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Economic Foundation of Dictatorship in Resource Exporting Economies*

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Abstract

This paper explains the lack of democratization in resource exporting countries using a two period resource extraction model. There are two classes of agents: elite who own capital and natural resources and citizens who own labor. The elite announce, in the first period, their plans for resource extraction and investment in the economy. Citizens, in the second period, decide whether to conduct a revolution against elite to capture their share of rents from un-extracted resources. Government policies are designed to ensure that the elite remain in power and that citizens do not have the incentive to revolt. These policies subsidize extraction and investment during the first period. The extraction subsidy reduces the benefit of revolution while the investment subsidy increases its cost. On the other hand, policies in the democracy case are not constrained by the revolution threat and represent the median voter preferences. The resource is over extracted in the non-democratic case compared to the democratic case. Also, investment in the non-resource sector is lower. The important finding of the model is that extraction path goes against price signals; first period extraction increases with the increase of the resource price in the second period. Non-Democratic institution is the rational choice of the elite even with the costly policies to prevent a revolution.

JEL Classification: D72; Q32; Q34. *Keywords:* resource curse; political transition; institutions

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1 Introduction

Among the top twenty five fuel exporting countries, only Norway is classified as a “full democracy” according to the Economist Index of Democracy. Similarly, a handful of countries are considered “full democracies” within the top countries exporting ores and minerals¹(Table 1). This observation is backed by several empirical studies that found a negative correlation between natural resources, specifically oil, and democracy, suggesting that resources have a negative impact on democracy [Frankel, 2010, Jensen and Wantchekon, 2004, Ross, 2001, Smith, 2004]. Alternatively, it could be that oil is present in countries where democracy is absent. Most of these countries are located in the Middle East where authoritarian regimes are the common denominator. The same applies to major oil exporting countries in Africa such as Nigeria, Gabon and Sudan. Either way, the question still remains why is it that resource dependent countries do not make the transition to democracy whereas resource poor countries make the political transformation. To my knowledge, there are no economic theoretical models that attempt to answer this question. This is mainly due to the fact that, until recently, economists have not dealt with democratization with an economic perspective.

The literature on democratization suggests that political transition could take place either through a rise of an economic class that demands more political power or through a political mass that has a credible threat of revolution. In the former case, the resource dependence crowds out other important economic activity in other sectors that are deemed necessary for growth and development such as investment in human and physical capital [Gylfason et al., 1999, Sachs and Warner, 2001]. This crowding out effect blocks the channel of modernization, as suggested by Lipset [1959], as it hinders the growth of a class of agents that is powerful economically and politically. As for the revolution channel, there is a new stream of economic literature that attempts to explain political transition but does not deal with resource dependent economies. It is based on conflict between two classes of agents: a rich minority that actually holds power and a poor majority that demands political power. In a non-democracy setting, elite use their political power to set redistributive policies to their benefit. Obviously, poor agents would favor a more redistributive scheme which they can only obtain in a democracy, where policies are, in principal, determined through voting and reflect the median voter preferences. It is important to emphasize that if decisions are solely economic and rational and there are no ideological preferences to a political structure over the other, elite will have the incentive to keep the political structure as it is. They might eventually consider “extending the franchise” if they are faced with a credible threat of

¹In 2008, the Economist Index of Democracy ranked 51 countries as “authoritarian”, 36 countries as “hybrid regimes”, 50 countries as “flawed democracies” and 30 as “full democracies”. Another index of political freedom is the Freedom House index which is less structured than the Economist Index of Democracy. The 2010 Freedom House Index classified 47 countries as “not-free”, 58 countries as “partially free” and 89 countries as “free”. Some resource exporting countries such as Chile and Bulgaria are considered “flawed democracies” while others such as Georgia and Armenia are considered “hybrid regimes”.

revolution. Such a move from citizens has potentially unfavorable consequences for the elite as they would lose more than they would have given away in the case of a democracy. The process of political transition, or democratization, is initiated when the cost of extending the franchise for elite and the cost of revolution for citizens are both low. Income inequality plays an important role in this process. The higher inequality the more redistribution of income will hurt the elite and benefit the poor in a non-democracy [Acemoglu and Robinson, 2006, 2001]. One can argue that democratization in Europe during the late eighteenth and early nineteenth century has followed this pattern. This literature opens the field for further analysis on the special case of countries where resource revenues are substantial and are concentrated within a small group of agents or collected by the government². The other interesting characteristic and is particular to resource dependent economies is the non-renewable supply of the resource.

This paper is an extension of the literature on democratization. It also uses the insights on the importance of rent seeking behavior in resource dependent economies. When rents generated by resource exports are collected by a group in power, they increase the value of staying in power and increase the cost of giving it away [Caselli and Cunningham, 2009, Robinson et al., 2006]. When faced by a challenger, the rational response by incumbent governments is to adopt policies such as patronage and unproductive investment that would increase the probability of retaining power. These create inefficiencies in the resource and non-resource sectors. There are a couple of missing elements in the existing political economy models of resource management. The first is that they do not address the possibility of a threat of revolution by the rest of the population in the economy. The only threat they consider is a threat of a challenging politician with a competing set of policies. The challenging politician does not necessarily represent the median voter preferences. If the transition does in fact take place, it is from on dictator to the other. The other missing element is that the policies offered by the challengers cannot be affected by the incumbent government. I address these missing elements in this paper. I model a threat of revolution conducted by citizens where the main benefit is to capture a representative part of the resource rents. This threat is a way to model different kinds of collective action. It could be a full fledged revolution or it could be a social unrest that would affect elite negatively. Taking the threat into consideration, the elite adopt policies that affect the whole economy and ensure that the revolution does not take place.

I also make the argument that the type of political institution determines whether a resource endowment is a blessing or a curse. Decentralized models that explore the institutional nature of the resource curse seem to dismiss this type of institution³. Institutional quality is modeled

²Oil extraction within the members of OPEC is either controlled by government directly or indirectly through government controlled firms.

³Empirical literature on the resource curse found robust negative correlation between resource dependence and economic growth Brunnschweiler and Bulte [2008], Sachs and Warner [1995, 1999, 2001]. For a comprehensive overview see Hodler [2006] and Sachs and Warner [2001].

as an exogenous parameter as in Mehlum et al. [2006], or as the initial number of productive entrepreneurs as in Baland and Francois [2000], or as the number of fractions or political groups within the economy as in Lane and Tornell [1996], Tornell and Lane [1999], Hodler [2006]. None of these models considers political institutions as a determining factor, as this paper argues. The linkage between economic choices of agents and the type of institutions is through the policies adopted in each setting. The main argument here is that a non-democratic government adopts distorted policies that are not necessarily beneficial to the whole economy. I show how policies are determined in both types of political structures. I map the effect of these policies on economic performance. In reality there are different degrees of dictatorship and democracy. However, for the purpose of this paper, I employ the two extreme cases of the spectrum of political institutions.

The model explains the absence of democratization in resource exporting economies using a two class framework and a resource extraction model. Inequality is created from asymmetric property rights over economic resources, specifically, non-renewable natural resources such as oil, metals and ores. The income of the elite is generated from their factor endowment, capital, in addition to income generated from resource extraction, whereas citizens can only derive income from labor in a manufacturing sector. Extraction and production take place in two periods. Political transition cannot be initiated through the increase of economic power of citizens because of asymmetric property rights. It can, however, be initiated through a threat of revolution that can take place at the beginning of the second period. In a democracy benchmark case, policies in the two sectors of the economy are not constrained by a revolution threat. Transfer policies in both sectors reflect the preferences of the median voter and there are no asymmetric property rights over resource extraction.

The model suggests that the elite distort the incentive for revolution by imposing an extraction plan that leaves very little for citizens to revolt for. This is done through subsidizing the resource extraction and financing the subsidy through taxation. An important finding of the model is that first period extraction in non-democracies is higher than in democracies. The return from over-extracting in the first period is higher because it is subsidized and because it averts the threat of the revolution. Resources revenues are collected in the current period rather than the future period. Resource booms, an exogenous increase in second period price, increase the subsidy and extraction in the first period. This suggests that price signals are weaker than the revolution constraint, leading to more inefficient extraction. In democracy, the resource extraction sector is actually taxed rather than being subsidized as a means of transferring income from elite to citizens. These different policies stem mainly from the different type of political institution, leading to resource rents are being substantially higher in the non-democracy case than in the democracy one. The other important finding of this model is that the elite sacrifice part of their income in order to increase the cost of revolution expressed as portion of citizens wage. The investment decision is also distorted by an investment subsidy which increases during resource booms. However, investment in the non-resource sector falls short of investment in the democracy benchmark where the optimal

investment subsidy is higher. This supports the notion of crowding out of investment. It only takes place when there are excessive transfers from the manufacturing sector to the resource sector as in the non-democracy case of this model. Additionally, the model shows that income in a non-democracy stagnates during resource booms while income grows in democracy. The main reason behind this divergence is that income in a non-democracy suffers from two drawbacks. It suffers from inefficient extraction that allocates almost all extraction to the first period even though a resource boom is expected in the second period. It also suffers from lower investment in the manufacturing sector. In the case where future prices are not known with certainty, inefficient extraction is increased.

