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Transparency and Stability

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Abstract

We revisit the theory that Hollyer, Rosendorff, and Vreeland use in their research program on transparency and political stability. We show that in a representative citizen setting and in their multi-citizen model, more transparency increases the likelihood of revolution if this likelihood is sufficiently small, but *reduces* the likelihood of revolution if it is sufficiently large. Rather than coordination concerns, the mechanism driving this result reflects the logic of “gambling for resurrection”: when you’re ahead, don’t give information, but when you’re behind, gamble for resurrection by providing more information. Their model suggests that protest risk drives transparency, not the converse: regimes facing a low likelihood of revolution should reduce transparency, while those facing a high likelihood of revolution should raise transparency, generating a positive correlation between transparency and instability. Moreover, we show that in Hollyer et al.’s core models, a citizen’s net payoff from revolting does not depend on either the citizen’s private economic well-being, or the public economic situation: economic interest, either self-interest or sociotropic interest, is not itself an incentive to protest. Rather, the model is a sun-spot game, with economic data playing the role of sun-spots, which, by assumption, act as focal points for coordination.

Keywords: Transparency, Stability, Protest, Revolution

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In a series of influential papers, Hollyer, Rosendorff, and Vreeland explore the relationship between transparency and political stability. These papers build on their 2015 APSR paper, “Transparency, Protest and Autocratic Instability”, and have been collected and expanded into a book, *Information, Democracy and Autocracy: Economic Transparency and Political (In)Stability* (Hollyer et al. 2018), by Cambridge University Press. The authors develop a model to argue that autocratic regimes that increase the transparency of their economic data face a higher probability of protest and regime change. Their notion of transparency is given by the variance of noise in economic data, which they empirically measure based on how much economic data are not reported. Hollyer, Rosendorff, and Vreeland’s research program is the most comprehensive line of inquiry in the literature that combines theory and data to understand the relationship between transparency and political stability. As such, this research program is well-positioned to guide and influence future research in the area. Our paper revisits the theoretical foundations of their model, highlighting issues with the interpretations and conclusions drawn.

We first develop a simple formulation of their model in which a single representative citizen must decide whether to revolt against a ruler whose type is unknown to the citizen. Revolt is optimal against sufficiently bad (low type) rulers, but not against sufficiently good (high type) ones, and the citizen receives a noisy signal of the ruler’s normally-distributed type. We prove that increased transparency (less noise in the signal) *increases* the likelihood of regime change if the ex-ante likelihood of regime change is below a threshold, but *reduces* it if this likelihood is above a threshold. Thus, a strategic regime would want to increase transparency when protest is likely, and reduce it when protest is unlikely. The logic is simple—if, ex ante, a regime is believed to be good, then it should prevent information arrival that could alter citizen views; but if beliefs suggest that the regime is bad, then it should gamble on news arrival that might sway citizen views. This logic suggests that transparency and the likelihood of protest should be *positively* correlated.

Hollyer et al.’s core model features a continuum of citizens who must decide whether to revolt when there is a binary state about which all citizens see a noisy public signal (interpreted as economic data) and additionally each receives a noisy private signal. We show that the game is isomorphic to a sunspot game, in which a citizen wants to revolt if and only if enough other citizens revolt, and nothing else matters. This gives rise to a continuum of equilibria in which the public signal acts as a coordinating device. Hollyer et al. analyze a particular equilibrium selection, a “responsive equilibrium” in which, following intermediate public signals, citizens

with sufficiently low private signals revolt, while those with higher signals do not. They then *assume* that when the public signal is below the lower threshold, everyone revolts, and when it is above, no one does. We extend their analysis to prove that the properties of transparency are the exact same as in our representative citizen setting: increased transparency (less noise in the signal) *increases* the likelihood of regime change if the ex-ante likelihood of regime change is below a threshold, but *reduces* it if this likelihood is above a threshold.

Our final contribution is to extend the Hollyer et al. setting from a binary ruler type to a continuum of types. We prove that, for any public signal, a unique responsive equilibrium exists in which a citizen revolts whenever his signal is below a (public-signal contingent) threshold. We also prove that the likelihood of regime change is less sensitive to marginal increases in the variance of the public signal than the variance of private signals, underscoring that the publicness of signals is not a key driving force. The impacts of transparency on regime survival are the same as in the base model.

