The Transparency Curse: Private Information and Political Freedom.

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Abstract

   I offer a model of the sustainability of authoritarian rule that is consistent with the apparent existence of a "resource curse", in which, at a given level of income, primary resource exporting countries appear to be more prone to authoritarian rule, and an income effect in which it is the poor countries that tend to suffer authoritarian rule. The key to the model is difficulty authoritarian governments face in monitoring the innovative sector of the economy. This leads it either to interfere with economic production or to liberalize.

Introduction

Authoritarian governments often display hostility to innovation, whether of the scientific sort, or of the entrepreneurial variety. During Summer, 1933 industrialist Carl Bosch complained to Hitler about the damaging effects on German competitiveness of widespread dismissals of Jewish professors in physics and chemistry. Hitler replied that "Germany could get on for another hundred years without any physics or chemistry at all" (Evans, 2003) p.426.

   While authoritarian governments are all too effective at forcing people to carry out easily monitored tasks, they have more difficulty inducing individuals to take hidden actions. Yet hidden actions are often an intrinsic part of

innovating and managing complicated and idiosyncratic enterprises. Indeed, even many mundane tasks, such as running a bodega, or share cropping, involved taking hidden actions. However, the autonomy necessary to do an effective job of extending the scientific frontier, or even running a solvent taxi company, may also be the autonomy one needs to mount an effective conspiracy. A government that allows it's citizens the freedom to innovate and produce as they will may also find it has left them with the freedom to plot its own downfall.

Here I present a model that incorporates economic activity that leaves citizens with private information about their productivity in an autonomous economic activity. This private information makes it difficult for the government to distinguish a worker with low productivity in the private sector from a worker with high productivity who is plotting. This inability to discern whether workers are plotting forces authoritarian governments to choose between liberalization or interfering with the productive sector of the economy. The less transparent the activity is, the greater the cost of maintaining an authoritarian government rather than liberalizing.

The model identifies conditions under which authoritarian governments will prefer to step down, as did Spain's Juán Carlos, as well as military governments in Chile and Korea, and the one-party state in the Republic of China (Taiwan), choosing to accept a smaller share of the larger pie that results from political liberalization. This is most likely to occur when hidden actions and innovation are important, and least likely when economic activity uses known and easy to monitor technologies.

These findings are relevant for two strands of the political economy literature that coexist uneasily: the association between high income and democracy identified by Lipset (1959), and pursued by many others, and the so-called "resource curse", see for example Gelb (1988). The first pole of the literature emphasizes that wealthy countries tend to be democratic, and schol-

ars often assert a causal relationship, typically from wealth to democracy, see for example Londregan and Poole (1990), or Cheibub et al. (1996). The second axis of investigation, focuses on the tendency for the governments of primary resource exporters to be authoritarian, an effect that is asserted to overwhelm any pro-democratic effects that may result from increased income Ross (2001), Humphrey's, Sachs and Stiglitz (2007), and Dunning (2008). The model I develop here implies the costs of totalitarian rule are higher when the information asymmetry between the government and workers in the productive sector is greater. This will produce an apparent "income effect" if high income economies are also harder for their governments to monitor. If we add the plausible ancillary hypothesis that resource extraction activities are relatively easy to monitor[1], then the model is also consistent with the hypothesis that the economic costs of totalitarian rule are lower in extractive economies. Rather than a "resource curse" linking large endowments of extractable resources to authoritarian rule, there is a "transparency curse", in which easy to monitor economic activities provide a stable base for authoritarian rule.

The next section of the paper sets forth a simple information theoretic model of the political economy of production and rent extraction by the government.

1   Information Theory and Rent Extraction

The model centers on the informational asymmetry between a citizen and her government. Because the government is sovereign it cannot bind itself to a contract. This is a key departure from principal-agent models in which the principal[2] is able to bind himself to a contract, see for example Laffont

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[1] Resource exploration is another matter, and resource extractive countries often experience difficulties in exploring for new reserves.

[2] This paper takes a somewhat darker vision of government than that of Hobbes, Locke, and Rousseau. Instead of a social contract there is a predatory state.

and Martimort (2002). In this model a citizen's productivity at innovative activity is drawn from a probability distribution–the realized value of her productivity is private information. In addition the citizen can devote a fraction of her time to plotting against the government. Whether a revolt against the government occurs depends on the citizen's decision to go through with her plot, and on whether she has spent enough time "arming" or otherwise organizing her intrigue. If rebellion occurs some output is destroyed and the citizen disposes of what remains[3]. The citizen is able to work in a risky activity with a high expected return, or she can work in a traditional productive activity where her productivity level is known to be low. For its part, the government can reward high levels of output and punish low levels using a combination of punishment, think of this as capital punishment, and economic rewards, in the form of giving the citizen back some of the output she has produced. If the government suspects plotting on the part of the citizen, it can inflict punishment and or withhold rewards. The government can observe the citizen's economic output but not her productivity, and it cannot observe directly the way she uses her time. At the initial stage of decision making the government decides whether to repress or to "liberalize", in which case it forgoes the ability to punish the citizen. If it does so the citizen can dismiss the government with probability one, but at a cost that is proportional to output. The output lost from dismissing the government is lower than the output destroyed in a successful rebellion.

If the government decides to repress, then at the initial stage of production, before nature has assigned the level of the citizen's productivity, the government must choose whether or not to allow the citizen to use a productive but hard to monitor technology where her productivity is private information for the citizen, or whether she is restricted to a traditional production technique where her productivity is known.

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[3]This feature of the model is shared with the framework set forth in chapters 4 and 5 of Acemoglu and Robinson (2005), though it differs in several other respects

1.1 The Model

The preferences of the citizen are:

$$U_C = t + \eta(\Phi q - t)$$

$$+ \alpha\left(\rho(\Lambda q - t) - \pi\big(t + \rho(\Lambda q - t) + B\big) - \eta(\Phi q - t)\right) \quad (1)$$

Here q is the output quantity produced by the citizen, all of which is under the control of the government, and t is the consumption alloted to citizens by the government, and $-B$ is the subjective value of being punished by the government, think of this as the death penalty, so that B is very large compared with the available resources.

Equation (1) says that if the government remains in place and does not punish the citizen she receives the transfer t that the government chooses for her. If she overthrows or expels the government she gets what remains of output, and if she is punished her wellbeing corresponds to $-B$.

Going through this a bit at a time, the variable α is an indicator for whether government chooses repressive institutions, with $\alpha = 1$ indicating that the government selects a repressive system that gives it the option to punish the citizen, while $\alpha = 0$ means the government relinquishes this capability. In equation (1) we see that if the government chooses not to repress then either the citizen chooses to expel it, setting $\eta = 1$, in which case she receives a payoff of Φq, where Φ represents the costs of losing the expertise of the government[4], or the citizen chooses to leave the government in place and accept the transfer the government offers her. If the government does choose to repress then the citizen is either punished, $\pi = 1$ with a payoff of $-B$, or she is allowed to remain alive. If she lives she either overthrows the

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[4]This can be less benign, it may include the destruction of files and fixtures and other forms of sabotage committed by an outgoing government.

government, if she has made the relevant preparations and chooses to rebel, or she accepts the government's transfer of t. In the wake of a successful rebellion the citizen receives all of the surviving output: Λq, where Λ is the fraction that makes it through the rebellion.