The most important contribution of this paper is that it explains why dictatorship is the preferred choice of political institution for the ruling elite. This endogenous choice reflects the costly nature of democracy for the elite in resource dependent economies. Elite income in a non-democracy is higher even with the costly subsidies they adopt to divert the threat of revolution. If a country is a non-democracy, it will remain so as long as its economy is resource dependent and as long as property rights over extraction are asymmetric.

The paper proceeds as follows. The model and its main findings are presented in the next section. Results of numerical simulations are in the third section. Next, two extensions of the model are presented, the first dealing with uncertainty in price of resources and the second deals with price determination in the world market. Section 5 concludes.

2 The Model

The model is a two period model with two sectors: manufacturing sector and resource extraction sector. There are two types of agents in the economy: ruling elite who are endowed with capital and citizens who are endowed with labor. The population is normalized to 1 where citizens constitute a fraction λ such that $\lambda \gg 1/2$. Both capital and labor are employed in the manufacturing sector. Ownership of the natural resource depends on the type of political institutions and governance. In a non-democratic institutional setting, elite own property rights over the natural resource exclusively. They determine the extraction schedule and capture resource rents. If, however, the economy is democratic, natural resource rents are allocated between the two groups according to their relative size. The economy is endowed with a resource stock S which can be extracted in two periods such that $x_1 + x_2 \leq S$. In the main model, p_1 and p_2 are the exogenous prices of the natural resource. The game starts in a non-democratic setting where the politician in power cares only about elite's income either because he is part of the elite or because he relies on their support to continue in power in the second period. At the beginning of the game, elite, represented by their politician, choose between adopting democracy or remaining as a non-democracy. If they choose the former, the game follows as a democracy where citizens rule and decide on transfers. If,

however, they decide to retain power, they will face a threat of revolution from citizens that enables them to capture their share of resource rents in the second period. The second decision elite take is whether to allow for revolution to take place or not. Preventing revolution is costly and so are its consequences. There are two policy instruments that the governing politician uses in the first period to prevent a revolution: an extraction subsidy and an investment subsidy. Both of which are essential to distort citizens incentives to conduct a revolution. Extraction subsidy increases the incentive for extraction in the first period versus the second period whereas investment subsidy increases the capital stock in the second period which increases wage income of citizens⁴. The total cost of these subsidies is covered through collecting a symmetric per head tax. Elite generate their income from profits in the manufacturing sector and rents from resource extraction. Citizens, on the other hand, can only generate income from wage in the manufacturing sector. If, however, they conduct a successful revolution, their income will increase by their share of resource rents net of what they have to sacrifice from their wage income as a cost of revolution . The flow of events in non-democracy is as follows:

- Relative price of the resource good is determined in the world market,
- Government (elite) sets the extraction and investment subsidies,
- Elite choose the extraction schedule in the first period that will maximize the resource rents and the investment level that will maximize capital profits,
- First period extraction and production take place,
- At the beginning of the second period, citizens determine whether it is beneficial to conduct a revolution or not,
- Extraction and production take place,
- Income of elite and citizens depends on the occurrence of a revolution.

The flow of events in an democracy is different in that there is no threat of revolution from citizens or elite. Citizens don't have an incentive to revolt since transfer policies would reflect their preferences. Also, there is no threat from elite to conduct a coup to regain power since they would have not chosen democracy if it was not optimal for them in the first place. I adopt the backward induction approach. The first step is to solve for optimal extraction and investment in both sectors.

⁴The construction of the model allows for the revolution to take place at the beginning of the second period. It is therefore unnecessary to include income transfers and subsidies in the second period. This would only complicate the model without providing additional insight into the working of revolution prevention. It is also useful to abstract from elite commitment to transfers in the second period.

Then, optimal subsidies are determined depending on the type of political institution. At each stage of the game, income of elite will be determined. This will be the primary basis for their decisions.

2.1 Optimal Extraction and Investment

Extraction decision can be expressed as a extractive firm that maximizes resource rents. The cost of extraction is quadratic in both periods, and the subsidy is a quantity subsidy in the first period.

$$R = \text{Max}_{x_1} R_1 + \text{Max}_{x_2} \beta R_2 = \text{Max}_{x_1, x_2} \left[(p_1 + s_1)x_1 - c_1x_1 - \frac{x_1^2}{2} + \beta \left(p_2x_2 - c_2x_2 - \frac{x_2^2}{2} \right) \right]$$

subject to the resource constraint:

$$S - x_1 - x_2 \geq 0$$

Expressing the above problem in Lagrangian form:

$$R^*(s_1) = L = (p_1 + s_1 - c_1)x_1 - \frac{x_1^2}{2} + \beta \left[(p_2 - c_2)x_2 - \frac{x_2^2}{2} \right] + \psi(S - x_1 - x_2) \quad (2.1)$$

The first order conditions are:

$$p_1 + s_1 - c_1 - x_1 = \psi$$

$$\beta(p_2 - c_2 - x_2) = \psi$$

$$S = x_1 + x_2$$

Solving for x_1^* , x_2^* , and ψ^* :

$$x_1^* = \frac{(p_1 + s_1 - c_1) - \beta(p_2 - c_2 - S)}{1 + \beta} \quad (2.2)$$

$$x_2^* = \frac{\beta(p_2 - c_2) - (p_1 + s_1 - c_1 - S)}{1 + \beta} \quad (2.3)$$

$$\psi^* = \frac{\beta(p_1 + s_1 - c_1 + p_2 - c_2 - S)}{1 + \beta} \quad (2.4)$$

From equation (2.1) and using the Envelope Theorem:

$$\frac{\partial R^*(s_1)}{\partial s_1} = \frac{\partial L}{\partial s_1} = x_1^*(s_1)$$

Also, it is clear that $\frac{dx_1^*}{dp_1} = \frac{dx_1^*}{ds_1} = \frac{1}{1+\beta} > 0$ ⁵.

The manufacturing sector employs the labor of citizens and the capital of elite. Using a Cobb-Douglas production function $Q = \lambda^\alpha K_t^{1-\alpha}$ and using the manufactured good as a numeraire, profits to owners of capital in each time period are:

$$\pi_t = (1 - \alpha)\lambda^\alpha K_t^{1-\alpha}$$

Where $K_2 = K_1 + I$. The total manufacturing profits from both time periods net of investment is:

$$\pi = \text{Max}_I [(1 - \alpha)\lambda^\alpha K_1^{1-\alpha} - (1 - q)I + \beta [(1 - \alpha)\lambda^\alpha (K_1 + I)^{1-\alpha} + \Phi(K_1 + I)]]$$

Where $\Phi(K_2)$ is the scrap value of capital at the end of the second period and q is the investment subsidy. Elite choose I that would maximize the above equation. The first order condition is:

$$\beta \left[(1 - \alpha)^2 \left(\frac{\lambda}{K_1 + I} \right)^\alpha + \Phi'(K_1 + I) \right] = 1 - q \quad (2.5)$$

The discounted marginal profits in the second period equals the marginal cost of investment net of subsidy. Assuming $\Phi(K_2) = \phi K_2$, such that $0 \leq \phi \leq 1$, then $\Phi'(K_1 + I) = \phi$. Solving for capital stock in the second period and optimal investment:

$$K_2 = \lambda \left[\frac{\beta(1 - \alpha)^2}{1 - q - \phi\beta} \right]^{\frac{1}{\alpha}} \quad (2.6)$$

$$I^*(q) = \lambda \left[\frac{\beta(1 - \alpha)^2}{1 - q - \phi\beta} \right]^{\frac{1}{\alpha}} - K_1 \quad (2.7)$$

