as large (small), if $0 < \varepsilon < 1$ ($\varepsilon > 1$). The only case where the two extraction-growth rates coincide is when oil demand elasticity is equal to unity.

Proposition 1: *A possibility of oil discovery induces*

(i) a faster extraction in the pre-discovery phase, i.e. $\gamma^d > \gamma$*, if either oil demand is elastic and EIS is small or oil demand is inelastic and EIS is large;*

(ii) a slower extraction, i.e. $\gamma^d < \gamma$*, if oil demand is elastic and EIS is large or oil demand is inelastic and EIS is small, satisfying restriction (7).*

Proof: provided in the Appendix.

The first part of Proposition 1 complies with the general intuition. If an oil discovery, representing a positive income shock, is anticipated in the future, it is optimal to engage in intertemporal consumption smoothing by consuming (and thus extracting) more in the present. This is exactly the opposite of the precautionary saving phenomenon in anticipation of a negative income shock. The second part of Proposition 1 seems at first counterintuitive. A closer look, however, reveals that a slower extraction in anticipation of a positive shock is indeed optimal in the two mentioned cases. By Lemma 1, the condition $0 < \beta < 1$ implies that the marginal oil revenue is positive, so that an increase in oil supply results in an increase in total oil rents. When an oil discovery occurs, the extraction rate jumps up on impact, oil supply increases allowing for higher rents and hence for higher consumption. Therefore, the time after the discovery would be exactly the right time to increase consumption. Increasing future consumption, however, requires that G is willing to shift his consumption from the present to the future, that is, a sufficiently large elasticity of intertemporal consumption substitution. With $1/\varepsilon > 1$, such a shift of consumption from the present to the future becomes feasible and indeed optimal. On the other hand, if EIS is relatively small ($1/\varepsilon < 1$), the agent cares relatively more about the current consumption rather than about the future consumption. If the oil demand is relatively inelastic ($1 < \beta < \frac{\varepsilon}{\varepsilon-1}$), a faster extraction implies a reduction in oil rents (Lemma 1) and a lower consumption today relative to tomorrow. Hence, it is optimal to delay extraction further into the future.

The distinction between a faster and a slower extraction, emphasized in Proposition 1, is important for determining the size of the remaining oil reserves on date τ, compared to the deterministic scenario without a possibility of an oil discovery. If the parameter constellations are such that the conditions of Proposition 1(ii) are satisfied, then we are certain that $S^d_{\tau+} > S_\tau$. If the parameter constellations are such that the conditions of Proposition 1(i) are satisfied, then $S^d_{\tau+} > S_\tau$ only of the new deposits are sufficiently large. Since our empirical investigation will be concerned only with giant oil and gas discoveries (larger than 500 million barrels), we assume that even if extraction is rapacious in the pre-discovery phase, the newly discovered deposits are large enough to ensure that the oil stock on date τ in the scenario with discovery is larger than its counterpart in the hypothetic scenario without discovery.

Assumption 1: *Newly discovered reserves are sufficiently large:* $\ln \Delta > (\gamma^d - \gamma)\tau$.

Assumption 1 is quite realistic: If, for example, an oil discovery leads to a 100% increase of the stock and the difference in extraction rates is 1%, then, for Assumption 1 to hold, τ needs to be less than 70 years. If an increase in the stock is only 50%, then τ needs to be less than 40 years, which is about the longest office lifetime of a leader in our sample. Among the leaders with discoveries half discovered oil or gas within the first 3 years of tenure and all but one within 30 years, with the average τ in our sample being only 6.5 years.

Having described the optimal extraction in the face of a possible discovery, we may now turn to the effect of the discovery on G's duration of stay in office.

2.3 Leadership Duration

In this section we bring together all the ingredients of the model developed so far and show how a resource discovery is relevant for leadership duration.

After (and if) the discovery has occurred, O realizes that it is optimal to fight for the large oil reserves and decides to stage a coup on some optimally-determined date T. G realizes that now he faces the threat of a coup. The programs of the two factions become identical to those analyzed in Section 2.1.3, except that they start at time $t = \tau$ instead of $t = 0$. Hence, the effect of an oil discovery on date τ, i.e. a change in S_τ, is equivalent to the effect of a change in S_0 in our resource-coup model of Section 2.1.3. In the previous subsection we showed that $S^d_{\tau+}$ in a scenario with a possible discovery may be larger or smaller than its counterpart in the scenario without a discovery, S_τ. We also showed that if EIS is sufficiently large, i.e. $1/\varepsilon > 1$, and oil demand is sufficiently elastic, i.e. $1/\beta > 1$, $S^d_{\tau+}$ is unambiguously larger than S_τ. We have also argued that even if the extraction rate in anticipation of a discovery becomes more rapacious, the newly discovered giant deposits compensate for the resource overuse leading to an ultimate increase in $S^d_{\tau+}$. Hence, we may argue that the effect of a discovery is equivalent to the effect of an *increase* in S_0 on the equilibrium duration of G's tenure in the benchmark resource-coup model.

Let us define the average duration of leadership as $D = T/\mu$. In other words, the average duration takes into account the timing of the coup and the probability of success of the Opposition. If O succeeds with probability 1, i.e. $\mu = 1$, 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 μ from (26), we obtain

$$D = \frac{T^*}{\mu^*} = T^*\left(1 + \frac{\alpha}{\xi}\right), \tag{28}$$

where T^* refers to the equilibrium time of the coup, determined by (20) and (26). By differentiating (28) with respect to S_0 we may decompose the effect of oil reserves on D into the effect on the timing, $\frac{dT^*}{dS_0}$, and the effect on the relative military power, $\frac{d\xi}{dS_0}$:

$$\frac{dD}{dS_0} = \left(1 + \frac{\alpha}{\xi}\right)\frac{dT^*}{dS_0} - \frac{T^*\alpha}{\xi^2}\frac{d\xi}{dS_0}. \tag{29}$$

From our Result 3, we know that the first effect is always positive. If the time of the coup is common knowledge, then the second effect is nil and the overall effect is thus positive. If the time of the coup is random from the perspective of G, then the second effect is positive or negative, depending on whether ε is smaller or larger than one, respectively. Our numerical results, presented in the appendix, show however that even if $d\xi/dS_0 > 0$, the positive effect of S_0 on T dominates and the overall effect on D is positive.

Proposition 2: *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: provided in the Appendix.

Proposition 2 yields two main testable implications of the model. The first implication is that large discoveries tend to stabilize autocratic regimes. The second implication relates directly to Assumption 1. For a given $\gamma^d - \gamma$, the smaller is τ relative to Δ, the more likely it is for Assumption 1 to hold, and thus the more likely it is that the discovery leads to an increase in S^d_τ even if extraction is more rapacious ($\gamma^d > \gamma$) during the pre-discovery phase. Hence, the sooner a discovery occurs within a leader's tenure, the more likely he is to stay in power longer. In the next section we test these predictions empirically by using survival analysis and a large dataset on leaders and discoveries of giant oil and gas fields going back to 1868.

3 Empirical Evidence

Our first main testable hypothesis is based on the result that a 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. On the one hand, a discovery unambiguously increases time to coup. Hence, our first sub-hypothesis is

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

On the other hand, a discovery may have a positive, zero or negative effect on the probability of coup success, depending on the magnitude of EIS and on how well the coup is concealed. Since we do not have an unambiguous prediction for the success probability, we formulate our second sub-hypotheses as follows:

Hypothesis 1b: *A discovery has no effect on the probability of coup success.*

Our second main hypothesis is

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 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. The dataset includes information on the leader, including year of birth and death, how the regime ended (EXIT) and post-tenure fate. The EXIT variable differentiates between REGULAR turnover which is defined as any voluntary secession of power such as an election, IRREGULAR turnover, which is defined as the leadership ending in some sort of internal coup or revolution, and NATURAL DEATH, in the cases when a leader died of natural causes while in office. As we are interested in how oil and gas affects the stability of autocratic leadership, we only code the IRREGULAR turnover as failure – so any other end to the leadership is treated as censored. 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 coup (e.g. Mobuto in Zaire) is coded as a failure. Including regular turnovers 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.