The government's preferences are:

$$U_G = (1-\eta)(q-t)$$
$$+ \alpha\left(\eta(q-t) + \pi\left(t + (\Psi-1)q + \rho(B+q-t)\right) - \rho(B+q-t)\right) \quad (2)$$

Equation (2) says that if the government liberalizes and the citizen chooses to let it stay in power, or if the government represses, leaves the citizen alive, and it is not overthrown, then it receives what is left of output after the citizen has received a transfer of t. If instead the citizen chooses to expel the government in an unrepressive environment it receives nothing, while in case of an overthrow it is the government that is punished. If a repressive government punishes the citizen the government receives a fraction Ψ of output, while the rest is deemed to be destroyed[5]. I shall assume that:

$$1 \leq \Psi + \Lambda \quad (3)$$

Equation (3) says that the government prefers to punish the citizen rather than having to appease her.

Now let's consider the sequence of events in more detail.

(1) Government selects the institutional structure, by choosing either $\alpha = 1$ and retaining the ability to punish the citizen and imposing its choice of productive technology ι, or $\alpha = 0$ and subjecting itself to removal by the citizen, while the citizen is left free to choose ι. As the government chooses

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[5]This can also be thought of as encompassing the costs to the government of inflicting punishment.
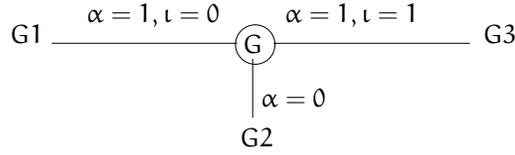
Figure 1: Regime Choice by the Government.

the political and productive regime it does so under uncertainty about the citizen's productivity parameter. The government does know the *ex ante* probabilities for $\bar{\theta}$ and $\underline{\theta}$.

There are two technologies, an innovative technology, indicated by $\iota = 1$ that depends on the citizen's productive type θ in which the quantity produced is $q = \theta s$, where $s \in [0, 1]$ is the fraction of her time the citizen devotes to production. The second technology, denoted $\iota = 0$, delivers a quantity of $q = \theta_0 s$, regardless of the citizen's productivity parameter. The parameter θ_0 satisfies:

$$\underline{\theta} < \theta_0 < \underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta}) \tag{4}$$

This says that the $\iota = 0$ technology is more productive than a citizen in the $\iota = 1$ activity if her productivity is low, but it falls short of the expected productivity of a citizen in the innovative industry. Expression (4) also tells us that the $\iota = 0$ technology is less productive than the high productivity realization of the $\iota = 1$ process.

The government's stage 1 choice is tantamount to selecting which of three subgames to play, G_1, in which the government and the citizen interact after the government has chosen a repressive regime with the safe but relatively unproductive $\iota = 0$ technology, G_3 in which the government represses and imposes the more promising but riskier $\iota = 1$ technology, and G_2 in which the government chooses to liberalize, leaving the choice of ι in the hands of the citizen.

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(2) Nature chooses $\theta \in \{\underline{\theta}, \bar{\theta}\}$. The probability of $\theta = \underline{\theta}$ is $1 - \epsilon$, while the probability that $\theta = \bar{\theta}$ is ϵ. While these probabilities are common knowledge, the citizen now observes natures choice of θ, while the government does not.
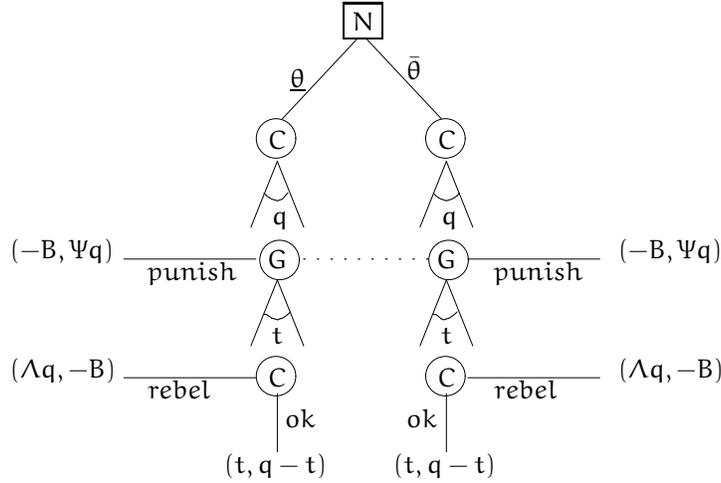
Now let's consider the different subgames in turn.

Figure 2: Output Selection with a Repressive Regime. $(G1, G3)$

G_1 and G_3 in these subgames, once the government has chosen a repressive political regime and it has imposed a technology, nature assigns a type to the citizen, who then makes her stage (3) choice of how to allocate her time, which is divided entirely between production or preparing a rebellion:

(3) If the citizen spends more than a fraction $1 - \xi$ of her time parparing to rebel she will be able to choose the value of $\rho \in \{0, 1\}$ at the rebellion stage. If she invests less than $1 - \xi$ of her time readying a rebellion, then $\rho = 0$ is her only option. The need to invest at least a fraction $1 - \xi$ of her time in order to have the option of rebelling is the same regardless of the citizen's productivity level θ.

(4) Once the citizen has made her time allocation decision, the government observes q. At this stage the government updates its beliefs about the citizen's productivity parameter θ on the basis of having observed q, and decides

whether to punish the citizen, setting $\pi = 1$ and receiving a terminal payoff of Ψq. If the government chooses $\pi = 1$ the citizen's payoff is $-B$ and the decision making comes to an end.

(5) If the government chooses not to punish, so that $\pi = 0$, the government proffers a transfer t to the citizen.

(6) At this stage the citizen either accepts the transfer of t, or does away with the government. She can only avail herself of the option of overthrowing the government if she spent at least a fraction $1 - \xi$ of her time preparing for rebellion during the production stage. Remember that if the citizen is punished at stage (4) then stages (5) and (6) do not occur.

If at stage (6) the citizen accepts t then her payoff is t while the government receives a payoff of $q - t$. If in contrast the citizen rebels the government's payoff is $-B$, while the citizen garners a payoff of Λq.

G_2 In this subgame the government has chosen to liberalize, with $\alpha = 0$. Now, at stage (iii) the citizen chooses the technology, $\iota = 0$ or $\iota = 1$, and decides how to allocate her time between production and preparing a rebellion, as under a repressive regime, but see the discussion at stage (vi).

(iv) Once the citizen has made her time allocation decision, the government observes q. At this stage the government updates its beliefs about the citizen's productivity parameter θ on the basis of having observed q.

(v) Having updated its beliefs, the government next chooses a transfer t to proffer.

(vi) At this stage the citizen either accepts the transfer of t, or does away with the government. If she accepts the transfer her payoff is t while the government pockets $q - t$. If she expels the government her payoff is Φq while that of the government is 0.