For investment to be positive, $K_1 < \lambda \left[\frac{\beta(1 - \alpha)^2}{1 - \phi\beta} \right]^{\frac{1}{\alpha}}$ in the absence of investment subsidy. It also

follows that $\frac{\partial I^*(q)}{\partial q} = \frac{\lambda}{\alpha} \left[\frac{(\beta(1 - \alpha)^2)^{\frac{1}{1+\alpha}}}{1 - q - \phi\beta} \right]^{\frac{1+\alpha}{\alpha}} > 0$ ⁶. Optimal profits from manufacturing sector are:

$$\pi^*(q) = (1 - \alpha)\lambda^\alpha K_1^{1-\alpha} - (1 - q)I^*(q) + \beta [(1 - \alpha)\lambda^\alpha (K_1 + I^*(q))^{1-\alpha} + \phi(K_1 + I^*(q))]$$

⁵ x_1^* is non-negative when $p_1 + s_1 - c_1 \geq \beta(p_2 - c_2 - S)$. The extraction subsidy is however only used to overcome the threat of revolution not to subsidize extraction due to low prices in the first period. It is therefore important to assume that, even without the subsidy s_1 , $p_1 - c_1 \geq \beta(p_2 - c_2 - S)$. To ensure that depleting the stock in the second period is optimal: $p_2 > c_2 + S$. Also, for $\psi^* > 0$, the following has to be hold: $p_1 + p_2 + s_1 > c_1 + c_2 + S$.

⁶From equation (2.5): $1 - q - \phi\beta > 0$

By the Envelope Theorem: $\frac{\partial \pi^*(q)}{\partial q} = I^*(q) > 0$. Similarly, in the absence of a revolution, the wage of income of citizens in each period is:

$$W_t = \alpha \lambda^\alpha K_t^{1-\alpha}$$

If a revolution is optimal for citizens, their income in the second period would be: $(1 - \theta)W_2 + \lambda R_2$ where $R_2 = \left[(p_2 - c_2)(S - x_1^*) - \frac{(S - x_1^*)^2}{2} \right]$ and θ is the exogenous cost of revolution. This could be thought as the resources in terms of labor time needed to organize themselves and to overtake elites⁷. It is assumed that conducting a revolution is collectively an optimal decision such that there is no free rider problem and that it would be successful once it is conducted⁸. If citizens do not conduct a revolution, there will no re-distribution of resource rents. An interesting variation of this model would have the cost of the revolution as a dependent variable of a policy of repression adopted by the government.

2.2 Optimal Policies in Non-Democracy

The optimal extraction subsidy s_1^* and investment subsidy q^* are determined by the politician or the government that is in power. The objective is to ensure that citizens will not have the incentive to conduct a revolution while maximizing income of elite; which can be expressed as:

$$Y_e = R^*(s_1) + \pi^*(q) + G_e - (1 - \lambda)T \quad (2.8)$$

where T is the per head tax imposed on elite and citizens such that $T \leq T^*$ where T^* is an exogenous maximum head tax. Total tax revenue covers the extraction and investment subsidies and a transfer to elite, G_e :

$$T = qI^*(q) + s_1x_1^*(s_1) + G_e \quad (2.9)$$

Substituting for G_e from equation (2.9) into (2.8), Y_e is:

$$Y_e = R^*(s_1) + \pi^*(q) + \lambda T - qI^*(q) - s_1x_1^*(s_1) \quad (2.10)$$

Citizens will not conduct a revolution if their wage income in the second period is greater than

⁷Formally wage in second period is $W_2 = \alpha ((1 - \theta')\lambda)^\alpha K_t^{1-\alpha}$ where θ' is the fraction of labor endowment that is allocated to revolution activities. However, post revolution wage income is expressed as $(1 - \theta)W_2$ to simplify mathematical presentation since λ is exogenous. Similarly elite profits in the second period will be reduced by the reduction in the labor force such that $\pi(\theta) < \pi(\theta = 0)$.

⁸This is a common assumption in the literature on democratization (See Acemoglu and Robinson [2001, 2006]). Another way of thinking of it is that θ is the necessary cost for a collective and successful action. I also abstract from ideological preferences since the purpose is to weigh the economic benefits and costs of political transition.

their net income with the revolution:

$$W_2 > (1 - \theta)W_2 + \lambda R_2$$

The non-revolution constraint can, therefore, be expressed as:

$$\theta W_2 > \lambda R_2 \quad (2.11)$$

Revolution is not rational if its cost is greater than its benefit. Both sides of the above inequality are controlled by the elite decisions in the first period. The cost of revolution is controlled through their investment decision and its benefit is controlled by their extraction plan. These costly transfers are still beneficial to the elite. It suffice to compare their income under dictatorship with transfers to prevent a revolution (Equation (2.10)) with their income in the event of a successful revolution, $Y_e(Rev)$:

$$Y_e(Rev) = R_1 + \beta(1 - \lambda)R_2 + \pi(\theta)$$

Resource rents are less due to the lack of extraction subsidy and due to sharing resource rents in the second period with citizens. Also, capital profits are less because of less labor working in the manufacturing sector and due to the lack of investment subsidies. Additionally, the elite receive a net transfer of $\lambda T - qI^*(q) - s_1 x_1^*(s_1)$. Obviously, it is optimal to use the taxing capacity such that $T = T^*$.

Proposition 1. *It is optimal for elite to distort the revolution incentives rather than allowing it to take place when $\lambda T^* - qI^*(q) - s_1 x_1^*(s_1) \geq 0$. Transfers to elite are positive in non-democracy.*

Proof. $Y_e > Y_e(Rev)$ when $\lambda T^* - qI^*(q) - s_1 x_1^*(s_1) \geq 0$. Under the same condition, $G_e = T^* - qI^*(q) - s_1 x_1^*(s_1) > 0$

□

Formally, the government problem is to maximize Y_e subject to (2.9) and (2.11) and is expressed using the following Lagrangian:

$$L = R^*(s_1) + \pi^*(q) + \lambda T^* - qI^*(q) - s_1 x_1^*(s_1) \quad (2.12)$$

$$+ \mu \left[\theta \alpha \lambda^\alpha (K_1 + I^*(q))^\alpha - \lambda \left((p_2 - c_2) [S - x_1^*(s_1)] - \frac{[S - x_1^*(s_1)]^2}{2} \right) \right]$$

The first order conditions are:

$$q^* = \mu^* \left[\theta \alpha (1 - \alpha) \left(\frac{\lambda}{K_1 + I^*(q)} \right)^\alpha \right] \quad (2.13)$$

$$s_1^* = \mu^* \lambda [p_2 - c_2 - S + x_1^*(s_1)] \quad (2.14)$$

$$\theta\alpha\lambda^\alpha (K_1 + I^*(q))^{1-\alpha} = \lambda \left[(p_2 - c_2) [S - x_1^*(s_1)] - \frac{[S - x_1^*(s_1)]^2}{2} \right] \quad (2.15)$$

Optimal subsidies can be found by solving the above system of equations (See Appendix B.2). Equation (2.15) entails that the non-revolution constraint binds and that the choice of variables s_1^* and q^* will guarantee that a revolution does not take place.

2.3 Optimal Policies in Democracy

In contrast to non-democracy, the objective a democratic government is to maximize the income of the median voter and is not constrained by a threat of revolution. In the case where $\lambda \gg 1/2$ the median voter is a citizen. The other key difference is that resource rents are shared between the elite and citizens according to their share in the population. Also, income transfer, G_c , is given to citizens rather than the elite. Using s_1^d and q^d as the optimal extraction and investment subsidies in democracy respectively, the optimal extraction, resource rents, and optimal investment are identical to the non-democracy case after substituting s_1^d for s_1 and q^d instead of q in equations (2.1), (2.2) and (2.7). Wage income of citizens from the manufacturing sector is:

$$W^*(q^d) = W_1 + \beta W_2 = \alpha\lambda^\alpha K_1^{1-\alpha} + \beta\alpha\lambda^\alpha (K_1 + I^*(q^d))^{1-\alpha}$$

Income of the median voter can, therefore, be expressed as:

$$Y_c^d = \lambda R^*(s_1^d) + W^*(q^d) + G_c - \lambda T$$

Using the same taxing capacity as in non-democracy, T^* , such that $T \leq T^*$, the government budget constraint is:

$$T = G_c + q^d I^*(q^d) + s_1^d x_1^*(s_1^d)$$

Using the full capacity to tax, the median vote income is:

$$Y_c^d = \lambda R^*(s_1) + W^*(q) + (1 - \lambda)T^* - qI^*(q) - s_1 x_1^*(s_1) \quad (2.16)$$