To create a variable for oil and gas discoveries during the tenure of a leader, we use the Giant Oil and Gas Fields of the World database (Horn & Myron, 2011). The dataset includes the discovery year, size and type of every giant oil and gas discovery since 1868.[12] 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 2.7). 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). The Polity2 variable is a common measure of regime characteristics in the literature (see e.g. Cuaresma *et al.*, 2011; Andersen & Aslaksen, 2013). Polity2 is an index ranging from -10 to 10, where 10 is the most democratic and -10 is the most autocratic. 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). 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.[13] This leaves 527 leadership durations 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 the Geddes *et al.* (2012) database[14] with

[12] 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.

[13] 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.

[14] The the dataset by Geddes *et al.* (2012) use how a regime starts as the defining feature of an autocracy, and does not distinguish between individual leaders.

largely similar results (see appendix 2.8).

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. In particular, we include covariates from the Haber & Menaldo dataset (Haber, 2011), which is compiled from several different sources of economic and political data, and goes back as far as 1800, thus allowing us to use all of the ARCHIGOS data. The dataset was created to test for the time-series properties related to the resource curse, and includes data on the control variables most commonly used in the literature. It gives us data on total oil reserves, other resource wealth, population, GDP, and several political and socio-economic variables. We include controls for the socio-economic situation outside of the oil discoveries: GDP and GDP growth as a baseline, with additional controls for income from other resources, and oil already being discovered in the country.

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; 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 (from Haber, 2011). We also include log of population to control for the size of the country. 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).[15]

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. 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

[15] 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.

from Ross & Mahdavi (2015). Using more detailed data on oil-companies' ownership structures, compiled by Brunnschweiler & Poelhekke (2019), does not change the results substantially. Further oil industry controls from ASPO through Cotet & Tsui (2013a) are incorporated in robustness checks.

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.[16]

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 but explore military spending in the appendix (2.3). The summary statistics are presented in Table 1. Finally, we cluster all standard errors at the country level.

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 2.1. The semi-parametric and parametric regression models allow for time varying covariates, and we rely on these to test hypotheses H1, H1a, and H2.

[16] 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?, 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 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
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 US (SIPRI)	3382.809	14697.95	1.619	250003	272
Wildcats	8.541	29.791	0	481	414

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

$$h_j(t|\boldsymbol{x_j}) = h_0(t)exp(\boldsymbol{x_j\beta_x}), \tag{30}$$

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 allows a minimum of assumptions to be placed on the data. For robustness, we include results using the parametric Weibull model.[17] 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.

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

success or failure of a coup) is a binary variable.

3.2.1 Potential sources of bias

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 2.4).

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 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). 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. Due to the time between discovery and extraction, it could be the case that the results are driven by access to credit and the expected value of future returns from the fields rather than the actual returns from the field. These returns would be driven by the initially estimated value of the resources, not the actual size. 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. 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 2.7).

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 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.[18]

Finally, 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 is the case, there would be an upward bias on the results. Based on the arguments put forward in Arezki *et al.* (2017) and Lei & Michaels (2014), we argue that this potential bias is not a problem when using giant oil and gas discoveries. Indeed, even if the leader can influence exploration intensity, he cannot know exactly when, where and how much oil/gas will be discovered. Moreover, as shown by Ahlvik & Harding (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 2.5).

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. (30). 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.

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

[18]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, and that (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.

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%. 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 finds 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 research (e.g. Gates *et al.*, 2006). 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 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 2: 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. All these alternative specifications point to the same conclusion: discoveries tend to stabilize autocracies.

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

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) Hazard ratio	(7) Parametric (Weibull, Haz. ratio)
Oil/Gas discovery	0.562***	0.501***	0.484***	0.522**	0.507**	0.325***	0.405**
	(0.120)	(0.110)	(0.117)	(0.152)	(0.148)	(0.122)	(0.153)
GDP per capita		0.992	0.995	0.957*	0.978	0.975	0.976
		(0.0148)	(0.0122)	(0.0232)	(0.0152)	(0.0167)	(0.0149)
GDP growth		0.973***	0.975***	0.974**	0.973**	0.968**	0.967***
		(0.00909)	(0.00899)	(0.0103)	(0.0104)	(0.0122)	(0.0119)
Coal Income per capita			0.990**		0.989*	0.917**	0.922**
			(0.00474)		(0.00584)	(0.0386)	(0.0371)
Metals Income per capita			1.000		1.000	1.000	1.000
			(0.000818)		(0.000913)	(0.000851)	(0.000855)
Oil already disc.			0.828		0.720	1.193	1.273
			(0.160)		(0.154)	(0.408)	(0.424)
Age at entry				1.001***	1.001***	1.001***	1.001**
				(0.000357)	(0.000332)	(0.000372)	(0.000453)
Median duration				1.000**	1.000**	1.000**	1.000**
				(4.11e-05)	(4.59e-05)	(5.55e-05)	(5.06e-05)
Polity 2				0.984	1.004	1.014	1.004
				(0.0267)	(0.0261)	(0.0292)	(0.0294)
Population (log)				0.938	1.005	0.948	0.936
				(0.0643)	(0.0739)	(0.0824)	(0.0762)
Nat'l oil company				1.117	1.279	0.958	0.849
				(0.288)	(0.367)	(0.349)	(0.314)
World democracy					0.967***	0.965**	0.968*
					(0.0111)	(0.0161)	(0.0163)
Regional democracy					0.999	1.002	1.003
					(0.00529)	(0.00564)	(0.00565)
Exploration intensity (Wildcats)						1.011*	1.011
						(0.00620)	(0.00670)
Constant							1.065
							(1.436)
p							0.728***
							(0.0589)
Leaders	527	429	426	383	382	273	273
Failures	207	170	169	149	149	105	105

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

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

VARIABLES	(1) Time Ratio	(2) Time ratio	(3) Time ratio	(4) Time ratio	(5) 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)
	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

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

3.3.2 Sub-hypothesis 1a: Time to Attack

The 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 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 pushed back by a factor of 3 to 4 relative to no discovery. The data thus supports Hypothesis 1a.

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

Table 4: Summary statistics, Hypothesis 1b: Coup success (ν)

	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

VARIABLES	(1) Coup outcome	(2) Coup outcome	(3) Coup outcome	(4) 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

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.

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 τ 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 a leader, and 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 τ in the regression indicates that a discovery lowers hazard, but that as τ increases, so does the hazard (column (3) of Table 6). The coefficient on τ 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

Table 6: Results, Hypothesis 2: Timing of discovery (τ)

VARIABLES	(1) Hazard ratio split at 3 years	(2) Hazard ratio split at 5 years	(3) Hazard ratio 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

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

later discoveries.

3.4 Implications

What does all this tell us about the political properties of resource discoveries? The clear conclusions to be drawn from our results 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. However, using the Geddes *et al.* (2012) dataset, we tested the effect of discoveries on democratic transition in appendix 2.9) and did not find strong evidence to support this claim. 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 chances 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 provided that the coup is a purely random event from the perspective of the incumbent and her EIS is sufficiently low. 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 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 2004. 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.

References

Acemoglu, Daron, Ticchi, Davide, & Vindigni, Andrea. 2010. A theory of military dictatorships. *American Economic Journal: Macroeconomics*, **2**(1), 1–42.

Acemoglu, Daron, Golosov, Mikhail, Tsyvinski, Aleh, & Yared, Pierre. 2012. A dynamic theory of resource wars. *The Quarterly Journal of Economics*, **127**(1), 283–331.

Ahlvik, Lassi, & Harding, Torfinn. 2019. Investment and the timing of taxes: Evidence from a cash refund program. *Working Paper*.

Andersen, Jorgen J, & Ross, Michael L. 2014. The Big Oil Change A Closer Look at the Haber–Menaldo Analysis. *Comparative Political Studies*, **47**(7), 993–1021.

Andersen, Jorgen Juel, & Aslaksen, Silje. 2013. Oil and political survival. *Journal of Development Economics*, **100**(1), 89–106.

Angrist, Joshua D, & Pischke, Jörn-Steffen. 2008. *Mostly harmless econometrics: An empiricist's companion*. Princeton university press.

Arezki, Rabah, Ramey, Valerie A, & Sheng, Liugang. 2017. News shocks in open economies: Evidence from giant oil discoveries. *The quarterly journal of economics*, **132**(1), 103–155.

Berman, Nicolas, Couttenier, Mathieu, Rohner, Dominic, & Thoenig, Mathias. 2017. This mine is mine! How minerals fuel conflicts in Africa. *American Economic Review*, **107**(6), 1564–1610.

Besley, Timothy, & Persson, Torsten. 2011. The logic of political violence. *The quarterly journal of economics*, **126**(3), 1411–1445.