The citizen could also avail herself of the option of rebellion, provided she spent at least a fraction $1 - \xi$ of her time preparing for rebellion during

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$(t, q - t)$ $(t, q - t)$

ok   ok

$(\Phi q, 0)$ ——— C   C ——— $(\Phi q, 0)$
expel   expel

t   t

G ·········· G

q   q

C   C

$\iota = 0$ $\iota = 0$

C — $\underline{\theta}$ — N — $\bar{\theta}$ — C

$\iota = 1$ $\iota = 1$

C   C

q   q

G ·········· G

t   t

$(\Phi q, 0)$ ——— C   C ——— $(\Phi q, 0)$
expel   expel

ok   ok
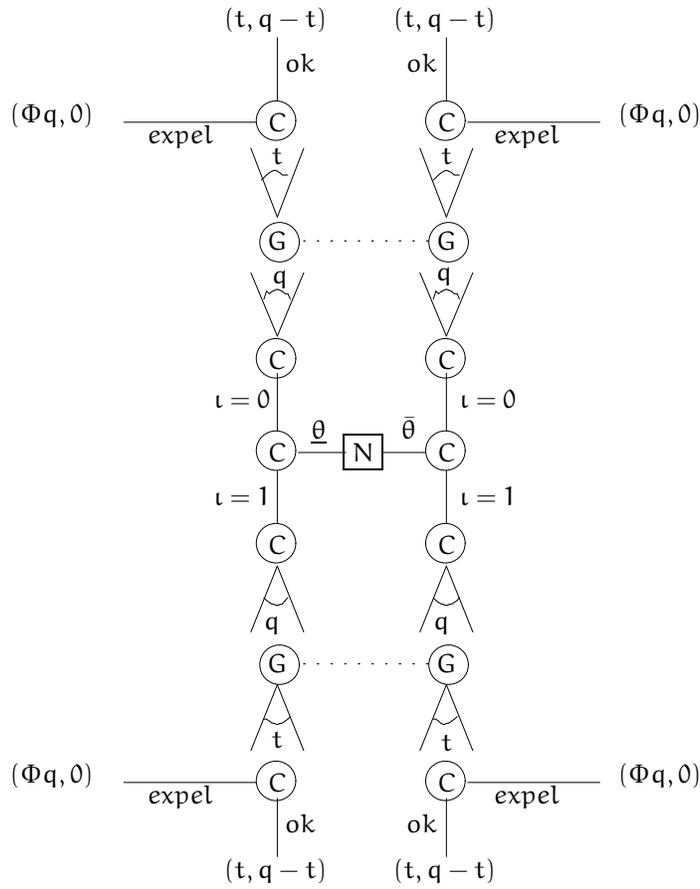
$(t, q - t)$ $(t, q - t)$

Figure 3: Output Selection with an Open Regime. (G2)

the production stage. However, if the citizen rebels against a non-repressive government her payoff is Λq. It seems reasonable that even the most chad infested, litigation ridden election will still result in less destruction than an armed rebellion, so I impose the condition:

$$\Lambda < \Phi \tag{5}$$

Hence, rebellion against a non-repressive regime is strictly dominated.

The following tables summarize the symbols used in the model. Firstly there are the strategic variables chosen by the government:

α	G's binary choice of regime type.
ι_G	G's binary choice of production technology (when $\alpha = 1$).
π	G's binary decision whether to punish.
t	G's non-negative transfer to C (when $\pi = 0$).

The citizen can choose the following variables:

ι_C	C's binary choice of production technology (when $\alpha = 0$)
ρ	C's binary choice whether to rebel.
η	C's binary choice whether to expel the leader (when $\alpha = 0$).
q	C's production decision.

In the $\alpha = 1$ regime, the time C does not spend on production is spent preparing to rebel.

The following variables are parameters of the model:

ϵ	The probability nature chooses $\theta = \bar{\theta}$.
θ_0	The productivity parameter for the $\iota = 0$ technology.
$\bar{\theta}$	The high value for the $\iota = 1$ productivity parameter.
$\underline{\theta}$	The low value for the $\iota = 1$ productivity parameter.
$-B$	The punishment payoff.
Φ	the fraction of output not lost when the government is expelled.
Λ	the fraction of output not lost when the government is overthrown.
Ψ	the fraction of output not lost when the citizen is punished.

I impose the following condition on the punishment payoff:

$$-B < -\frac{2\bar{\theta}}{\epsilon} \tag{6}$$

being punished is "a very bad thing".

Finally we denote the information set for the government at stage 1 of the game by $\mathfrak{I}_1$, while it's information set at stages (4A) and (5) is $\mathfrak{I}_4$. Likewise, let $\mathfrak{K}_3$ denote the citizen's information set at stage 3, while $\mathfrak{K}_6$ is

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her information at stage 6 if it is reached. In contrast with the government the citizen observes θ, so her only source of uncertainty at stage 3 arises from not knowing what policies, t and π, the government will select. At stage 6 she knows the entire state of the system.

A strategy for the government is a set of contingent plans setting forth how the government will choose α, and if it selects $\alpha = 1$, how it will choose ι at at stage 1 given $\Im_1$, and how it will choose π at stage $(4a)$ (when $\alpha = 1$), and how it will select t at stage (5) (provided $\alpha\pi \neq 1$) contingent on $\Im_4$.

I will denote this as:

$$
\sigma_G \equiv \begin{pmatrix} \alpha^* \\ \iota_G^* \\ \pi^* \\ t^* \end{pmatrix} \tag{7}
$$

A strategy for the citizen is a similar set of plans that depend on her information at stage 3, for the choice of q, (and of ι if $\alpha = 0$) and at stage 6, for the selection of η and ρ:

$$
\sigma_C \equiv \begin{pmatrix} \iota_C^* \\ q^* \\ \eta^* \\ \rho^* \end{pmatrix} \tag{8}
$$

Definition: A *perfect Bayesian equilibrium* (Fudenberg and Tirole, 1991) to this game consists of a pair of strategies σ_G and σ_C, and a set of beliefs at each decision node, such that:

(a) α^*, and ι_G^* solve (9):

$$\underset{\alpha, \iota_G}{\text{Max}} \; E\{(1-\alpha)(1-\eta)(q-t)$$

$$+ \alpha\big(\pi\Psi q + (1-\pi)(1-\rho)(q-t) - (1-\pi)\rho B\big)|\mathfrak{J}_1\} \quad (9)$$

(b) q^* and ι_C^* solve (10):

$$\underset{q, \iota_C}{\text{Max}} \; E\{(1-\alpha)\big(t + \eta(\Phi q - t)\big) + \alpha\bigg((1-\pi)\big(t + \rho(\Lambda q - t)\big) - \pi B\bigg)|\mathfrak{K}_3\}$$

subject to

$$q \leq \theta_0 + \big((1-\alpha)\iota_C + \alpha\iota_G\big)\big(\theta - \theta_0\big) \quad (10)$$

(c) if $\alpha = 1$ then π^* solves (11):

$$\underset{\pi}{\text{Max}} \; E\{\alpha\bigg(\pi\big(\Psi q - (1-\rho)(q-t) + \rho B\big) + (1-\rho)(q-t) - \rho B\bigg)|\mathfrak{J}_4\} \quad (11)$$

(d) t^* solves (12):

$$\underset{t}{\text{Max}} \; E\{(1-\alpha)(1-\eta)(q-t) + \alpha(1-\pi)\big((1-\rho)(q-t) - \rho B\big)|\mathfrak{J}_4\} \quad (12)$$

(e) if $\alpha = 0$ then η^* solves (13):

$$\underset{\eta}{\text{Max}} \; \big((1-\eta)t + \eta\Phi q\big) \quad (13)$$

(f) If $\xi\theta < q$ then $\rho^* \equiv 0$, while if $q \leq \xi\theta$ and $\alpha = 1$ then ρ^* solves (14):

$$\underset{\rho}{\text{Max}} \; (1-\pi)\big((1-\rho)t + \rho\Lambda q\big) \quad (14)$$

Beliefs, expressed as a probability distribution over decision nodes in the same information set, reflect the strategies used by the other player and satisfy Bayes' rule when this is decisive.

