Resource Discoveries and Duration of Autocratic Leadership

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March 29, 2019

PRELIMINARY DRAFT

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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 resource war model where incumbent and opposition invest in stocks of military arsenal and the opposition strategically chooses the timing of attack. We show that a random increase in the resource stock allows the incumbent stay in power longer by lowering the probability of coup success and increasing the time to attack. We test this prediction with a novel empirical analysis based on duration models and extended data on discoveries of giant oil and gas fields. Our results show that an increase in the stock of natural resources lowers the hazard faced by an autocrat; resource discoveries thus appear to have a stabilizing effect on autocratic regimes.

JEL Classification:

Key Words:

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1 Introduction

When an autocratic leader discovers natural resources, two things may happen. On the one hand, his wealth increases, which may allow him to solidify and extend his rule. On the other hand, the promised future rents of the resources may be enticing enough to induce an opposition to stage a coup d'état, or induce an insurgency to create a revolution. Which effect will prevail? According to the results we present in this paper, the former effect is stronger than the latter: a resource discovery tends to help an autocratic leader remain in power.

We first propose a dynamic resource war model featuring a random resource discovery and subsequently test the predictions of the model empirically with survival analysis. Our model setup relies on the latest dynamic resource war models (e.g., van der Ploeg (2017)), where one faction enjoys the power in office and decides on resource exploitation (say, government or autocrat) and a rival faction (say, opposition) tries to gain control over office and resource rents by challenging the incumbent. We extend this framework in three dimensions. First, we distinguish between the hazard of being attacked and the probability of the attack being successful. In other words, we allow for a possibility that a staged coup might turn out to be unsuccessful. Second, we depart from constant contest-success probabilities (Tullock (1975), Gallego & Pitchik (2004), Cuaresma *et al.* (2011)) by letting them be a function of accumulated stocks of military power. This allows us to (i) introduce a dynamic effect in success probabilities and (ii) endogenize the probabilities by taking into account the fact that the sacrifice of current consumption in favor of building military power needs to be incurred continuously and over time, as opposed to a one-time fighting effort. Third, in addition to the coup uncertainty we introduce another source of randomness - the resource discovery.

By considering the effect of oil and gas discoveries[1] on autocratic leadership duration our paper contributes to the literature on the resource curse (i.e. the somewhat paradoxical notion that resource rich countries tend to see poor economic outcomes and be less democratic than their resource-poor counterparts), a field that has received much scholarly attention and produced a large and varied literature (see section 2) in both political science and economics.

Much is written on the effect resources have on a variety of political outcomes, and a small subset of the literature looks specifically at how resources affect the *duration* of leadership. While the destabilizing effect of resources is well documented in the conflict literature, resources may also have a stabilizing effect if they tend to strengthen regimes. Our theoretical model predicts that a resource

[1] A discovery is considered as the year that an oil/gas field is proven to exist. Oil production/extraction - the actual process of taking oil out of the ground so that it can be sold - requires significant investments and infrastructure and usually starts years later.

discovery is beneficial for the incumbent for two reasons: (i) it helps accumulate more military power for the incumbent relative to the opposition, and (ii) it delays the optimal time of attack. The results from the empirical analysis, based on the data for over 500 leaders, also indicate a stabilizing effect of discoveries.

There is a large body of literature that explores political effects of resources. A few studies within this literature also use survival analysis to explore political effects of resource abundance (Omgba (2009), De Mesquita & Smith (2010), Andersen & Aslaksen (2013), Cuaresma *et al.* (2011)). However, their measures of resource wealth are better described as resource dependence as they focus on *flow* variables (e.g., oil rents, oil exports or oil income as percentage of GDP) in their empirical analysis. The extraction rate and export level of resources, as well as the economic dependency on resources are all results of strategic choices made by leaders and could be endogenous to other choices made by the same leaders. While the use of the international commodity price will introduce a degree of reasonably exogenous variation, we believe that measures of the resource *stock* are better than resource flows when it comes to making claims to causality.[2] 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. Further, 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) and Hamilton (2009b)). Moreover, production rates may well be influenced by price changes. On the contrary, resource 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 (see Arezki *et al.* (2015), Cotet & Tsui (2013b), and Cotet & Tsui (2013a)). Of course, discoveries are not a perfect natural experiment. Previous discoveries, discoveries in neighboring areas, and particularly the intensity of exploration efforts, will increase the probability of observing another discovery in a given area and may be related to outcomes. However, it is certainly the case that a leader cannot choose exactly when, where and how much oil/gas will be discovered. We therefore prefer discoveries as a measure of stock variation when estimating the effect of a change in resource *wealth* on leadership duration. To our knowledge, no other study looks at the effect of oil and gas discoveries on the leadership durations in autocratic regimes.

Perhaps the most closely related paper is Cuaresma *et al.* (2011), where the authors also rely on theoretical predictions to structure **(or *inform*)** their empirical analysis. However, they look at the effect of the flow of resources, while we are primarily concerned with the stock. Our theoretical model builds on very different foundations, and our use of oil discoveries rather than production value

[2]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 and Bulte (2008) find that "resources can be a blessing for both institutional and economic development - not a curse." (p. 250)

allows us to use a much larger sample. Indeed, our specification of oil wealth allows us to use resource data going back to as far as 1868 covering the most extensive time period we have come across (most measures of oil dependence are only available from 1950 and onwards).

Our paper thus 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.

In this paper, section 2 reviews some of the relevant literature on the political effects of the resource curse, where we summarize some theoretical arguments for why resource wealth might affect political outcomes, and then review some of the empirical evidence that backs up these theories. In Section 3 we first introduce a theoretical model of a dynamic resource war (3.1) and then examine how a discovery of additional stock of natural resources affects the conflict outcome (3.2). Section 4 presents our empirical investigation, where we use survival analysis to estimate the effect of discoveries on leadership durations in autocratic regimes. We discuss the possible limitations and implications of the results (4.4). The final section (5) concludes.

2 Literature review

2.1 Theoretical literature

In his pioneering work on rentier state Mahdavy (1970) pointed out that natural resource rents provide governments with revenues that enable them to remain unaccountable to citizens; natural resource wealth may thus enable, empower and perpetuate autocracies. The anti-democratic properties of resource wealth have since been well documented (see Ross 2014 for a recent and comprehensive review of the literature), but remain controversial (see e.g. Dunning (2008) and Haber and Menaldo 2011). Since then, two main strands of literature have emerged: one which examines the link between resources and conflict, and the other on the link among resources, regime type and leader behavior.

Van der Ploeg & Rohner (2012) build a theoretical framework, which allows them to study endogenous conflict emergence together with endogenous resource exploitation. They show that possibility of an armed conflict makes resource extraction more voracious, which reduces the fighting steaks for the rebel group. Van der Ploeg (2017) develops a dynamic model of 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.

Much of the theoretical literature focuses on how a ruler can use the rents from resource extraction to ensure support from key groups in the country Cabrales & Hauk (2011). Building on the idea of the rentier state, the literature tends to posit three main links between resources and democracy, a *taxation effect* - as pointed out by Beblawi (1990), a *spending effect* - leaders can essentially "buy off" the population with public spending, lowering the demand for democratic reforms - and a *group formation effect* - leaders use windfalls to prevent the formation of opposition groups Andersen & Aslaksen (2013). As Andersen & Aslaksen (2013) point out, these links all indicate that the ruling elite is "taking strategic action" to remain in power (p. 91). Ross (2014) suggests that oil wealth could weaken democracy in two broad ways: it can strengthen autocratic rulers, and it can push democracy into autocracy. In his review, Ross finds that there seems to be evidence for the former effect, while the latter remains contested.

A model on 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.

Another example is Caselli and Tesei (2011), who present a model of how increases in resource windfalls can affect political regimes. Their model shows that oil wealth shocks will have a heterogeneous effect on regimes, depending on the initial state of the regime. In particular, democratic and strongly autocratic regimes will see almost no change, while weakly autocratic regimes will tend to become more autocratic as oil wealth increases.

Clearly, there are many ways to model the link between resources and political outcomes. There is also an extensive literature attempting to establish these links empirically. However, the relationship between resources and political outcomes is hard to test, and there is considerable divergence in the results. In particular, there is an endogeneity issue; it is not clear whether it is the resource abundance that is causing poor political outcomes, or if countries e.g. with poor institutions are more prone to having resource dependent economies.

2.2 Empirical literature

Empirical research on resource wealth often finds a negative effect on growth, institutional quality, and democracy (Cabrales & Hauk, 2011). An influential paper by Collier & Hoeffler (2004) finds a link between natural resources abundance and civil war, suggesting that resources can help fund long term insurrections. Oil tends to exhibit the most consistent negative effect (see Ross (2001) and Ross

(2014)). However, this effect is still debated. Research has shown that these results are very sensitive to the choice of econometric specification, variables, samples etc. (e.g. Brunnschweiler & Bulte, 2008), and some specifications reveal no evidence of a resource curse. Looking at the link between oil wealth and democracy, Horiuchi & Wagle (2008) and Herb (2005) find no correlation when including country fixed effects or when removing oil from the initial income level. Using survival analysis techniques and resource exports as a share of GDP, Gurses (2011) finds that resource wealth strengthens and stabilizes democracies, while Andersen & Aslaksen (2013) find no evidence of an effect on these regimes using a similar econometric specification but oil *income* as a percentage of GDP. Haber & Menaldo (2011) created a dataset that goes back to 1800 to allow them to start their analysis before the onset of resource dependence, and find no evidence of the resource curse. However, Andersen & Ross (2014) revisit the Haber and Menaldo's analysis, allowing for a structural break in the 1970s when governments started gaining more direct control over their oil resources, and find evidence of a resource curse starting from about 1980.

In this paper, we focus on autocratic regime stability as the outcome variable, and estimate it using survival analysis. Exploring similar issues, Smith (2004) finds that oil wealth seems to increase durability - even when controlling for level of repression. Wright *et al.* (2013) use the Haber (2011) data on oil income per capita to test the effect of oil on autocratic regime survival, and find that a higher oil income tends to lower the risk of transition to any other regime. However, both these papers use probability models. These models are less suited to handle the serial correlation of the country year observations than survival analysis is (Cleves *et al.*, 2010). Only a few papers use survival analysis to explore the political effects of resources. Omgba (2009) finds that higher oil rents as a percentage of GDP tend to stabilize regimes; leaders in oil rich countries tend to stay in office longer than leaders in countries without oil. Working from a theoretical model that shows how leaders can more easily retain power with resources, De Mesquita & Smith (2010) use survival analysis to show that leaders who have access to resources - specified as oil exports as a percentage of GDP - are more likely to survive threats to their political survival. Andersen & Aslaksen (2013) find that resource reliance affects the duration of political party leadership, but that the effect depends on the type of resource and the type of regime. Oil, they discover, has the most robust positive impact on leadership duration. The type of regime matters greatly; only intermediate and authoritarian regimes are affected, not democratic ones. Cuaresma *et al.* (2011) were the first to look specifically at the link between autocratic leadership duration and oil windfalls through survival analysis, finding that the leadership durations are positively related to increases in the value of oil production (oil extraction and oil price). However, as Cotet & Tsui (2013a) point out, these analyses are sensitive to sample period and the measure of resource wealth.

Several papers have used the timing of oil and gas discoveries in an attempt to reduce the endogeneity in the link between resource wealth and democracy. While oil discoveries are arguably correlated with exploration effort, which could again be linked to several variables of interest, the chance of discovering a giant oil field is low enough for it to be considered reasonably random (see Lei & Michaels, 2014; Arezki *et al.*, 2015). Cotet & Tsui (2013b) exploit this randomness and use the timing of oil 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. In a different paper, Cotet & Tsui (2013a) use these data to look at the well-documented association between oil and internal armed conflicts. When controlling for country fixed effects, using oil prices and oil wealth and instrumenting with the timing of oil discoveries, they find that the link between internal armed conflicts and oil wealth disappears. Instead, they find that oil discoveries tend to increase military spending in non-democratic countries. Based on this, they suggest that rather than causing internal conflict, oil wealth could increase the ability of the state to deal with insurrections and deter civil wars.

However, using a different dataset and a different specification, Lei & Michaels (2014) find that oil discoveries increase conflict incidents when allowing for a lag between the oil discovery and the onset of a conflict.[3]

Our paper adds to this research by exploring another potential effect of oil discoveries on political outcomes, i.e. whether such discoveries strengthen autocratic rulers. Moreover, using random changes in the resource stock, as measured by oil discoveries, allows us to avoid the potential endogeneity associated with flow measures of resource abundance such as value of production, value of oil exports or resource exports as percentage of GDP. The oil discovery variable is thus less endogenous and available for a longer time span than most measures of resource abundance (and dependence).

3 Theoretical Model

3.1 Dynamic Model of Resource War

We start by presenting a dynamic model of resource war, building on van der Ploeg (2017). In the next section we shall introduce a random resource discovery

[3]Lei & Michaels (2014) find that countries that have had conflicts in the past will see an increase of $5-8\%$ in the probability of armed conflict occurring within the $4-8$ years following an oil discovery, with a baseline probability of 10%. Tsui (2011) also uses this data to look at the link between natural resources and democracy. He finds that oil wealth seems to slow down the democratic transition: a discovery of 100 billion barrels of oil will lead to a democracy level almost 20 percentage points below the trend for non-oil rich countries 30 years after discovery. The results only hold for non-democratic countries; oil discoveries seem to have no negative impact on democratic countries.

in our benchmark resource-war model and examine how a possibility of a discovery affects the equilibrium duration of leadership.

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 is denoted by S_0 and the oil demand function is given by $p_t = R_t^{-\beta}$, where $\beta > 0$ is the inverse of oil demand elasticity.[4] The incumbent leader or government, denoted by G for short, has full control over the natural resource. Following van der Ploeg (2017), we assume that G distributes a fraction $\theta \in (0, 1)$ of the resource rents to the citizens. The citizens constitute a pool of potential Opposition, denoted by O for short. We refer to the competing faction as Opposition, although one may also think of an elite or G's entourage which may decide to overthrow the leader at some future point in time in order to gain control over resources. Parameter θ may be viewed as redistribution in general (to the elite or population) and may be set by the constitution or tradition (Besley & Persson (2011)). Importantly, we shall not treat θ as a strategic choice of G because otherwise G will always be able to avoid a coup by choosing an appropriate redistribution policy.[5] In this setting an oil discovery will unambiguously "help" the leader remain in power longer, as it relaxes G's budget constraint and allows for more redistribution payments. In order to avoid such a positive bias, we shall treat θ as fixed but we shall nonetheless take into account the incentive-compatibility constraint (in terms of θ and S_0), such that it is indeed optimal for the Opposition to eventually stage a coup. We discuss this in more detail in Section 3.1.2.

Once the fraction θ of resource rents has been given to the citizens, the remaining rents, $(1 - \theta)p_t R_t$, are divided between G's current consumption, c_t, and investment in the military power or "self-preservation".[6] We denote the stock of arms by m_t. Alternatively, one may think of m_t as a stock of assets which the incumbent will use to convince or bribe army generals to join her side when there is a threat from the Opposition. Let us assume that a fraction $\delta \in [0, 1)$ is spent on financing the army (i.e. military-spending propensity) and $(1 - \delta)$ on G's current consumption. If a coup is staged by the Opposition at some date t,

[4]It is typically assumed in the literature that $\beta \in (0, 1)$ to ensure that the marginal revenue is positive. At the same time, there is substantial empirical evidence that oil demand elasticity, both short run and long run, is less than unity.

[5]Alternatively, we may assume that G chooses her redistribution policy θ from the interval $[\bar{\theta}, 1)$, where $\bar{\theta} \in (0, 1)$ denotes the minimum share needed to ensure functioning of the economy. If $\bar{\theta}$ is large enough, such that the incentive compatibility constraint (ICC) for a given S_0 is not satisfied, then G sets $\theta = \bar{\theta}$ and the Opposition never stages a coup. This scenario is not relevant for our analysis since the incumbent remains in power forever. Hence we are only interested in a scenario where $\bar{\theta}$ is sufficiently low, such that ICC is satisfied. In this case, however, a resource discovery relaxes G's budget constraint and may allow her to avoid the coup by raising θ above $\bar{\theta}$.

[6]Throughout the paper we shall refer to the incumbent's or the opposition's military power as their ability to defend themselves by, e.g., building a strong and a loyal army or by having sufficient assets to buy off army generals. We do not consider military coups, as in Acemoglu et al. (2010).

the incumbent wins with probability

$$\nu_t = \frac{\alpha m_t}{\alpha m_t + m_t^o}, \quad \alpha > 0, \tag{1}$$

where $\alpha \gtrless 1$ represents the relative military efficiency of G and m_t^o stands for the stock of arms held by O on date t. Eq. (1) is the Tullock contest-success function and is often used in the literature on contests/wars to model success probability. It is often assumed, however, that this probability depends on the *current* fighting efforts of the players involved. Here we generalize the standard setup by allowing for the success probability to depend on the *stocks* of arms of both factions and thus possibly on time.

In our setting the Opposition will not only choose its military power, m_t^o, but also the timing of coup. We shall assume for simplicity that if the coup fails, O is prosecuted and does not attempt to stage another coup, while G does not need to accumulate more military power or share resource rents. If the coup is successful, O gains full control over the oil and does not share any rents with G. In other words, if G loses office her utility drops to a scrap value which we normalize to zero.[7] The next two subsections describe the optimization problems of G and O, respectively, and then we turn to the determination of the equilibrium. In describing the optimal behavior of the two factions, it is important to specify the information sets available to each of them. We shall distinguish between two information sets, symmetric and asymmetric, where symmetry or asymmetry refers to the information about the stock of military that each player possesses at each point in time, i.e. m_t and m_t^o. In the former case, both players know exactly how much ammunition the other player has. This is a simplified information structure which may serve as a useful benchmark but has the drawback of not being realistic, as staging a coup typically involves secrecy, both with respect to timing and military support. This is why in the rest of the paper we focus on the second case where we assume that G does not have information on the military power of O, while the military power of G is observable by O.