The first order condition of equation (2.16) with respect to s_1^d is:

$$\lambda \frac{\partial R^*(s_1^d)}{s_1^d} - x_1^d(s_1^d) - s_1^d \frac{\partial x_1^d(s_1^d)}{s_1^d} = 0$$

Recalling that $\frac{\partial R^*(s_1^d)}{s_1^d} = x_1^d(s_1^d)$ and $\frac{\partial x_1^d(s_1^d)}{s_1^d} = \frac{1}{1+\beta}$:

$$s_1^d = -(1 + \beta)(1 - \lambda)x_1^d(s_1^d)$$

Substituting for $x_1^d(s_1^d)$, the optimal extraction subsidy is:

$$s_1^d = -\frac{(1 - \lambda)[p_1 - c_1 - \beta(p_2 - c_2 - S)]}{2 - \lambda} \quad (2.17)$$

Substituting equation (2.17) back into $x_1^d(s_1^d)$ gives the expression for optimal extraction in democracy as a function of the model parameters:

$$x_1^d(s_1^d) = \frac{(p_1 - c_1) - \beta(p_2 - c_2 - S)}{(1 + \beta)(2 - \lambda)} \quad (2.18)$$

Also, the first order condition for investment subsidy is:

$$\frac{\partial W^*(q^d)}{\partial q^d} - I^*(q^d) - q^d \frac{\partial I^*(q^d)}{\partial q^d} = 0$$

Using $I^*(q^d) = \lambda \left[\frac{\beta(1-\alpha)^2}{1-q^d-\phi\beta} \right]^{\frac{1}{\alpha}} - K_1$, $\frac{\partial W^*(q^d)}{\partial q^d} = \frac{\lambda}{1-\alpha} \left[\frac{\beta(1-\alpha)^2}{1-q^d-\phi\beta} \right]^{\frac{1}{\alpha}}$ and $\frac{\partial I^*(q^d)}{\partial q^d} = \frac{\lambda}{\alpha} \left[\frac{(\beta(1-\alpha)^2)^{\frac{1}{1+\alpha}}}{1-q^d-\phi\beta} \right]^{\frac{1+\alpha}{\alpha}}$ the first order condition is:

$$\frac{\alpha}{1-\alpha} \left[\frac{1}{1-q^d-\phi\beta} \right]^{\frac{1}{\alpha}} + \frac{K_1}{\lambda(\beta(1-\alpha)^2)^{\frac{1}{\alpha}}} - \frac{q^d}{\alpha} \left[\frac{1}{1-q^d-\phi\beta} \right]^{\frac{1+\alpha}{\alpha}} = 0 \quad (2.19)$$

Equation (2.19) is non-linear and can only be solved numerically.

2.4 Optimal Policies and Resource Booms

The following propositions regarding optimal policies can be deduced from the above analysis:

Proposition 2. *Optimal subsidies for resource extraction and investment are positive in non-democracy. Resource extraction is taxed in democracy when $(p_1 - c_1) > \beta(p_2 - c_2 - S)$.*

Proof. Since the non-revolution constraint binds (Equation (2.15)), μ^* is positive. It follows from equations (2.13) and (2.14) and the assumption of $p_2 > c_2 + S$ that $q^* > 0$ and $s_1^* > 0$. The second part of the proposition follows directly from equation (2.17). \square

It very important to point out that if it were not for the threat of revolution, elite would have chosen zero subsidies in both sectors. In this case, there would be no need to sacrifice any part of

their income to stay in power. On the other hand, resource extraction is taxed in democracy as long as it is feasible to extract. Resource extraction is subsidized only when $\beta(p_2 - c_2 - S) \geq (p_1 - c_1)$, the condition under which first period extraction is non-positive. For the sake of comparison between the two types of political institutions, the condition for feasible extraction is maintained.

Proposition 3. *First period optimal extraction under non-democracy is higher than under democracy.*

Proof. From Proposition 2, Extraction is subsidized in non-democracy whereas it is taxed in democracy (Equation (2.17)), for the same price and cost parameters, and stock of resource, it is clear that $x_1^* > x_1^d$.

It follows from the above propositions that resources rents in non-democracy are higher than in democracy due to the over extraction subsidy. □

Proposition 4. *Resource rents are higher in non-democracy than in democracy.*

Proof. Since $x_1^* > x_1^d$ and since $\frac{\partial R^*(s_1^*)}{\partial s_1^*} = x_1^*(s_1^*) > 0$ and $\frac{\partial R^*(s_1^d)}{\partial s_1^d} = x_1^d(s_1^d) > 0$, then $R^*(s_1^*) > R^*(s_1^d)$. □

The comparison between the performance of manufacturing sectors in non-democracy and democracy is not as evident as in the resource sector. Optimal investment and profits will depend on optimal investment subsidies. If $q^d > q^*$, investment and capital profits will be higher in democracy than in non-democracy. Intuition suggests the magnitude of both subsidies depends largely on the value of α . It is expected that q^d and q^* increase with α but for different reasons. In both cases, higher α leads to lower optimal investment. In the first case, as α increases, citizens in democracy have a preference for higher investment subsidy to increase their wage income and to compensate for reduced optimal investment. On the other hand, elite in non-democracy will have an incentive to increase q^* to increase the low cost of revolution caused by low wage income.

Proposition 5. *An increase in p_2 increases extraction subsidy and extraction in the first period in non-democracy.*

Proof. See Appendix (B.1) □

Extraction is increased in the first period in response to price booms in the second period. The mechanism is simple: an increase in p_2 causes an increase in extraction subsidy for two reasons. First, extraction subsidy creates an incentive for extraction in the first period and compensates for forgone profits in the second period. Second, the subsidy reduces the incentive for citizens to revolt by reducing the resource revenue in the second period. These two effects are generated

solely by the non-revolution constraint. This result is quite different from the result of Robinson et. al. (2006) where they find that resource booms reduce the inefficient extraction. Also, this is a sharp contrast to the democracy case where price booms would necessarily lead to a reduction in the extraction tax to increase overall extraction and to reallocate extraction to the second period to increase rents (from equation 2.18: $\frac{\partial x_1^d}{\partial p_2} = \frac{-\beta}{(1+\beta)(2-\lambda)} < 0$).

Proposition 6. *An increase in p_2 decreases optimal investment subsidy and optimal investment if $p_1 + s_1 - c_1 - S > \beta(2 + \beta)(p_2 - c_2)$.*

Proof. See Appendix (B.1). □

The effect of price booms on investment subsidy is not straightforward as its effect on the extraction subsidy. Again, there are two opposing effects. Since an increase in p_2 reduces the stock of resources remained in the second period as suggested by Proposition 5, there is less of an incentive for elite to subsidize investment in order to increase the cost of revolution. The opposing effect is that lower investment subsidy decreases investment and lead to a reduction of income of elite through lower profits. With the above condition, the latter effect is stronger than the first effect. Worth noting that investment subsidy and optimal investment in democracy do not depend on resource prices as in the case of the non-democracy.

3 Numerical Simulation

The numerical simulation provides an additional insight on areas where the theoretical model was ambiguous. Detailed results are robust to parameters values and are presented in Appendix C. The first result is that investment subsidy in democracy is greater than in non-democracy. The intuition behind this result goes back to the purpose of the subsidy in each case. In non-democracy, elite face two constraints in determining q^* , the taxing capacity constraint and the non-revolution constraint. If they were constrained by the former only, optimal q^* would have been zero. However, the second constraint forces the elite to choose a positive q^* . The investment subsidy is used as a tool to increase the cost of revolution (the left hand side of equation (2.11)). On the other hand, investment subsidy in democracy is a transfer from elite to citizens and is determined by citizens. It is only constrained by the taxing capacity (Figure C.4). This results leads to the following proposition.