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1.2 Equilibrium

A central feature of the game set forth in the previous section is the government's fear that under the repressive regime, with $\alpha = 1$, the citizen is dividing her time between production and preparing a rebellion. In equilibrium producing an output below $\xi\bar{\theta}$ is a risky undertaking that can result in being punished. This threat terrorizes most citizens into dedicating their time to meeting production quotas, rather than preparing a rebellion. However, if the technology is sufficiently heterogeneous, any production level high enough to ensure the high productivity types are not preparing a rebellion is too high for the low productivity types to meet, even if they were to dedicate their entire time to doing so. The result is that in the equilibrium considered here nothing the low productivity types do can completely remove the threat of punishment once the government has selected the $\iota = 1$ technology. This leaves the regime to choose between a high probability of inflicting costly punishment or having to revert to the transparent technology, setting $\iota = 0$, with a lower expected productivity. Either option reduces the expected rents for the repressive regime, and both make liberalization a relatively more attractive option.

In the appendix I identify a perfect Bayesian equilibrium for this model, though I do not fully characterize the set of all such equilibria. The following result characterizes the government's equilibrium choice of regime type:

Corollary to Proposition 1: The government's choice of α^* consistent with the perfect Bayesian equilibrium set forth in Proposition 1 (stated and proved in the appendix) is:

$$
\alpha^* = \begin{cases} 1 & \xi \leq \dfrac{\underline{\theta}}{\bar{\theta}} \text{ and } 1 - \Phi < \tau_H \\ 1 & \dfrac{\underline{\theta}}{\bar{\theta}} < \xi \text{ and } 1 - \Phi < \tau_L \\ 0 & \text{otherwise} \end{cases}
$$

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where

$$\tau_H = \frac{\left(\underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})\right)}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)} > \frac{\left(\Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta})\right)}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)} = \tau_L$$

while:

$$\omega = \frac{\epsilon(B + \underline{\theta}) - (1 - \Psi)\underline{\theta}}{\epsilon(B + \Psi\underline{\theta})} \in (0, 1) \tag{15}$$

Proof: This is a corollary to Proposition 1, which is stated and proved in the Appendix.

An important role is played in this model by beliefs. While the citizen knows her type throughout the game, the government must form an inference about this quantity. As in all perfect Bayesian equilibria the government applies Bayes rule whenever this is relevant. Moreover, there are a set of out of equilibrium moves in which q either reveals the citizen's type or in which it is so high, or so low, that the government can infer that whatever the citizen's type she is either certain to pose a threat, or certain not to.

This leaves us with the government's beliefs about the citizen's type for "ambiguous" out of equilibrium output quantities, for which the high productivity types are able to rebel while the low θ citizens are not:

$$\xi\underline{\theta} < q < \min\{\underline{\theta}, \xi\bar{\theta}\} \tag{16}$$

While there is a voluminous literature on out of equilibrium beliefs offering various "refinements", a defining characteristic of repressive regimes is their seeming paranoia. We might expect this paranoia to express itself in precisely the cases in which rational inference, as represented by Bayes' rule, fails, that is, in the interval represented by (16). The paranoia that characterizes autocratic leaders is legendary. A consideration of this equilibrium suggests that such paranoia might also be strategically important. What is really important about out of equilibrium beliefs in this model is

not that the government would actually hold them–after all out of equilibrium moves never happen in equilibrium! The key is rather that the citizen believes that the government will hold these beliefs. Thus we might expect autocrats to want people to believe that they suffer from a sort of controlled paranoia–updating according to Bayes rule when possible, but falling back on pessimistic conjectures about the nature of citizens who defect from equilibrium. Of course, autocrats who actually tend to hold such suspicious beliefs will also be autocrats who tend to survive. In the perfect Bayesian equilibrium set forth in the appendix the government assigns a probability of ϵ to an out of equilibrium quantity that deviates into the range corresponding to (16) comes from dangerous high productivity type who is ready to rebel, just as "Uncle Joe" would have suspected.

2 Discussion

The government seeks to exploit the maxim "the devil makes work for idle hands"[6]: the government would like to ensure citizens work hard enough to preclude their preparing a rebellion. When the ratio of low productivity to high productivity $\frac{\underline{\theta}}{\overline{\theta}}$ is high, so that uncertainty about θ is relatively unimportant, then the limiting equilibrium set forth in the appendix makes it nearly certain that both types of citizen will produce enough to rule out the possibility of overthrowing the government, and the government's rents from having a repressive regime are high. Although there is some loss in expected output from the government not directly observing the value of θ before it imposes its choice of technology, once it has chosen, the repressive government captures all of the potential surplus.

In contrast, the combination of a repressive regime with a harder to monitor technology, represented by a low $\frac{\underline{\theta}}{\overline{\theta}}$ ratio, results in a less efficient outcome.

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[6]In this case of course, one might better think of the devil as the regime!

The government's mixed punishment strategy puts all of the low productivity types at risk, and a fraction of the high productivity types pool with the low types. This limits output, and so rents for the government, and it also confronts the government with a non-trivial risk of being overthrown. Alternatively the government may opt for the less productive but easy to monitor "backstop" technology $\iota = 0$. Both of these options are less lucrative than adopting an easy to monitor technology, and so both result in a lower threshold for liberalizing, that is, for setting $\alpha = 0$.

While the features of the model are somewhat stark the substitutability of effort between rebellion and production is a feature one encounters in the real world. The essential idea is that the freedom to engage in hard to monitor economic activities also confers the freedom to work against the government. An economy in which hundreds of thousands of high school students are instructed in chemistry every year, and in which chemical fertilizer can be bought in large quantities without a special license and background check is an environment in which the Oklahoma City bombers of 1995 can blow up the largest government office building in that state. When box cutters are for sale, and when people are free to contract for flying lessons[7] the September 11, 2001 murders can take place. The simple economic freedoms that one readily takes for granted can be easily converted to sinister purpose by those with the time and determination to do so. Consider the measures needed to suppress such activities–a license to haul fertilizer? A background check to buy box-cutters? An environment in which Steve Jobs and Steve Wozniak can found Apple Computer in Jobs's parents' garage is an environment in which anti-government plotters can conspire and prepare bombs, recruit followers, and launch a rebellion. In a free society there are thankfully few people willing to take up such a cause–a group large enough to prepare a secret rebellion would do better to organize a 527 committee and start a viral marketing campaign

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[7]In the future students may need at least to feign interest in the procedures for *landing*.

for their pet idea. But a repressive government that does not exercise careful vigilance may find itself faced not with a few disgruntled sociopaths the likes of the Oklahoma City conspirators but with an insurrection of tens of thousands of individuals.

The seemingly pathological suspicion with which most authoritarian regimes view activities that permit access to weapons, contact with foreigners, or the ability to travel within a country may be perfectly well founded on the possibility that these activities could mask anti-regime activities. While shepherds in the Pyrenees and fisherman along the English Channel have for centuries exploited synergies between their official occupation and smuggling, a repressive regime (consider Vichy France) will tend to heavily restrict or completely outlaw their legal activities for fear that they are being used to cloak preparations to overthrow the government.

Of course, some activities are easier to monitor than others, and this is what the ratio $\frac{\theta}{\bar{\theta}}$ in the model is meant to capture. In particular, many of the activities associated with technical innovation and commerce, especially international commerce, will be very hard for an authoritarian government effectively to keep tabs on, and these correspond to a technology with a low $\frac{\theta}{\bar{\theta}}$ ratio. On the other hand, we might expect that extractive activities, such as pumping oil from known reserves, or mining known deposits, or harvesting old growth timber in the rain-forests of Indonesia[8] will be relatively easy for the authorities to track, so that the ratio $\frac{\theta}{\bar{\theta}}$ will rise closer to 1. However, other easy to monitor activities, such as certain occupations in traditional agriculture will also be easy to monitor, while some extractive activities, such as oil exploration, will be hard to track.

The tendency for oil exporting countries to exhibit "Dutch disease", in which export oriented manufactures suffer, is widely noted, as is a tendency for resource exporters to give short shrift to education Humphrey's, Sachs and

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[8]This last is the focus of Ross (2001).