Brunnschweiler, Christa N, & Bulte, Erwin H. 2008. The resource curse revisited and revised: A tale of paradoxes and red herrings. *Journal of environmental economics and management*, **55**(3), 248–264.

Brunnschweiler, Christa N, & Poelhekke, Steven. 2019. Pushing One's Luck: Petroleum ownership and discoveries. *OxCarre Research Paper 219*.

Cabrales, Antonio, & Hauk, Esther. 2011. The Quality of Political Institutions and the Curse of Natural Resources. *The Economic Journal*, **121**(551), 58–88.

Carden, Art, & James, Harvey S. 2013. Time under autocratic rule and economic growth. *Contemporary Economic Policy*, **31**(1), 44–61.

Caselli, Francesco, & Tesei, Andrea. 2016. Resource windfalls, political regimes, and political stability. *Review of Economics and Statistics*, **98**(3), 573–590.

Caselli, Francesco, Morelli, Massimo, & Rohner, Dominic. 2015. The geography of interstate resource wars. *The Quarterly Journal of Economics*, **130**(1), 267–315.

Cleves, Mario, Gould, William, Gutierrez, Roberto G., & Marchenko, Yulia V. 2010. *An introduction to survival analysis using Stata - Third Edition.* Stata Press.

Cotet, Anca M, & Tsui, Kevin K. 2013a. Oil and conflict: what does the cross country evidence really show? *American Economic Journal: Macroeconomics*, **5**(1), 49–80.

Cotet, Anca M, & Tsui, Kevin K. 2013b. Oil, Growth, and Health: What Does the Cross-Country Evidence Really Show? *The Scandinavian Journal of Economics*, **115**(4), 1107–1137.

Cuaresma, Jesus Crespo, Oberhofer, Harald, & Raschky, Paul A. 2011. Oil and the duration of dictatorships. *Public Choice*, **148**(3-4), 505–530.

De Bruin, Erica. 2018. Preventing coups d'état: How counterbalancing works. *Journal of Conflict Resolution*, **62**(7), 1433–1458.

De Mesquita, Bruce Bueno, & Smith, Alastair. 2005. *The logic of political survival.* Cambridge, Massachusetts: MIT press.

De Mesquita, Bruce Bueno, & Smith, Alastair. 2010. Leader survival, revolutions, and the nature of government finance. *American Journal of Political Science*, **54**(4), 936–950.

de Onis, Juan. 1975. Faisal's killer is put to death. *The New York Times Archives*, June.

Easterly, William. 2011. Benevolent autocrats. *Working Paper, Dev. Res. Inst., New York University, New York.*

Federal Reserve Bank of St. Louis. 2013. *Spot Crude Oil Price: West Texas Intermediate (WTI) [WTISPLC].*

Gallego, Maria, & Pitchik, Carolyn. 2004. An economic theory of leadership turnover. *Journal of Public Economics*, **88**(12), 2361–2382.

Gates, Scott, Hegre, Håvard, Jones, Mark P, & Strand, Håvard. 2006. Institutional inconsistency and political instability: Polity duration, 1800–2000. *American Journal of Political Science*, **50**(4), 893–908.

Geddes, B, Wright, J, & Frantz, E. 2012. *Autocratic Regimes Dataset.*

Gleditsch, Kristian Skrede, & Ward, Michael D. 2006. Diffusion and the international context of democratization. *International organization*, 911–933.

Goemans, Henk E, Gleditsch, Kristian Skrede, & Chiozza, Giacomo. 2009. Introducing Archigos: A dataset of political leaders. *Journal of Peace research*, **46**(2), 269–283.

Gurses, Mehmet. 2011. Elites, Oil, and Democratization: A Survival Analysis. *Social science quarterly*, **92**(1), 164–184.

Haber, Stephen. 2011. *Haber-Menaldo 2011 APSR Dataset.*

Haber, Stephen, & Menaldo, Victor. 2011. Do natural resources fuel authoritarianism? A reappraisal of the resource curse. *American political science Review*, **105**(01), 1–26.

Hamilton, James D. 2009a. Causes and Consequences of the Oil Shock of 2007-08. *Brookings Papers on Economic Activity*, **1**(Spring), 215–261.

Hamilton, James D. 2009b. Understanding crude oil prices. *The Energy Journal*, **30**(2), 179–206.

Hegre, Håvard. 2001. Toward a democratic civil peace? Democracy, political change, and civil war, 1816–1992. *American Political Science Association*, **95**(01), 33–48.

Herb, Michael. 2005. No representation without taxation? Rents, development, and democracy. *Comparative Politics*, 297–316.

Hirst, David. 2010. From the archive, 26 March 1975: Faisal murder puts Mideast nearer abyss. *The Guardian*, March.

Horiuchi, Yusaku, & Wagle, Swarnim. 2008. 100 Years of Oil: Did it Depress Democracy and Sustain Autocracy? *Paper presented at the annual meeting of the APSA 2008.* `http://www.allacademic.com/meta/p280339_index.html`.

Horn, Myron K, & Myron, K. 2011. *Giant oil and gas fields of the world.*

Jackson, Matthew O, & Morelli, Massimo. 2009. Strategic Militarization, Deterrence and Wars. *Quarterly Journal of Political Science*, **4**(4), 279–313.

Laherrere, Jean. 2001. Estimates of oil reserves. *EMF/IEA/IEW Meeting, IIASA Laxenburg, Austria.*

Le Billon, Philippe. 2001. The political ecology of war: natural resources and armed conflicts. *Political geography*, **20**(5), 561–584.

Le Billon, Philippe. 2012. *Wars of plunder: Conflicts, profits and the politics of resources.* New York: Columbia University Press.

Lei, Yu-Hsiang, & Michaels, Guy. 2014. Do giant oilfield discoveries fuel internal armed conflicts? *Journal of Development Economics*, **110**, 139–157.

Marshall, Monty G, & Jaggers, Keith. 2002. *Polity IV project: Political regime characteristics and transitions, 1800-2002.*

Nordvik, Frode Martin. 2019. Does Oil Promote or Prevent Coups? The Answer is Yes. *The Economic Journal*, **129**(619), 1425–1456.

Omgba, Luc Desire. 2009. On the Duration of Political Power in Africa The Role of Oil Rents. *Comparative Political Studies*, **42**(3), 416–436.

Owen, Nick A, Inderwildi, Oliver R, & King, David A. 2010. The status of conventional world oil reserves—Hype or cause for concern? *Energy policy*, **38**(8), 4743–4749.

Powell, Jonathan M, & Thyne, Clayton L. 2011. Global instances of coups from 1950 to 2010: A new dataset. *Journal of Peace Research*, **48**(2), 249–259.

Ross, Michael L. 2004. What do we know about natural resources and civil war? *Journal of peace research*, **41**(3), 337–356.

Ross, Michael L. 2005. Booty futures. *UCLA Department of Political Science Working Papers, available at https://www.sscnet.ucla.edu/polisci/faculty/ross/papers/working/bootyfutures.pdf.*

Ross, Michael L. 2008. Blood barrels: Why oil wealth fuels conflict. *Foreign Affairs*, 2–8.

Ross, Michael L, & Mahdavi, Paasha. 2015. *Oil and Gas Data, 1932-2014*. Harvard Dataverse V2.

Smith, Benjamin. 2004. Oil wealth and regime survival in the developing world, 1960–1999. *American Journal of Political Science*, **48**(2), 232–246.

The Economist. 2019. Are dictatorships better than democracies at fighting climate change? Sep.

Tsui, Kevin K. 2011. More oil, less democracy: Evidence from worldwide crude oil discoveries. *The Economic Journal*, **121**(551), 89–115.

Tullock, Gordon. 1975. On the efficient organization of trials. *Kyklos*, **28**(4), 745–762.

van der Ploeg, Frederick. 2018. Political economy of dynamic resource wars. *Journal of Environmental Economics and Management*, **92**, 765–782.

Van Der Ploeg, Frederick, & Poelhekke, Steven. 2017. The impact of natural resources: Survey of recent quantitative evidence. *The Journal of Development Studies*, **53**(2), 205–216.

Van der Ploeg, Frederick, & Rohner, Dominic. 2012. War and natural resource exploitation. *European Economic Review*, **56**(8), 1714–1729.

Victor, David G, Hults, David R, & Thurber, Mark C. 2011. *Oil and governance: state-owned enterprises and the world energy supply.* Cambridge University Press.