3.1.1 Incumbent Government

The objective of the incumbent is to maximize the present discounted value of lifetime welfare knowing that a possibility of a coup exists but not knowing either the exact time of the coup nor how much military power is possessed by O. While the date of a possible coup, T, is random from the perspective of G, the coup hazard rate is assumed to be known and constant, given by ψ. G also knows

[7]We could also assume that in case of a successful (failed) coup G (O) will still receive a fraction of resource rents. Such a modification of the model would not affect our results qualitatively. We therefore prefer to use a slightly simpler version of the model where the utility of the defeated faction drops to zero.

that in case a coup is staged, her probability of staying in power is given by (1). In maximizing her welfare, G decides on the optimal oil extraction rate, R_t, and on the military-spending propensity, δ. The 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_T. 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 follows:

$$\max_{\delta,R} \int_0^\infty \left\{ \int_0^T u(c_t)e^{-\rho t}dt + \nu_T \int_T^\infty u(\bar{c}_t)e^{-\rho t}dt \right\} \psi e^{-\psi T} dT \tag{2}$$

subject to

$$c_t = (1-\theta)(1-\delta)p_t R_t, \tag{3}$$

$$\bar{c}_t = p_t R_t, \tag{4}$$

$$\dot{m}_t = (1-\theta)\delta p_t R_t, \quad m_0 = 0, \tag{5}$$

$$\dot{S}_t = -R_t, \tag{6}$$

$$p_t = R_t^{-\beta}, \tag{7}$$

$$\nu_T = \frac{\alpha m_T}{\alpha m_T + m_T^o}. \tag{8}$$

Eq. (3) states that G's current consumption in the pre-coup phase is equal to oil rents net of constitutional payments and military spending. Eq. (4) states that in case of a failed coup G consumes the entire oil rents, as there is no need to either share them with O, who is prosecuted, or accumulate more military power. Eq. (5) is the dynamic law for the stock of arms, where we normalized the initial stock to zero, while Eq. (6) is the dynamic law for the stock of oil. The solution to the problem in (2) - (8) proceeds backwards. First, we compute the optimal extraction trajectory in the post-coup phase and the associated present value of welfare. Second, we compute the optimal extraction and welfare in the stochastic pre-coup phase. Lastly, the optimal military-spending propensity is found by maximizing the total expected lifetime welfare. In order to simplify the exposistion and following van der Ploeg (2017), we make the following

Assumption 1: *Both players are risk neutral, i.e.* $u(c) = c$.

The more general case where agents may exhibit risk aversion is treated in the appendix.

Post-coup Phase

First, we compute the optimal extraction and welfare in the post-coup phase, provided that G survives the coup. Since no arms need to be accumulated after a failed coup, the problem involves only one state variable, the oil stock. This standard Hotelling-extraction problem has the following solution (see appendix):

$$\hat{R}_t = -\frac{\rho}{\beta} \equiv -\tilde{\gamma}, \quad R_T = \tilde{\gamma} S_T, \tag{9}$$

$$\hat{\bar{c}}_t = -(1-\beta)\tilde{\gamma}, \quad \bar{c}_T = (\tilde{\gamma} S_T)^{1-\beta} \tag{10}$$

where a hat over a variable denotes the growth rate. The present value of welfare in the post-coup phase is therefore given by

$$W_{II} \equiv \int_T^\infty u(\bar{c}_t) e^{-\rho t} dt = \frac{u(\bar{c}_T) e^{-\rho T}}{\tilde{\gamma}}. \tag{11}$$

Pre-coup Phase

The problem in the pre-coup phase is stochastic due to the presence of coup uncertainty. The extraction and consumption feature growth rates which are larger in absolute value than those in (9)-(10):

$$\hat{R}_t = -\frac{\rho + \psi}{\beta} \equiv -\bar{\gamma}, \quad R_0 = \bar{\gamma} S_0, \tag{12}$$

$$\hat{\bar{c}}_t = -(1-\beta)\bar{\gamma}, \quad c_0 = (1-\theta)(1-\delta) R_0^{1-\beta}, \tag{13}$$

while the stock of arms held on date T is given by

$$m_T = m_T(\delta) = (1-\theta)\delta R_0^{1-\beta} \frac{1 - e^{-\bar{\gamma}(1-\beta)T}}{\bar{\gamma}(1-\beta)}. \tag{14}$$

Note that it depends on the military-spending propensity δ which is yet to be determined. The welfare of the pre-coup phase can be computed as:

$$W_I = \int_0^T u(c_t) e^{-\rho t} dt = u(c_0) \frac{1 - e^{-(\bar{\gamma}(1-\beta)+\rho)T}}{\bar{\gamma}(1-\beta)+\rho}. \tag{15}$$

Note that if there were no coup uncertainty, i.e. $\psi = 0$, the extraction would proceed at the same rate $\tilde{\gamma}$ in both phases. The threat of a possible overthrow thus makes extraction more rapacious, as in van der Ploeg (2017).

The optimal military-spending propensity is obtained by maximizing (2) with respect to δ and setting the first-order condition to zero.[8] Since there is no need for arms accumulation during the post-coup phase, W_{II} is independent of δ, so that we have:

$$\int_0^\infty \frac{dW_I}{d\delta} \psi e^{-\psi T} dT + \int_0^\infty \frac{d\nu_T}{d\delta} W_{II} \psi e^{-\psi T} dT = 0,$$

which yields the following implicit equation in δ representing the reaction function

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

of G:

$$\frac{1}{\psi\bar{\gamma}} = \frac{\alpha m_T^o \tilde{\gamma}^{-\beta} S_0^{1-\beta}}{\bar{\gamma}(1-\beta)} \Omega, \tag{16}$$

where $\Omega \equiv \int_0^\infty \frac{e^{-\bar{\gamma}T}(1-e^{-\bar{\gamma}(1-\beta)T})}{(\alpha m_T + m_T^o)^2} dT$. The left-hand side of (16) represents the present value of the welfare loss in the pre-coup phase due to a marginal unit of rents being spent on military power instead of on current consumption. The right-hand side represents the present value of expected welfare gain in the post-coup phase due to a higher probability of staying in power thanks to an extra unit of military spending.

We turn next to the optimization problem of the Opposition in order to compute its reaction function and then determine the equilibrium probability of success, as well as the timing of the coup.

3.1.2 Opposition

The Opposition (O for short) faces two options: The first one is to collect the rents offered by G forever and refrain from staging a coup. The second option is to stage a coup at some optimally chosen date, T, in order to attempt gaining office and control over the oil stock. We specify in the appendix the exact incentive-compatibility constraint (ICC) under which it is indeed optimal for O to stage a coup and we proceed below under the assumption that ICC holds. In the event of a coup, the probability of success is determined by the stock of arms held by O relative to that of G:

$$\mu_t = 1 - \nu_t = \frac{m_t^o}{\alpha m_t + m_t^o}.$$

Under our assumption about the information set, O has full information about the military strength of G. If the coup is successful, O stays in office for the remainder of the planning horizon, while the defeated faction is prosecuted and its utility drops to zero. 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, with respect to how much military to accumulate in preparation for the coup, δ^o, and with respect to the extraction rate in the post-coup phase (if successful):

$$\max_{\delta^o, T, R_t} \quad \int_0^T u(c_t^o) e^{-\rho t} dt + \mu_T \int_T^\infty u(\bar{c}_t^o) e^{-\rho t} dt \tag{17}$$

subject to

$$c_t^o = \theta(1-\delta^o) R_0^{1-\beta} e^{-\bar{\gamma}(1-\beta)t}, \tag{18}$$

$$\bar{c}_t^o = p_t R_t, \tag{19}$$

$$\dot{m}_t^o = \theta\delta^o R_0^{1-\beta} e^{-\bar{\gamma}(1-\beta)t}, \quad m_0^o = 0, \tag{20}$$

$$\dot{S}_t = -R_t, \quad p_t = R_t^{-\beta}, \ t > T, \ S_T \ \text{ given} \tag{21}$$

$$\mu_T = 1 - \nu_T = \frac{m_T^o}{\alpha m_T + m_T^o}. \tag{22}$$

The interpretation of Eqs. (18) - (22) is similar to that of (3) - (8). In maximizing (17), O essentially faces two trade-offs. On the one hand, staging a coup earlier would allow her to gain control over a larger oil stock. On the other hand, if the coup is staged too soon, O may not have sufficient military power to defeat G. The choice of the optimal program proceeds backwards. That is, first we solve for the optimal extraction in the post-coup phase and subsequently turn to the pre-coup phase. Since the post-coup problem is symmetric with respect to the problem of G (discussed in the previous subsection), we already know the solution for the optimal extraction and consumption profile, as well as the welfare, from Eqs. (9) - (11). We may therefore write directly

$$W_{II}^o \equiv \int_T^\infty u(\bar{c}_t^o) e^{-\rho t} dt = \frac{u(\bar{c}_T^o) e^{-\rho T}}{\tilde{\gamma}}, \quad \bar{c}_T^o = (\tilde{\gamma} S_T)^{1-\beta}. \tag{23}$$

The stock of arms on date T and the discounted welfare in the first phase also have similar expressions as those of G in Eqs. (14) - (15):

$$m_T^o = \theta\delta^o R_0^{1-\beta} \frac{1 - e^{-\bar{\gamma}(1-\beta)T}}{\bar{\gamma}(1-\beta)}, \tag{24}$$

$$W_I^o = \int_0^T u(c_t^o) e^{-\rho t} dt = u(c_0^o) \frac{1 - e^{-(\bar{\gamma}(1-\beta)+\rho)T}}{\bar{\gamma}(1-\beta)+\rho}, \tag{25}$$

with $c_0^o = \theta(1-\delta^o)(\bar{\gamma} S_0)^{1-\beta}$.

The optimal military-spending propensity is found by maximizing the expected lifetime welfare with respect to δ^o and setting the first-order condition to zero:

$$\frac{dW_I^o}{d\delta^o} + \frac{d\mu_T}{d\delta^o} W_{II}^o = 0.$$

Note that since O can observe the military power of G, O realizes that the coup success probability is given by:

$$\mu_T = \frac{\xi}{\alpha + \xi}, \quad \text{where } \ \xi \equiv \frac{m_T^o}{m_T} = \frac{\theta}{1-\theta} \frac{\delta^o}{\delta}. \tag{26}$$

Note that if the rents were shared equally and the military spending propensities of the two factions were identical, the success probability would be given by

$\mu_T = \frac{1}{1+\alpha} \gtrless \frac{1}{2} \Leftrightarrow \alpha \lessgtr 1$. If G's military is relatively more (less) efficient, i.e. $\alpha > 1$ (resp., $\alpha < 1$), then O's success probability is lower (larger) than 1/2.

The reaction function of O can then be written as

$$\theta \bar{\gamma}^{1-\beta} \frac{1 - e^{-(\bar{\gamma}(1-\beta)+\rho)T}}{\bar{\gamma}(1-\beta)+\rho} = \frac{\alpha \tilde{\theta} \tilde{\gamma}^{-\beta}}{(\alpha+\xi)^2} e^{-(\bar{\gamma}(1-\beta)+\rho)T}, \tag{27}$$

where $\tilde{\theta} = \partial \xi / \partial \delta^o = \frac{\theta}{1-\theta} \frac{1}{\delta}$. The term on the left-hand side of (27) represents the present value of pre-coup welfare loss due to using one unit of rents on military spending instead of current consumption. The term on the right-hand side represents the the present value of expected welfare gain in the post-coup phase due to improved success probability resulting from this extra unit of military spending.

The optimal timing of the coup is found from the optimality condition:

$$\frac{\partial W_I^o}{\partial T} + \mu_T \frac{\partial W_{II}^o}{\partial T} = 0$$

which trades off the marginal welfare gain in the pre-coup phase with the marginal welfare loss in the post-coup phase (which happens with probability μ_T). The welfare gain in the pre-coup phase occurs because by delaying the coup by one unit of time O enjoys certain consumption of the oil rents shared by G. However, by delaying the coup O incurs an expected welfare loss in the post-coup phase because, if it gains office, it will gain control over a smaller oil stock. At the optimum we thus have:

$$u(c_0^o) e^{-(\bar{\gamma}(1-\beta)+\rho)T} - \mu_T \frac{u(\bar{c}_T^o) e^{-\rho T} (\bar{\gamma}(1-\beta)+\rho)}{\tilde{\gamma}} = 0.$$

This condition may be rewritten in terms of the optimal military-spending propensity as a function of success probability (or, equivalently, the military-spending propensity of G, δ):

$$\delta^o = \delta^o(\delta) = 1 - \mu_T \left(\frac{\tilde{\gamma}}{\bar{\gamma}} \right)^{1-\beta} \frac{\bar{\gamma}(1-\beta)+\rho}{\theta \tilde{\gamma}}. \tag{28}$$

The optimal T, as a function of δ, is then found by combining (28) and (27). These optimal values, however, are not yet the equilibrium solutions of the dynamic resource war since they still depend on G's reaction function, (i.e. the choice of δ). We turn next to the equilibrium.

3.1.3 Equilibrium

Our ultimate goal is to determine the equilibrium probability of coup success and the equilibrium timing of the coup in our resource-war model. We shall then be in a position to analyze how these values respond to a random resource discovery, which we introduce in the next section.

The equilibrium of the model is characterized by the triplet $(\delta^*, \delta^{o*}, T^*)$ which is the solution to the system of equations (16), (27) and (28). By combining the latter with the first two, the system can be reduced to just two equations which can be conveniently analyzed:

$$e^{(\bar{\gamma}(1-\beta)+\rho)T} - 1 - \frac{\alpha\tilde{\theta}(\delta)\kappa}{\Big(\alpha + \xi(\delta)\Big)^2} = 0 \equiv A, \tag{29}$$

$$\tilde{\kappa} S_0^{-2(1-\beta)} - \delta^o(\delta)(1 - e^{-\bar{\gamma}(1-\beta)T})\Omega(\delta, S_0) = 0 \equiv B, \tag{30}$$

where we defined for convenience the constants $\kappa = \left(\frac{\tilde{\gamma}}{\bar{\gamma}}\right)^{1-\beta} \frac{\bar{\gamma}(1-\beta)+\rho}{\theta\tilde{\gamma}} > 0$ and $\tilde{\kappa} = \frac{(1-\beta)^2(\tilde{\gamma}\bar{\gamma})^\beta}{\alpha\psi\theta} > 0$. We also indicated explicitly that $\tilde{\theta}$, ξ, δ^o, and Ω are functions of δ. In particular, we may rewrite (28) as

$$\delta^o(\delta) = 1 - \frac{\kappa\xi(\delta)}{\alpha + \xi(\delta)}. \tag{31}$$

Once we have expressed δ^o in terms of δ, the equilibrium of the model can be described in terms of only two endogenous variables, δ^* and T^*, which are the solution to (29) - (30). We are particularly interested in how this solution is affected by an exogenous change in resource wealth. For the moment we only note that by totally differentiating the system (29) - (30) with respect to δ, T and S_0 (the details are relegated to the appendix), we find

Result 1: *The equilibrium timing of the coup and G's military spending propensity both increase in the initial oil stock.*

Proof: provided in the Appendix.

3.2 Dynamic Resource War with Oil Discovery

Let us assume that a resource discovery follows a 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, keeping in mind that multiple discoveries can be analyzed in a similar way.

It is useful at this stage to set the timing of events. If an oil discovery occurs after the coup has already been staged by the opposition, the discovery is irrelevant for the success/failure of the coup which is consistent with the empirical findings of Lei and Michaels (2014). We shall therefore focus on the sequence of events where a discovery precedes the coup. Therefore, we shall assume that initial resource endowment is relatively small, so that staging a coup does not pay off initially. Only if a large discovery occurs, it becomes attractive to fight for the resource.[9] G learns about a possibility of a coup once the (large) discovery has taken place. This also guarantees consistency with our empirical investigation later in the paper.

3.2.1 Optimal Oil Extraction in Anticipation of Discovery

When G does not expect any coup, her objective function is:

$$\max_{c_t} \ \mathbb{E}\left\{\int_0^\infty u(c_t)e^{-\rho t}dt\right\},$$

where expectation is with respect to the time of the discovery, denoted by τ. With our assumption on the distribution of τ, the objective may be rewritten as

$$\max_{c_t,\tilde{c}_t} \int_0^\infty \left\{\int_0^\tau u(c_t)e^{-\rho t}dt + \int_\tau^\infty u(\tilde{c}_t)e^{-\rho t}dt\right\} f_\tau d\tau$$

subject to

$$c_t = (1-\theta)p_t R_t, \ \forall t \in [0,\tau), \ \tilde{c}_t = (1-\theta)p_t \tilde{R}_t, \ \forall t \geqslant \tau, \tag{32}$$

$$p_t = R_t^{-\beta}, \tag{33}$$

$$dS_t = -R_t dt + (\Delta - 1)S_t dq_t. \tag{34}$$

For clarity, we denote all endogenous post-discovery variables with a tilde. For instance, at the time of the discovery the oil stock changes from S_{τ_-} to $S_{\tau_+} \equiv \tilde{S}_\tau = \Delta S_{\tau_-}$ and then follows its optimal trajectory $\tilde{S}_t$. Associated with the optimal path of $\tilde{S}_t$, there is an extraction path $\tilde{R}_t$ and the corresponding consumption rate $\tilde{c}_t$.