Stiglitz (2007). While in the case of it's eponymous country Dutch disease is likely the result of exchange rate appreciation, one notes that authoritarian regimes looking to stay in control would likely resist the emergence of new industries, and the expansion of education, given they would make surveillance more difficult. Likewise, cultivation on large estates that makes inefficient use of landless laborers is likely easier to monitor than small individual land holdings, offering a new perspective on Robinson's argument that small coffee growers in Costa Rica have been a mainstay of that country's democracy. More generally, we might expect authoritarian regimes to have been more resistant to the expansion of agriculture to remote venues that are harder to monitor and control. Indeed, Britain's North American colonies of a quarter millennium ago were given considerable economic autonomy, and used the opportunity to prepare a rebellion.

Likewise, the model set forth here is consistent with regimes that remain authoritarian despite asymmetric information imposing intrusive controls on innovative economic activity. The extreme form of this is illustrated in Solzhenitzyn's novel *First Circle* in which research scientists work inside a prison, so that Stalin's henchmen can keep them under constant surveillance. However, the tendency for authoritarian regimes to place nearly crippling controls on any sort of innovative or independent economic activity is widespread. This corresponds to the cases in the model in which $\frac{\theta}{\bar{\theta}}$ is small, but not so small that the regime actually liberalizes.

The "Transparency Curse" and Innovation.

While there is no presumption that information issues have become more intensive over time–hunting and gathering activities are notoriously complex, while assembly line work is infamous for its repetitive drudgery, it is likely that innovative activities are harder to monitor, if only because they are intrinsically novel. Moreover, the entrepreneurial process of translating new

inventions into marketable results may be particularly hard to distinguish from an aggressive anti-government conspiracy.

One might thus expect that the pressures to liberalize will be particularly keenly felt at moments of economic transformation–especially when that transformation involves the creation of new technology. Greenwood and Yorukoglu (1997) note that the adoption of new technology is often accompanied by an increase in the skill premium (in the model here this would correspond with a lower $\frac{\underline{\theta}}{\bar{\theta}}$ and a more severe monitoring problem). Of course, buying that technology "off the rack" is one thing, integrating it into the economy is another. Repressive governments have been heavy consumers of the latest military technology as far back as history recounts, and during the notoriously repressive Czarist regime in Russia the aristocracy in that country were nevertheless avid consumers of the latest luxuries. However, integrating a new technology into the economic fabric of a society is another matter. Across Europe repressive regimes were replaced by more liberal ones as the industrial revolution progressed, and today repressive states such as China and Iran struggle with the trade-off between repressing cyber technology, notably the internet, in order to maintain repressive control, and liberalizing in order to capture the economic benefits of the unrestricted application of new innovations.

While an elevated skill premium during times of innovation is not identical with the "inverted U-shaped" relationship between inequality and growth predicted by Kuznets (1955) and often referred to as the "Kuznets curve" it bears some similarities. Assuming that $\epsilon < \frac{1}{2}$, if one was to measure uncertainty about output in the model using the coefficient of Gini (1921) to measure the dispersion of the probability distribution over output. In the case that arises when $\frac{\underline{\theta}}{\bar{\theta}}$ is high enough to permit the government to distinguish between low productivity citizens producing at full force and high productivity citizens who have devoted sufficient time to plotting that

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they are dangerous (which we might label the "bureaucratic authoritarian" case) the Gini statistic for the pdf over output is:

$$G_{BA} = \frac{\epsilon(1-\epsilon)(\bar{\theta} - \underline{\theta})}{\underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})}$$

this is greater than the dispersion of output with a liberal regime:

$$G_{free} = \frac{\epsilon(1-\epsilon)(\bar{\theta} - \theta_0)}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)}$$

More ambiguous is the comparison with "Stalinist" repression in which no low productivity types can avoid the risk of being punished even if they work at full capacity:

$$G_{Stalin} = \frac{\epsilon\omega(1-\epsilon\omega)(\bar{\theta} - \Phi\underline{\theta})}{\Phi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Phi\underline{\theta})}$$

Of course the fate the despot can anticipate if he relents and sets $\alpha = 0$ is also relevant. Even the inefficiency and high variability of the Stalinist regime may be preferable from the standpoint of the despot to liberalizing if the former dictator in the liberal regime cannot lay claim to enough surplus, that is, if $1 - \Phi$ is too low (or in other words, if Φ is too high). However, the corollary to proposition 1 tells us that the range of $1 - \Phi$ consistent with choosing $\alpha = 0$ is wider for the potentially Stalinist regime facing a hard to monitor technology than for a bureaucratic authoritarian regime with an easier to monitor production technology. Perhaps ironically the polities with the best prospects for freedom, *ceteris paribus* are very similar, in terms of $\frac{\underline{\theta}}{\bar{\theta}}$ to those that have the most destructive form of authoritarian rule. Perhaps it is less of an accidental fluke than it appears that some of the worst repressive regimes have occurred in some of the most modernized countries.

Because this model addresses informational issues it is not directly comparable with the discussion by Acemoglu and Robinson (2002) of the political

genesis of the "Kuznets curve". However, those authors observe heterogeneous responses to economic growth, and the model here does so as well, albeit in a somewhat different way. From the perspective of this paper it is lack of transparency in the means of production that best fosters the emergence of democracy. Curiously the most innovative sectors of the world's economy may often be expected to be the least transparent, and so we might anticipate an association between the emergence of democracy and innovation. Notice that polities that produce using more transparent technologies may still participate in waves of growth in the world economy with less pressure for liberalization. It is not economic growth *per se* that creates the most favorable environment for the emergence of democracy (as Acemoglu and Robinson (2002) argue it can by exacerbating inequality and so spurring rebellion). Instead it is the lack of transparency in the productive technology that best fosters the emergence of political freedom.

Comparison with the "Resource Curse"

The income and democracy hypothesis put forward by Lipset (1959) asserted that wealthier countries are more likely to be democratic. While it lacked a theoretical foundation, it had the advantage of verisimilitude–even a cursory cross-national analysis reveals that wealth and democracy tend to appear together, although there are some glaring exceptions–including the resource rich monarchies of the Persian Gulf and the impoverished but democratic nation of India. Inspired in part by the example of the oil exporting kingdoms of the Middle East, and in part by close study of the internal politics of primary resource exporting countries, Ross (2001) and others have argued that there is something about primary resource exploitation that allows authoritarians to cling to power. This nebulous causal link has come to bear the label "resource curse".

However, just as there are nagging counterexamples to the income and democracy association, so too the "resource curse" has its detractors. Haber and Menaldo (2007) find little evidence that positive shocks to resource earnings have a different impact on the adoption of democratic institutions than to other positive earnings shocks. Turning to cases, consider the example of pharaonic Egypt. For thousands of years farm workers in Egypt used essentially the same technology to irrigate and till the Nile flood plane, and for thousands of years oppressive rulers extracted most of the surplus from their toils. This pattern comports closely with the portrayal in the literature of an extractive economy, except that the economic activity was not extractive: every year brought a new crop! Notice that this situation appears closely to comport with the case of $\xi < \frac{\theta}{\theta}$. In contrast, consider the flurry of gold prospecting in California in 1849: while the gold rush was all a matter of extracting resources, the miners were highly autonomous, setting up *de facto* local governments the inhabitants referred to as "mining districts" Umbeck (1981)–an example of even-handed governance that is hardly consistent with the stereotype of an extractive authoritarian state.