Wright, Joseph, Frantz, Erica, & Geddes, Barbara. 2013. Oil and Autocratic Regime Survival. *British Journal of Political Science*, 1–20.

Appendix

1 Appendix to Section 2

1.1 Resource-driven Coup

Incumbent

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:

$$H = u(\tilde{p}\tilde{R}) - \lambda\tilde{R}. \tag{A.1}$$

We use a tilde to denote the post-failed-coup variables. The optimality conditions are:

$$\tilde{R}: \qquad u'(\tilde{p}\tilde{R})[\tilde{p}'\tilde{R} + \tilde{p}] - \lambda = 0, \tag{A.2}$$

$$\tilde{S}: \qquad 0 = \rho\lambda - \dot{\lambda}. \tag{A.3}$$

From the first condition, combined with the oil demand function, we obtain $\tilde{R}^{-(1-\beta)\varepsilon}[-\beta\tilde{R}^{-\beta-1} + \tilde{R}^{-\beta}] = \lambda$ or $(1-\beta)\tilde{R}^{-[\varepsilon(1-\beta)+\beta]} = \lambda$. Defining $\eta = (1-\varepsilon)(1-\beta)$, we obtain $(1-\beta)\tilde{R}^{-(1-\eta)} = \lambda$. Hence, $\hat{\lambda} = -(1-\eta)\hat{\tilde{R}}$. 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, $\hat{\lambda} = \rho$, which yields: $-(1-\eta)\hat{\tilde{R}} = \rho$ or

$$\hat{\tilde{R}} = -\frac{\rho}{1-\eta} \equiv -\gamma. \tag{A.4}$$

In order to make sure that $\gamma > 0$, we need to impose the following restriction on parameter values: $\eta < 1$. This restriction is automatically satisfied if either (i) $\varepsilon \in [0,1]$ and $\beta \in [0,1]$; or (ii) $\varepsilon > 1$ and $\beta \in [0,1]$; or (iii) $\varepsilon \in [0,1]$ and $\beta > 1$. Hence, the only case where the restriction is not automatically satisfied is $\varepsilon > 1$ and $\beta > 1$. For this case the restriction becomes $1 < \beta < \frac{\varepsilon}{\varepsilon-1}$ or $1 < \varepsilon < \frac{\beta}{\beta-1}$.

Eq. (A.4) implies that $\tilde{R}_t = \tilde{R}_T e^{-\gamma(t-T)}$. Using this in $\dot{\tilde{S}}_t = -\tilde{R}_t$, along with $\lim_{t\to\infty} \tilde{S}_t e^{-\rho t} = 0$, yields $\tilde{R}_T = \gamma\tilde{S}_T$ and $\tilde{S}_t = \tilde{S}_T e^{-\gamma(t-T)}$, $\forall t > T$. Hence, consumption path is given by $\tilde{c}_t = \tilde{p}_t\tilde{R}_t = \tilde{c}_T e^{-\gamma(1-\beta)(t-T)}$, where $\tilde{c}_T = \tilde{p}_T\tilde{R}_T = \tilde{R}_T^{1-\beta} = (\gamma\tilde{S}_T)^{1-\beta}$. The current value of the post-coup problem is then given by

$$V(\tilde{S}_t) = \int_t^\infty u(\tilde{c}_s)e^{-\rho(s-t)}ds = \frac{(\gamma\tilde{S}_t)^\eta}{(1-\varepsilon)\gamma}. \tag{A.5}$$

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

$$\rho V(S) = \max_R \left\{u(pR) - V_S R + \psi\left[\nu[V(\tilde{S}) - V(S)] + (1-\nu)[\bar{V} - V(S)]\right]\right\}, \tag{A.6}$$

where $V(\tilde{S})$ is given by (A.5) and $\bar{V} = \frac{u(K)}{\rho}$ refers to the scrap value if the coup succeeds. The optimality conditions are

$$R: \qquad u'(c)[p'R + p] - V_S = 0, \tag{A.7}$$

$$S: \qquad \rho V_S = -V_{SS}R + \psi \left[\nu(\frac{dV(\tilde{S})}{dS} - V_S) - (1-\nu)V_S \right]. \tag{A.8}$$

These conditions can be rewritten as

$$V_S = (1-\beta)R^{-(1-\eta)}, \tag{A.9}$$

$$\rho = -\frac{V_{SS}R}{V_S} + \psi \left[\nu \left(\frac{\frac{dV(\tilde{S})}{dS}}{V_S} - 1 \right) - (1-\nu) \right] = -(1-\eta)\hat{R} + \psi \left[\nu \frac{\frac{dV(\tilde{S})}{dS}}{V_S} - 1 \right], \tag{A.10}$$

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

Exploiting (A.5), we can make the following guess of the value function: $V(S) = \frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c} + X$, where γ^c and X are unknown constants. With this guess, $V_S = (1-\beta)(\gamma^c S)^{-(1-\eta)}$ and eq. (A.10) becomes:

$$\rho = -(1-\eta)\hat{R} + \psi \left[\nu \left(\frac{\gamma^c}{\gamma} \right)^{1-\eta} - 1 \right]. \tag{A.11}$$

Moreover, our guess of the value function implies that $\hat{R} = -\gamma^c$, in parallel to eq. (A.4). Using this in the equation above, we obtain:

$$\rho = (1-\eta)\gamma^c + \psi \left[\nu \left(\frac{\gamma^c}{\gamma} \right)^{1-\eta} - 1 \right] \tag{A.12}$$

or

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

which is an implicit equation in γ^c. This equation has a unique solution because (i) the LHS is a strictly increasing function of γ^c, while the RHS is a monotone decreasing and convex function of γ^c, and (ii) LHS evaluated at zero is zero and lies below the RHS evaluated at zero (which is equal to $\rho + \psi > 0$). In spite of the unavailability of an analytical solution for γ^c, we can nonetheless say something about the relationship between γ^c and γ. Note that the term in the square brackets multiplying ψ can be in general of ambiguous sign. Suppose that $\gamma^c < \gamma$. Then $(1-\eta)\gamma > (1-\eta)\gamma^c$, so the LHS increases. By the same reasoning the RHS decreases, so instead of $LHS = RHS$ we get $LHS > RHS$. However, when $\gamma^c < \gamma$, the term $\left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}$ is clearly less than unity, so that $1 - \nu \left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}$ is unambiguously positive, so the RHS has actually increased, which contradicts our supposition. Hence, $\gamma^c < \gamma$ cannot be true. Suppose next that $\gamma^c = \gamma$. Then the LHS becomes $(1-\eta)\gamma = \rho$ by the definition of γ. The RHS becomes $\rho + \psi[1-\nu] > \rho$, hence the equality is violated. Therefore the only possibility is that $\gamma^c > \gamma$.

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.6):

$$\begin{aligned}
\rho\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}+\rho X &= \frac{R^{(1-\beta)(1-\varepsilon)}}{1-\varepsilon}-R\frac{\eta(\gamma^c)^\eta S^{\eta-1}}{(1-\varepsilon)\gamma^c}+\psi\left\{\nu\left[\frac{(\gamma S)^\eta}{(1-\varepsilon)\gamma}-\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}-X\right]+\right. \\
&\left.+(1-\nu)\left[\frac{u(K)}{\rho}-\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}-X\right]\right\} \qquad (A.14)\\
\rho\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}+\rho X &= \frac{(\gamma^c S)^\eta}{1-\varepsilon}-\frac{\eta(\gamma^c S)^\eta}{(1-\varepsilon)}+\psi\left\{\nu\frac{(\gamma S)^\eta}{(1-\varepsilon)\gamma}-\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}-\nu X+\right. \\
&\left.+(1-\nu)\left[\frac{u(K)}{\rho}-X\right]\right\}. \qquad (A.15)
\end{aligned}$$

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 γ^c and to compare it to our solution (A.12). Then we will equate the constant terms and solve for X. Starting with the terms in S and dividing both sides by $\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}$:

$$\begin{aligned}
\rho\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c} &= \frac{(\gamma^c S)^\eta}{1-\varepsilon}-\frac{\eta(\gamma^c S)^\eta}{(1-\varepsilon)}+\psi\left\{\nu\frac{(\gamma S)^\eta}{(1-\varepsilon)\gamma}-\frac{(\gamma^c S)^\eta}{(1-\varepsilon)\gamma^c}\right\} \qquad (A.16)\\
\rho &= \gamma^c-\eta\gamma^c+\psi\left\{\nu\left(\frac{\gamma^c}{\gamma}\right)^{1-\eta}-1\right\}. \qquad (A.17)
\end{aligned}$$