The solution to this problem proceeds backwards. First we obtain the optimal consumption and depletion paths in the last, post-discovery phase, and compute the present value of welfare in that phase. Then, we turn to the first, stochastic phase.

Post-discovery phase

G's objective is to optimally deplete the oil stock $\tilde{S}_\tau$ to maximize the present value of utility. This is a standard Hotelling-type problem, which yields, given the constraints above, the following solution:

$$\hat{\tilde{R}}_t = -\tilde{\gamma}, \quad \tilde{R}_\tau = \tilde{\gamma}\tilde{S}_\tau = \tilde{\gamma}\Delta S_{\tau_-}, \tag{35}$$

$$\hat{\tilde{c}}_t = -(1-\beta)\tilde{\gamma}, \quad \tilde{c}_\tau = (1-\theta)\tilde{R}_\tau^{1-\beta}. \tag{36}$$

Extraction declines at the rate $\tilde{\gamma}$, defined previously, the oil stock declines at the same rate, and the extraction rate is a fraction $\tilde{\gamma}$ of the (augmented) oil stock. We

[9] In other words, we assume that initially the incentive-compatibility constraint is not met.

may therefore write $\tilde{c}_t = (1-\theta)\tilde{\gamma}^{1-\beta}\tilde{S}_t^{1-\beta}$. And thus the time-$\tau$ welfare becomes

$$V(\tilde{S}_\tau) = \int_\tau^\infty u(\tilde{c}_t)e^{-\rho(t-\tau)}dt = \frac{u(\tilde{c}_\tau)}{\tilde{\gamma}} = (1-\theta)\tilde{\gamma}^{-\beta}\tilde{S}_\tau^{1-\beta}. \tag{37}$$

Pre-discovery phase

This problem involves uncertainty with respect to the timing of oil discovery and is therefore a stochastic control problem which can be tackled with the help of the following Hamilton-Jacobi-Bellman equation:

$$\rho V(S) = \max_R \left\{ u(c) + V_S[-R] + \lambda[V(\tilde{S}) - V(S)] \right\}.$$

We shall postulate a guess of the value function $V(S) = (1-\theta)\gamma^{-\beta}S^{1-\beta}$ and verify that this guess is indeed correct with the constant γ given by the solution to the following equation:

$$\rho = \gamma\beta + \lambda \left[\left(\frac{\tilde{\gamma}}{\gamma} \right)^{-\beta} \Delta^{1-\beta} - 1 \right]. \tag{38}$$

The constant γ represents the share of extraction in current stock, $R_t = \gamma S_t$. The optimality conditions with respect to the extraction rate and the oil stock yield the optimal behavior of the depletion rate (see Appendix):

$$\frac{dR_t}{R_t} = -\gamma dt + \left(\frac{\tilde{R}_t}{R_t} - 1 \right) dq_t, \tag{39}$$

Eq. (39) states that before the discovery occurs, the extraction declines at a constant rate γ, while at the time of the discovery it jumps from R_τ to $\tilde{R}_\tau$. We can therefore determine the time profile of the oil stock until the discovery: $S_t = S_0 e^{-\gamma t}$. Note that in the presence of a random oil discovery, the depletion rate may in general be either more or less rapacious than without oil discovery. 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 more slowly. Whether the depletion proceeds more quickly or more slowly depends on the magnitude of the oil demand elasticity.

Proposition 1: *Possibility of oil discovery induces (i) a* <u>*faster*</u> *extraction in the pre-discovery phase, i.e.* $\gamma > \tilde{\gamma}$, *if oil demand is inelastic* ($\beta > 1$) *but (ii) a* <u>*slower*</u> *extraction, i.e.* $\gamma < \tilde{\gamma}$, *if oil demand is elastic* ($0 < \beta < 1$).

Proof: provided in the Appendix.

Proposition 1 implies that up to the date of the discovery, τ, G depletes its oil reserves at the rate γ and after time τ the extraction proceeds at a rate $\tilde{\gamma} \gtrless \gamma$. The extraction rate on date τ jumps upwards or downwards from $R_\tau = \gamma S_\tau$ to $\tilde{R}_\tau = \tilde{\gamma}\tilde{S}_\tau$. If $\gamma < \tilde{\gamma}$, then the extraction rate jumps upwards unambiguously. It may fall, however, provided that $\gamma > \tilde{\gamma}$ and the newly discovered reserves are relatively small.

The first part of Proposition 1 complies with the general intuition. If an oil discovery is anticipated in the future, representing a positive income shock, it is optimal to engage in intertemporal consumption smoothing by consuming (and thus extracting) more already 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 the optimal response, provided that β is less than unity. This condition states that oil demand is elastic, implying that the marginal revenue is positive, i.e. an increase in oil supply results in an increase in total oil rents: $d(pR)/dR = (1-\beta)p > 0$. If oil discovery occurs in the future and thus oil supply will increase allowing for higher rents (and thus higher consumption), this would be exactly the right time to increase consumption. This, however, requires that the agent is willing to shift her consumption from the present to the future, i.e. a sufficiently large elasticity of intertemporal consumption substitution. Given Assumption 1, this is indeed the case, so that such a shift of consumption from the present to the future becomes indeed feasible and, moreover, optimal. Proposition 1A in the appendix generalizes Proposition 1 by relaxing Assumption 1.

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 scenario without any oil discovery. This will become clear once we formally define the equilibrium duration of leadership. If a discovery induces a faster extraction, the size of the remaining reserves (including the newly discovered ones), $\tilde{S}_\tau$ may be lower than the amount of remaining reserves had no discovery been possible at all. Alternatively, if a discovery induces a slower extraction, $\tilde{S}_\tau$ is unambiguously larger than the reserves without the possibility of a discovery not only because of the newly discovered deposits but also because less has been extracted over the period from 0 to τ. Since out empirical investigation will be concerned with only giant oil and gas discoveries, we shall only focus on the latter scenario, where a discovery leads to an unambiguous increase in resource stock. 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.

3.3 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 the duration of leadership.

After (and if) the discovery has occurred, the Opposition realizes that it is optimal to fight for the large oil reserves (ICC is now binding) and decides to stage a coup on some optimally-determined date T. G realizes that now it faces the threat of a coup. The programs of the two factions become identical to those analyzed in Section 3.1, 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 benchmark model of Section 3.1.

Let us define the average duration of dictatorship as $D = T/\mu_T$. 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. $\mu_T = 1$, 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 substitution for μ_T from (26), we obtain

$$D = \frac{T(\alpha m_T + m_T^o)}{m_T^o} = T\left(1 + \frac{\alpha}{\xi}\right). \tag{40}$$

We shall break down the effect of an oil discovery on G's duration of leadership into two steps. In the first step we identify what effect a discovery has on the oil stock remaining on date τ. Then we know that the direction of a change in leadership duration following a change in the oil stock on date τ is equivalent to the direction of change in D following a change in S_0 in the benchmark model. Thus in the second step we determine the latter, dD/dS_0.

Effect of discovery on reserves

The oil stock on date τ (after the discovery) may be written as $\tilde{S}_\tau = \Delta S_0 e^{-\gamma\tau}$. We already know from Proposition 1(ii) that if β lies between zero and unity, then a possible discovery induces a slower extraction ($\gamma < \tilde{\gamma}$) and hence $\tilde{S}_\tau$ is unambiguously larger than what it would have been without a discovery.[10] In the rest of the analysis we shall proceed under the following

Assumption 2: *Oil demand is sufficiently elastic, i.e.* $\beta \in (0, 1)$.

[10]If oil demand is inelastic ($\beta > 1$) and thus $\gamma > \tilde{\gamma}$, then we will need to assume that the newly discovered deposits are sufficiently large, $\Delta > e^{(\gamma-\tilde{\gamma})\tau}$, in order to ensure that the new oil stock on date τ, after the discovery, is unambiguously larger than the stock which would have prevailed had the discovery not been possible at all. In our empirical investigation we look only at discoveries of giant oil and gas fields, larger than 500 million barrels. The evidence on the magnitude of oil demand elasticity suggests that both short run and long run values are below unity (Dahl (1993), Cooper (2003), Brons *et al.* (2008)). These values are typically estimated from a large sample of countries and refer to total oil demand in these countries. The oil demand faced by an individual exporter, however, is likely to be much more elastic.

This assumption ensures that a discovery induces an unambiguous increase in the resource stock on date τ as compared to a scenario without a possibility of a discovery.

Effect of reserves on leadership duration

By differentiating (40) 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, $\frac{d\xi}{dS_0}$:

$$\frac{dD}{dS_0} = \left(1 + \frac{\alpha}{\xi}\right)\frac{dT}{dS_0} - \frac{T\alpha}{\xi^2}\frac{d\xi}{dS_0}. \tag{41}$$

The relative military power may be written as (see (26))

$$\xi = \frac{\theta}{1-\theta}\frac{\delta^o(\delta)}{\delta},$$

where $\delta^o(\delta)$ is given in (31). We may therefore rewrite (41) as:

$$\frac{dD}{dS_0} = \left(1 + \frac{\alpha}{\xi}\right)\frac{dT}{dS_0} - \frac{T\alpha}{\xi^2}\frac{d\xi}{d\delta}\frac{d\delta}{dS_0}, \tag{42}$$

with

$$\frac{d\xi}{d\delta} = \frac{\xi}{\delta}\left(\frac{d\delta^o}{d\delta}\frac{\delta}{\delta^o} - 1\right) = \frac{\xi}{\delta}\left(\epsilon_{\delta^o} - 1\right) < 0, \tag{43}$$

where $\epsilon_{\delta^o} \in (0,1)$ is the elasticity of δ^o with respect to δ. The direction of the effect of S_0 on T and δ can be found by totally differentiating the system (29) - (30) which characterizes the equilibrium in our benchmark resource-war model:

$$\underbrace{\begin{pmatrix} \frac{dA}{dT} & \frac{dA}{d\delta} \\ \frac{dB}{dT} & \frac{dB}{d\delta} \end{pmatrix}}_{M} \times \begin{pmatrix} dT \\ d\delta \end{pmatrix} = \begin{pmatrix} 0 \\ -\frac{dB}{dS_0} \end{pmatrix} \times dS_0,$$

where all the terms and derivations are described in the appendix. Here we provide only the final results (using the Cramer's rule):

$$\frac{dT}{dS_0} = \frac{\frac{dB}{dS_0}\frac{dA}{d\delta}}{|M|} > 0, \tag{44}$$

$$\frac{d\delta}{dS_0} = -\frac{\frac{dB}{dS_0}\frac{dA}{dT}}{|M|} > 0. \tag{45}$$

Substituting (44) and (45) into (41) and taking account of (43) yields

Proposition 2: *Under Assumptions 1 and 2 a resource discovery tends to lengthen the expected leadership duration.*

An oil discovery benefits the incumbent because of two complementary effects: (i) an increase in the oil stock allows the incumbent to raise her military power proportionally more than the opposition and thus decreases the probability of coup success, and (ii) an increase in the oil stock delays the onset of the coup. We generalize Proposition 2 in the appendix, where we relax the two assumptions above and we no longer require that a discovery is relatively large.

The next section tests Proposition 2 empirically by using the survival analysis and an extended data on discoveries of giant oil and gas fields going back to 1868.

4 Empirical Evidence

Based on the model, we want to test the following hypothesis: *Ceteris paribus*, an autocratic leader who discovers an oil or gas field will face a lower political hazard rate, thus remains in power longer, than a similar leader who sees no such exogenous increase in the resource stock of the country.

Identification strategy: Ideally, we would test this hypothesis by an experiment where identical leaders in identical countries were assigned different levels of resource wealth. Clearly, this is not feasible. Instead, we rely on discoveries, the measure of resource wealth that most closely resembles such an experiment. The survival analysis 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. The identification strategy rests on the assumption that oil discoveries are exogenous conditional on the inclusion of covariates.

4.1 Data

Our main variable of interest is the duration of autocratic leadership. We use the ARCHIGOS 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 will be considered as censored in the sense that the leadership duration did not end in failure. 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. Neither is a leadership that ends 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.

To create a variable for oil and gas discoveries during the tenure of a leader, we use Horn's dataset on giant hydrocarbon discoveries (Horn & Myron (2011)). The dataset includes the discovery year, size and type of every giant oil and gas discovery since 1868.[11] 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 tend to be unreliable, we code the discoveries as a dummy rather than using the size (see discussion in appendix B.5). 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.

Following the literature, we use the Polity IV Project to restrict the datasets to leaders in autocracies (see e.g. Cuaresma *et al.* (2011) and Andersen & Aslaksen (2013); Marshall & Jaggers (2002)). The Polity2 variable is the preferred measure of regime characteristics in the literature. Polity2 is an index ranging from -10 to 10, where 10 is the most democratic and -10 is the most autocratic. The Polity2 score is a combination of scores in the variables Autoc and Democ, which 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). The combined polity score is calculated by simply subtracting the Autoc score from the Democ score. 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.[12] In our robustness

[11] 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.

[12] One potential issue with using the Polity2 score as a cutoff is that this score is estimated yearly,

checks, we estimate our model with different cutoffs (see appendix B.6)

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 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. In the appendix, we also control for exploration intensity. To improve accuracy, we control for other variables that may affect leadership durations.

In particular, we include covariates from the Haber and 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 the median duration of leaders prior to the leader in question. To control for larger scale political trends, we include diffusion of democracy in the world and in the region – measured as the percentage of countries that are considered democratic. We include log of population and dependency ratio to control for demographics in the country (the dependency ratio is from the World Bank, and only available from 1960 - as it significantly reduces the sample size we only include it in one specification). Finally, we include the age at entry for each leader, as it is hypothesized that an older leader will have shorter tenure than

and therefore varies within the leadership duration of many of the leaders. We choose to include all leaders who ever have a polity score below our cutoff, to make sure that we include all leaders who are ever 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. This method gives us 529 leadership durations to work with, of which 79 find at least one giant oil or gas field.

younger leaders (Andersen & Aslaksen (2013), Cuaresma *et al.* (2011)).

Further, as argued by Andersen & Ross (2014), the nationalization movement in oil 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 country has ever set up a national oil company to control for this shift without reducing our sample size. This data is from Ross & Mahdavi (2015). Further oil industry controls from Cotet & Tsui (2013a) are incorporated in robustness checks.

As our theoretical model includes spending on fighting, we would like to include military spending in the specification. The best dataset is from SIPRI, but it has several issues: it only covers certain countries over a limited time period, and much of the data is based on estimates that (as described by SIPRI) are not very reliable. Additionally, spending on the military is not the only way a leader can invest in 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 fighting efforts. Ties between leaders and military varies greatly from country to country. 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 Rebel group, and spending on, e.g. the secret police would be the investment the leader makes in her stock of arms. It is therefore unlikely that the SIPRI military spending variable would fully capture the resources the leader dedicates to remaining in power. Thus we do not include military spending in our main analysis, but explore the SIPRI data further in appendix B.3.

Finally, we cluster the errors at the country level, as they are likely to be serially correlated. The summary statistics for these variables are presented in Table 1.

4.2 Econometric specifications

We use survival analysis to asses the impact of a resource discovery 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. We rely on the semi-parametric Cox regression for our baseline results, and complement this analysis through robustness checks with several other model specifications.

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Oil/Gas discovery	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	9	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
Dependency	7.877	3.772	1.239	21.781	164
Military expenditure, 2016 US (SIPRI)	3382.809	14697.95	1.619	250003	272
Wildcats	8.541	29.791	0	481	414

4.2.1 Non-Parametric

The non-parametric model includes no parameters and puts no restrictions on the data, using only information in the data to construct hazard- and survival functions. The effect of a variable can be gauged by splitting the sample into subgroups, and comparing the groups' 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 exogeneity, its time varying nature makes it a bad candidate 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 asses the basic properties of the hazard- and survival functions by looking at the shape of the non-parametric models and use them to see if the raw data indicates any effect of resources (Cleves *et al.* (2010)). We therefore include the Kaplan-Meyer function and the Nelson-Aalen hazard models, by 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. Results are reported in section 4.3.1.

4.2.2 Choice of Semi-Parametric and Parametric

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

$$h_j(t|\boldsymbol{x_j}) = h_0(t)exp(\boldsymbol{x_j}\boldsymbol{\beta_x}) \quad (46)$$

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.

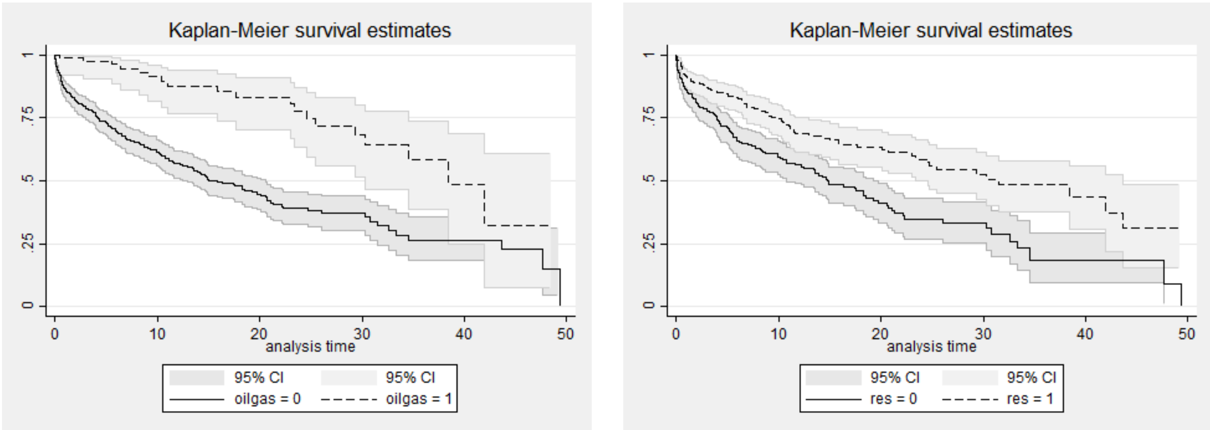
The Parametric class models are written the same way as the Cox models, but require that we impose a functional form on $h_0(t)$. As Cleves *et al.* (2010) point out, these models use more of the available data, and are therefore more efficient than the semi-parametric models - *if the baseline hazard 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 as the main analysis, as this allows a minimum of assumptions to be placed on the data. We conduct robustness checks using a Weibull model, and get similar results to the main analysis.