Of course, individual counter-examples are not definitive evidence, and nature is a notoriously poor research assistant when it comes to designing experiments. Nevertheless, between the apparent counter examples and one's desire for a compact explanation one would like to look for an explanation based on something intrinsic to the tension between freedom and authoritarian rule to explain the association between economic activity and government type.

The model set forth here shares with the literature on the resource curse and on the association between high income and democracy that there are some economic environments more congenial to authoritarian rule. It is even the case that the informational explanation posited here makes predictions that are correlated with the both the "resource curse" and the "democracy

as a normal good" hypotheses. But despite the similarity of some of its predictions, this model is different. It places central importance on the level of transparency that a particular productive activity entails, and not on whether it makes use of an exhaustible input, nor on how high the level of output happens to be.

3 Conclusion

The hypothesis set forth here, that it is asymmetric information that maximizes the pressure for political freedom, suggests that we will observe heterogeneity among the governments observed in different countries that is related to the difficulty of monitoring economic activity. While this difficulty is likely to be correlated with the level of income, and with extractive activities, it is the informational environment itself that is key to the emergence of democracy. Looked at the other way, too little information asymmetry creates what we might think of as a "curse of information": regimes that can easily monitor productive activity and so detect plotting at an early stage will tend to remain autocratic. A transparent productive technology may be the enemy of nascent democracy!

Appendix: The Equilibrium

Proposition 1: The following strategies and beliefs constitute a perfect Bayesian equilibrium to the game set forth in section 1.1. If $\alpha = 0$, then:

$$\eta^* = \begin{cases} 1 & t < \Phi q \\ 0 & \Phi q \leq t \end{cases}$$

while if $\alpha = 1$:

$$\rho^* = \begin{cases} 1 & t < \Lambda q \text{ and } q < \xi\big(\theta_0 + \iota(\theta - \theta_0)\big) \\ 0 & \Lambda q \leq t \text{ or } \xi\big(\theta_0 + \iota(\theta - \theta_0)\big) < q \end{cases}$$

while in either case the government chooses t:

$$t^* = \begin{cases} \Phi q & \alpha = 0 \\ 0 & \text{otherwise} \end{cases}$$

If $\alpha = 1$ the government also chooses π:

$$\text{Prob}\{\pi^* = 1\} = \begin{cases} 0 & \iota = 0 \text{ and } \xi\theta_0 < q \\ 0 & \iota = 1 \text{ and } \xi\bar{\theta} < q \\ \frac{\Lambda q}{B + \Lambda q} & \iota = 1 \text{ and } \underline{\theta} < \xi\bar{\theta} \text{ and } q = \underline{\theta} \\ 1 & \text{otherwise} \end{cases}$$

In any case, the citizen chooses q^*:

$$q^* = \begin{cases} \theta_0 & \alpha = 0 \text{ and } \theta = \underline{\theta} \\ \bar{\theta} & \alpha = 0 \text{ and } \theta = \bar{\theta} \\ \theta_0 & \iota = 0 \text{ and } \alpha = 1 \\ \underline{\theta} & \iota = 1 \text{ and } \alpha = 1 \text{ and } \theta = \underline{\theta} \\ \bar{\theta} & \iota = 1 \text{ and } \alpha = 1 \text{ and } \theta = \bar{\theta} \text{ and } \xi \leq \frac{\underline{\theta}}{\bar{\theta}} \end{cases}$$

Finally, if $\iota = 1$ and $\alpha = 1$ and $\theta = \bar{\theta}$ and $\frac{\underline{\theta}}{\bar{\theta}} < \xi$, then the citizen plays a mixed strategy with:

$$\text{Pr}\{\tilde{q}\} = \begin{cases} \omega & \tilde{q} = \bar{\theta} \\ 1 - \omega & \tilde{q} = \underline{\theta} \end{cases}$$

where ω is given in equation (15) It follows from (6) that $\omega \in (0, 1)$.

$$\iota_C^* = \begin{cases} 1 & \theta = \bar{\theta} \\ 0 & \theta = \underline{\theta} \end{cases}$$

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$$
\iota_G^* = \begin{cases} 1 & \xi \leq \frac{\underline{\theta}}{\bar{\theta}} \text{ and } \theta_0 < \underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta}) \\ 1 & \frac{\underline{\theta}}{\bar{\theta}} < \xi \text{ and } \theta_0 < \Psi\underline{\theta} + \epsilon(1 - \omega)(\bar{\theta} - \Psi\underline{\theta}) \\ 0 & \text{otherwise} \end{cases}
$$

where:

$$
\alpha^* = \begin{cases} 1 & \xi \leq \frac{\underline{\theta}}{\bar{\theta}} \text{ and } 1 - \Phi < \tau_H \\ 1 & \frac{\underline{\theta}}{\bar{\theta}} < \xi \text{ and } 1 - \Phi < \tau_L \\ 0 & \text{otherwise} \end{cases}
$$

where

$$
\tau_H = \frac{\underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)}
$$
$$
\tau_L = \frac{\max\{\theta_0, \Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta})\}}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)}
$$

From conditions (4) and the definition of $\Psi \in (0,1)$ it follows that: $\tau_H > \tau_L$.

Next consider beliefs. At stage 2 the government's beliefs about θ are characterized by a Bernoulli distribution with $\Pr\{\theta = \bar{\theta}\} = \epsilon$ and $\Pr\{\theta = \underline{\theta}\} = 1 - \epsilon$. At stage 4 if $\alpha = 0$ the government's beliefs about the level of θ are irrelevant, as it simply offers transfer of Φq regardless of what it thinks of the citizen's type[9].

If $\alpha = 1$ and $\iota = 0$ the government's stage 4 beliefs remain Bernoulli with $\Pr\{\theta = \bar{\theta}\} = \epsilon$ and $\Pr\{\theta = \underline{\theta}\} = 1 - \epsilon$, although these are irrelevant to the government's decision making.

If $\alpha = 1$ and $\iota_G = 1$ and $\xi \leq \frac{\underline{\theta}}{\bar{\theta}}$ then at stage 4 the government's beliefs are given by:

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[9]Of course, if the citizen follows her equilibrium strategy then her type is revealed, however the government's beliefs in the wake of an out of equilibrium move are irrelevant. No value for q above $\bar{\theta}$ is possible, any value of $q \in (\underline{\theta}, \bar{\theta}]$ will lead the government to assign a posterior density of 1 to $\theta = \bar{\theta}$, and any value for $q < \underline{\theta}$ will lead to the government offering a transfer of Φq, regardless of the relative weight the government assigns to the events $\theta = \bar{\theta}$ and $\theta = \underline{\theta}$.

$$p(\theta = \bar{\theta}|q) = \begin{cases} 1 & q \in (\underline{\theta}, \bar{\theta}] \\ r_1 & q \in (\xi\bar{\theta}, \underline{\theta}] \\ \epsilon & q \in (\xi\underline{\theta}, \xi\bar{\theta}) \\ r_2 & q \leq \xi\underline{\theta} \end{cases}$$

where $r_1 = 1$, and $r_2 = 0$. However, notice that any values for $r_i \in [0, 1]$, $i \in \{1, 2\}$ will support the rest of the equilibrium.

If $\alpha = 1$ and $\iota_G = 1$ and $\dfrac{\underline{\theta}}{\bar{\theta}} < \xi$, then

$$p(\theta = \bar{\theta}|q) = \begin{cases} 1 & q \in (\underline{\theta}, \bar{\theta}] \\ \frac{(1-\Psi)\theta}{B+\underline{\theta}} & q = \underline{\theta} \\ \epsilon & q \in [\xi\underline{\theta}, \underline{\theta}) \\ r_3 & q \in [0, \xi\underline{\theta}) \end{cases}$$

where $r_3 = 0$, although any value for $r_3 \in [0, 1]$ will support the rest of the equilibrium.