Our findings seem to conflict with the core message of Hollyer et al., who emphasize that autocratic regimes that increase the transparency of their economic data face an increased risk of protest and regime change. What accounts for this? We identify three broad issues with their theoretical foundations. First, we show that in their model, regardless of whether the revolution succeeds or fails, a citizen’s net payoff from revolting does not depend on either the citizen’s private economic well-being, or the public aggregate economic situation. Thus, economic interest, either self-interest or sociotropic interest, is not itself an incentive for individual action. Instead, public economic data are *assumed* to be focal points for coordination, making them indistinguishable from any other public data. This payoff structure results in a continuum of equilibria, of which Hollyer et al. select one. In this equilibrium, for some range of public economic data, citizens’ actions depend on their private economic well-being, while for other ranges of public economic data, private economic well-being does not influence behavior. We show that other, simpler, equilibria include a class in which all citizens revolt only when public data are bad, and a class in which all citizens revolt only when public data are good.

To see this multiplicity, consider Hollyer et al. (2019b), which extends their model of protest to analyze transparency and stability in democracies by adding a voting stage before the protesting stage. Citizens vote sincerely based on an incumbent’s economic performance. Voting perfectly reveals whether the incumbent is good or bad, but the same continuum of equilibria exists at the protest stage regardless of his revealed type. For example, while Hollyer et al.

assume that all citizens protest and remove an incumbent who wins if and only if the election reveals that he is bad, there is an otherwise identical equilibrium in which citizens only remove good incumbents.

Second, their key empirical prediction is that, when revolution is sufficiently unlikely, more precise public data increases the likelihood of regime change. As we show, when revolution is sufficiently likely, more precise public data reduces the likelihood of regime change (Hollyer et al. conjectured that the relationship between transparency and stability is ambiguous in this case). They attribute their prediction to coordination incentives or to differences between public and private signals. However, the same predictions obtains in our representative citizen setting—having multiple citizens is unnecessary. The true causal mechanism is ‘gambling for resurrection’ (Downs and Rocke 1994): when you’re ahead, don’t give any information; but when you’re behind, “gamble for resurrection” and provide more information. In the context of regime change, this logic implies that stable regimes are safe as long as accurate bad information does not arrive, so they should send noisy, uninformative signals—if it’s not broken, don’t fix it. In contrast, unstable regimes likely collapse unless accurate good information changes citizens’ behavior, so they should gamble to resurrect. This result appears in many settings, including revolutions and media freedom (Shadmehr and Bernhardt 2011, 2015; Edmond 2013; Gehlbach and Sonin 2014), electoral competition (Gul and Pesendorfer 2012), grading standards (Boleslavsky and Cotton 2015), and Bayesian persuasion models (Kamenica and Gentzkow 2011).

Third, in their model, the risk of protest causally drives transparency not, as claimed, the reverse. When the risk of protest is high, regimes optimally provide informative economic data, “gambling for resurrection”, implying a positive empirical correlation between protest and economic transparency. Contrary to this direction of causality, Hollyer et al. posit that (i) the relevant parameter region is where the prior likelihood of revolution is low, which excludes the logic of “gambling for resurrection,” and (ii) regimes exogenously use high transparency—even though it *reduces* the regime’s stability. To address this, Hollyer et al. (2019a) develop a new model in which higher transparency raises the likelihood of regime change, but this, in turn, reduces the probability of a coup because, *by assumption*, greater transparency subjects coup leaders to even greater risks of revolt. They argue that regimes use higher transparency to destabilize themselves and thereby discourage coups. This combination of assumptions and models lets them reconcile the positive correlation between transparency and political stability. However, the logic of “gambling for resurrection” and accounting for prior protest risk already does this.