This expression is exactly our equation (A.12). Now we collect the constant terms:

$$\begin{aligned}
\rho X &= \psi\left\{-\nu X+(1-\nu)\left[\frac{u(K)}{\rho}-X\right]\right\} \qquad (A.18)\\
\rho X &= -\psi X+\psi(1-\nu)\frac{u(K)}{\rho} \qquad (A.19)\\
(\rho+\psi)X &= \psi(1-\nu)\frac{u(K)}{\rho} \qquad (A.20)\\
X &= \frac{\psi(1-\nu)\frac{u(K)}{\rho}}{\rho+\psi}. \qquad (A.21)
\end{aligned}$$

1.1.1 Incentive-compatibility Constraint

If the Opposition decided to simply live off the rents shared by G and to never stage a coup, her discounted lifetime welfare would be equal to

$$W^o_{nc}=\int_0^\infty u(c^{nc}_t)e^{-\rho t}dt=\frac{\theta^{1-\varepsilon}(\gamma^c S_0)^\eta}{(\gamma^c\eta+\rho)(1-\varepsilon)}. \qquad (A.22)$$

If, on the other hand, the Opposition staged a coup, her expected discounted lifetime welfare would be equal to

$$W^o_c=\frac{\theta^{1-\varepsilon}(\gamma^c S_0)^\eta(1-e^{-(\gamma^c\eta+\rho)T})}{(\gamma^c\eta+\rho)(1-\varepsilon)}+\mu\frac{(\gamma S_T)^\eta e^{-\rho T}}{\gamma(1-\varepsilon)}+(1-\mu)\frac{u(K^o)e^{-\rho T}}{\rho}. \qquad (A.23)$$

It is optimal to stage a coup as long as $W_c^o > W_{nc}^o$ or:

$$\frac{\theta^{1-\varepsilon}(\gamma^c S_0)^\eta(1-e^{-(\gamma^c\eta+\rho)T})}{(\gamma^c\eta+\rho)(1-\varepsilon)} + \mu\frac{(\gamma S_T)^\eta e^{(\gamma\eta-\gamma)T}}{\gamma(1-\varepsilon)} + (1-\mu)\frac{u(K^o)e^{-\rho T}}{\rho} > \frac{\theta^{1-\varepsilon}(\gamma S_0)^\eta}{\gamma(1-\varepsilon)}$$
$$\mu\frac{(\gamma S_0)^\eta e^{(-\gamma^c\eta+\gamma\eta-\gamma)T}}{\gamma(1-\varepsilon)} + (1-\mu)\frac{u(K^o)e^{-\rho T}}{\rho} > \frac{\theta^{1-\varepsilon}(\gamma^c S_0)^\eta e^{-(\gamma^c\eta+\rho)T}}{(\gamma^c\eta+\rho)(1-\varepsilon)}$$
$$\frac{\mu\gamma^\eta}{(1-\varepsilon)\gamma(\gamma^c)^\eta} + \frac{(1-\mu)u(K^o)e^{\gamma^c\eta T}}{\rho(\gamma^c S_0)^\eta} > \frac{\theta^{1-\varepsilon}}{(\gamma^c\eta+\rho)(1-\varepsilon)}$$

Substitute for $e^{\gamma^c\eta T}$ from (20) to get:

$$\frac{\mu\gamma^\eta}{(1-\varepsilon)\gamma(\gamma^c)^\eta} + \frac{(1-\mu)u(K^o)\Omega(\gamma^c S_0)^\eta}{(1-\mu)(K^o)^{1-\varepsilon}\rho(\gamma^c S_0)^\eta} > \frac{\theta^{1-\varepsilon}}{(\gamma^c\eta+\rho)(1-\varepsilon)}$$
$$\frac{\rho+\eta\gamma^c}{(1-\varepsilon)\rho}\left[\frac{\theta^{1-\varepsilon}}{\rho+\eta\gamma^c} - \frac{\mu}{\gamma}\left(\frac{\gamma}{\gamma^c}\right)^\eta\right] > \frac{1}{(1-\varepsilon)}\left[\frac{\theta^{1-\varepsilon}}{\rho+\eta\gamma^c} - \frac{\mu}{\gamma}\left(\frac{\gamma}{\gamma^c}\right)^\eta\right]$$
$$\frac{1}{(1-\varepsilon)\rho} > \frac{1}{(1-\varepsilon)(\rho+\eta\gamma^c)}.$$

If $\varepsilon < 1$, then the inequality becomes

$$\frac{1}{\rho} > \frac{1}{(\rho+\eta\gamma^c)}.$$

Since $\rho + \eta\gamma^c > 0$, the inequality holds only if

$$\rho < \rho + \eta\gamma^c \quad \text{or} \quad \eta > 0 \quad \text{or} \quad \beta \in (0,1).$$

If $\varepsilon > 1$, then the inequality becomes

$$\frac{1}{\rho} < \frac{1}{(\rho+\eta\gamma^c)}.$$

Since $\rho + \eta\gamma^c > 0$, the inequality holds only if

$$\rho > \rho + \eta\gamma^c \quad \text{or} \quad \eta < 0 \quad \text{or} \quad \beta \in (0,1).$$

1.2 Endogenous Success Probability

1.2.1 Equilibrium of the Deterministic Model

The equilibrium is described by T^* and ξ, which are the solutions to the system

$$e^{-\eta\gamma T} - \left[\frac{(1-\mu)(K^o)^{1-\varepsilon}}{\Omega(\gamma S_0)^\eta}\right] = 0 \equiv A, \tag{A.24}$$
$$\xi - \left[\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K^o)}{\rho}\right]\left[\frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K)}{\rho}\right]^{-1} = 0 \equiv B \tag{A.25}$$

where $\Omega \equiv \theta^{1-\varepsilon} - \mu > 0$ and $\mu = \frac{\xi}{\alpha+\xi}$. It will also be convenient to define

$$\Gamma \equiv \frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K)}{\rho} \quad \text{and} \quad \Gamma^o \equiv \frac{(\gamma S_T)^\eta}{\gamma(1-\varepsilon)} - \frac{u(K^o)}{\rho},$$

so that equation B can be simply written as $\xi - \frac{\Gamma^o}{\Gamma} = 0$. By totally differentiating the system with respect to T, ξ, and S_0, we obtain

$$\underbrace{\begin{pmatrix} \Delta_{TA} & \Delta_{\xi A} \\ \Delta_{TB} & \Delta_{\xi B} \end{pmatrix}}_{M} \times \begin{pmatrix} dT \\ d\xi \end{pmatrix} = \begin{pmatrix} \Delta_{SA} \\ \Delta_{SB} \end{pmatrix}$$

where the Δs are given by

$$\begin{aligned}
\Delta_{TA} &\equiv \frac{\partial A}{\partial T} = -\eta\gamma e^{-\eta\gamma T} \gtreqless 0 \Leftrightarrow \eta \lesseqgtr 0,\\
\Delta_{\xi A} &\equiv \frac{\partial A}{\partial \xi} = \left(\frac{d\mu/d\xi}{\nu}\right) \frac{\theta^{1-\varepsilon}-1}{\Omega} e^{-\eta\gamma T} \gtreqless 0 \Leftrightarrow \varepsilon \gtreqless 1,\\
\Delta_{SA} &\equiv -\frac{\partial A}{\partial S_0} = -\frac{\eta e^{-\eta\gamma T}}{S_0} \gtreqless 0 \Leftrightarrow \eta \lesseqgtr 0,\\
\Delta_{TB} &\equiv \frac{\partial B}{\partial T} = -(1-\beta)(\gamma S_T)^\eta \frac{u(K)-u(K^o)}{\rho\Gamma^2} \leq 0 \Leftrightarrow K \geq K^o,\\
\Delta_{\xi B} &\equiv \frac{\partial B}{\partial \xi} = 1 > 0,\\
\Delta_{SB} &\equiv -\frac{\partial B}{\partial S_0} = -(1-\beta)(\gamma S_T)^{\eta-1} e^{-\gamma T} \frac{u(K)-u(K^o)}{\rho\Gamma^2} \leq 0 \Leftrightarrow K \geq K^o.
\end{aligned}$$

The effects of interest are

$$\frac{dT}{dS_0} = \frac{|M_T|}{|M|} \quad \text{and} \quad \frac{d\xi}{dS_0} = \frac{|M_\xi|}{|M|}$$

where

$$|M| = \Delta_{TA}\Delta_{\xi B} - \Delta_{\xi A}\Delta_{TB} \tag{A.26}$$

$$|M_T| = \Delta_{SA}\Delta_{\xi B} - \Delta_{SB}\Delta_{\xi A} \tag{A.27}$$

$$|M_\xi| = \Delta_{TA}\Delta_{SB} - \Delta_{TB}\Delta_{SA} = 0.$$

In order to sign the expressions $|M|$ and $|M_T|$, we need to consider various cases. In particular, the first distinction is between the case where $K = K^o$ and $K > K^o$.