At each of the citizen's decision nodes she is aware of nature's choice of θ–her only sources of uncertainty in this game are the mixed strategies she and the government employ at the quantity-setting and punishment phases. **Proof:** Working backwards through the time line, notice that if $\pi = 1$ then stage 6 does not arise. The choice of ρ is also irrelevant if either $\alpha = 0$ (in which case the citizen can simply vote the government out out office, which by inequality (5) is easier than staging a revolt) or $q \geq \xi(\theta_0 + \iota(\theta - \theta_0))$ in which case the citizen has not dedicated enough time to preparing a rebellion to have the option of setting $\rho = 1$. However, if $\alpha = 1, \pi = 0$ and $q < \xi(\theta_0 + \iota(\theta - \theta_0))$ equation (14) becomes:

$$\underset{\rho}{\text{Max}} \; U_C = t + \rho(\Lambda q - t)$$

Here U_C is increasing in ρ for $t < \Lambda q$ and decreasing in ρ when $\Lambda q < t$, so

$$\rho^* = \begin{cases} 1 & t < \Lambda q \\ 0 & t \geq \Lambda q \end{cases}$$

is maximal.

If $\alpha = 0$ equation (13) becomes:

$$\underset{\eta}{\text{Max}}\ U_C = t + \eta\big(\Phi q - t\big)$$

Again, recall from inequality (5) that even if it required no preparation at all the citizen would prefer to oust the government *via* legal means, setting $\eta = 1$ rather than rebel with $\rho = 1$.

Here U_C is increasing in η for $t < \Phi q$ and decreasing in η when $\Phi q < t$, so

$$\eta^* = \begin{cases} 1 & t < \Phi q \\ 0 & t \geq \Phi q \end{cases}$$

is maximal.

At stages 4 and 5, if $\alpha = 0$ then the government cannot choose π, while it receives a payoff of 0 if it sets a transfer of $t < \Phi q$, whereas it receives $q - t$ if $\Phi q \leq t$. As this is decreasing in t it will choose $t = \Phi q$ when $\alpha = 0$. Next suppose that $\alpha = 1$ and $\iota = 0$, while $\pi = 0$. In this case, if we have in addition $\xi\theta_0 < q$ the citizen is not "armed" for rebellion, and the government sets a transfer of $t = 0$. If instead $q \leq \xi\theta_0$ when $\alpha = 1$ and $\iota = 0$, with $\pi = 0$ then the government faces certain rebellion if it does not offer a transfer of at least Λq, while it can garner Ψq by punishing the citizen. By condition (3) the government prefers to repress, and so it's best response is to set $\pi = 1$ and $t = 0$.

Now consider the cases that arise when $\alpha = 1$ and $\iota = 1$. If we add the condition that $\xi\bar{\theta} < q$ then the citizen is not prepared to rebel, and the

government sets $\pi = 0$ and offers a transfer of $t = 0$. If instead $q < \xi\underline{\theta}$ the government can be sure that the citizen is armed and ready to rebel if she does not receive a transfer of Λq, so that by condition (3) the government prefers to punish, setting $\pi = 1$ and $t = 0$. Likewise, for $q \in (\underline{\theta}, \xi\bar{\theta})$ (a situation that only arises if $\frac{\underline{\theta}}{\bar{\theta}} < \xi$) the government knows that the citizen must be of type $\theta = \bar{\theta}$ and so infers that she is armed, and that it must either appease with a transfer of Λq or punish, so by condition (3) it opts to punish, setting $\pi = 1$ and $t = 0$.

Now suppose that $q \in (\xi\underline{\theta}, \underline{\theta})$. The government assigns a probability ϵ to the possibility that the citizen has the high productivity level $\bar{\theta}$, and a probability $1-\epsilon$ that her productivity is instead equal to $\underline{\theta}$. The government's expected utility from not repressing and setting a transfer level of $0 \leq< t < \Lambda q$ is:

$$-\epsilon B + (1 - \epsilon)(q - t) \leq -\epsilon B + (1 - \epsilon)q < 0$$

where the strict inequality follows from condition (6). If the government transfer is larger: $\Lambda q \leq t$ then it garners an expected utility of $q - t$, and so sets $t = \Lambda q$. However, by condition (3) it prefers the payoff of Ψq that it can achieve by punishing the citizen and setting a transfer of 0.

Finally consider the case with $\frac{\underline{\theta}}{\bar{\theta}} < \xi$ and $q = \underline{\theta}$. The government's expected utility from not repressing is:

$$
\begin{aligned}
p(\bar{\theta}|\underline{\theta})(-B) + \left(1 - p(\bar{\theta}|\underline{\theta})\right)\underline{\theta} &= -\frac{(1 - \Psi)\underline{\theta}}{B + \underline{\theta}}B + \frac{B + \Psi\underline{\theta}}{B + \underline{\theta}}\underline{\theta} \\
&= \frac{-B\underline{\theta} + \Psi\underline{\theta}B + B\underline{\theta} + \Psi\underline{\theta}^2}{B + \underline{\theta}}
\end{aligned}
$$

$$= \Psi\underline{\theta}$$

whereas it nets a payoff of $\Psi\underline{\theta}$ if it punishes the citizen. As these expected payoffs are equal the government is willing to mix between punishment and forbearance as called for by its equilibrium strategy when $q = \underline{\theta}$ and $\frac{\underline{\theta}}{\bar{\theta}} < \xi$.

Next let's turn our attention to the citizen's output decision at stage 3, suppose ι has already been selected. If $\alpha = 0$ then $t^* = \Phi q$ and equation (10) simplifies to:

$$\underset{q}{\text{Max}} \ E\{\big(\Phi q + \eta^*(\Phi q - \Phi q)\big)|\Re_3\}$$

That is:

$$\underset{q}{\text{Max}} \ \Phi q \tag{17}$$

and so the citizen produces up to capacity, namely $q = \theta$.

By the same token, if $\alpha = 0$ it is up to the citizen to choose ι. Substituting $q = \theta_0 + \iota_C^*(\bar{\theta} - \theta_0)$ into (17) we have:

$$\underset{\iota_C}{\text{Max}} \ \Phi\big(\theta_0 + \iota_C(\theta - \theta_0)\big)$$

the solution to this problem will be $\iota_C = 1$ if $\theta = \bar{\theta} > \theta_0$ and $\iota_C = 0$ if $\theta = \underline{\theta} < \theta_0$, so that:

$$q^* = \begin{cases} \theta_0 & \alpha = 0 \text{ and } \theta = \underline{\theta} \\ \bar{\theta} & \alpha = 0 \text{ and } \theta = \bar{\theta} \end{cases}$$

If instead $\alpha = 1$ then the citizen's stage 3 objective becomes:

$$\underset{q}{\text{Max}} \ E\{(1 - \pi^*)\big(t^* + \rho^*\big(\Lambda q - t^*\big) - \pi^* B|\Re_3\}$$

Notice that given the government's equilibrium (π^*, t^*), when $\iota = 0$ the citizen's utility function becomes:

$$U_C = \begin{cases} 0 & \xi\theta_0 < q \\ -B & q \leq \xi\theta_0 \end{cases}$$

The citizen seeks to maximize this subject to the constraint that $q \leq \theta_0$. The result $q = \theta_0$ is maximal.