4.3 Results

4.3.1 Non-parametric analysis

We first present the preliminary results of the non-parametric analysis, to show that the raw data indicates the existence of a stabilizing effect. The Kaplan-Meyer survival functions (figure 1), and the Nelson-Aalen hazard functions (figure 2) 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 discussed in section 4.2.1, we also include survival and hazard functions for leaders with and without oil reserves. As seen in the figures, the survival function is higher when the leader sees an increase in the resource wealth (oilgas=1) or if the country of the leader has oil reserves (res=1). This shows that more leaders survive past any given time t when they get more oil/gas and if they have oil reserves. 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 and political survival (hazard rates) of autocratic leaders. We next use semi-parametric regressions to move past simple correlation and establish the causality of this relationship

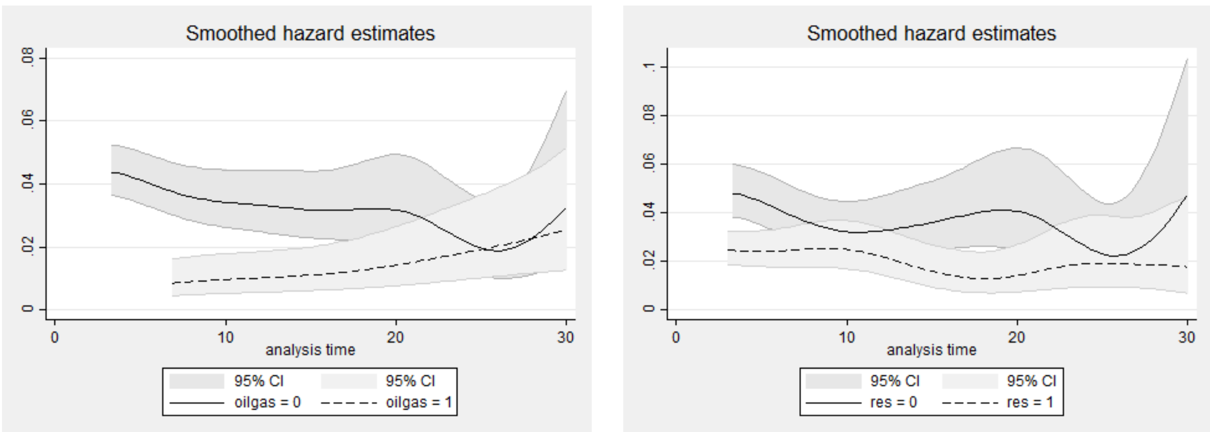
Figure 1: Survival functions of leaders



Hydrocarbon discoveries

Oil reserves

Figure 2: Political hazard rate



Hydrocarbon discoveries

Oil reserves

4.3.2 Semi-Parametric - Cox Regression

Table 2 reports the results of the semi-parametric regression. We report exponentiated coefficients i.e. hazard ratios; a value below (above) unity indicates that the variable in question decreases (increases) the hazard rate. The coefficient on the discovery dummy is below unity and significant at the 10% level or lower in every specification.

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, it may be somewhat surprising to see such a strong effect over the whole time sample. 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. Similarly, Cuaresma *et al.* (2011) find the effect of increasing oil production by 1000 barrels/day to be more than a 30% increase in duration.

Looking at the economic controls, we see 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 be significantly different from zero. This could indicate that fuels are more important than other resources when it comes to determining political outcomes - a proposition that would be an interesting topic for further study. Prior establishment of an oil company increases hazard, but only with statistical significance in column 5, where the inclusion of the dependency ratio reduces the sample to starting from 1960.

Age at entry has the expected sign and is significant: an older leader faces a higher hazard rate. The median duration of previous leaders does not seem to have an effect.

Of the political controls, world democracy and Polity2 are statistically significant. While regional democracy remains insignificant, world democracy appears to significantly lower 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

Table 2: Results, Cox regression

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) Hazard ratio
Oil/Gas discovery	0.561***	0.502***	0.479***	0.344**	0.363*	0.546**
	(0.111)	(0.114)	(0.125)	(0.155)	(0.162)	(0.151)
GDP per capita		0.991	0.995	0.981	0.980	0.982
		(0.0151)	(0.0123)	(0.0179)	(0.0174)	(0.0142)
GDP growth		0.974***	0.976***	0.994	0.992	0.976**
		(0.00912)	(0.00899)	(0.0178)	(0.0174)	(0.0102)
Coal Income per capita			0.990**		0.994	0.989*
			(0.00474)		(0.00351)	(0.00589)
Metals Income per capita			1.000		0.998	1.000
			(0.000815)		(0.00108)	(0.000925)
Oil already disc.			0.842		0.735	0.734
			(0.163)		(0.321)	(0.152)
Nat'l oil company				1.717	3.341**	1.350
				(0.697)	(1.910)	(0.403)
Age at entry				1.024*	1.030*	1.026***
				(0.0133)	(0.0167)	(0.00963)
Median duration of previous leaders				1.000	1.000	1.000
				(8.00e-05)	(8.10e-05)	(4.66e-05)
Polity 2				1.095**	1.151***	1.078***
				(0.0505)	(0.0597)	(0.0301)
Population (log)				0.847	0.774*	0.919
				(0.0980)	(0.106)	(0.0706)
Dependency				0.979	1.020	
				(0.0592)	(0.0832)	
World democracy					0.903***	0.956***
					(0.0277)	(0.0106)
Regional democracy					1.019	0.999
					(0.0135)	(0.00519)
Leaders	529	431	428	136	135	384
Failures	208	171	188	48	48	150

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

all the observations in the sample are autocratic, this means that changing from a very repressive to slightly less repressive regime is associated with a higher hazard. This is in line with previous research.

Overall, these results indicate that discovering a giant oil or gas field lowers the political hazard of an autocratic leader, as our model predicted. 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 (see appendix B), all of which point to the same result.

4.4 Discussion

4.4.1 Potential sources of bias

We do not include small hydrocarbon discoveries or the discoveries of other resources, which potentially leads to a downward bias on the magnitude of the results. Leaving out other resource discoveries means that we are comparing autocratic leaders who find hydrocarbon reserves to a baseline that includes both leaders who find no resources and leaders who find other resources. This could bias the baseline hazard function upwards, and the difference to the hazard faced by discoverers will be lower than in reality. However, Tsui (2011) finds little to no effect of small discoveries on democracy, and 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 results.

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. 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) and Owen *et al.* (2010)). 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 than the actual returns from the field. These returns would be driven by the initially estimated value of the resources, not the actual size. The difference between the currently estimated size of the field and the initially estimated size is another source of measurement error that we avoid by using the dummy indicator. 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 the reported size of their reserves), we choose to not rely on it 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 size further in the appendix (section B.5)

Finally, our identification strategy rests on discoveries being exogenous given covariates. If lower political risk makes oil companies more willing to participate in exploration, the exploration intensity - and by extension the number of discoveries - 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.* (2015) and Lei & Michaels (2014), we assume that this potential bias is not a problem when using giant oil and gas discoveries. However, we still 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 should be conditionally exogenous. In the robustness checks we also include the number of wildcat wells drilled - a proxy for exploration intensity - and find that this does not significantly alter the results.

Another issue could be that the extraction of oil usually begins on average 6-8 years after a discovery (Arezki *et al.* (2015)). One could thus argue that we should include the discoveries with a similar lag, or that the discovery variable does not affect leadership duration through the increase in wealth. However, the leader will immediately have access to funds as once an oil discovery has been made public, as she can borrow on the international credit markets using the future oil revenues as collateral. Indeed, Arezki *et al.* (2015) 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.[13]

4.4.2 Other types of resources

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 might thus apply only to point source resources.

4.4.3 Measure of political outcomes

As we look only at the duration of leadership until it ends with a successful coup, our results are based on a very specific measure of political stability. While our model shows that resources will lower the incidence rate of coups, our empirical results cannot rule out that resources embolden insurgencies and lead to a larger number of *attempted* coups while simply lowering the number of *successful* coups. Thus it may be that the resource discovery creates instability in the sense that it emboldens the opposition to move against the leader.

[13]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 etc. 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); note however, that this is not impossible - see Ross (2005) for case studies providing examples). If the incumbent is the only player that can rely on the added wealth from the discovery, she might gain an upper hand versus her opposition in a way that would not be possible with discoveries of other resources.

However, this specificity is also a strength, in that it makes it very clear what exactly is being measured. Adding complexity to the measure of stability and leader strength can easily come at the cost of clarity in interpretation. Overall, we consider leadership duration to be a good measure of stability.

4.5 Implications

What does all this tell us about the political properties of resources? The clear conclusion to be drawn from our results is that (1) there is a political effect of increasing resource wealth, (2) this effect is positive for autocratic regimes, as (3) oil rich autocrats tend to last longer in political office then their oil poor counterparts.

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. Resources may decrease the probability of a leader failing in a coup, and at the same time increase the incidence and duration of conflict. Further, as Cabrales & Hauk (2011) point out, scholars tend to find heterogenous 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 other countries. It may even be the case that long lasting autocratic regimes prevail centrally, while resource fueled conflicts occur at the periphery. However, research indicates that civil war is more prevalent in less autocratic regimes (see Hegre (2001)). Further, Le Billon (2012) points out that the location of oil fields relative to opposition groups and ethnic minority areas can drive conflicts. 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.

To return to our initial motivation of describing the resource curse, the results clearly indicate that oil and gas impact political outcomes. It seems that giant hydrocarbon discoveries are very good news for autocratic leaders. Whether such discoveries are good news in general is less clear.

Indeed, it is not clear that the results indicate that there is a resource *curse*. Stable regimes may be preferable to unstable regimes, even if they happen to be autocratic. While strong autocratic leaders seem undesirable from a democratic point of view - it seems likely that our results mean that oil also slows down the democratic transition - 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). 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) and Easterly (2011)).

Further, the empirical results add to the debate regarding the Haber & Menaldo (2011) analysis. Contrary to Haber & Menaldo who find no evidence of a resource curse when looking at the effect of resource stocks over a long time span, our results indicate that oil does have a strong political effect on autocratic regimes. Importantly, we find this effect to hold using the whole sample, i.e. going back to before 1875 in some cases. Andersen & Ross (2014) claim that Haber & Menaldo should not have assumed that the relationship between oil wealth and political outcomes has remained unchanged over the last 200 years, as Andersen and Ross only find an effect when allowing for a structural break around 1980. Contrary to this finding, our results seem to robustly apply to almost the whole period considered by Haber & Menaldo - and certainly a much larger time period than Andersen & Ross. However, note that our sample is different from both these papers (we leave out several countries, and, perhaps crucially, only start including colonies after they are independent), and that we use a different measure of the political outcome. Our results therefore complement the two papers by showing this sample and measure of resource wealth and political outcomes, there (i) is evidence of a resource curse which (ii) does hold over a large time period.

5 Conclusion

In this paper, we have shown that discoveries of oil and gas fields increase leadership durations of autocratic leaders because discoveries reduce the probability that a leader will be forcefully ousted. In a theoretical model, we have shown mechanism through which resource wealth affect political outcomes. In particular, we have showed how increasing the stock of oil allows a leader to fight off threats to her regime. We then showed empirically that the same results can be found in the data. The empirical results are consistent across time, holding for the entire period between 1875 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 the known stock of resources in a country will stabilize and strengthen an autocratic regime. This again points to the anti-democratic properties of resources. Our contribution to the literature is thus twofold: we show theoretically the effect of increases in resource stocks on autocratic leaders in a dynamic model of resource wars, and we show empirically the that oil and gas wealth have political implications that are robust to using oil and gas discoveries as the measure of wealth, and we show that these apparently anti-democratic effects hold over a large time period.

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Appendix

A Appendix to Section 3

In this Appendix we develop a more general case of our model where agents may exhibit risk aversion. We shall assume that the utility function takes the iso-elastic form, i.e. $u(c) = \frac{c^{1-\varepsilon}}{1-\varepsilon}$ with $1/\varepsilon$ being the elasticity of intertemporal consumption substitution. The special case $\varepsilon = 0$ is presented in the main text.

A.1 Resource-war Model with Risk Aversion

A.1.1 Incumbent

Post-coup Phase

G's problem is

$$\max_{R_t} \int_T^\infty u(\bar{c}_t) e^{-\rho t} dt$$

s.t.

$$\bar{c}_t = p_t R_t,$$
$$p_t = R_t^{-\beta},$$
$$\dot{S}_t = -R_t, \quad S_T \text{ given.}$$

Setting up the Hamiltonian and using the first-order conditions yields:

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

$$\hat{\bar{c}}_t = -(1-\beta)\tilde{\gamma}, \quad \bar{c}_T = (\tilde{\gamma} S_T)^{1-\beta} \tag{A.2}$$

where $\eta \equiv (1-\beta)(1-\varepsilon)$. The present value of welfare in the post-coup phase is therefore given by

$$W_{II} \equiv \int_T^\infty u(\bar{c}_t) e^{-\rho t} dt = \frac{u(\bar{c}_T) e^{-\rho T}}{\tilde{\gamma}}. \tag{A.3}$$

Pre-coup Phase

Since a successful coup involves total loss of utility, the HJB equation reads:

$$\rho V(S) = \max_{R,S} \{u(c) - R V_S - \psi V(S)\}$$

s.t.

$$
\begin{aligned}
c_t &= (1-\theta)(1-\delta)p_t R_t, \\
\dot{S}_t &= -R_t, \\
p_t &= R_t^{-\beta}.
\end{aligned}
$$

The optimality conditions yield:

$$\hat{R}_t = -\frac{\rho + \psi}{1-\eta} \equiv -\bar{\gamma}, \quad R_0 = \bar{\gamma} S_0, \tag{A.4}$$

$$\hat{c}_t = -(1-\beta)\bar{\gamma}, \quad c_0 = (1-\theta)(1-\delta)R_0^{1-\beta}. \tag{A.5}$$

Using (A.4) in the differential equation (5) allows to solve for the stock of arms held on date T:

$$m_T = m_T(\delta) = (1-\theta)\delta R_0^{1-\beta} \frac{1 - e^{-\bar{\gamma}(1-\beta)T}}{\bar{\gamma}(1-\beta)}. \tag{A.6}$$

The welfare of the pre-coup phase can be computed as:

$$W_I = \int_0^T u(c_t) e^{-\rho t} dt = u(c_0) \frac{1 - e^{-(\bar{\gamma}\eta + \rho)T}}{\bar{\gamma}\eta + \rho}. \tag{A.7}$$

Maximizing (2) with respect to δ yields the following implicit equation in δ representing the reaction function of G:

$$[(1-\theta)(1-\delta)]^{-\varepsilon} \bar{\gamma}^{-\varepsilon(1-\beta)} = \frac{\alpha m_T^o \psi \tilde{\gamma}^{\eta-1} S_0^{1-\beta}}{\eta} \Omega, \tag{A.8}$$

where $\Omega \equiv \int_0^\infty \frac{e^{-\bar{\gamma}T}(1-e^{-\bar{\gamma}(1-\beta)T})}{(\alpha m_T + m_T^o)^2} dT$.

A.1.2 Opposition

O's problem reads:

$$\max_{\delta^o, T, R_t} \quad \int_0^T u(c_t^o) e^{-\rho t} dt + \mu_T \int_T^\infty u(\bar{c}_t^o) e^{-\rho t} dt \tag{A.9}$$

subject to

$$c_t^o = \theta(1-\delta^o) R_0^{1-\beta} e^{-\bar{\gamma}(1-\beta)t}, \tag{A.10}$$

$$\bar{c}_t^o = p_t R_t, \tag{A.11}$$

$$\dot{m}_t^o = \theta \delta^o R_0^{1-\beta} e^{-\bar{\gamma}(1-\beta)t}, \quad m_0^o = 0, \tag{A.12}$$

$$\dot{S}_t = -R_t, \quad p_t = R_t^{-\beta}, \; t > T, \; S_T \text{ given} \tag{A.13}$$

$$\mu_T = 1 - \nu_T = \frac{m_T^o}{\alpha m_T + m_T^o}. \tag{A.14}$$

Since the post-coup problem is symmetric with respect to the problem of G, while in the pre-coup phase O does not need to choose extraction, we may write directly

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

$$m_T^o = \theta\delta^o R_0^{1-\beta}\frac{1-e^{-\bar{\gamma}(1-\beta)T}}{\bar{\gamma}(1-\beta)}, \tag{A.16}$$

$$W_I^o = \int_0^T u(c_t^o)e^{-\rho t}dt = u(c_0^o)\frac{1-e^{-(\bar{\gamma}\eta+\rho)T}}{\bar{\gamma}\eta+\rho}, \tag{A.17}$$

with $c_0^o = \theta(1-\delta^o)(\bar{\gamma}S_0)^{1-\beta}$.