Proposition 7. *When $q^d > q^*$, optimal investment and manufacturing sector profits are higher in democracy than in non-democracy.*

Proof. Since $\frac{\partial I^*(q)}{\partial q} > 0$ then $I^*(q^d) > I^*(q^*)$ when $q^d > q^*$. Similarly since $\frac{\partial \pi^*(q)}{\partial q} > 0$, then $\pi^*(q^d) > \pi^*(q^*)$ when $q^d > q^*$

□

3.1 Choice of Political Institution

Elite choice to adopt democracy depends on the income they get under both types of political institution. Recalling equation (2.10):

$$Y_e = R^*(s_1^*) + \pi^*(q^*) + \lambda T^* - q^* I^*(q^*) - s_1^* x_1^*(s_1)$$

While income of elite under democracy is:

$$Y_e^d = (1 - \lambda)R^*(s_1^d) + \pi^*(q^d) - (1 - \lambda)T^*$$

Formally, elite will choose dictatorship and would not allow for political transition if:

$$Y_e > Y_e^d$$

Alternatively, the above inequality can be expressed as:

$$T^* - q^* I^*(q^*) - s_1^* x_1^*(s_1) > [(1 - \lambda)R^*(s_1^d) - R^*(s_1^*)] + [\pi^*(q^d) - \pi^*(q^*)] \quad (3.1)$$

Proposition 1 suggests that the left hand side of the equation (3.1) is positive. The first part of the right hand side is negative (Proposition 4) while the second part is positive (Proposition 7). However, the amount of resource rents that elite have to let go in democracy is substantially higher than the amount of manufacturing profits they gain in return. Therefore, the net transfer in non-democracy is always higher than the net potential “gain” in democracy because the right hand side of the above inequality is always negative (Figure C.5). Elite choose to retain power and discard democracy as a choice of political institution.

3.2 Resource Booms

Extraction subsidy is substantial compared to the first period price (Figure C.1). The most intriguing result is the difference between the effect of resource booms on extraction in democracies and non-democracies (Figures C.2 and C.3). In the democracy case, optimal extraction in the first period is reduced in response to future increase in price. The exact opposite takes place in non-democracy. Actually, the resource stock is nearly depleted in the first period and over-extraction increases as p_2 increases. These results are in line with Propositions 3 and 5. Optimal

investment subsidy does in fact increase with the increase of p_2 (Figure C.4). This leads to an increasing investment in non-resource sector during resource booms. However, as predicted by Proposition 7, investment in democracy is greater than investment in non-democracy for all values of p_2/p_1 . Finally, income in democracies increases due to price booms whereas income in non-democracies increases by a negligible amount compared to democracies (Figure C.6). This reflects the effect of both inefficiencies in resource sector: the subsidy inefficiency and inefficient intertemporal allocation. It also reflects the weak investment in manufacturing sector. Income in democracy is less than income in non-democracy at low levels p_2/p_1 of due to the effect of extraction taxation.

4 Model Extensions

The first extension studies the effect of resource price uncertainty, specifically second period prices, on first period extraction. The second extension, prices of resource good are determined based on a game between a democratic and a non-democratic country.

4.1 Second Period Price Uncertainty

In order to determine the effect of second period price on the extraction decisions, an assumption about the risk aversion of the extractive firm is required. The utility over extraction rents, $U(R)$, is a concave function such that $U' > 0$ and $U'' < 0$. Price in the second period is uncertain such that $p_2 = \tilde{p}_2 + \epsilon$ and $E(p_2) = \tilde{p}_2$. An approach similar to that of Sandmo [1971] is adopted to determine the impact of uncertainty in price on resource extraction. The resource extracting firm maximizes its expected utility from extraction rents:

$$E[U(R)] = EU \left[(p_1 + s_1 - c_1)x_1 - \frac{x_1^2}{2} + \beta \left((p_2 - c_2)(S - x_1) - \frac{(S - x_1)^2}{2} \right) \right]$$

The first order condition with respect to x_1 is: $E \left[U'(R) \cdot \frac{\partial R}{\partial x_1} \right] = 0$ where: $\frac{\partial R}{\partial x_1} = p_1 + s_1 - \beta p_2 - C'(x_1)$ and $C'(x_1) = c_1 - \beta(c_2 + S) + (1 + \beta)x_1$. The above expression then becomes:

$$E \left[U'(R) \cdot \frac{\partial R}{\partial x_1} \right] = E [U'(R)(p_1 + s_1 - \beta p_2 - C'(x_1))]$$

$$E [U'(R) (p_1 + s_1 - C'(x_1))] = E [U'(R)\beta p_2]$$

subtracting $E [U'(R)\beta \tilde{p}_2]$ from both sides of the equation:

$$E [U'(R) (p_1 + s_1 - C'(x_1) - \beta \tilde{p}_2)] = E \left[U'(R) \left(\beta(p_2 - \tilde{p}_2) \right) \right] \quad (4.1)$$

The expected resource rents are:

$$E(R) = E \left[(p_1 + s_1 - c_1)x_1 - \frac{x_1^2}{2} + \beta \left((p_2 - c_2)(S - x_1) - \frac{(S - x_1)^2}{2} \right) \right]$$

$$E(R) = (p_1 + s_1 - c_1)x_1 - \frac{x_1^2}{2} + \beta \left[(\tilde{p}_2 - c_2)(S - x_1) - \frac{(S - x_1)^2}{2} \right]$$

whereas:

$$R = (p_1 + s_1 - c_1)x_1 - \frac{x_1^2}{2} + \beta \left[(p_2 - c_2)(S - x_1) - \frac{(S - x_1)^2}{2} \right]$$

which leads to:

$$R = E(R) + (p_2 - \tilde{p}_2)(S - x_1)$$

$$R = E(R) + \epsilon(S - x_1)$$

If $\epsilon > 0$ then $R > E(R)$ and $U'(R) < U'(E(R))$ which leads to:

$$U'(R) \left(\beta(p_2 - \tilde{p}_2) \right) < U'(E(R)) \left(\beta(p_2 - \tilde{p}_2) \right)$$

Taking expectations of both sides:

$$E \left[U'(R) \left(\beta(p_2 - \tilde{p}_2) \right) \right] < E \left[U'(E(R)) \left(\beta(p_2 - \tilde{p}_2) \right) \right]$$

Since right hand side equals zero, it follows that $E \left[U'(R) \left(\beta(p_2 - \tilde{p}_2) \right) \right] < 0$. Recalling equation (4.1), this implies $E \left[U'(R) (p_1 + s_1 - C'(x_1) - \beta\tilde{p}_2) \right] < 0$. It is clear that:

$$p_1 + s_1 < C'(x_1) + \beta\tilde{p}_2$$

Substituting for $C'(x)$:

$$x_1 > \frac{p_1 + s_1 - c_1 - \beta(\tilde{p}_2 - c_2 - S)}{1 + \beta} \quad (4.2)$$

Proposition 8. *Resource extraction is greater in the case of price uncertainty than it is in the case of price certainty.*

Proof. Comparing equation (4.2) with the first order conditions under certainty (equation 2.2), the extractive firm over-extracts compared to the certainty case. □

In the case of non-democracy, over-extraction in the first period will go over and above what

is optimal given the extraction subsidy. This is to guarantee that there is no benefit for citizens in their revolution decision when the realized value of p_2 is greater than its expected value.

4.2 Endogenous Resource Price

A simple Cournot game with one country as a non-democracy (country i) and another as a democracy (country j) is used to investigate how prices in world market is affected by extraction subsidies in non-democracies⁹. An identical linear demand function is used such that extraction in the first period will determine the prices in the two periods:

$$p_1 = a - b(x_1^i + x_1^j)$$

$$p_2 = a - b(x_2^i + x_2^j)$$

Using $S^i = x_1^i + x_2^i$ and $S^j = x_1^j + x_2^j$, p_2 is:

$$p_2 = a + b(x_1^i + x_1^j) - b(S^i + S^j)$$

Using identical cost of extraction in both countries, the resource extracting firm in the non-democratic country maximizes resource rents:

$$\begin{aligned} R^i \equiv & \text{Max} [a - b(x_1^i + x_1^j)] x_1^i + s_1 x_1^i - c_1 x_1^i - (x_1^i)^2 \\ & + \beta [(a + b(x_1^i + x_1^j) - b(S^i + S^j)) (S^i - x_1^i) - c_2 (S^i - x_1^i) - (S^i - x_1^i)^2] \end{aligned}$$

whereas in country j :

$$\begin{aligned} R^j \equiv & \text{Max} [a - b(x_1^i + x_1^j)] x_1^j - c_1 x_1^j - (x_1^j)^2 \\ & + \beta [(a + b(x_1^i + x_1^j) - b(S^i + S^j)) (S^j - x_1^j) - c_2 (S^j - x_1^j) - (S^j - x_1^j)^2] \end{aligned}$$

Using the Envelope Theorem: $\frac{\partial R_i}{\partial s_1} = x_1^i$ and $\frac{\partial R_j}{\partial x_1^i} = \beta b S^j - (1 + \beta) b x_1^j$. The optimal extraction in the first period is:

$$x_1^i = \frac{a(1 - \beta) - b x_1^j (1 + \beta) + s_1 - c_1 + \beta [(2b + 1) S^i + b S^j + c_2]}{(2b + 1)(1 + \beta)}$$

$$x_1^j = \frac{a(1 - \beta) - b x_1^i (1 + \beta) - c_1 + \beta [(2b + 1) S^j + b S^i + c_2]}{(2b + 1)(1 + \beta)}$$

⁹This part of the paper abstracts from the extraction taxation in democracy as it does not add any new intuition to the findings of this section.