When $\alpha = 1$, $\iota = 1$, $\theta = \bar{\theta}$, and $\xi \leq \frac{\underline{\theta}}{\bar{\theta}}$ the citizen's equilibrium utility simplifies to:

$$U_C = \begin{cases} 0 & q > \xi\bar{\theta} \\ -B & q \leq \xi\bar{\theta} \end{cases}$$

Maximizing U_C subject to the constraint that $q \leq \bar{\theta}$ the quantity $q = \bar{\theta}$ is a solution.

When $\alpha = 1$, $\iota = 1$, $\theta = \bar{\theta}$, and $\frac{\underline{\theta}}{\bar{\theta}} < \xi$, then if the citizen selects an output level of $q = \underline{\theta}$ her expected utility is:

$$\mathrm{pr}\{\pi^* = 1 | q = \underline{\theta}\}(-B) + \mathrm{pr}\{\pi^* = 1 | q = \underline{\theta}\}\underline{\theta} = \frac{\Lambda\underline{\theta}}{B + \Lambda\underline{\theta}}(-B) + \frac{B}{B + \Lambda\underline{\theta}}\Lambda q = 0$$

so her equilibrium expected utility simplifies to:

$$U_C = \begin{cases} 0 & q > \xi\bar{\theta} \\ 0 & q = \underline{\theta} \\ -B & \text{otherwise} \end{cases}$$

this leaves the citizen indifferent between choosing $q = \underline{\theta}$ and $q = \bar{\theta}$ and so she is willing to carry out her equilibrium strategy of mixing between the two.

When $\alpha = 1$, $\iota = 1$, and $\theta = \underline{\theta}$ and $\xi \leq \frac{\underline{\theta}}{\bar{\theta}}$ the citizen's equilibrium utility simplifies to:

$$U_C = \begin{cases} 0 & q > \xi\bar{\theta} \\ -B & q \leq \xi\bar{\theta} \end{cases}$$

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Maximizing U_C subject to the constraint that $q \leq \underline{\theta}$ the quantity $q = \underline{\theta}$ is a solution.

If instead $\alpha = 1$, $\iota = 1$, and $\theta = \bar{\theta}$ and $\xi < \dfrac{\underline{\theta}}{\bar{\theta}}$ then if the citizen chooses $q = \underline{\theta}$ she receives an expected utility of:

$$pr\{\pi^* = 1 | q = \underline{\theta}\}(-B) + pr\{\pi^* = 1 | q = \underline{\theta}\} \times 0 = \frac{-B\Lambda\underline{\theta}}{B + \Lambda\underline{\theta}} > -B$$

and so her expected utility as a function of q becomes:

$$U_C = \begin{cases} \frac{-B\Lambda\underline{\theta}}{B+\Lambda\underline{\theta}} & q = \underline{\theta} \\ -B & q < \underline{\theta} \end{cases}$$

hence $q = \underline{\theta}$ is maximal.

If the government has chosen $\alpha = 1$ then it must select ι. If it opts for $\iota_G = 0$ the government's expected utility becomes θ_0.

If instead $\alpha = 1$ with $\xi \leq \dfrac{\underline{\theta}}{\bar{\theta}}$ a choice of $\iota_G = 1$ yields an expected utility of:

$$\underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta}) \tag{18}$$

if follows from the expression (4) that:

$$\theta_0 < \underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})$$

so the government will select $\iota_G = 1$.

Now let's take up the case of $\dfrac{\underline{\theta}}{\bar{\theta}} < \xi$. A choice of $\iota_G = 1$ yields the government an expected utility of:

$$\Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta}) \tag{19}$$

The government will select $\iota_G = 1$ if

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$$\theta_0 < \Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta})$$

while it will choose $\iota_G = 0$ otherwise.

Finally, we come to the government's stage 2 decision whether to liberalize or to repress. A choice of $\alpha = 0$ will net the government an expected payoff of:

$$U_G = (1 - \Phi)\big(\theta_0 + \epsilon(\bar{\theta} - \theta_0)\big)$$

in contrast, if $\xi \leq \dfrac{\underline{\theta}}{\bar{\theta}}$ the government's expected payoff from choosing $\alpha = 1$ is given by (18), and so the government will repress if and only if:

$$(1 - \Phi)\big(\theta_0 + \epsilon(\bar{\theta} - \theta_0)\big) < \underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})$$

that is, if and only if:

$$(1 - \Phi) < \frac{\underline{\theta} + \epsilon(\bar{\theta} - \underline{\theta})}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)}$$

If $\dfrac{\underline{\theta}}{\bar{\theta}} < \xi$ then the government garners the expected utility in expression (19) if it selects $\iota = 1$. It will prefer to do so if and only if:

$$(1 - \Phi)\big(\theta_0 + \epsilon(\bar{\theta} - \theta_0)\big) < \max\{\theta_0, \Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta})\} \equiv \tau_H$$

this condition simplifies to:

$$(1 - \Phi) < \frac{\max\{\theta_0, \Psi\underline{\theta} + \epsilon\omega(\bar{\theta} - \Psi\underline{\theta})\}}{\theta_0 + \epsilon(\bar{\theta} - \theta_0)} \equiv \tau_L$$

As for the government's beliefs about θ, these are irrelevant when $q \leq \xi\dfrac{\underline{\theta}}{\bar{\theta}}$, in which case the government can be certain the citizen will rebel if she is neither punished nor appeased. Likewise, the government's beliefs are irrelevant when $\xi\bar{\theta} < q$, in which case the government can be certain that

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the citizen is unable to rebel, whatever her type. When $\underline{\theta} < q \leq \xi\bar{\theta}$, the government can be certain that $\theta = \bar{\theta}$ and that the citizen will rebel unless appeased or punished. When $q = \underline{\theta}$ and $\frac{\theta}{\bar{\theta}} < \xi$ then the government can use the mixed strategy of the high types, and the pure strategy of the low productivity citizens to formulate its beliefs about the citizen's type:

$$p(\theta = \bar{\theta}|q = \underline{\theta}) = \frac{\epsilon(1-\omega)}{\epsilon(1-\omega)+1-\epsilon} = \frac{\epsilon(1-\omega)}{1-\epsilon\omega}$$

substituting ω from equation (15) we have:

$$p(\theta = \bar{\theta}|q = \underline{\theta}) = \frac{\epsilon\left(1 - \left(\frac{\epsilon(B+\underline{\theta})-(1-\Psi)\underline{\theta}}{\epsilon(B+\Psi\underline{\theta})}\right)\right)}{1 - \epsilon\left(\frac{\epsilon(B+\underline{\theta})-(1-\Psi)\underline{\theta}\epsilon}{\epsilon(B+\Psi\underline{\theta})}\right)}$$

$$= \frac{\epsilon\left(\frac{\underline{\theta}(1-\epsilon)(1-\Psi)}{\epsilon(B+\Psi\underline{\theta})}\right)}{1 - \epsilon\left(\frac{\epsilon(B+\underline{\theta})-(1-\Psi)\underline{\theta}\epsilon}{\epsilon(B+\Psi\underline{\theta})}\right)}$$

$$= \frac{\frac{\underline{\theta}(1-\epsilon)(1-\Psi)}{(B+\Psi\underline{\theta})}}{\frac{B(1-\epsilon)+\Psi\underline{\theta}(1-\epsilon)}{(B+\Psi\underline{\theta})}}$$

$$= \frac{(1-\Psi)\underline{\theta}}{B + \Psi\underline{\theta}}$$

When the citizen produces an out of equilibrium quantity that satisfies (16) then Bayes rule does not apply, as the move occurs with zero probability in equilibrium. In this case the government assigns a probability of ϵ to the citizen having $\theta = \bar{\theta}$. $\square$

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