One can also approach their model’s empirical implication from a different angle. Hollyer et al.’s *implicit* argument is that regimes can commit to a level of transparency. Concretely, ex-ante stable regimes can commit to low transparency. Then, if the likelihood of regime change were to rise, then a regime could not increase transparency—due to commitment—even if later adverse events would make it want to gamble for resurrection. Such commitment is strong, especially when their measure of transparency is based on how much economic data is reported and how much is missing (Hollyer et al. 2014, 2018). It seems likely that regimes that control reporting agencies can and would order them to report more economic data when it is in their interest. Finally, their measure of transparency is based on data disclosure and missing economic data,¹ but their model formalization of transparency is based on noise variance in the data. Models of censoring public data (Shadmehr and Bernhardt 2015) are different from models of making public data noisier (Edmond 2013): a regime censors by not reporting bad news, which is not the same as adding noise to the original distribution, as in their formulation.

Transparency and Stability

We begin with a simple model featuring a single representative citizen who must decide whether to revolt against a ruler whose type is unknown to the citizen. Revolting costs $k > 0$. If the citizen revolts, the revolution succeeds with probability $p \in (0, 1)$. Some rulers are better than others. The ruler’s type is given by $\theta \in \mathbb{R}$: higher θ s are better rulers. The citizen receives a net payoff of 1 from revolting and removing a ruler whose type is below a threshold, $\theta \leq T$, and he receives a net payoff of 0 from removing better rulers with types $\theta > T$. We assume that $k/p \in (0, 1)$, so that revolting is sometimes optimal. Let $a = 1$ indicate that the citizen revolts and $a = 0$ indicate that he does not revolt. The citizen’s payoff from action $a \in \{0, 1\}$ in state θ is:

$$u(a, \theta) = a \cdot (p \cdot \mathbf{1}_{\{\theta \leq T\}} - k),$$

where $\mathbf{1}_{\{\cdot\}}$ is the indicator function. The ruler’s type is uncertain, with $\theta \sim N(0, \rho)$. The citizen does not see θ , but he sees a noisy signal $y = \theta + \nu$, where $\nu \sim N(0, \tau)$ is distributed independently. We derive when, from an ex-ante perspective, lower signal noise (higher transparency)

¹“Our empirical measure of this concept is a function of the missingness/nonmissingness of data from the WDI [World Development Indicators from the World Bank]” (Hollyer et al. 2014, p. 426).

increases the likelihood of revolution.

Given signal y , the citizen wants to revolt if and only if $Pr(\theta \leq T|y) > k/p$, i.e.,

$$\Phi \left(\frac{T - \frac{\rho^2}{\rho^2 + \tau^2} y}{\sqrt{\frac{\rho^2 \tau^2}{\rho^2 + \tau^2}}} \right) > k/p.$$

A lower signal y means that a ruler is more likely to have a lower type. Thus, the citizen revolts if and only if:

$$y < y^* \equiv \frac{\rho^2 + \tau^2}{\rho^2} \left(T - \sqrt{\frac{\rho^2 \tau^2}{\rho^2 + \tau^2}} \Phi^{-1}(k/p) \right).$$

This implies that ex-ante likelihood of regime change is:

$$P(\tau) \equiv Pr(y < y^*) = \Phi \left(\frac{y^*}{\sqrt{\rho^2 + \tau^2}} \right) = \Phi \left(\frac{\sqrt{1 + (\tau/\rho)^2} T - \tau \Phi^{-1}(k/p)}{\rho} \right).$$

Differentiating with respect to τ yields:

$$\frac{\partial P}{\partial \tau} > 0 \text{ if } \frac{\tau/\rho^2}{\sqrt{1 + (\tau/\rho)^2}} \cdot T > \Phi^{-1}(k/p), \quad \text{but} \quad \frac{\partial P}{\partial \tau} < 0 \text{ if } \frac{\tau/\rho^2}{\sqrt{1 + (\tau/\rho)^2}} \cdot T < \Phi^{-1}(k/p).$$

Thus, when the normalized costs of revolt k/p is high or the threshold T is low, so that revolution is unlikely, lower noise (higher transparency), raises the likelihood of revolution. In contrast when k/p is low or the threshold T is high, so that revolution is likely, lower noise reduces the likelihood of revolution. Summarizing,

Proposition 1 *In this representative citizen setting, more transparency increases the likelihood of regime change if this likelihood is below a threshold, but reduces the likelihood of regime change if this likelihood is above a threshold.*