Substituting the expression of x_1^j into x_1^i :

$$x_1^i = \frac{a(1 - \beta) - c_1 + \beta [(2b + 1)S^i + bS^j + c_2]}{(3b^2 + 2b + 1)} \left[\frac{1 + b}{(1 + \beta)} \right] + \frac{(2b + 1)s_1}{(3b^2 + 2b + 1)(1 + \beta)}$$

And substituting the expression of x_1^i into x_1^j :

$$x_1^j = \frac{a(1 - \beta) - c_1 + \beta [(2b + 1)S^j + bS^i + c_2]}{(3b^2 + 2b + 1)} \frac{(1 + b)}{(1 + \beta)} - \frac{bs_1}{(3b^2 + 2b + 1)(1 + \beta)}$$

In the special case where $S^i = S^j$, $x_1^i > x_1^j$ due to the effect of the subsidy as in the main model where firms were price takers (Proposition 3).

Proposition 9. *Price in the first period decreases with extraction subsidy while price in the second period increases with subsidy.*

Proof. Substituting the expression for x_1^i and x_1^j into the expressions for p_1 and p_2 :

$$\frac{\partial p_1}{\partial s_1} = \frac{-b(b + 1)}{(3b^2 + 2b + 1)(1 + \beta)} < 0$$

$$\frac{\partial p_2}{\partial s_1} = \frac{b(b + 1)}{(3b^2 + 2b + 1)(1 + \beta)} > 0$$

□

Proposition 10. *Democratic countries gain from extraction subsidies in non-democratic countries.*

Proof. If $\frac{\partial R_j}{\partial x_1^i} > 0$ then $\frac{\partial R_j}{\partial s_1} > 0$. $\frac{\partial R_j}{\partial x_1^i} > 0$ when $S^j > \frac{(1 + \beta)x_1^j}{\beta}$. Substituting the expression for x_1^j in gives:

$$S^j > \frac{1}{\beta} \left[\frac{(1 + b) [a(1 - \beta) - c_1 + \beta (bS^i + c_2)]}{[3b^2 + (2b + 1)(1 - \beta)]} - \frac{bs_1}{[3b^2 + (2b + 1)(1 - \beta)]} \right]$$

Under the above condition, $\frac{\partial R_j}{\partial s_1} > 0$

□

The higher the extraction subsidy, the smaller the right hand side of the above inequality making it easier for the democratic country gain. The gains comes from selling more at a higher price in the second period. At the extreme case, where over-extraction in country i depletes its stock in the first period, country j will have monopoly power of the resource market. Alternatively, if the stock in country i is infinite, country j will not benefit from the resource extraction subsidy. Similarly, gains in democratic country are easily achieved when their stock of resource is infinite.

5 Conclusion

This paper contributes to the recent literature on political transition by examining the special and interesting case of resource dependent economies. The model presented in this paper shows that political institutions determine whether resource dependence constitutes a blessing or a curse. It shows that non-democracy, as a type of political institutions performs less than a democracy during resource booms; even though they have identical endowments. This result adds to the literature on the institutional nature of the resource curse. The main result of the model is that over-extraction takes place because of distortions created by extraction subsidies which are needed to sustain dictatorship. The numerical simulation suggests that resource stock is almost depleted in the first period. Resource booms are actually a curse for a non-democracy because over-extraction is increased to dampen the potential of a successful revolution. This paper suggests a new channel that causes inefficient extraction and it also shows that investment is inferior in non-democracies. The other novelty in this paper is that it employs the threat of revolution to study the lack of political transition in resource exporting countries. It endogenizes the benefit and cost of revolution through the extraction plan and investment decision of elites respectively. Citizens do not conduct a revolution and political transition does not take place because its costly and with little benefit. Finally, the paper's main contribution is a model with endogenous choice of political institution by the ruling elite. The benefit of retaining power through setting transfers in the economy and the benefit from holding exclusive property rights over resource extraction make choosing democracy a very costly choice for ruling elite.

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A Resource Exporting Countries

Table 1: Resource Exporting Countries

Fuel Exporting Countries	Fuel Exports*	Ores and Metals Exporting Countries	Ores and Metals Exports*
Bahrain	60.9	Chile	19.4
Qatar	55.4	Bahrain	12.4
United Arab Emirates	50.4	Zambia	12.3
Nigeria	49.0	Peru	9.8
Kuwait	48.7	Zimbabwe	8.4
Oman	47.0	Armenia	8.3
Gabon	46.6	Kazakhstan	7.8
Libya	44.6	Georgia	7.7
Azerbaijan	40.8	Luxembourg	7.3
Algeria	39.2	Bulgaria	7.3
Kazakhstan	36.0	Iceland	6.9
Saudi Arabia	35.2	Guyana	6.1
Venezuela	30.6	South Africa	5.9
Seychelles	28.2	Bolivia	5.8
Norway	27.8	Jordan	5.8
Syria	23.7	Togo	4.3
Yemen	23.0	Gabon	3.4
Iran	21.0	Kyrgyz Republic	3.1
Belarus	18.3	Norway	3.1
Russia	17.5	Morocco	2.7
Ecuador	14.4	Russian Federation	2.7
Lithuania	13.6	Hong Kong	2.6
Egypt	12.3	Dominica	2.6
Sudan	12.1	Slovenia	2.5
Cameroon	11.9	Panama	2.5

* Exports expressed as % of GDP. Data from the World Bank World Development Indicators (2004) [2004] .

B Mathematical Appendix

B.1 Proof of Proposition 5 and 6

Recalling the first order conditions of equation (2.12):

$$L_\mu = \alpha\theta \left[\frac{\beta(1-\alpha)^2}{1-q-\phi\beta} \right]^{\frac{1-\alpha}{\alpha}}$$

$$- \left[(p_2 - c_2) \left(S - \frac{(p_1 + s_1 - c_1) - \beta(p_2 - c_2 - S)}{(1+\beta)} \right) - \frac{1}{2} \left(S - \frac{(p_1 + s_1 - c_1) - \beta(p_2 - c_2 - S)}{(1+\beta)} \right)^2 \right] = 0$$

$$L_q = -q + \mu\alpha\theta \frac{1-q-\phi\beta}{\beta(1-\alpha)} = 0$$

$$L_{s_1} = -s_1 + \mu\lambda \left[p_2 - c_2 - S + \frac{(p_1 + s_1 - c_1) - \beta(p_2 - c_2 - S)}{(1+\beta)} \right] = 0$$

The corresponding second order conditions are:

$$\begin{bmatrix} \frac{\partial L_\mu}{\partial \mu} & \frac{\partial L_\mu}{\partial q} & \frac{\partial L_\mu}{\partial s_1} \\ \frac{\partial L_q}{\partial \mu} & \frac{\partial L_q}{\partial q} & \frac{\partial L_q}{\partial s_1} \\ \frac{\partial L_{s_1}}{\partial \mu} & \frac{\partial L_{s_1}}{\partial q} & \frac{\partial L_{s_1}}{\partial s_1} \end{bmatrix} \begin{bmatrix} \partial \mu \\ \partial q \\ \partial s_1 \end{bmatrix} = \begin{bmatrix} - \left(\frac{(p_1 + s_1 - c_1 - S) + (p_2 - c_2)}{(1+\beta)^2} \right) \partial p_1 + \left(\frac{\beta(2+\beta)(p_2 - c_2) - (p_1 + s_1 - c_1 - S)}{(1+\beta)^2} \right) \partial p_2 \\ 0 \\ - \frac{\mu\lambda}{1+\beta} \partial p_1 - \left(\mu\lambda \frac{1+2\beta}{1+\beta} \right) \partial p_2 \end{bmatrix}$$

such that:

$$\frac{\partial L_\mu}{\partial \mu} = 0; \frac{\partial L_\mu}{\partial q} = \frac{(1-\alpha)\theta[\beta(1-\alpha)]^{\frac{2(1-\alpha)}{\alpha}}}{(1-q-\phi\beta)^{\frac{1}{\alpha}}} > 0; \frac{\partial L_\mu}{\partial s_1} = \frac{(p_1 + s_1 - c_1 - S) + (p_2 - c_2)}{(1+\beta)^2} > 0.$$

$$\frac{\partial L_q}{\partial \mu} = \alpha\theta \frac{1-q-\phi\beta}{\beta(1-\alpha)} > 0; \frac{\partial L_q}{\partial q} = - \left(1 + \frac{\mu\alpha\theta}{\beta(1-\alpha)} \right) < 0; \frac{\partial L_q}{\partial s_1} = 0.$$

$$\frac{\partial L_{s_1}}{\partial \mu} = \lambda \left[\frac{(p_1 + s_1 - c_1 - S) + (p_2 - c_2)}{1+\beta} \right] > 0; \frac{\partial L_{s_1}}{\partial q} = 0; \frac{\partial L_{s_1}}{\partial s_1} = \frac{\mu\lambda}{1+\beta} - 1 < 0 \text{ if } \mu\lambda < 1 + \beta.$$