The optimal military-spending propensity is found by maximizing $W_I^o + \mu_T W_{II}^o$ with respect to δ^o and setting the first-order condition to zero:

$$\frac{dW_I^o}{d\delta^o} + \frac{d\mu_T}{d\delta^o}W_{II}^o = 0.$$

Note that since O can observe the military power of G, O realizes that the coup success probability is given by:

$$\mu_T = \frac{\xi}{\alpha+\xi}, \quad \text{where} \quad \xi \equiv \frac{m_T^o}{m_T} = \frac{\theta}{1-\theta}\frac{\delta^o}{\delta}. \tag{A.18}$$

The reaction function of O can then be written as

$$[\theta(1-\delta^o)]^{-\varepsilon}\theta\bar{\gamma}^\eta\frac{1-e^{-(\bar{\gamma}\eta+\rho)T}}{\bar{\gamma}\eta+\rho} = \frac{\alpha\tilde{\theta}}{(\alpha+\xi)^2}\frac{\tilde{\gamma}^{\eta-1}e^{-(\bar{\gamma}\eta+\rho)T}}{1-\varepsilon}, \tag{A.19}$$

where $\tilde{\theta} = \partial\xi/\partial\delta^o = \frac{\theta}{1-\theta}\frac{1}{\delta}$.

The optimal timing of the coup is found from the optimality condition:

$$\frac{\partial W_I^o}{\partial T} + \mu_T\frac{\partial W_{II}^o}{\partial T} = 0$$

which yields:

$$u(c_0^o)e^{-(\bar{\gamma}\eta+\rho)T} - \mu_T\frac{u(\bar{c}_T^o)e^{-\rho T}(\bar{\gamma}\eta+\rho)}{\tilde{\gamma}} = 0.$$

This condition may be rewritten in terms of the optimal military-spending propensity as a function of success probability (or, equivalently, the military-spending propensity of G, δ):

$$\delta^o = \delta^o(\delta) = 1 - \frac{1}{\theta}\left[\mu_T\left(\frac{\tilde{\gamma}}{\bar{\gamma}}\right)^\eta\frac{\bar{\gamma}\eta+\rho}{\tilde{\gamma}}\right]^{\frac{1}{1-\varepsilon}}. \tag{A.20}$$

The optimal T, as a function of δ, is then found by combining (28) and (27).

A.1.3 Equilibrium

The equilibrium of the model is characterized by the triplet $(\delta^*, \delta^{o*}, T)$ which is the solution to the system of equations (16), (27) and (28). By combining the latter with the first two, the system can be reduced to just two equations:

$$e^{(\bar{\gamma}\eta+\rho)T} - 1 - \frac{\alpha\tilde{\theta}(\delta)\kappa}{\Big(\alpha+\xi(\delta)\Big)^2} = 0, \tag{A.21}$$

$$\tilde{\kappa}S_0^{-2(1-\beta)} - \delta^o(\delta)(1-e^{-\bar{\gamma}(1-\beta)T})\Omega(\delta, S_0) = 0, \quad \text{with} \tag{A.22}$$

$$\delta^o(\delta) = 1 - \frac{\kappa\xi(\delta)}{\alpha+\xi(\delta)}, \tag{A.23}$$

where we defined for convenience the positive constants $\kappa = \frac{1}{\theta}\left(\frac{\tilde{\gamma}}{\bar{\gamma}}\right)^{1-\beta}\frac{\bar{\gamma}(1-\beta)+\rho}{\tilde{\gamma}} > 0$, $\tilde{\kappa} = \frac{(1-\beta)^2(\tilde{\gamma}\bar{\gamma})^\beta}{\alpha\psi\theta} > 0$, and indicated explicitly that $\tilde{\theta}$, ξ, δ^o, and Ω are functions of δ.

A.1.4 Incentive-compatibility Constraint

It is optimal for O to stage a coup if and only if the expected lifetime welfare from doing so, which we denote by W_c, is at least as large as the lifetime welfare O derives from collecting the rents shared by G, which we denote by W_{nc}. Hence the coup is staged if

$$W_c > W_{nc} \quad \Leftrightarrow \quad W_I^o(\delta^{o*}) + \mu_T^* W_{II}^o > \frac{u(\theta R_0^{1-\beta})}{\bar{\gamma}\eta+\rho},$$

where we used a star to indicate the equilibrium values. Note that the threat of a coup itself ($\psi > 0$) makes the coup more likely because it induces a more rapacious extraction on behalf of G. In other words, a larger ψ makes the left-hand side larger and the right-hand side smaller.

A.2 Dynamic Resource War with Oil Discovery

A.2.1 Optimal Oil Extraction in Anticipation of Discovery

When G does not expect any coup, her objective function is:

$$\max_{c_t} \mathbb{E}\left\{\int_0^\infty u(c_t)e^{-\rho t}dt\right\},$$

where expectation is with respect to the time of the discovery, denoted by τ. With our assumption on the distribution of τ, the objective may be rewritten as

$$\max_{c_t,\tilde{c}_t} \int_0^\infty \left\{\int_0^\tau u(c_t)e^{-\rho t}dt + \int_\tau^\infty u(\tilde{c}_t)e^{-\rho t}dt\right\} f_\tau d\tau$$

subject to

$$c_t = (1-\theta)p_t R_t,\ \forall t \in [0,\tau),\ \tilde{c}_t = (1-\theta)p_t \tilde{R}_t,\ \forall t \geqslant \tau, \tag{A.24}$$

$$p_t = R_t^{-\beta}, \tag{A.25}$$

$$dS_t = -R_t dt + \Delta S_t dq_t. \tag{A.26}$$

Post-discovery phase

Setting up the Hamiltonian and taking first-order conditions yields the following solution:

$$\hat{\tilde{R}}_t = -\tilde{\gamma}, \quad \tilde{R}_\tau = \tilde{\gamma}\tilde{S}_\tau = \tilde{\gamma}\Delta S_{\tau_-}, \tag{A.27}$$

$$\hat{\tilde{c}}_t = -(1-\beta)\tilde{\gamma}, \quad \tilde{c}_\tau = (1-\theta)\tilde{R}_\tau^{1-\beta}. \tag{A.28}$$

The time-τ welfare becomes

$$V(\tilde{S}_\tau) = \int_\tau^\infty u(\tilde{c}_t)e^{-\rho(t-\tau)}dt = \frac{u(\tilde{c}_\tau)}{\tilde{\gamma}} = \frac{(1-\theta)^{1-\varepsilon}\tilde{\gamma}^{\eta-1}\tilde{S}_\tau^\eta}{1-\varepsilon} \tag{A.29}$$

where $\eta \equiv (1-\beta)(1-\varepsilon)$ as before.

Pre-discovery phase

The Hamilton-Jacobi-Bellman equation for the problem in the pre-discovery phase may be written as:

$$\rho V(S) = \max_R \left\{ u[(1-\theta)pR] + V_S[-R] + \lambda[\tilde{V}(\tilde{S}) - V(S)] \right\}$$

and the optimality conditions consist of

$$R: \qquad u'(c)(1-\theta)(p'R + p) - V_S = 0, \tag{A.30}$$

$$S: \qquad \rho V_S = -RV_{SS} + \lambda\left[\tilde{V}_S(\tilde{S})\Delta - V_S(S)\right]. \tag{A.31}$$

Using our value function guess $V(S) = \frac{(1-\theta)^{1-\varepsilon}\gamma^{\eta-1}S^\eta}{1-\varepsilon}$ and the definition of $\eta = (1-\varepsilon)(1-\beta)$ we get $V_S = (1-\beta)(1-\theta)^{1-\varepsilon}\gamma^{\eta-1}S^{\eta-1}$. Combining the latter expression with Eq. (A.30), we obtain a possible policy function: $R = \gamma S$. To verify our value-function guess, we insert this policy function into the HJB equation and obtain a solution for γ, given by the implicit equation:

$$\rho = \gamma(1-\eta) + \lambda\left[\left(\frac{\tilde{\gamma}}{\gamma}\right)^{\eta-1}\Delta^\eta - 1\right]. \tag{A.32}$$

To obtain the growth rate of R, we apply the change of variable formula to the differential of V_S and use Eq. (A.31) to substitute for $-RV_{SS}$:

$$\begin{aligned}
dV_S &= -RV_{SS}dt + [\tilde{V}_S - V_S]dq = \\
&= \Big\{\rho V_S - \lambda\Big[\tilde{V}_S\Delta - V_S\Big]\Big\}\, dt + [\tilde{V}_S - V_S]dq = \\
&= V_S\left\{\rho - \lambda\Big[\frac{\tilde{V}_S\Delta}{V_S} - 1\Big]\right\} dt + [\tilde{V}_S - V_S]dq.
\end{aligned}$$

Recalling from Eq. (A.30) that $V_S = (1-\theta)^{1-\varepsilon}(1-\beta)R^{\eta-1}$, we may express R as a function of V_S, such as $R = f(V_S)$ with $f'(V_S) = \frac{1}{\eta-1}\left[(1-\theta)^{1-\varepsilon}(1-\beta)\right]^{\frac{1}{\eta-1}} V_S^{\frac{2-\eta}{\eta-1}}$. Now applying the change of variable formula to the differential of R we obtain:

$$\begin{aligned}
dR &= f'(V_S)V_S\left\{\rho - \lambda\Big[\frac{\tilde{V}_S\Delta}{V_S} - 1\Big]\right\} dt + [f(\tilde{V}_S) - f(V_S)]dq \\
&= \frac{R}{1-\eta}\left\{\lambda\Big[\frac{(1-\theta)^{1-\varepsilon}\tilde{\gamma}^{\eta-1}\eta\tilde{S}^{\eta-1}\Delta}{(1-\varepsilon)V_S} - 1\Big] - \rho\right\} dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq \\
&= \frac{R}{1-\eta}\left\{\lambda\Big[\frac{(1-\theta)^{1-\varepsilon}\tilde{\gamma}^{\eta-1}\eta\tilde{S}^{\eta-1}\Delta}{(1-\varepsilon)(1-\theta)^{1-\varepsilon}(1-\beta)(\gamma S)^{\eta-1}} - 1\Big] - \rho\right\} dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq \\
&= \frac{R}{1-\eta}\left\{\lambda\Big[\frac{\tilde{\gamma}^{\eta-1}(\Delta S)^{\eta-1}\Delta}{(\gamma S)^{\eta-1}} - 1\Big] - \rho\right\} dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq \\
&= \frac{R}{1-\eta}\left\{\lambda\Big[\frac{\tilde{\gamma}^{\eta-1}}{\gamma^{\eta-1}}\Delta^{\eta} - 1\Big] - \rho\right\} dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq \\
&= \frac{R}{1-\eta}\left\{\rho - \gamma(1-\eta) - \rho\right\} dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq \\
&= -\gamma R dt + R\left(\frac{\tilde{R}}{R} - 1\right) dq,
\end{aligned}$$

where we used Eq. (A.32) to substitute for the term multiplying λ.

In light of eq. (A.32), the Proposition 1 in the main text is modified as follows:

Proposition 1A: *Possibility of oil discovery induces (i) a faster extraction in the pre-discovery phase, i.e.* $\gamma > \tilde{\gamma}$*, if either oil demand is elastic (*$\beta \in (0,1)$*) and EIS is small (*$\varepsilon > 1$*) or oil demand is inelastic (*$\beta > 1$*) and EIS is large (*$\varepsilon \in (0,1)$*) but (ii) a slower extraction, i.e.* $\gamma < \tilde{\gamma}$*, if oil demand is elastic (*$\beta \in (0,1)$*) and EIS is large (*$\varepsilon \in [0,1)$*).*

Proof: Rewrite Eq. (A.32) as:

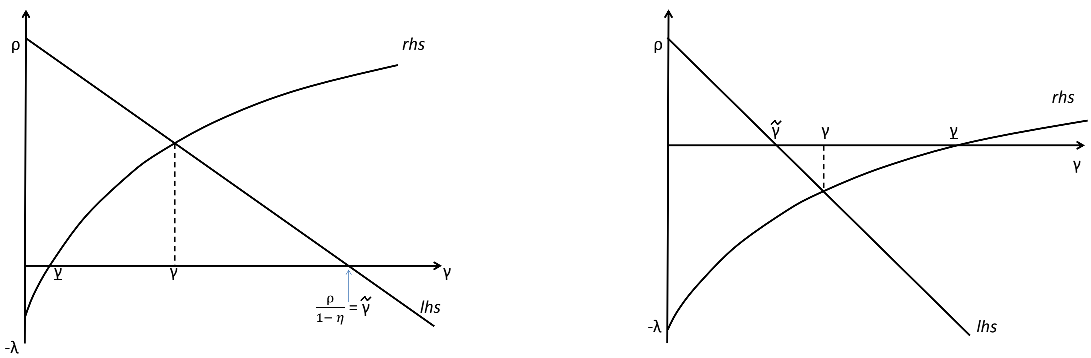
$$\rho - \gamma(1-\eta) = \lambda\left[\tilde{\gamma}^{\eta-1}\gamma^{1-\eta}\Delta^{\eta} - 1\right]. \tag{A.33}$$

The solution for γ may be represented graphically as the intersection of the left-hand side, $lhs(\gamma) = \rho - \gamma(1-\eta)$, and the right-hand side $rhs(\gamma) = \lambda\left[\tilde{\gamma}^{\eta-1}\gamma^{1-\eta}\Delta^{\eta} - 1\right]$. The function $lhs(\gamma)$ is decreasing and linear in γ with the slope $-(1-\eta) < 0$

and the intercept with the vertical axes at $\rho > 0$ and with the horizontal axes at $\frac{\rho}{1-\eta} > 0$. Recalling the definition of $\tilde{\gamma}$, we may rewrite it as $\tilde{\gamma} = \frac{\rho}{1-\eta}$. Thus the function lhs intersects with the horizontal axes at $\gamma = \tilde{\gamma}$. The function rhs is increasing and concave in γ with the intercept with the vertical axes at $-\lambda < 0$ and with the horizontal axes at $\underline{\gamma} = \left[\frac{\tilde{\gamma}^{1-\eta}}{\Delta^{\eta}}\right]^{\frac{1}{1-\eta}} > 0$.

Figure 3: Graphical solution of Eq. (A.33).

(a) **(b)**



If both β and ε lie between zero and unity or both lie above unity, i.e. $\eta > 0$, then $\underline{\gamma} < \tilde{\gamma}$, as shown in figure 2a. To see this, rewrite $\underline{\gamma}$ as $\underline{\gamma} = \tilde{\gamma}\Delta^{-\frac{\eta}{1-\eta}}$. Since $\Delta > 1$, the term $\Delta^{-\frac{\eta}{1-\eta}} \gtrless 1 \Leftrightarrow \eta \lesseqgtr 0$. Therefore, the value of γ which corresponds to the intersection between lhs with rhs is such that $\underline{\gamma} < \gamma < \tilde{\gamma}$. If, however, either β or ε exceed unity, while the value of the other parameter lies between zero and unity, i.e. $\eta < 0$, then we have the opposite case, depicted in figure 2b: $\gamma > \tilde{\gamma}$. ■

A.2.2 Effect of Discovery on D when $\gamma > \tilde{\gamma}$

Totally differentiating Eq. (A.32), we obtain[14]:

$$\frac{d\gamma}{d\lambda} = -\frac{\gamma^{1-\eta}\Delta^{\eta}\tilde{\gamma}^{\eta-1} - 1}{(1-\eta)[1 + \lambda\gamma^{-\eta}\Delta^{\eta}\tilde{\gamma}^{\eta-1}]} > 0, \tag{A.34}$$

$$\frac{d\gamma}{d\Delta} = -\frac{\lambda\eta\gamma^{1-\eta}\Delta^{\eta-1}\tilde{\gamma}^{\eta-1}}{(1-\eta)[1 + \lambda\gamma^{-\eta}\Delta^{\eta}\tilde{\gamma}^{\eta-1}]} < 0 \tag{A.35}$$

[14]Note that the numerator in $d\gamma/d\lambda$ is negative because the condition $\gamma > \tilde{\gamma}$ implies that the right-hand side of (A.33) is negative.

and

$$\frac{d\tilde{S}_\tau}{d\lambda} = -\tau\Delta S_\tau \frac{d\gamma}{d\lambda} = \tau\tilde{S}_\tau \frac{\gamma^{1-\eta}\Delta^\eta\tilde{\gamma}^{\eta-1} - 1}{(1-\eta)[1+\lambda\gamma^{-\eta}\Delta^\eta\tilde{\gamma}^{\eta-1}]} < 0, \tag{A.36}$$

$$\frac{d\tilde{S}_\tau}{d\Delta} = S_\tau - \tau\Delta S_\tau \frac{d\gamma}{d\Delta} = S_\tau \left\{1 + \frac{\tau\lambda\eta\gamma^{1-\eta}\Delta^\eta\tilde{\gamma}^{\eta-1}}{(1-\eta)[1+\lambda\gamma^{-\eta}\Delta^\eta\tilde{\gamma}^{\eta-1}]}\right\} > 0. \tag{A.37}$$

We may thus conclude that if extraction in the face of a possible discovery is rapacious, then the hazard rate and the size of the discovery exert opposing forces on the oil stock remaining at time τ. If, however, the size of the discovery is sufficiently large, then the total effect on the oil stock is positive. This is indeed the empirically relevant scenario, since the data that we use in our empirical model concerns giant oil and gas discoveries.