Proposition 1 establishes that transparency in the sense of lower noise variance hurts stable regimes but helps unstable regimes. The intuition is simple: when you're ahead, don't give information, but when you're behind, gamble for resurrection. To see this, suppose the citizen does not receive any signal y , or equivalently, the variance τ is almost infinite so the signal y is almost pure noise and hence irrelevant. Now, the citizen acts only based on his prior, revolting if and only if $Pr(\theta \leq T) > k/p$. As a result, if T is small or k/p is large, the citizen

never revolts. Therefore, the ruler would not want to give the citizen any information—greater transparency can only increase the risk of revolution. In contrast, if T is large or k/p is small, the citizen always revolts. Now, absent additional information, the citizen is sure to revolt, so giving information can only help the ruler—transparency can only reduce the risk of revolution. This logic holds even in our simple single representative citizen model, indicating that it does not hinge on coordination, different effects of public or private signals, higher order beliefs, or the methodology of global games, beauty contests, or sun spot games.

This logic also suggests an empirical implication: the likelihood of protest and transparency should be positively correlated. To illustrate, suppose we begin from a setting where all regimes are equally transparent, but some face a high likelihood of protest while others face a low risk, for example due to differences in T or k/p . Now, regimes with a high likelihood of protest should raise transparency, and those with a low likelihood should reduce it. Let (protest risk, transparency) denote a combination of the likelihood of protest and transparency. The logic says that if, for example, we begin with $\{(\text{low}, \text{medium}), (\text{high}, \text{medium})\}$, we may end up with $\{(\text{very low}, \text{low}), (\text{medium}, \text{high})\}$. That is, the model suggests that strategic decisions by regimes should generate a positive correlation between protest and transparency, with higher protest risk causing more transparency.

The Hollyer et al. Model

In Hollyer et al.’s core model a continuum of citizens decide whether to revolt. A revolution succeeds if and only if the fraction of revolvers, l , exceeds a threshold $T \in (0, 1)$. There is a binary state of world $\theta \in \{0, 1\}$. Citizens share a prior that $Pr(\theta = 1) = p$. Citizens observe a public signal, $y = \theta + \nu$, where $\nu \sim N(0, \tau)$, and each citizen i sees a private signal, $x_i = \theta + \epsilon_i$, where $\epsilon_i \sim N(0, \sigma)$, and θ , ν and ϵ_i s are independently distributed. Figure 1 presents citizen payoffs, where $k > 0$ is the cost of revolt, and $\beta > k$ is the benefit of participating in a successful revolt.

		outcome	
		$l \geq T$	$l < T$
Citizen i	Protest	$E[\theta] + \beta - k$	$E[\theta x_i, y] - k$
	No Protest	$E[\theta]$	$E[\theta x_i, y]$

Figure 1: Hollyer et al.’s Citizen Game

Hollyer et al. interpret the public signal y as public economic data, x_i s as citizens' income, and θ as the ruler's type. After a regime change, a random ruler is selected, whose type θ becomes the average income. Because citizens lack information about the new ruler other than their prior, their expectation of his type is $E[\theta]$. Without regime change, the current ruler remains in power, whose type θ , is again the average income. Given public signal y and private signal x_i , citizen i 's expectation about the current ruler's type is $E[\theta|x_i, y]$.

Their model has an additional stage, in which the ruler moves before citizens, deciding whether to provide a public good. If he provides the public good, average income is $g > 0$; if he does not provide it, average income is 0. A type θ ruler's payoff is $\mathbf{1}_{\{\text{provide public good}\}} \cdot \theta$. Thus, a $\theta = 1$ ruler provides the public good, and a $\theta = 0$ ruler does not. We set $g = 1$ to save on notation without losing content, so a ruler's type equals average income.