Case 1: $K > K^o$

We consider the constellations of ε and β which are relevant for Proposition 1 and for the ICC. Since the ICC is satisfied only when $\beta < 1$, we need to consider only two cases: $\beta \in (0, 1)$, $\varepsilon \in (0, 1)$

and $\beta \in (0,1)$, $\varepsilon > 1$.

Case 1.1: $\varepsilon \in (0,1)$, $\beta \in (0,1)$

In this case η is positive. Consider first $|M|$ and its components: $\Delta_{TA} < 0$, $\Delta_{\xi B} > 0$, $\Delta_{TB} < 0$, $\Delta_{\xi A} < 0$, implying that $|M| < 0$. Consider then $|M_T|$ and its components: $\Delta_{SA} < 0$, $\Delta_{\xi B} > 0$, $\Delta_{SB} < 0$, $\Delta_{\xi A} < 0$, implying that $|M_T| < 0$. Thus, $dT/dS_0 > 0$.

Case 1.2: $\varepsilon > 1$, $\beta \in (0,1)$

In this case $\eta < 0$. The determinant of M switches sign and becomes positive because $\Delta_{TA} > 0$, $\Delta_{\xi B} > 0$, $\Delta_{TB} < 0$, $\Delta_{\xi A} > 0$. $|M_T|$ also switches sign because $\Delta_{SA} > 0$, $\Delta_{\xi B} > 0$, $\Delta_{SB} < 0$, $\Delta_{\xi A} > 0$. Thus, $dT/dS_0 > 0$ remains.

Case 2: $K = K^o$

This particular case implies $\xi = 1$, i.e. identical investment in military by both factions. Thus, ξ is independent of S_0; the probabilities ν and μ are constant and given by $\nu = \frac{\alpha}{1+\alpha}$ and $\mu = \frac{1}{1+\alpha}$. Hence, the effect of S_0 on T is given by Result 1.

1.3 Equilibrium of the Stochastic Model

The objective function of G is now modified to include the cost of military spending:

$$\max_{R,m} \int_0^\infty \left\{ \int_0^T u(c_t)e^{-\rho t}dt + \nu(m) \int_T^\infty u(\tilde{c}_t)e^{-\rho t}dt + \Big(1-\nu(m)\Big) \int_T^\infty u(K)e^{-\rho t}dt \right\} \psi e^{-\psi T} dT - C(m) \tag{A.28}$$

The optimal paths of extraction and consumption remain as those described in eqs. (5) - (6). The optimal military spending must satisfy the following first-order condition[19]:

$$\int_0^\infty \frac{d\nu}{dm}\left[W_{II} - \frac{u(K)e^{-\rho T}}{\rho}\right] \psi e^{-\psi T} dT - C'(m) = 0,$$

which yields the following implicit equation in m:

$$\frac{\alpha m^o \psi}{(\alpha m + m^o)^2}\left[\frac{(\gamma S_0)^\eta}{\gamma^c \gamma (1-\varepsilon)} - \frac{u(K)}{\rho(\rho+\psi)}\right] = 1. \tag{A.29}$$

The optimization problem of O is modified in a similar way. The optimal military spending of O must satisfy the following first-order condition:

$$\frac{d(1-\nu)}{dm^o}\left[W_{II}^o - \frac{u(K^o)e^{-\rho T}}{\rho}\right] = C'(m^o),$$

which yields an implicit equation in m^o:

$$\frac{\alpha m e^{-\rho T}}{(\alpha m + m^o)^2}\left[\frac{(\gamma S_T)^\eta}{(1-\varepsilon)\gamma} - \frac{u(K^o)}{\rho}\right] = 1. \tag{A.30}$$

[19] It can be shown that the second-order condition is negative.

Dividing (A.29) by (A.30), we obtain

$$\xi = \frac{\Gamma^{st}}{\Gamma^{o}}, \quad \Gamma^{st} \equiv \frac{(\gamma S_0)^{\eta}}{\gamma^{c}\gamma(1-\varepsilon)} - \frac{u(K)}{\rho(\rho+\psi)}. \tag{A.31}$$

The equilibrium is described by T^* and ξ, which are the solutions to the system

$$e^{-\eta\gamma^{c}T} - \left[\frac{(1-\mu)(K^{o})^{1-\varepsilon}}{\Omega(\gamma^{c}S_0)^{\eta}}\right] = 0 \equiv A, \tag{A.32}$$

$$\xi - \frac{\Gamma^{st}}{\Gamma^{o}} = 0 \equiv B \tag{A.33}$$

where $\Omega \equiv \theta^{1-\varepsilon} - \frac{\mu}{\gamma}\left(\frac{\gamma}{\gamma^{c}}\right)^{\eta}(\rho+\eta\gamma^{c}) > 0$.

The Δs are now given by

$$\begin{aligned}
\Delta_{TA} &\equiv \frac{\partial A}{\partial T} = -\eta\gamma^{c}e^{-\eta\gamma^{c}T} \gtrless 0 \Leftrightarrow \eta \lesseqgtr 0,\\
\Delta_{\xi A} &\equiv \frac{\partial A}{\partial \xi} = \left(\frac{d\mu/d\xi}{\nu}\right)\frac{\theta^{1-\varepsilon}-1}{\Omega}e^{-\eta\gamma T} \gtrless 0 \Leftrightarrow \varepsilon \gtrless 1,\\
\Delta_{SA} &\equiv -\frac{\partial A}{\partial S_0} = -\frac{\eta e^{-\eta\gamma^{c}T}}{S_0} \gtrless 0 \Leftrightarrow \eta \lesseqgtr 0,\\
\Delta_{TB} &\equiv \frac{\partial B}{\partial T} = \left(\frac{1}{\psi}\right)\left[(1-\beta)(\gamma S_T)^{\eta}\frac{\gamma^{c}}{\gamma} + \rho\Gamma^{o}\right] > 0 \Leftrightarrow K \geq K^{o},\\
\Delta_{\xi B} &\equiv \frac{\partial B}{\partial \xi} = 1 - \frac{\xi}{\Gamma^{st}}\frac{(\gamma S_0)^{\eta}}{\gamma(1-\varepsilon\varepsilon)(\gamma^{c})^{2}}\frac{\partial\gamma^{c}}{\partial\mu}\frac{d\mu}{d\xi} > 0 \text{ for } \ \varepsilon > 1,\\
\Delta_{SB} &\equiv -\frac{\partial B}{\partial S_0} = \frac{e^{-\rho T}(1-\beta)}{\psi(\Gamma^{st})^{2}}\left[(\gamma S_T)^{\eta-1}e^{-\gamma^{c}T}\Gamma^{st} - \frac{(\gamma S_0)^{\eta-1}}{\gamma^{c}}\Gamma^{o}\right] < 0.
\end{aligned}$$