A.2.3 Effect of Reserves on T and δ

Consider the system:

$$\underbrace{\begin{pmatrix} \frac{dA}{dT} & \frac{dA}{d\delta} \\ \frac{dB}{dT} & \frac{dB}{d\delta} \end{pmatrix}}_{M} \times \begin{pmatrix} dT \\ d\delta \end{pmatrix} = \begin{pmatrix} 0 \\ -\frac{dB}{dS_0} \end{pmatrix} \times dS_0,$$

where all the terms can be found by totally differentiating the equilibrium conditions (29) - (30):

$$\frac{dA}{dT} = [\bar{\gamma}(1-\beta)+\rho]e^{(\bar{\gamma}(1-\beta)+\rho)T} > 0, \tag{A.38}$$

$$\frac{dB}{dT} = -\delta^o\bar{\gamma}(1-\beta)\Omega e^{-\bar{\gamma}(1-\beta)T} < 0, \tag{A.39}$$

$$\frac{dA}{d\delta} = \frac{\alpha\kappa\tilde{\theta}}{\delta(\alpha+\xi)^3}\left[\alpha+\xi+2\xi(\epsilon_{\delta^o}-1)\right] < 0, \tag{A.40}$$

$$\frac{dB}{d\delta} = -(1-e^{-\bar{\gamma}(1-\beta)T})\left[\Omega\frac{d\delta^o}{d\delta} + \delta^o\frac{d\Omega}{d\delta}\right] < 0, \tag{A.41}$$

$$\frac{dB}{dS_0} = \int_0^\infty \left\{\frac{d^2W_I}{d\delta dS_0} + W_{II}\frac{d^2\nu_T}{d\delta dS_0} + \frac{d\nu_T}{d\delta}\frac{dW_{II}}{dS_0}\right\}\psi e^{-\psi T}dT \gtrless 0. \tag{A.42}$$

The expressions in (A.40) and (A.41) appear to be a priori ambiguous. However, $dA/d\delta$ can be expressed as $(dA/d\delta^o)(d\delta^o/d\delta)$, where the latter term is positive and the former term corresponds to the second-order condition of O's optimal choice of δ^o and hence negative. Similarly, $dB/d\delta$ is the second-order condition for G's optimal choice of δ and thus negative. The determinant of M is given by

$$|M| = \frac{dA}{dT}\frac{dB}{d\delta} - \frac{dA}{d\delta}\frac{dB}{dT} < 0.$$

The expression for dB/dS_0 is quite involved. It can be shown that after some simplifications, its sign depends on the sign of the expression:

$$\frac{2\alpha\xi^2}{\delta(\alpha+\xi)^3} - \frac{e^{(\bar{\gamma}(1-\beta)+\rho)T} - 1}{\theta\kappa} \gtrless 0.$$

Using (29), we may rewrite the last term as $e^{(\bar{\gamma}(1-\beta)+\rho)T} - 1 = \frac{\alpha\tilde{\theta}\kappa}{(\alpha+\xi)^2}$. Then it can be shown that $dB/dS_0 > 0$ if $\xi > \bar{\xi}$, where $\bar{\xi} = \frac{1+\sqrt{1+8(1-\theta)\alpha}}{4(1-\theta)} \gtrless 1 \Leftrightarrow \alpha \gtrless 2(1-\theta)-1$. The more unequal the rent sharing and the less efficient G's military technology is, the easier it is for the condition to be satisfied.

Applying Cramer's rule, we finally obtain:

$$\frac{dT}{dS_0} = \frac{\frac{dB}{dS_0}\frac{dA}{d\delta}}{|M|} > 0, \tag{A.43}$$

$$\frac{d\delta}{dS_0} = -\frac{\frac{dB}{dS_0}\frac{dA}{dT}}{|M|} > 0. \tag{A.44}$$

B Appendix to Section 4

B.1 Hypothesis tests for non-parametric analysis

B.1.1 Mean and Median survival

Table 3: Mean survival by discovery

Oil disc.	No. of subjects	Restricted mean	Std. Err.	95% Conf.	Interval
0	423	21.489	1.279	18.983	23.995
1	86	34.886(*)	2.283	30.411	39.360
total	509	24.078	1.155	21.814	26.3423

(*) largest observed analysis time is censored, mean is underestimated

Table 4: Mean survival by oil reserves

Oil reserves	No. of subjects	Restricted mean	Std. Err.	95% Conf.	Interval
0	253	19.547	1.484	16.639	22.454
1	256	28.773(*)	1.685	30.411	39.360
total	509	24.078	1.155	25.471	32.076

(*) largest observed analysis time is censored, mean is underestimated

We performed several tests to see whether the non-parametric analysis contributes to the hypothesis that oil wealth increases leadership durations in autocracies.

Results are reported in table 3. The mean survival time seem to be significantly different for dictators who find oil and for those who do not find oil. The same result is seen in leaders with oil reserves (table 4).

B.1.2 Survival and hazard functions

Table 5: Results, Hypothesis tests for equality of survival functions, oil disc

Test	χ^2	Pr> χ^2
Log-rank	26.35	0.000
Wilcoxon (Breslow)	28.87	0.000
Tarone-Ware	30.07	0.000
Peto-Peto	29.63	0.000

We run a series of tests to check if the survival functions are significantly different for leaders who discover oil and leaders who do not. The results are reported in Table 5, and indicate that the functions are indeed different for the two groups. The results are the same for leaders that have oil reserves.

B.2 Parametric Analysis

While the semi-parametric analysis is less efficient than the parametric *if the baseline hazard is correctly specified*, it is the better choice if we have no idea what

Table 6: 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	0.594**	0.532***	0.535***	0.403*	0.381*	0.628
	(0.129)	(0.115)	(0.129)	(0.207)	(0.217)	(0.184)
GDP per capita		0.991	0.994	0.981	0.983	0.984
		(0.0144)	(0.0117)	(0.0175)	(0.0176)	(0.0129)
GDP growth		0.973***	0.975***	0.986	0.980	0.974**
		(0.00905)	(0.00898)	(0.0226)	(0.0243)	(0.0103)
Coal Income per capita			0.990**		0.993*	0.990*
			(0.00459)		(0.00351)	(0.00585)
Metals Income per capita			1,000		0.999	1,000
			(0.000798)		(0.00112)	(0.000907)
new_alreadyoil			0.845		0.655	0.753
			(0.161)		(0.269)	(0.151)
Age at entry				1,000	1,000	1.001***
				(0.000394)	(0.000386)	(0.000390)
Median duration				1,000	1,000	1.000**
				(8.01e-05)	(8.60e-05)	(4.45e-05)
Polity 2				1.088*	1.162**	1.085***
				(0.0547)	(0.0682)	(0.0293)
Population (log)				0.889	0.881	0.975
				(0.114)	(0.134)	(0.0693)
Nat'l oil company				1,535	2.646*	1,227
				(0.648)	-1,350	(0.381)
Dependency				0.982	1,052	
				(0.0607)	(0.0817)	
World democracy					0.906***	0.961***
					(0.0293)	(0.0113)
Regional democracy					1,012	1,000
					(0.0118)	(0.00505)
Constant	0.111***	0.141***	0.163***	1,339	18.50	1,429
	(0.0183)	(0.0260)	(0.0312)	-2,591	(44.21)	-1,733
p	0.633***	0.628***	0.636***	0.760*	0.874	0.664***
	(0.0418)	(0.0495)	(0.0507)	(0.116)	(0.132)	(0.0547)
Observations	5.692	4.008	3.882	1.204	1.196	3.272

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

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 thus rely on Aikike's Information Criterion (AIC) to determine the best fitting model, and find that the Weibull distributions has the most consistently good fit (when the gamma model converges, it tends to have a lower AIC, but for several specifications it does not converge). Further, Weibull nests the exponential model. The exponential model has constant hazard, and thus fits our theoretical model the best. Further, the Weibull model is commonly used in the literature to model politcal hazard. 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 6.

Table 7: Results, Military expenditure

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio	(5) Hazard ratio	(6) Hazard ratio
Military spending as frac of gdp	1.054	1.054	1.093	0.964	1.036	1.074
	(0.103)	(0.0989)	(0.0948)	(0.144)	(0.178)	(0.0987)
Oil/Gas discovery	0.324***	0.389**	0.397**	0.278*	0.207*	0.422
	(0.118)	(0.148)	(0.166)	(0.208)	(0.177)	(0.223)
GDP per capita		0.959	0.972	0.984	0.923	0.968
		(0.0300)	(0.0260)	(0.0552)	(0.0775)	(0.0273)
GDP growth		0.977**	0.977**	0.982	0.968	0.969**
		(0.0112)	(0.0112)	(0.0251)	(0.0289)	(0.0135)
Coal Income per capita			0.996**		0.993**	0.996**
			(0.00199)		(0.00346)	(0.00172)
Metals Income per capita			1.000		0.998	0.999
			(0.00169)		(0.00212)	(0.00170)
Oil already disc.			0.837		1.267	0.707
			(0.201)		(0.886)	(0.160)
Age at entry				1.000	1.000	1.001***
				(0.000534)	(0.000436)	(0.000330)
Median duration				1.000	1.000	1.000***
				(9.17e-05)	(9.25e-05)	(6.42e-05)
Polity 2				1.099*	1.181***	1.064*
				(0.0572)	(0.0758)	(0.0376)
Population (log)				0.994	0.972	0.973
				(0.214)	(0.229)	(0.0888)
Nat'l oil company				2.003	3.299	1.515
				(1.133)	(2.785)	(0.549)
Dependency				1.012	1.142	
				(0.0575)	(0.124)	
World democracy					0.838***	0.948***
					(0.0424)	(0.0170)
Regional democracy					1.025*	1.000
					(0.0140)	(0.00813)
Leaders	263	262	262	93	93	236
Failures	96	96	96	29	29	89

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

B.3 Military spending

We attempt to include a variable on military spending from the SIPRI dataset. Results are reported in tables 7.

The results show that the coefficient on military spending is insignificant in 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.

B.4 Wildcat drilling

We try to address the concern that there is reverse causality in play, i.e. the stability of a leader increases the probability of a large oil discovery. If the stability of the leader affects the oil industry, it should first and foremost affect *drilling activity*, as that is something an oil company or a leader actually can control. We therefore include the number of wildcats drilled in a country in a given year. The results are given in table 8 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

Table 8: 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

activity tends to *increase* hazard. We therefore feel confident in our conclusion that it is *discoveries* rather than drilling activity that drives our results.

B.5 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 very reliable, and not known at the time of the discovery. Further, multiple discoveries tend to happen in rapid succession, so this also helps avoid issues of serial correlation. However, this means ignoring information available in the data, so in this section we include results using the size data.

The number of discoveries have an ambiguous effect on the hazard rate. Depending on the specification the point estimate either increases or decreases hazard. However, the standard errors are very large, and the results are not significant at standard levels. Including a squared term increases the precision of the results. This model specification indicates that hazard decreases at low levels of discoveries, and then increases at higher numbers.

The size of oil discoveries have a similar ambiguous effect to the count of discoveries. In the full model, the size of discoveries seem to increase hazard.

However, the results of both of these specifications are driven by a few extreme

Table 9: Results, Count of discoveries

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio
count_disc	0.998	1.019	0.802**	0.756*
	(0.0571)	(0.0935)	(0.0880)	(0.119)
GDP per capita		0.977		0.980
		(0.0146)		(0.0146)
GDP growth		0.976**		0.977**
		(0.0102)		(0.0101)
Age at entry		1.001***		1.001***
		(0.000296)		(0.000304)
World democracy		0.956***		0.957***
		(0.0105)		(0.0106)
Regional democracy		1.000		1.000
		(0.00501)		(0.00510)
Median duration		1.000**		1.000**
		(4.64e-05)		(4.69e-05)
Polity 2		1.096***		1.093***
		(0.0293)		(0.0292)
Population (log)		0.959		0.965
		(0.0718)		(0.0714)
Coal Income per capita		0.989*		0.989*
		(0.00610)		(0.00594)
Metals Income per capita		1.000		1.000
		(0.000941)		(0.000936)
new_alreadyoil		0.688*		0.723
		(0.144)		(0.150)
noc2_c		1.229		1.284
		(0.388)		(0.391)
count2			1.021***	1.027***
			(0.00806)	(0.00949)
Leader years	5,692	3,272	5,692	3,272

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

outliers (by DFBETA). Specifically, dropping King Faisal of Saudi Arabia, who reigned while huge oil discoveries were made in Saudi Arabia and was assassinated by his nephew, removes the statistical significance of the result that shows that the size of discoveries increases hazard. When dropping the second outlier, Prime Minister Mohammad Mosaddegh of Iran, the results again show that discoveries are associated with a lower hazard rate.

Overall, the results of the count and size of discoveries 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.

Table 10: Results, Size of discoveries

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio
addo1000	1.025	1.074**	1.016	0.756
	(0.0339)	(0.0346)	(0.0834)	(0.297)
GDP per capita		0.976		0.979
		(0.0146)		(0.0148)
GDP growth		0.976**		0.976**
		(0.0101)		(0.0101)
Age at entry		1.001***		1.001***
		(0.000292)		(0.000297)
World democracy		0.956***		0.957***
		(0.0105)		(0.0106)
Regional democracy		1.000		1.000
		(0.00494)		(0.00499)
Median duration		1.000**		1.000**
		(4.68e-05)		(4.73e-05)
Polity 2		1.097***		1.094***
		(0.0291)		(0.0293)
Population (log)		0.956		0.965
		(0.0708)		(0.0713)
Coal Income per capita		0.990*		0.989*
		(0.00606)		(0.00602)
Metals Income per capita		1.000		1.000
		(0.000943)		(0.000942)
new_alreadyoil		0.689*		0.699*
		(0.143)		(0.145)
noc2_c		1.208		1.245
		(0.374)		(0.376)
addo2			1.000	1.000
			(3.73e-07)	(2.13e-06)
Leader years	5,692	3,272	5,692	3,272

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

Table 11: Results, Size of discoveries w/o outliers

VARIABLES	(1) Hazard ratio	(2) Hazard ratio	(3) Hazard ratio	(4) Hazard ratio
addo1000	0.989	0.479*	0.920	0.786
	(0.0689)	(0.212)	(0.185)	(0.781)
addo2			1.000	1.000
			(7.16e-07)	(3.45e-05)
GDP per capita		0.973		0.972
		(0.0196)		(0.0201)
GDP growth		0.976**		0.976**
		(0.0103)		(0.0104)
Age at entry		1.001***		1.001***
		(0.000302)		(0.000302)
World democracy		0.958***		0.958***
		(0.0105)		(0.0104)
Regional democracy		1.000		1.000
		(0.00501)		(0.00501)
Median duration		1.000**		1.000**
		(4.88e-05)		(4.89e-05)
Polity 2		1.093***		1.093***
		(0.0291)		(0.0291)
Population (log)		0.969		0.968
		(0.0706)		(0.0706)
Coal Income per capita		0.989*		0.989*
		(0.00591)		(0.00593)
Metals Income per capita		1.000		1.000
		(0.000932)		(0.000933)
new_alreadyoil		0.711*		0.705*
		(0.146)		(0.146)
noc2_c		1.306		1.298
		(0.384)		(0.384)
Leader years	5,655	3,235	5,655	3,235

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

Table 12: 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)
new_alreadyoil			0.827		0.865	0.729
			(0.162)		(0.371)	(0.150)
noc2_c				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				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)
Observations	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

B.6 Different specifications

B.6.1 Varying cutoff for 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 table 12 for cutoff value of -5 and 13 for cutoff value of -7.

B.6.2 Using only the first discovery

We argue as Arezki *et al.* (2015), Cotet & Tsui (2013a) and Cotet & Tsui (2013b) that using the discoveries of new oil and gas fields offers a more exogenous measure of variation in resource wealth than the standard measures. However, it does not solve the endogeneity problem. A better estimate could be to use only the first discovery; the first discovery may be harder to anticipate than subsequent discoveries, and could thus be considered more random. This is not clear however - the endogeneity issue explored in section 4.4.1 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

Table 13: 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				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)
Observations	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

starting exploration in a completely new area. Potentially, the costs involved in oil exploration makes such uncertain exploration an even larger gamble.

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 15). 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. The results do not cast doubt on our main analysis.

B.6.3 Using different definitions of failure

Using the Powell & Thyne (2011) dataset, we check if the results are robust to using different types of coups. Regular turnover is not affected, and the other definitions of coups appear to show the same direction of the effect, but with less statistical significant. This is natural as the other definitions are more restrictive and reduces sample size. The Powell & Thyne (2011) dataset starts in 1950, so the sample size is significantly reduced. The evidence is consistent with our previous conclusions.

Table 14: Different failure definitions

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

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

B.6.4 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 period. 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. While the inclusion of the dependency ratio narrows the time range to start at 1960, and results remain significant, we still 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 16, and reveal no significant change.

We also check whether using subperiods of the data affect 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.

B.6.5 Other models

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

Table 15: 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)
Observations	5,692	4,008	3,882	3,272

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

Table 16: 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
Note: Not enough observations with discoveries to estimate the effect.