The first key point to glean from citizen payoffs in Figure 1 is that $E[\theta]$ and $E[\theta|x_i, y]$ are irrelevant for individual decision making. To see this, observe that citizens base decisions to protest on comparisons of net payoffs. When at least measure T revolt, the net payoff from protest is $(E[\theta] + \beta - k) - E[\theta] = \beta - k$, and when fewer than measure T revolt, the net payoff from protest is $(E[\theta|x_i, y] - k) - E[\theta|x_i, y] = -k$. Thus, strategic behavior and the set of equilibria are exactly the same as when citizen payoffs are given by Figure 2 below, in which all parameters, including the threshold T , are known.

		outcome	
		$l \geq T$	$l < T$
Citizen i	Protest	$\beta - k$	$-k$
	No Protest	0	0

Figure 2: Hollyer et al.'s Citizen Game

Thus, in their model, a citizen's incentive to revolt does not depend on whether the ruler is good or bad (θ), the citizen's private economic well-being (x_i), or the aggregate economic data y . Hollyer et al. (2015) observe that "incentives to engage in unrest...are highest when...economic performance is poor" (p. 766). However, their model lacks this feature: in their model, a poor citizen does not revolt because he has lower *opportunity costs* of revolt, or because he is more frustrated with the status quo (*expressive motives*), or because he believes a new ruler is likely to be better, and wants to participate in a movement that replaces a bad ruler with a better one (*pleasure-in-agency motives*). Rather, a citizen revolts only because he somehow believes others

are likely to revolt. That is, the model is a sun-spot coordination game, with economic data playing the role of sun spots, which act as focal points for coordination. This is problematic: if economic well-being is a key citizen concern, then, in addition to the chances for a revolution's success, aspirations to improve own economic well-being or that of the country should enter decisions to revolt. However, in the model, how a citizen acts is just based on an *exogenous social norm*.

It directly follows that there is a continuum of equilibria. For example, it is an equilibrium when citizens revolt if and only if aggregate economic data are neither too good nor too bad, e.g., if and only if $y \in [-1, 1]$. To see this, note that if everyone revolts, the revolution succeeds, in which case a citizen who revolted receives $\beta - k > 0$ by assumption. Thus, if a citizen believes that all others revolt after seeing economic data $y \in [-1, 1]$, then he revolts. Beliefs and equilibrium strategies are consistent, so this is an equilibrium. There is also an equilibrium in which citizens revolt if and only if the second digit of the aggregate economic data is odd: beliefs are so unrestricted that even implausible outcomes are not precluded.

From a methodological perspective, this is a sun-spot game (Cass and Shell 1983), in which the public signal acts as a coordinating device. Given any public signal, there are two equilibria, one in which everyone revolts and the regime changes, and one in which no one revolts and the regime survives: nothing links survival to fundamentals, so absent an arbitrary equilibrium selection criteria, there are no empirical restrictions. Because uncertainty, whether public or private, has nothing to do with citizens' payoffs, this game is essentially unrelated to global games or beauty contests (Morris and Shin 2002, 2003) or their applications (Bueno de Mequita 2010; Boix and Svolik 2013; Casper and Tyson 2014; Rundlett and Svolik 2016; Tyson and Smith 2018), save for being a game with strategic complementarities. Hollyer et al. (2015) relate their model to global games, "We depart from global games literature in a technical assumption: Classical formulations of global games exhibit the property of two-sided limit dominance" (p. 768), but this omits more fundamental departures.

Analysis

We next re-derive the equilibrium that Hollyer et al. (2015, 2018) characterize. Our proofs simplify algebra and extend the domain of the characterization beyond the conditions (e.g., $\sigma < \tau$) used in their proofs. We also highlight two adverse properties of that equilibrium: the

equilibrium thresholds for revolution set by citizens are not continuous in the public signal, and citizens' equilibrium behavior is insensitive to model parameters.

Hollyer et al. focus on a particular equilibrium selection, a “responsive equilibrium” (responsive to private signals) in which given the public signal, citizens with sufficiently low private signals revolt, while those with higher signals do not. That is, for some realizations of the public signal y , a citizen i revolts whenever his signal is below a threshold $x^*(y) \in \mathbb{R}$. A responsive equilibrium exists whenever the public signal falls between two thresholds ($\underline{y} < y < \bar{y}$), neither too low, nor too high. To close equilibrium selection for other public signals, Hollyer et al. assume that when the public signal is below the lower threshold ($y < \underline{y}$), everyone revolts, and when it exceeds the upper threshold ($y > \bar{y}$), no one revolts.