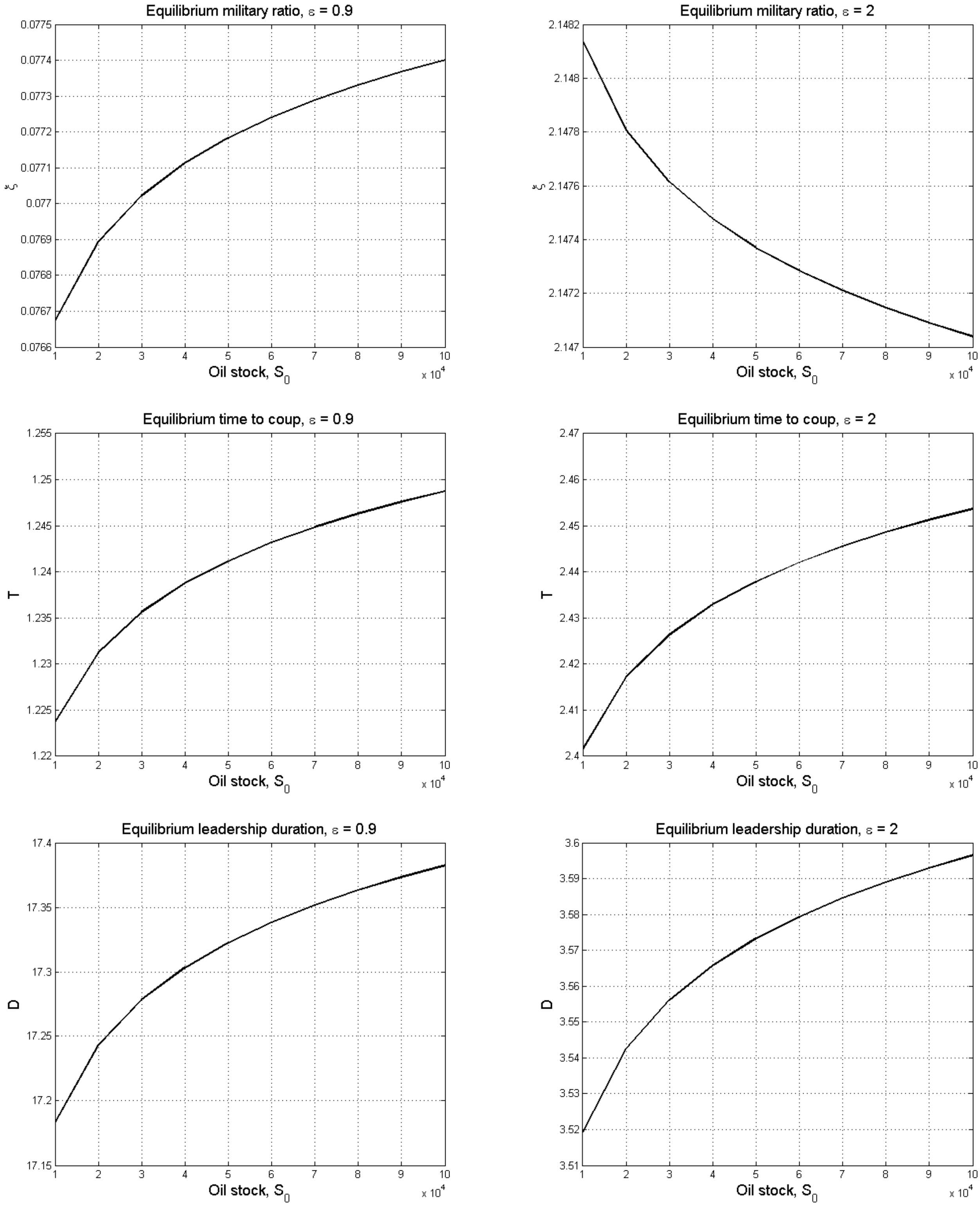
Because many of the terms have an ambiguous sign, we resort to numerical simulations in order to identify the direction of the effect of S_0 on T^* and ξ. The parameters of the model are calibrated as follows: We show the initial oil wealth on the horizontal axes and the relevant endogenous

Table 7: Benchmark values of parameters.

ρ	ψ	β	α	θ	K	K^o
0.01	0.1	0.9	1	0.5	$2e-5$	$1e-5$

variable on the vertical axes. We distinguish between two case: the first case refers to $\varepsilon < 1$, the second case refers to $\varepsilon > 1$. Figure 2 shows the results for the equilibrium ratio of military spending, time to coup, and leadership duration when $\varepsilon = 0.9$ and when $\varepsilon = 2$. The results indicate a clear pattern of response. While the time to attack increases in oil wealth for any value of ε, the response of the military ratio flips sign. For $\varepsilon < 1$, ξ increases in S_0, while for $\varepsilon > 1$ it decreases in S_0. The overall effect on D, however, remains strictly positive in both cases.

Figure 2: Equilibrium ratio of military spending (ξ), time of coup, T, and leadership duration as a function of initial oil wealth, $\varepsilon = 0.9$ and $\varepsilon = 2$



2 Appendix to Section 3

2.1 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.

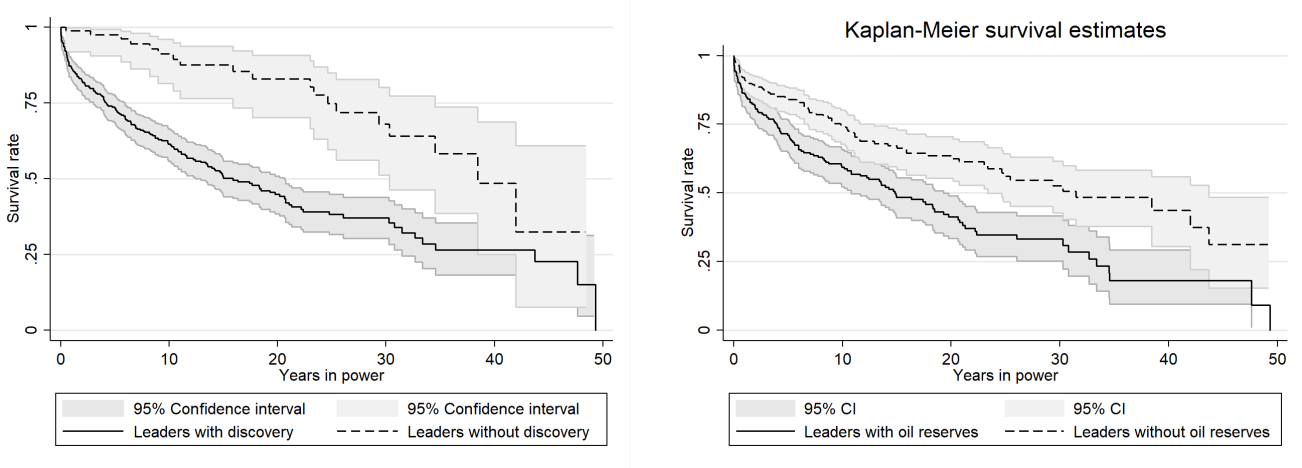
However, we assess the basic properties of the hazard- and survival functions by looking at the shape of the non-parametric models and using them to see if the raw data indicates any effect of resource discoveries and endowments (Cleves *et al.*, 2010).

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 3) and the Nelson-Aalen hazard functions (figure 4) 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 3, 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.

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.

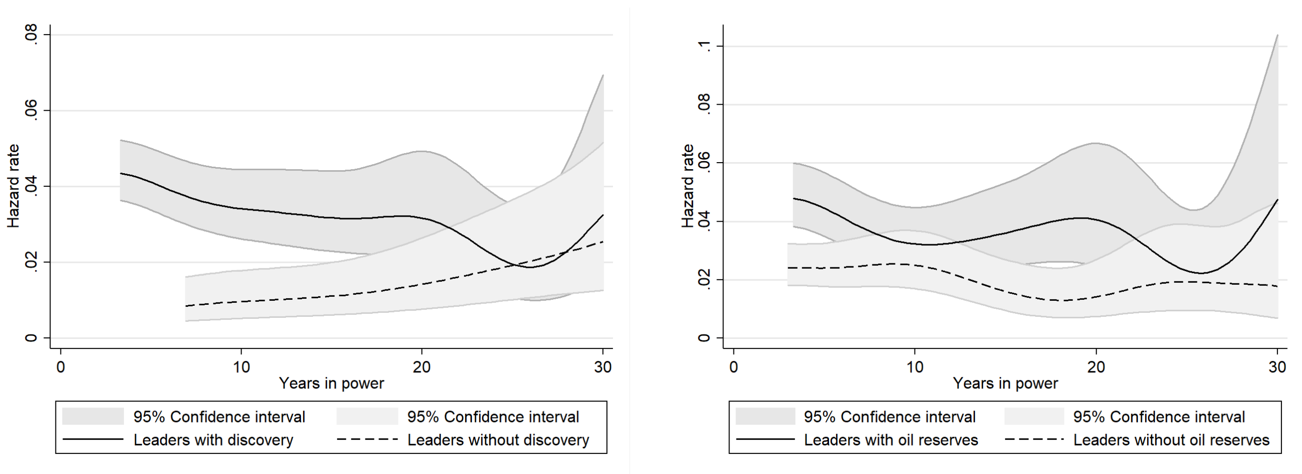
Figure 3: Survival functions of leaders with and without oil reserves and discoveries



Hydrocarbon discoveries

Oil reserves

Figure 4: Political hazard rate



Hydrocarbon discoveries

Oil reserves

2.2 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.