B.7 List of autocratic leaders

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
AFG	Shir 'Ali Khan	1868	1878	0	0	-6	-6
AFG	Mohammad Ya'qub Khan	1879	1879	0	0	-6	-6
AFG	Mohammad Jan	1879	1879	0	0	-6	-6
AFG	Abdor Rahman Khan	1880	1901	0	0	-6	-6
AFG	Habibullah Khan	1901	1918	1	0	-6	-6
AFG	Amanullah Khan	1920	1929	0	0	-6	-6
AFG	Inayatullah Khan	1929	1929	1	0	-6	-6
AFG	Habibullah Ghazi	1929	1929	1	0	-6	-6
AFG	Nadir Shah	1929	1933	1	0	-6	-6
AFG	Hashim Khan	1933	1945	0	0	-10	-6
AFG	Mahmud Khan Ghazi	1946	1953	1	0	-10	-10
AFG	Sardar Mohammad Daud Khan	1953	1962	0	1	-10	-10
AFG	Mohammad Yusuf	1963	1965	0	0	-10	-7
AFG	Mohammad Hashim Maiwandwal	1965	1966	0	0	-7	-7
AFG	Abdallah Yakta	1967	1967	0	0	-7	-7
AFG	Nur Ahmad Etemadi	1967	1970	0	0	-7	-7
AFG	Abdul Zahir	1971	1972	0	0	-7	-7
AFG	Mohammad Musa Shafiq	1972	1972	1	0	-7	-7
AFG	Sardar Mohammad Daud Khan	1973	1977	1	0	-7	-7
AFG	Najibullah	1986	1991	1	0	-8	-8
AFG	Mullah Omar	1996	2001	1	0	-7	-7
ALB	Zogu	1925	1939	0	0	-9	0
ALB	Hoxha	1944	1984	0	1	-9	0
ALB	Alia	1985	1991	0	0	-9	1
ALG	Ben Khedda	1962	1962	0	1	-8	-8
ALG	Bella	1962	1964	1	1	-8	-8
ALG	Boumedienne	1965	1978	0	1	-9	-9
ALG	Bitat	1978	1978	0	0	-9	-9
ALG	Benjedid	1979	1991	1	0	-9	-2
ALG	Boudiaf	1992	1992	1	0	-7	-7
ALG	Kafi	1992	1993	0	0	-7	-7
ALG	Zeroual	1994	1999	0	1	-7	-3
ANG	Neto	1975	1978	0	0	-7	-7
ANG	Dos Santos	1979	2015	0	1	-7	0
ARG	J. Felix Uriburu	1930	1931	0	0	-8	-8
ARG	Justo	1932	1938	0	0	-8	5
ARG	Rawson	1943	1943	1	0	-8	-8
ARG	Ramirez	1943	1943	0	0	-8	-8
ARG	Farrell	1944	1946	0	0	-8	-8
ARG	Peron	1946	1955	1	0	-9	-6
ARG	Lonardi	1955	1955	1	0	-6	-6
ARG	Aramburu	1955	1957	0	0	-6	-1
ARG	Ongania	1966	1969	1	0	-9	-9
ARG	Lanusse	1970	1970	0	0	-9	-9
ARG	Levingston	1970	1970	1	0	-9	-9
ARG	Lanusse	1971	1973	0	1	-9	6
ARG	Videla	1976	1980	0	1	-9	-9
ARG	Viola	1981	1981	0	0	-8	-8
ARG	Liendo	1981	1981	1	0	-8	-8
ARG	Galtieri	1981	1981	1	0	-8	-8
ARG	Saint-Jean	1982	1982	0	0	-8	-8
ARM	Ter-Petrosyan	1991	1997	0	0	-6	7
AUS	Dollfuss	1932	1934	1	0	-9	8
AUS	Schuschnigg	1934	1937	0	0	-9	-9
AZE	H. Aliyev	1993	2003	0	1	-7	-3
AZE	Ilhma Aliyev	2003	2015	0	1	-7	-7
BAH	Isa Ibn Al-Khalifah	1971	1998	0	0	-10	-7
BAH	Hamad Isa Ibn Al-Khalifah	1999	2015	0	0	-10	-5
BAV	Ludwig II	1864	1871	0	0	-7	-7
BEN	Apithy	1964	1965	1	0	-7	-4
BEN	Congacou	1965	1965	1	0	-7	-7
BEN	Soglo	1965	1966	1	0	-7	-7
BEN	Alley	1967	1967	0	0	-7	-7
BEN	Zinsou	1968	1969	1	0	-7	-7
BEN	Kouandete	1969	1969	0	0	-7	-7
BEN	Paul-Emile de Souza	1969	1969	0	0	-7	-7
BEN	Ahomadegbe	1972	1972	1	0	-7	-7
BEN	Kerekou	1972	1990	0	0	-7	0
BFO	Yameogo	1960	1965	1	0	-7	-7
BFO	Lamizana	1966	1971	0	0	-7	-4
BFO	Lamizana	1974	1980	1	0	-4	5
BFO	Zerbo	1980	1981	1	0	-7	-7
BFO	J. P. Ouedraogo	1982	1982	1	0	-7	-7

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
BFO	Sankara	1983	1987	1	0	-7	-7
BFO	Campaore	1987	2014	0	0	-7	0
BHU	Wangchuk, Jigme	1926	1951	0	0	-10	-10
BHU	Wangchuk, Jigme Dorji	1952	1972	0	0	-10	-10
BHU	Wangchuck, Jigme Singye	1972	1997	0	0	-10	-10
BHU	Lyonpo Jigme Thinley	1998	1998	0	0	-10	-10
BHU	Lyonpo Sangay Ngedup	1999	2000	0	0	-10	-10
BHU	Lyonpo Yeshey Zimba	2000	2001	0	0	-10	-10
BHU	Lyonpo Khandu Wangchuk	2001	2002	0	0	-10	-10
BHU	Lyonpo Kinzang Dorji	2002	2003	0	0	-10	-10
BHU	Lyonpo Jigme Thinley	2003	2003	0	0	-10	-10
BHU	Lyonpo Yeshey Zimba	2004	2005	0	0	-10	-5
BLR	Lukashenko	1994	2015	0	0	-7	7
BNG	Moshtaque Ahmed	1975	1975	1	0	-7	-7
BNG	Ziaur Rahman	1975	1980	1	1	-7	-4
BNG	Ershad	1982	1990	1	0	-7	-5
BNG	Fakhruddin	2007	2008	0	0	-6	-6
BOL	Daza	1876	1879	1	0	-7	-7
BOL	Banzer Suarez	1971	1977	1	0	-7	-7
BOL	Garcia Meza Tejada	1980	1981	1	0	-7	-7
BOL	Torrelio Villa	1981	1981	1	0	-7	-7
BRA	Pedro II	1840	1889	1	0	-6	-3
BRA	Vargas	1930	1945	1	0	-7	-4
BRA	Castello Branco	1964	1966	0	1	-9	-3
BRA	Costa de Silva	1967	1969	0	1	-9	-9
BRA	Military Junta	1969	1969	0	0	-9	-9
BRA	Medici	1969	1973	0	1	-9	-9
BUI	Mwambutsa	1962	1966	1	0	-7	0
BUI	Ntare	1966	1966	1	0	-7	-7
BUI	Micombero	1966	1975	1	0	-7	-7
BUI	Bagaza	1976	1986	1	0	-7	-7
BUI	Buyoya	1987	1992	0	0	-7	-3
BUL	Ferdinand I	1887	1918	0	0	-9	-5
BUL	Boris III	1918	1942	0	0	-10	2
BUL	Georgiev	1944	1946	0	0	-6	-2
BUL	Georgi Dimitrov	1946	1948	0	0	-7	-6
BUL	Kolarov	1949	1949	0	0	-7	-7
BUL	Chervenkov	1950	1956	0	0	-7	-7
BUL	Zhivkov	1956	1989	0	0	-7	-7
BUL	Mladenov	1989	1989	0	0	-7	-7
CAM	Sihanouk	1953	1969	1	0	-9	-3
CAM	Lon Nol	1970	1975	1	0	-7	0
CAM	Pol Pot	1975	1978	0	0	-7	0
CAM	Hun Sen	1997	2015	0	0	-7	2
CAO	Ahidjo	1960	1982	0	0	-8	-6
CAO	Biya	1982	2015	0	0	-8	-4
CDI	Houphouet-Boigny	1960	1993	0	1	-9	-7
CDI	Konan Bedie	1993	1999	1	0	-7	-1
CEN	Dacko	1960	1965	1	0	-7	-7
CEN	Bokassa	1966	1979	0	0	-7	-7
CEN	Dacko	1979	1980	1	0	-7	-7
CEN	Kolingba	1981	1993	0	0	-7	-6
CHA	Tombalbaye	1960	1974	1	0	-9	-9
CHA	Malloum	1975	1978	1	0	-7	-3
CHA	Habre	1982	1990	1	0	-7	0
CHA	Deby	1990	2015	0	0	-7	-2
CHL	Pinochet	1973	1989	0	0	-7	8
CHN	Tz'u Hsi	1861	1908	0	0	-6	-6
CHN	Zaifeng	1908	1911	1	0	-6	-2
CHN	Mao Tse-Tung	1949	1975	0	1	-9	-8
CHN	Hua Guofeng	1976	1979	0	0	-7	-7
CHN	Deng Xiaoping	1980	1996	0	1	-7	-7
CHN	Jiang Zemin	1997	2003	0	1	-7	-7
CHN	Hu Jintao	2003	2012	0	1	-7	-7
CHN	Xi Jinping	2012	2015	0	0	-7	-7
COM	Bob Denard	1978	1989	1	0	-7	-5
COM	Djohar	1989	1994	1	0	-7	4
CON	Debat	1963	1968	1	0	-7	-7
CON	Raoul	1968	1968	0	0	-7	-7
CON	Ngouabi	1969	1977	1	1	-7	-7
CON	Opango	1977	1978	1	0	-7	-7
CON	Nguesso	1979	1992	0	1	-8	5
CON	Nguesso	1997	2015	0	0	-6	-4
CUB	Batista	1952	1958	1	0	-9	0

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
CUB	Castro	1959	2008	0	0	-7	0
CUB	Raul Castro	2008	2015	0	0	-7	-7
CZE	Gottwald	1948	1952	0	0	-7	-7
CZE	Zapotocky	1953	1957	0	0	-7	-7
CZE	Novotny	1957	1967	0	0	-7	-7
CZE	Husak	1968	1989	0	0	-7	0
CZE	Calfa	1989	1991	0	0	-6	8
DJI	Gouled Aptidon	1977	1998	0	0	-8	-6
DOM	Rafel Trujillo	1930	1960	1	0	-9	-5
DRC	Kasavubu	1960	1965	1	0	-9	0
DRC	Mobutu	1965	1996	1	0	-9	0
DRV	Ho Chi Minh	1945	1969	0	1	-9	-7
DRV	Le Duan	1969	1975	0	0	-7	-7
DRV	Le Duan	1976	2015	0	0	-7	-7
EGY	Fuad I	1922	1936	0	0	-6	4
EGY	Naguib	1952	1954	0	0	-7	-7
EGY	Nasser	1954	1969	0	1	-7	-7
EGY	Sadat	1970	1981	1	1	-7	-6
EGY	Mubarak	1981	2010	1	1	-6	-3
EQG	Macias Nguema	1968	1978	1	0	-7	2
EQG	Nguema Mbasogo	1979	2015	0	1	-7	-5
ERI	Afeworki	1993	2015	0	0	-7	-6
EST	Pats	1933	1939	0	0	-6	6
ETH	Selassie	1941	1974	1	0	-9	0
ETH	Banti	1974	1976	1	0	-7	0
ETH	Mengistu Marriam	1977	1991	1	0	-8	0
FRN	Petain	1940	1941	0	0	-9	-9
FRN	Laval	1942	1944	0	0	-9	-3
GAB	Mba	1960	1963	1	0	-7	-7
GAB	Aubaume	1964	1964	0	0	-7	-7
GAB	Mba	1964	1967	0	0	-7	-7
GAB	Bongo	1967	2008	0	1	-9	-4
GAM	Jammeh	1994	2015	0	0	-7	-5
GDR	Wilhelm Pieck	1946	1950	0	0	-8	-7
GDR	Ulbricht	1950	1970	0	0	-9	-8
GDR	Honecker	1971	1989	0	0	-9	-9
GHA	Nkrumah	1952	1965	1	0	-9	-8
GHA	Ankrah	1966	1969	0	0	-7	-2
GHA	Acheampong	1972	1978	1	0	-7	0
GHA	Rawlings	1981	2000	0	0	-7	2
GMY	Wilhelm I	1858	1887	0	0	-8	-4
GMY	Hitler	1933	1945	0	0	-9	-9
GNB	Cabral	1974	1980	1	0	-7	-7
GNB	Vieira	1980	1998	1	0	-8	5
GRC	Pangalos	1925	1926	1	0	-6	10
GRC	Metaxas	1936	1940	0	0	-8	-8
GRC	Kanellopoulos	1967	1967	1	0	-7	-7
GRC	Kollias	1967	1967	1	0	-7	-7
GRC	Papadopoulos	1967	1972	1	0	-7	-7
GRC	Ionannides	1973	1973	0	0	-7	-7
GUA	Estrada-Cabrera	1898	1920	1	0	-9	2
GUA	Herrera y Luna	1920	1921	1	0	-9	2
GUA	Reyna Andrade	1931	1931	0	0	-9	-9
GUA	Ubico Castaneda	1931	1944	1	0	-9	5
GUA	Diaz	1954	1954	1	0	-6	-6
GUA	Monzon	1954	1954	1	0	-6	-6
GUA	Castillo Armas	1954	1957	1	0	-6	-6
GUA	Gonzalez Lopez	1957	1957	1	0	-6	-6
GUA	Mendoza Azurdia	1957	1957	1	0	-6	-6
GUA	Flores Avendano	1957	1957	0	0	-6	-6
GUA	Rios Montt	1982	1983	1	0	-7	-7
GUA	Mejia Victores	1983	1985	0	0	-7	-1
GUI	Toure	1958	1983	0	0	-9	-9
GUI	Beavogui	1984	1984	1	0	-7	-7
GUI	Conte	1984	2008	0	0	-7	-1
GUY	Burnham	1966	1985	0	0	-7	2
GUY	Hoyte	1985	1992	0	0	-7	6
HAI	Duvalier, Francois	1957	1970	0	0	-9	-5
HAI	Duvalier, Jean-Claude	1971	1985	1	0	-10	-9
HAI	Namphy	1986	1987	0	0	-8	-8
HAI	Manigat	1988	1988	1	0	-7	-7
HAI	Namphy	1988	1988	1	0	-7	-7
HAI	Avril	1988	1989	1	0	-7	-6
HAI	Aristide	1991	1991	1	0	-7	-7
HAI	Cedras	1991	1994	0	0	-7	7

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
HUN	Karolyi	1918	1918	1	0	-6	-6
HUN	Kun	1919	1919	0	0	-7	-7
HUN	Peidl	1919	1919	1	0	-7	-7
HUN	Friedrich	1919	1919	0	0	-7	-7
HUN	Huszar	1919	1919	0	0	-7	-7
HUN	Rakoski	1945	1956	1	0	-7	-2
HUN	Kadar	1956	1987	0	1	-7	-7
INS	Suharto	1966	1998	0	1	-7	-5
IRN	Nasir Ad-Din	1848	1895	1	0	-10	-10
IRN	Muzaffar ad-Din	1896	1906	0	0	-10	-10
IRN	Reza Khan	1921	1941	0	1	-8	-1
IRN	Mohammad Reza	1953	1978	1	1	-10	-4
IRN	Ayatollah Khomeini	1979	1989	0	1	-6	0
IRN	Khamenei	1989	1989	0	0	-6	-6
IRN	Rafsanjani	1989	1996	0	1	-6	-6
IRN	Ahmadinejad	2005	2012	0	1	-7	-6
IRN	Rouhani	2013	2015	0	0	-7	-7
IRQ	Rahmen Aref	1966	1968	1	0	-7	-5
IRQ	Hassan Al-Bakr	1968	1978	0	1	-7	-7
IRQ	Saddam Hussein	1979	2002	0	1	-9	-9
ITA	Mussolini	1922	1942	1	0	-9	-2
JOR	Abdullah Al-Hussein	1921	1951	1	0	-10	-4
JOR	Hussein Ibn Talal El-Hashim	1952	1998	0	0	-10	-1
KEN	Kenyatta	1963	1977	0	0	-7	2
KEN	Moi	1978	2002	0	0	-7	8
KUW	Abdullah As-Sabah	1950	1965	0	1	-9	-8
KUW	Sabah As-Sabah	1965	1977	0	1	-10	-8
KUW	Jabir As-Sabah	1978	1990	0	1	-10	-8
KUW	Jabir As-Sabah	1991	2005	0	0	-9	-7
KUW	Saad Al-Abdullah Al-Salim Al-Sabah	2006	2006	0	0	-7	-7
KUW	Sabah Al Ahmad Al Jabir Al Sabah	2006	2015	0	0	-7	-7
KZK	Nazarbayev	1990	2015	0	1	-6	-3
LAO	Souvanna Phouma	1964	1975	1	0	-7	0
LAO	Phomivan	1975	1991	0	0	-7	-7
LAO	Phounsavanh	1992	1997	0	0	-7	-7
LAO	Siphandon	1998	2006	0	0	-7	-7
LAO	Sayasone	2006	2015	0	0	-7	-7
LAT	Ulmanis	1934	1940	0	0	-9	-9
LBR	Arthur Barclay	1904	1911	0	0	-6	-4
LBR	Daniel E. Howard	1912	1920	0	0	-6	-6
LBR	Burgess King	1920	1930	0	0	-6	-6
LBR	Edwin Barclay	1930	1943	0	0	-6	-6
LBR	Tubman	1944	1971	0	0	-6	-6
LBR	Tolbert	1971	1979	1	0	-6	-6
LBR	Doe	1980	1990	1	0	-7	0
LES	Jonathan	1966	1985	1	0	-9	9
LES	Lekhanya	1986	1991	1	0	-7	-7
LES	Ramaema	1991	1992	0	0	-7	-7
LIB	Idris	1951	1968	1	1	-7	-7
LIB	Qaddafi	1969	2010	1	1	-7	-7
LIT	Smetona	1926	1939	0	0	-9	0
MAA	Ould Daddah	1960	1977	1	0	-7	-4
MAA	Ould Mohamed Salek	1978	1978	1	0	-7	-7
MAA	Ould Bouceif	1979	1979	0	0	-7	-7
MAA	Ould Sidi	1979	1979	0	0	-7	-7
MAA	Ould Ahmed Louly	1979	1979	1	0	-7	-7
MAA	Ould Haidalla	1980	1984	1	0	-7	-7
MAA	Sidi Ahmed Taya	1984	2004	1	0	-7	-6
MAG	Ratsimandrava	1975	1975	1	0	-6	-6
MAG	Gilles Andriamahazo	1975	1975	0	0	-6	-6
MAG	Ratsiraka	1975	1992	0	0	-6	9
MAW	Banda	1964	1993	0	0	-9	-8
MEX	de Tejada	1872	1876	1	0	-6	-5
MEX	Diaz	1876	1910	1	1	-9	-6
MEX	Ortiz Rubio	1930	1932	0	1	-6	-6
MEX	Rodriguez	1932	1934	0	0	-6	-6
MEX	Cardenas	1934	1940	0	0	-6	-6
MEX	Avila Camacho	1940	1945	0	0	-6	-6
MEX	Aleman Valdes	1946	1952	0	1	-6	-6
MEX	Ruiz Cortines	1952	1957	0	1	-6	-6
MEX	Lopez Mateos	1958	1964	0	1	-6	-6
MEX	Diaz Ordaz	1964	1969	0	1	-6	-6
MEX	Echeverria Alvarez	1970	1976	0	1	-6	-6
MEX	Lopez Portillo	1976	1981	0	1	-6	-3
MLI	Keita	1960	1968	1	0	-7	-7
MLI	Traore	1968	1990	1	0	-7	-7