It can be verified that the determinant of the Hessian matrix is positive for the second order conditions to hold.

$$\frac{\partial s_1^*}{dp_2} = \frac{\det \begin{bmatrix} 0 & \frac{(1-\alpha)\theta[\beta(1-\alpha)]^{\frac{2(1-\alpha)}{\alpha}}}{(1-q-\phi\beta)^{\frac{1}{\alpha}}} & \frac{\beta(2+\beta)(p_2-c_2)-(p_1+s_1-c_1-S)}{(1+\beta)^2} \\ \alpha\theta\frac{1-q-\phi\beta}{\beta(1-\alpha)} & -(1+\frac{\mu\alpha\theta}{\beta(1-\alpha)}) & 0 \\ \lambda \left[\frac{(p_1+s_1-c_1-S)+(p_2-c_2)}{1+\beta} \right] & 0 & -\mu\lambda\frac{1+2\beta}{1+\beta} \end{bmatrix}}{\det \begin{bmatrix} \frac{\partial L_\mu}{\partial \mu} & \frac{\partial L_\mu}{\partial q} & \frac{\partial L_\mu}{\partial s_1} \\ \frac{\partial L_q}{\partial \mu} & \frac{\partial L_q}{\partial q} & \frac{\partial L_q}{\partial s_1} \\ \frac{\partial L_{s_1}}{\partial \mu} & \frac{\partial L_{s_1}}{\partial q} & \frac{\partial L_{s_1}}{\partial s_1} \end{bmatrix}}$$

It can also be verified from the above equation that the numerator is also positive, therefore $\frac{\partial s_1^*}{dp_2} > 0$. And since $\frac{dx_1^*}{ds_1} = \frac{1}{1+\beta} > 0$, then $\frac{dx_1^*}{dp_2} > 0$.

To determine the effect of price booms on investment subsidy and investment, the same approach is used:

$$\frac{\partial q^*}{dp_2} = \frac{\det \begin{bmatrix} 0 & \frac{\beta(2+\beta)(p_2-c_2)-(p_1+s_1-c_1-S)}{(1+\beta)^2} & \frac{(p_1+s_1-c_1-S)+(p_2-c_2)}{(1+\beta)^2} \\ \alpha\theta\frac{1-q-\phi\beta}{\beta(1-\alpha)} & 0 & 0 \\ \lambda \left[\frac{(p_1+s_1-c_1-S)+(p_2-c_2)}{1+\beta} \right] & -\mu\lambda\frac{1+2\beta}{1+\beta} & \frac{\mu\lambda}{1+\beta} - 1 \end{bmatrix}}{\det \begin{bmatrix} \frac{\partial L_\mu}{\partial \mu} & \frac{\partial L_\mu}{\partial q} & \frac{\partial L_\mu}{\partial s_1} \\ \frac{\partial L_q}{\partial \mu} & \frac{\partial L_q}{\partial q} & \frac{\partial L_q}{\partial s_1} \\ \frac{\partial L_{s_1}}{\partial \mu} & \frac{\partial L_{s_1}}{\partial q} & \frac{\partial L_{s_1}}{\partial s_1} \end{bmatrix}} \quad (\text{B.1})$$

The sign of the numerator positive when $p_1 + s_1 - c_1 - S > \beta(2 + \beta)(p_2 - c_2)$. Since $\frac{\partial q^*}{dp_2} > 0$ and since $\frac{\partial I(q^*)}{\partial q^*} > 0$, then $\frac{\partial I(q^*)}{dp_2}$ under the same condition.

B.2 Solving for Optimal Subsidies

Dividing (2.13) by (2.14):

$$\frac{q^*}{s_1^*} = \frac{(1-\alpha)\alpha\theta [K_1 + I^*(q)]^{-\alpha} \lambda^\alpha}{\lambda [p_2 - c_2 - S + x_1^*(s_1)]} \quad (\text{B.2})$$

Recalling equations (2.2) and (2.6), then equation (B.2) becomes::

$$\frac{q^*}{1 - q^* - \phi\beta} = \frac{\alpha\theta(1+\beta)s_1^*}{\lambda\beta(1-\alpha) [(p_2 - c_2 - S) + (p_1 + s_1^* - c_1)]} \quad (\text{B.3})$$

Also, substituting (2.2) and (2.6) into (2.15) gives:

$$q^* = 1 - \phi\beta - \beta(1 - \alpha)^2 \left[\frac{\alpha\theta}{(p_2 - c_2) \left(\frac{\beta(p_2 - c_2) - (p_1 + s_1^* - c_1 - S)}{(1 + \beta)} \right) - \frac{1}{2} \left(\frac{\beta(p_2 - c_2) - (p_1 + s_1^* - c_1 - S)}{(1 + \beta)} \right)^2} \right]^{\frac{\alpha}{1 - \alpha}} \quad (\text{B.4})$$

Substituting B.4 into B.3:

$$\frac{(1 - \phi\beta) \left[(p_2 - c_2) \left(\frac{\beta(p_2 - c_2) - (p_1 + s_1 - c_1 - S)}{(1 + \beta)} \right) - \frac{1}{2} \left(\frac{\beta(p_2 - c_2) - (p_1 + s_1 - c_1 - S)}{(1 + \beta)} \right)^2 \right]^{\frac{\alpha}{1 - \alpha}}}{\beta(1 - \alpha)^2 (\alpha\theta)^{\frac{\alpha}{1 - \alpha}}} - \frac{\alpha\theta(1 + \beta)s_1}{\lambda\beta(1 - \alpha) [(p_2 - c_2 - S) + (p_1 + s_1 - c_1)]} - 1 = 0 \quad (\text{B.5})$$

The above equation is used to solve for s_1^* numerically.

C Results of Numerical Simulation

Equation (B.5) is solved using the Quasi-Newton method on a Matlab routine. Resource price in the second period, p_2 , is varied to analyze the effect of resource booms. The value of s_1^* is used to calculate the other variables such as $x_1^*(s_1), q^*, I(q^*)$ and total income of elite and citizens. Also equation (2.19) is solved using a the same routine. Unless otherwise indicated, the table below indicates the values used for model parameters:

α	β	λ	θ	K	S	ϕ	c_1	c_2	p_1
0.5	0.99	0.75	0.25	0.5	5	0.8	2	2	10

Figure C.1: Extraction Subsidy and Price Booms

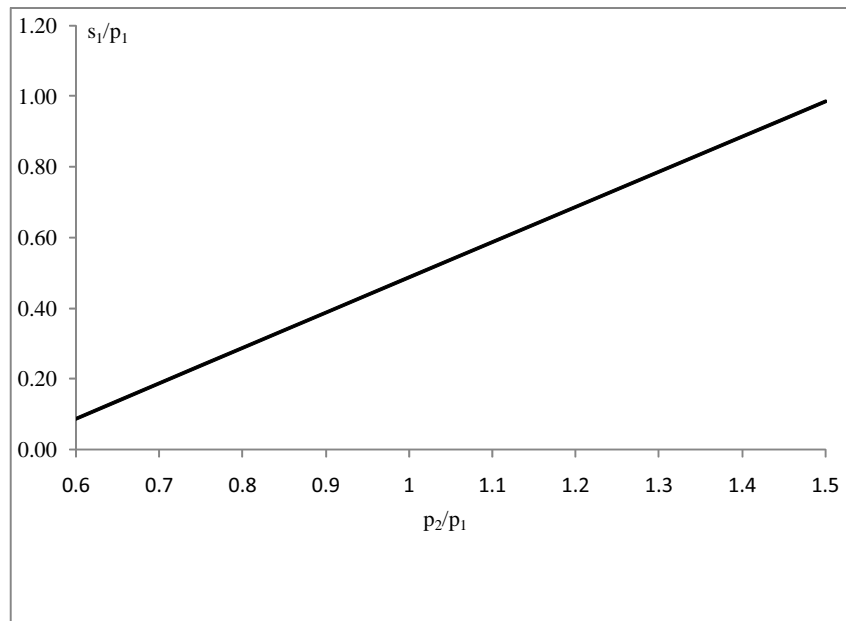


Figure C.2: Optimal Extraction in Non-Democracy

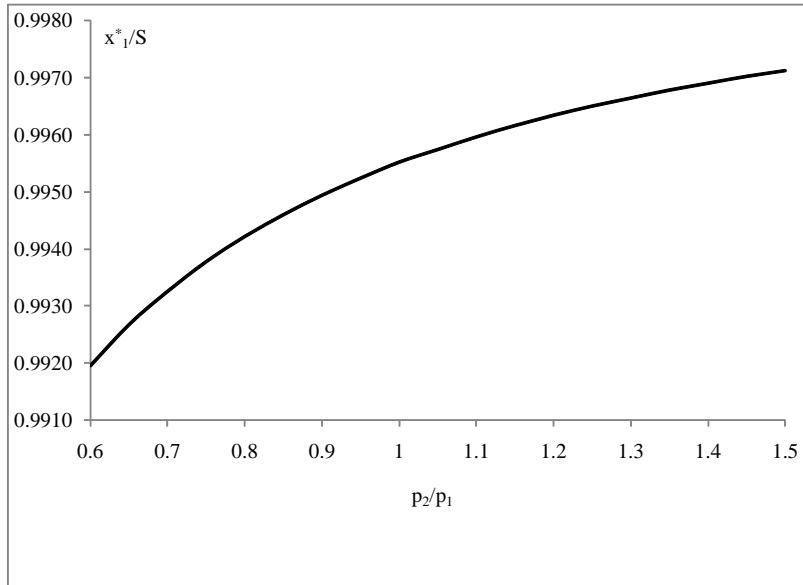


Figure C.3: Optimal Extraction in Democracy

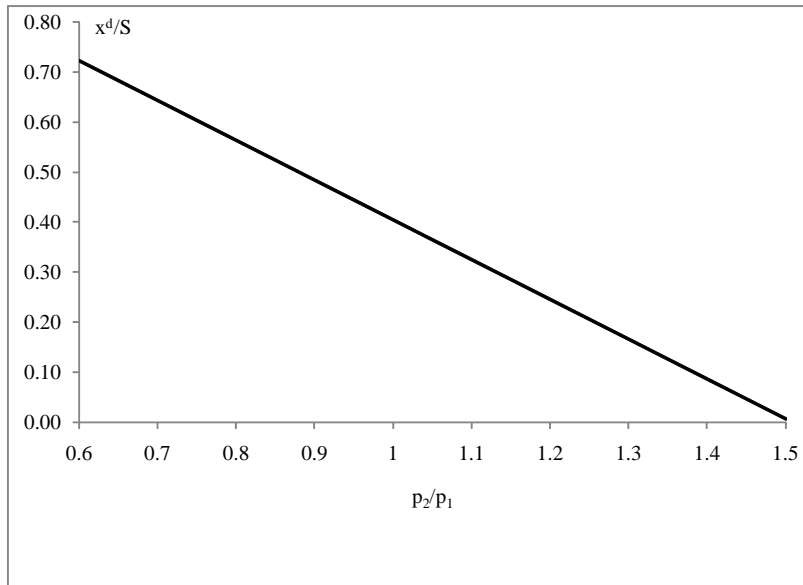
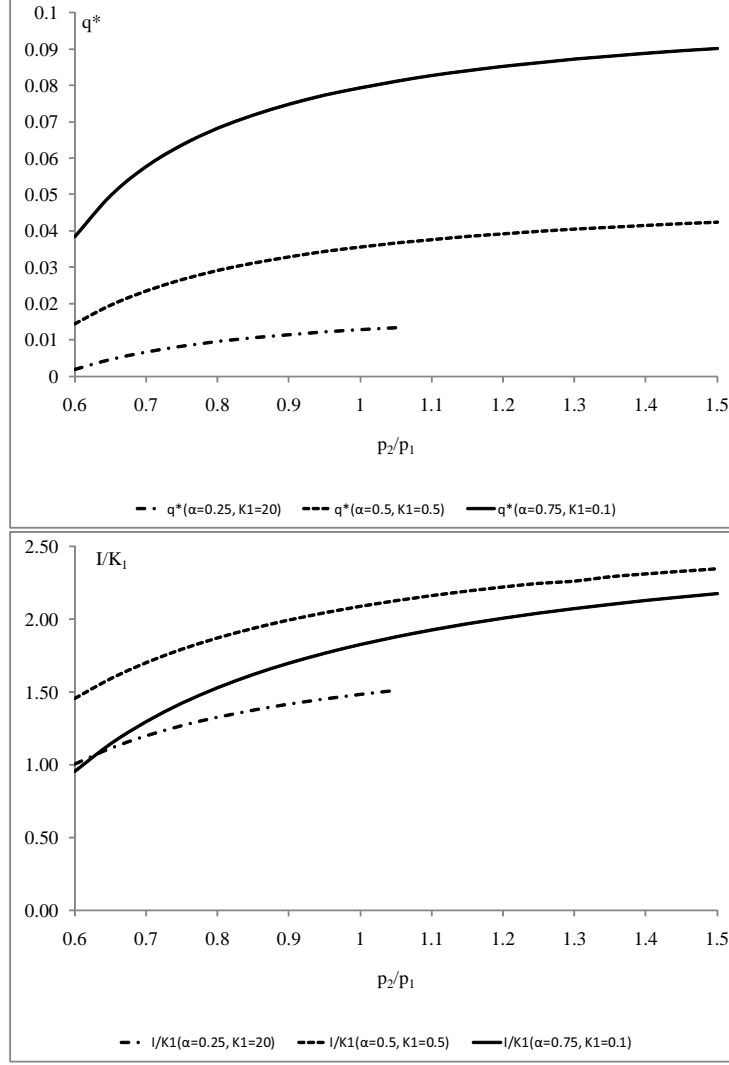


Figure C.4: Optimal Investment Subsidy and Investment in Non-Democracy



The corresponding values for q^d and $\frac{I^d}{K_1}$ are:

	$\alpha = 0.25, K_1 = 20$	$\alpha = 0.5, K_1 = 0.5$	$\alpha = 0.75, K_1 = 0.1$
q^d	0.028	0.077	0.146
$\frac{I^d}{K_1}$	2.44	4.39	6.47

Optimal investment subsidy and investment in democracy do not vary with p_2 .

Figure C.5: Elite Net Gain from Democracy

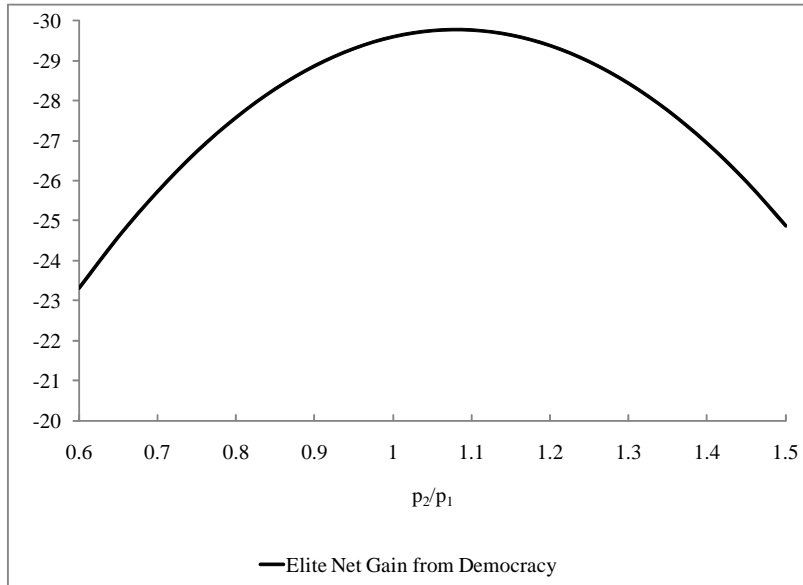


Figure C.6: Income and Resource Booms