Table 8: 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

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 8.

2.3 Military spending

We attempt to include a variable on military spending from the SIPRI dataset. Results are reported in table 9. 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

Table 9: Results, Military expenditure

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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)
GDP per capita		0.959	0.969	0.935*	0.955	0.909***
		(0.0294)	(0.0267)	(0.0348)	(0.0275)	(0.0331)
GDP growth		0.976**	0.977**	0.971**	0.966**	0.963**
		(0.0111)	(0.0112)	(0.0136)	(0.0140)	(0.0161)
Coal Income per capita			0.996**		0.996**	0.916
			(0.00191)		(0.00153)	(0.0716)
Metals Income per capita			1.000		0.999	1.000
			(0.00171)		(0.00169)	(0.00162)
Oil already disc.			0.839		0.692*	1.513
			(0.202)		(0.151)	(0.597)
Age at entry				1.001**	1.001**	1.001***
				(0.000377)	(0.000355)	(0.000367)
Median duration				1.000***	1.000***	1.000***
				(5.97e-05)	(6.27e-05)	(7.10e-05)
Polity 2				0.929*	0.955	0.963
				(0.0396)	(0.0358)	(0.0500)
Population (log)				0.968	1.026	0.803**
				(0.0890)	(0.0843)	(0.0869)
Nat'l oil company				1.166	1.517	0.985
				(0.384)	(0.538)	(0.379)
World democracy					0.960**	0.957*
					(0.0177)	(0.0241)
Regional democracy					1.000	1.000
					(0.00797)	(0.0102)
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

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.

2.4 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 way as for the large discoveries. Results are reported in table 10. 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.

2.5 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.

Table 10: Results, Small discoveries

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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

The results are given in table 11 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.

2.6 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 12 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.

2.7 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.

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 13 show that more discoveries lower hazard, but that the effect is not statistically significant. Adding

Table 11: Results, Wildcat drilling

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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)
GDP per capita		0.997	0.997	0.972	0.975	0.978
		(0.0112)	(0.0116)	(0.0264)	(0.0246)	(0.0156)
GDP growth		0.977**	0.978*	0.982	0.980	0.971**
		(0.0113)	(0.0114)	(0.0202)	(0.0211)	(0.0122)
Coal Income per capita			0.965		0.729**	0.914**
			(0.0209)		(0.115)	(0.0400)
Metals Income per capita			1.000		0.998	1.000
			(0.000802)		(0.00107)	(0.000859)
Oil already disc.			1.000		1.086	1.225
			(0.238)		(0.696)	(0.409)
Nat'l oil company				3.727***	4.944**	0.954
				(1.650)	(3.636)	(0.362)
Age at entry				1.002	1.016	1.020*
				(0.0135)	(0.0170)	(0.0108)
Median duration of previous leaders				1.000*	1.000	1.000***
				(6.28e-05)	(7.17e-05)	(5.65e-05)
Polity 2				1.075	1.062	1.009
				(0.0539)	(0.0585)	(0.0325)
Population (log)				0.754*	0.916	0.924
				(0.114)	(0.119)	(0.0703)
Dependency				0.921	0.941	
				(0.103)	(0.132)	
World democracy					0.908**	0.958***
					(0.0361)	(0.0148)
Regional democracy					1.045**	1.003
					(0.0205)	(0.00580)
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

Table 12: Results, Oil price

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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

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 13)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[20]. We redo the previous analysis without these two outliers, and report the results in table 14. 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.

[20] King Faisal was assassinated by his nephew, whose motives for the assassination were unclear (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 13: Different specifications of size and number of discoveries

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***	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 14: 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

2.8 Different specifications

2.8.1 Varying the definition of autocracy

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 15 for cutoff value of -5 and table 16 for cutoff value of -7.

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 17.

2.8.2 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 18). 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.

2.8.3 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 19. 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

Table 15: Cutoff, Polity 2 <-5

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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)
GDP per capita		0.989	0.994	0.975	0.975	0.981
		(0.0158)	(0.0124)	(0.0217)	(0.0230)	(0.0141)
GDP growth		0.977***	0.979**	0.996	0.995	0.981**
		(0.00846)	(0.00828)	(0.0166)	(0.0165)	(0.00887)
Coal Income per capita			0.988**		0.994	0.988**
			(0.00509)		(0.00369)	(0.00603)
Metals Income per capita			1.000		0.999	1.000
			(0.000930)		(0.00105)	(0.00102)
Oil already disc.			0.827		0.865	0.729
			(0.162)		(0.371)	(0.150)
Nat'l oil company				1.770	2.688**	1.411
				(0.728)	(1.348)	(0.403)
Age at entry				1.000	1.000	1.001**
				(0.000382)	(0.000371)	(0.000369)
Median duration				1.000**	1.000	1.000**
				(5.79e-05)	(6.78e-05)	(4.73e-05)
Polity 2				1.104**	1.170***	1.083***
				(0.0467)	(0.0508)	(0.0283)
Population (log)				0.859	0.814	0.945
				(0.0999)	(0.109)	(0.0695)
Dependency ratio				0.977	1.023	
				(0.0594)	(0.0834)	
World democracy					0.906***	0.963***
					(0.0274)	(0.0111)
Regional democracy					1.015	0.998
					(0.0132)	(0.00520)
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 16: Cutoff, Polity 2 <-7

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) 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)
GDP per capita		0.990	0.992	0.978	0.980	0.975
		(0.0162)	(0.0141)	(0.0214)	(0.0186)	(0.0173)
GDP growth		0.971***	0.973***	0.991	0.989	0.974**
		(0.0105)	(0.0103)	(0.0207)	(0.0194)	(0.0118)
Coal Income per capita			0.990**		0.994	0.990**
			(0.00441)		(0.00367)	(0.00486)
Metals Income per capita			1.000		0.997	1.000
			(0.00103)		(0.00182)	(0.00121)
Oil already disc.			0.930		0.665	0.739
			(0.180)		(0.315)	(0.161)
Nat'l oil company				1.993	4.988**	1.645*
				(0.875)	(3.180)	(0.489)
Age at entry				1.000	1.000	1.001***
				(0.000386)	(0.000359)	(0.000354)
Median duration				1.000	1.000	1.000
				(7.47e-05)	(8.58e-05)	(4.67e-05)
Polity 2				1.143***	1.229***	1.080***
				(0.0480)	(0.0607)	(0.0319)
Population (log)				0.885	0.820	0.980
				(0.108)	(0.115)	(0.0808)
Dependency ratio				0.984	1.044	
				(0.0606)	(0.0875)	
World democracy					0.897***	0.952***
					(0.0311)	(0.0117)
Regional democracy					1.017	0.999
					(0.0144)	(0.00507)
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

Table 17: Using Geddes *et al.* (2012) dataset

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) 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

Table 18: Using only the first discovery

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) 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)
GDP per capita		0.983	0.989	0.977
		(0.0178)	(0.0147)	(0.0146)
GDP growth		0.974***	0.976***	0.976**
		(0.00910)	(0.00907)	(0.0102)
Coal Income per capita			0.990**	0.989*
			(0.00471)	(0.00606)
Metals Income per capita			1.000	1.000
			(0.000821)	(0.000944)
Oil already disc.			0.733	0.701*
			(0.140)	(0.148)
Nat'l oil company				1.225
				(0.367)
Age at entry				1.001***
				(0.000295)
Median duration				1.000**
				(4.58e-05)
Polity 2				1.095***
				(0.0290)
Population (log)				0.961
				(0.0698)
World democracy				0.955***
				(0.0106)
Regional democracy				1.000
				(0.00501)
Leader years	5,692	4,008	3,882	3,272

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

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 19: 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

2.8.4 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 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 20, and reveal no significant change.

We also check whether using subperiods of the data affects the result. 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.

2.8.5 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.

2.8.6 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.

2.9 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

Table 20: Controlling for time

VARIABLES	(1) Year FE	(2) From 1950	(3) From 1960	(4) From 1970	(5) 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.

Table 21: No "bad" controls

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) 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
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 22: Transition to democracy

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) 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

show that a discovery lowers the hazard of a democratic transition, but that the effect is not statistically significant.

2.10 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

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