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
MON	Danzin	1923	1924	1	0	-7	-7
MON	Elbek-Dorzhi Rinchino	1924	1924	0	0	-7	-7
MON	Dambadorji	1925	1928	0	0	-7	-7
MON	Gendun	1928	1935	0	0	-9	-7
MON	Choibalsan	1936	1951	0	0	-9	-9
MON	Tsedenbal	1952	1984	0	0	-7	-7
MON	Batmonh	1984	1989	0	0	-7	-7
MOR	Abu Ali al-Hasan	1873	1893	0	0	-6	-6
MOR	Abd al-Aziz	1894	1907	1	0	-6	-6
MOR	Hassan II	1961	1999	0	1	-9	-3
MOR	Muhammad VI	1999	2015	0	0	-6	-4
MYA	Ne Win	1962	1988	0	0	-8	-6
MYA	Sein Lwin	1988	1988	0	0	-6	-6
MYA	Maung Maung	1988	1988	1	0	-6	-6
MYA	Saw Maung	1988	1991	0	1	-7	-6
MYA	Than Shwe	1992	2010	0	1	-8	-6
MZM	Machel	1975	1986	0	0	-8	-7
MZM	Chissano	1986	2004	0	0	-7	5
NEP	Mohan Rana	1948	1951	1	0	-7	-5
NEP	Tribhuvan	1951	1955	0	0	-7	-7
NEP	Mahendra	1955	1971	0	0	-10	2
NEP	Birendra	1972	1990	0	0	-9	5
NEP	Sher Bahdur Deuba	2001	2002	0	0	-6	6
NEP	Lokendra Bahadur Chand	2002	2002	0	0	-6	-6
NEP	Surya Bahadur Thapa	2003	2003	0	0	-6	-6
NEP	Sher Bahdur Deuba	2004	2004	0	0	-6	-6
NEP	Gyanendra	2005	2006	1	0	-6	6
NIC	Jarquin	1936	1936	0	0	-8	-8
NIC	Anastasio Somoza Garcia	1937	1947	0	0	-8	-8
NIC	Arguello	1947	1947	1	0	-8	-8
NIC	Anastasio Somoza Garcia	1947	1956	1	0	-8	-8
NIC	Luis Somoza Debayle	1956	1962	0	0	-8	-8
NIC	Shick Gutierrez	1963	1966	0	0	-8	-8
NIC	Guerrero Gutierrez	1966	1966	0	0	-8	-8
NIC	Anastasio Somoza Debayle	1967	1979	1	0	-8	0
NIG	Ironsi	1966	1966	1	0	-7	-7
NIG	Gowon	1966	1974	1	1	-7	-7
NIG	Ramat Mohammed	1975	1975	1	0	-7	-7
NIG	Obasanjo	1976	1979	0	0	-7	7
NIG	Buhari	1983	1984	1	0	-7	7
NIG	Babangida	1985	1992	0	1	-7	-5
NIG	Shonekan	1993	1993	1	0	-7	-7
NIG	Abacha	1993	1997	0	1	-7	-6
NIR	Diori	1960	1973	1	0	-7	-7
NIR	Kountche	1974	1987	0	0	-7	-7
NIR	Seibou	1987	1992	0	0	-7	8
NIR	Mainassara	1996	1999	1	0	-6	5
OMA	Turki ibn Sa'id	1871	1888	0	0	-6	-6
OMA	Faysal ibn Turki	1888	1913	0	0	-6	-6
OMA	Taimur ibn Faysal	1913	1931	0	0	-6	-6
OMA	Sa'id ibn Taimur	1932	1970	1	1	-10	-6
OMA	Qabus Bin Said	1970	2015	0	1	-10	-8
PAK	Ayub Khan	1958	1968	1	0	-7	1
PAK	Zia	1977	1988	1	0	-7	8
PAK	Musharraf	1999	2007	0	0	-6	2
PAN	Arias, A.	1968	1968	1	0	-7	-7
PAN	Torrijos Herrera	1968	1980	0	0	-7	-6
PAN	Florez Aguilar	1981	1981	1	0	-6	-6
PAN	Noriega	1983	1989	0	0	-8	8
PAR	Rafael Franco	1936	1937	1	0	-7	2
PAR	Estigarribia	1939	1940	0	0	-9	2
PAR	Higinio Morínigo	1940	1947	1	0	-9	-5
PAR	Pareira	1954	1954	0	0	-9	-9
PAR	Stroessner	1954	1988	1	0	-9	-8
PER	Leguia	1919	1930	1	0	-9	-4
PER	Ponce Brousset	1930	1930	1	0	-6	-6
PER	Sanchez Cerro	1930	1930	1	0	-6	-6
PER	Odria	1948	1949	0	0	-6	-6
PER	Perez Godoy	1962	1962	1	0	-6	-6
PER	Velasco Alvarado	1968	1974	1	0	-7	-7
PER	Morales Bermudez	1975	1979	0	0	-7	3
PHI	Marcos	1965	1985	1	0	-9	5
POL	Smigly-Rydz	1935	1939	0	0	-6	0
POL	Bierut	1944	1955	0	0	-7	0
POL	Ochab	1956	1956	0	0	-7	-7
POL	Gomulka	1956	1970	1	0	-7	-7

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
POL	Gierek	1970	1979	0	0	-7	-7
POL	Kania	1980	1981	0	0	-8	-6
POL	Jaruzelski	1981	1990	0	0	-8	5
POR	Luis I	1861	1888	0	0	-7	-5
POR	Carlos I	1889	1907	1	0	-5	-1
POR	Carmona	1926	1932	0	0	-9	4
POR	Salazar	1932	1968	0	0	-9	-9
POR	Caetano	1968	1973	1	0	-9	-9
PRK	Kim Il-Sung	1948	1993	0	0	-9	-7
PRK	Kim Jong-Il	1994	2011	0	0	-10	-10
PRK	Kim Jong Un	2011	2015	0	0	-10	-10
QAT	Ahmed Ath-Thani	1971	1971	1	1	-10	-10
QAT	Khalifah Ath-Thani	1972	1995	1	1	-10	-10
QAT	Hamad ibn Khalifah Al Thani	1995	2012	0	0	-10	-10
QAT	Tamim ibn Hamad Al Thani	2013	2015	0	0	-10	-10
ROK	Chang Do Yong	1961	1961	1	0	-7	-7
ROK	Hee Park	1961	1979	1	0	-9	3
ROK	Choi Kuy Hay	1979	1979	0	0	-8	-8
ROK	Park Choong Hoon	1980	1980	0	0	-8	-8
ROK	Chun Doo Hwan	1980	1987	0	0	-8	1
RUM	Carol I	1866	1914	0	1	-7	-4
RUM	Carol II	1930	1940	1	0	-7	-4
RUM	Antonescu	1940	1943	1	0	-7	-7
RUM	Michael	1944	1947	1	0	-7	-7
RUM	Georghiu-Dej	1947	1964	0	0	-7	-7
RUM	Ceausescu	1965	1989	1	0	-8	-2
RUS	Alexander II	1855	1881	1	0	-10	-10
RUS	Alexander III	1881	1894	0	1	-10	-10
RUS	Nicholas II	1894	1917	1	1	-10	-1
RUS	Stalin	1923	1952	0	1	-9	-7
RUS	Malenkov	1953	1953	0	1	-7	-7
RUS	Khrushchev	1953	1964	0	1	-7	-7
RUS	Brezhnev	1964	1982	0	1	-7	-7
RUS	Andropov	1982	1983	0	1	-7	-7
RUS	Chernenko	1984	1985	0	1	-7	-7
RUS	Gorbachev	1985	1991	1	1	-7	0
RWA	Habyarimana	1973	1993	1	0	-7	-7
RWA	Sindikubwabo	1994	1994	0	0	-6	-6
RWA	Paul Kagame	1994	2015	0	0	-6	-3
SAL	Escalon	1903	1906	0	0	-6	-6
SAL	Figueroa	1907	1910	0	0	-6	-6
SAL	Araujo	1911	1912	1	0	-6	-6
SAL	C. Melendez	1913	1914	0	0	-6	-6
SAL	Quinonez Molina	1914	1914	0	0	-6	-6
SAL	C. Melendez	1915	1918	0	0	-6	-6
SAL	Quinonez Molina	1918	1918	0	0	-6	-6
SAL	J. Melendez	1919	1922	0	0	-6	-6
SAL	Quinonez Molina	1923	1926	0	0	-6	-6
SAL	Romeo Bosque	1927	1930	0	0	-6	-6
SAL	Arajuo, A.	1931	1931	1	0	-9	-9
SAL	Hernandez Martinez	1931	1933	0	0	-9	-9
SAL	Menendez, A.I.	1934	1934	0	0	-9	-9
SAL	Hernandez Martinez	1935	1944	1	0	-9	-8
SAL	Menendez, A.I.	1944	1944	1	0	-8	-8
SAL	Aguirre Salinas	1944	1944	0	0	-8	-8
SAL	Castaneda Castro	1945	1948	1	0	-8	-7
SAL	Cordova	1948	1948	0	0	-7	-7
SAL	Osorio	1949	1949	0	0	-7	-7
SAL	Oscar Bolanos	1949	1949	0	0	-7	-7
SAL	Osorio	1950	1956	0	0	-6	-5
SAL	Romero Mena	1977	1979	1	0	-6	-4
SAU	Aziz	1927	1953	0	1	-10	-10
SAU	Saud	1953	1963	0	1	-10	-10
SAU	Faisal	1964	1974	1	1	-10	-10
SAU	Khalid	1975	1982	0	1	-10	-10
SAU	Fahd	1982	1995	0	1	-10	-10
SAU	Abdullah ibn Abdilaziz	1996	2015	0	1	-10	-10
SEN	Senghor	1960	1980	0	0	-7	-1
SIE	Lansana	1967	1967	1	0	-7	-7
SIE	Juxon-Smith	1967	1968	1	0	-7	1
SIE	Stevens	1968	1985	0	0	-7	1
SIE	Momoh	1985	1991	1	0	-7	-6
SIE	Strasser	1992	1995	1	0	-7	-7
SOM	Siad Barre	1969	1990	1	0	-7	-7
SPN	de Rivera	1923	1929	0	0	-7	-6

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
SPN	Miaja	1939	1939	1	0	-7	-7
SPN	Franco	1939	1975	0	0	-7	-3
SUD	Abboud	1958	1963	1	0	-7	-7
SUD	Nimeiri	1969	1971	1	0	-7	2
SUD	Osman	1971	1971	1	0	-7	-7
SUD	Nimeiri	1971	1984	1	1	-7	-7
SUD	Sadiq al-Mahdi	1986	1989	1	0	-7	7
SUD	Al-Bashir	1989	2015	0	1	-7	-2
SUR	Bouterse	1980	1987	0	0	-6	-1
SWA	Subhuza II	1968	1981	0	0	-10	0
SWA	Dzeliwe Shongwe	1982	1982	1	0	-10	-10
SWA	Ntombe Thwala	1983	1985	0	0	-10	-10
SWA	Mswati	1986	2015	0	0	-10	-9
SYR	Al-Zaim	1949	1949	1	0	-7	-7
SYR	Hinnawi	1949	1949	1	0	-7	-7
SYR	Shishakli	1949	1953	1	0	-7	2
SYR	Atassi, L.	1963	1963	1	0	-7	-7
SYR	Al-Hafiz	1963	1965	1	0	-7	-7
SYR	El-Atassi, N.	1966	1970	1	0	-9	-7
SYR	Al-Khatib	1970	1970	0	0	-9	-9
SYR	Al-Assad H.	1971	2000	0	0	-9	-7
SYR	Bashar al-Assad	2000	2015	0	0	-9	-7
TAJ	Iskandrov	1992	1992	0	0	-6	-6
TAJ	Rakhmonov	1992	2015	0	0	-6	-1
TAW	Li Tsung-jen	1949	1950	1	0	-8	-8
TAW	Chiang Kai-shek	1950	1975	0	0	-8	-7
TAW	Yen Chia-Kan	1975	1978	0	0	-7	-7
TAW	Chiang Ching-Kuo	1978	1987	0	0	-7	-1
TAZ	Nyerere	1961	1984	0	0	-6	-6
TAZ	Mwinyi	1985	1994	0	0	-6	-5
THI	Rama V	1868	1910	0	0	-10	-10
THI	Rama VI	1910	1925	0	0	-10	-10
THI	Rama VII	1925	1932	1	0	-10	-8
THI	Phraya Mano	1932	1932	1	0	-8	-8
THI	Phahon	1933	1938	0	0	-6	-3
THI	Plaek Pibulsongkram	1947	1956	1	0	-6	-3
THI	Sarit	1958	1963	0	0	-7	-7
THI	Thanon Kittakachorn	1963	1972	1	0	-7	2
THI	Kukrot Pramoj	1975	1976	0	0	-7	3
THI	Seni Pramoj	1976	1976	1	0	-7	-7
THI	Sangad	1976	1976	0	0	-7	-7
THI	Thanin Kraivichien	1976	1976	1	0	-7	-7
TKM	Niyazov	1990	2006	0	1	-9	-8
TKM	Berdymukhammedov	2006	2015	0	1	-9	-8
TOG	Olympio	1960	1962	1	0	-6	-6
TOG	Grunitzky	1963	1966	1	0	-6	-6
TOG	Dadjo	1967	1967	1	0	-7	-7
TOG	Eyadema	1967	2004	0	0	-7	-2
TUN	Ben Ali Bourguiba	1957	1987	1	1	-9	-5
TUR	Abdul Aziz	1861	1875	1	0	-10	-10
TUR	Hamid II	1876	1908	1	0	-10	-4
TUR	Ataturk	1922	1938	0	0	-7	0
TUR	Inonu	1938	1949	0	0	-7	7
UAE	An-Nahayan	1971	2003	0	1	-8	-8
UAE	Khalifa Al Nahayan	2004	2015	0	0	-8	-8
UGA	Obote	1962	1970	1	0	-7	7
UGA	Amin	1971	1979	0	0	-7	-7
UGA	Museveni	1986	2015	0	0	-7	-1
URU	Bordaberry	1972	1976	1	0	-8	-3
URU	Demichelli	1976	1976	1	0	-8	-8
URU	Mendez Manfredini	1976	1980	0	0	-8	-7
URU	Alvarez Armalino	1981	1984	0	0	-7	-7
UZB	Karimov	1990	2015	0	0	-9	-9
VEN	Gomez	1908	1934	0	1	-9	-3
VEN	Lopez Contreras	1935	1940	0	1	-7	-5
YEM	Yahya	1904	1947	1	0	-10	-7
YEM	Ibn Ahmed Alwazir	1948	1948	1	0	-6	-6
YEM	Ibn Yahya Hamid	1948	1962	0	0	-6	0
YEM	Al-Ghashmi	1977	1977	1	0	-6	-6
YEM	Saleh al-Hashidi	1978	2011	0	1	-6	-2
YPR	Ali Rubayyi	1969	1978	1	0	-8	-5
YPR	Ali Nassir Hassani	1978	1978	0	0	-8	-8
YPR	Ismail	1978	1979	0	0	-8	-8
YPR	Ali Nassir Hassani	1980	1985	1	0	-8	-8
YPR	Attas	1986	1990	0	0	-7	-7

Ccode	*Leader*	*Enter*	*Exit*	*Fail.*	*Disc.*	*Min.Pol.*	*Max.Pol.*
YUG	Alexander	1918	1933	1	0	-10	0
YUG	Prince Paul	1934	1940	1	0	-10	2
YUG	Tito	1945	1980	0	0	-7	-5
YUG	Milosevic	1989	2000	0	0	-7	7
ZAM	Kaunda	1964	1991	0	0	-9	6
ZIM	Mugabe	1980	2015	0	0	-6	4