Proposition 2 (Hollyer et al. 2015, 2018) *Let $s(x_i, y)$ be the strategy of a citizen who observes private signal x_i and public signal y , where $s = 1$ indicates revolt, and $s = 0$ indicates no revolt. Equilibrium is described by three thresholds $(x^*(y), \underline{y}, \bar{y})$:*

$$s(x_i, y) = \begin{cases} 1 & ; y \leq \underline{y} \\ 1 & ; \underline{y} < y \leq \bar{y} \text{ and } x_i \leq x^*(y) \\ 0 & ; \underline{y} < y \leq \bar{y} \text{ and } x_i > x^*(y) \\ 0 & ; \bar{y} < y \end{cases} \quad \text{where } Pr(\theta = 0 | x_i = x^*(y), y) = \frac{k}{\beta},$$

and $\underline{y} < \bar{y}$ solve:

$$Pr(\theta = 0 | x_i = 1 + \sigma\Phi^{-1}(T), \underline{y}) = Pr(\theta = 0 | x_i = \sigma\Phi^{-1}(T), \bar{y}) = \frac{k}{\beta}. \quad (1)$$

Regime change occurs if $y \leq \underline{y}$, but not if $y > \bar{y}$, and if $y \in (\underline{y}, \bar{y}]$, regime change occurs if and only if $\theta = 0$.

A proof is in Appendix A. When $y < \underline{y}$, Hollyer et al. choose an equilibrium in which citizens always revolt, in effect setting $x^*(y) = \infty$ for $y < \underline{y}$. Similarly, they choose an equilibrium for $y > \bar{y}$ that corresponds to setting $x^*(y) = -\infty$ for $y > \bar{y}$. Because $x^*(y)$ remains finite when $y \in (\underline{y}, \bar{y})$, this implies that $x^*(y)$ is discontinuous at the thresholds $\underline{y}$ and $\bar{y}$, reflecting that the behavior of citizens inside the interval $(\underline{y}, \bar{y})$ is unrelated to their assumed behavior outside of it.

From Proposition 2, the ex-ante likelihood of regime change given public signal y is:

$$Pr(\text{regime change}|y) = \begin{cases} 1 & ; y \leq \underline{y} \\ Pr(\theta = 0|y) & ; \underline{y} < y \leq \bar{y} \\ 0 & ; \bar{y} < y. \end{cases}$$

Just as $x^*(y)$ was discontinuous at the boundaries $\underline{y}$ and $\bar{y}$, so is $Pr(\text{regime change}|y)$. For almost all public signal realizations, citizens do not respond to marginal variations in the environment:

$$\frac{\partial Pr(\text{regime change}|y)}{\partial(\text{any model parameter})} = 0, \quad \forall y \notin \{\underline{y}, \bar{y}\}.$$

Similarly, for any $y \in (\underline{y}, \bar{y})$, a citizen's behavior does not change if he believes others are marginally more or less likely to revolt. This is because, when $y \in (\underline{y}, \bar{y})$, by construction of the equilibrium, the citizen only cares about estimating the likelihood that the state is $\theta = 0$. Hol-lyer et al. analyze the effect of variations in the variance of public signal noise τ on the ex-ante likelihood of revolt. Within any region ($y < \underline{y}$, $\underline{y} < y < \bar{y}$, $\bar{y} < y$), a citizen's behavior and likelihood of regime change for the equilibrium of that region do *not* change with variations in model parameters, including τ . However, variations do change the unconditional ex-ante likelihood of regime change by altering the thresholds $\underline{y}$ and $\bar{y}$ that separate regions with different selected equilibrium. We next present the result that covers both the case where revolution is unlikely and where it is likely, extending the characterization in Hol-lyer et al. A proof is in Appendix A.

Corollary 1 *More transparency increases the likelihood of regime change if this likelihood is below a threshold, but reduces the likelihood of regime change if the likelihood exceeds a threshold.*

The intuition is identical to that for Proposition 1 in our representative citizen economy: when you're ahead, don't give information, but when you're behind, gamble for resurrection by giving more information. Hol-lyer et al. (2015, Proposition 3) focus on the first part of Corollary 1, missing the second part that reflects the logic of gambling for resurrection. They argue that "since incidences of successful mass protest are relatively rare," only the first part is relevant "in the vast majority of cases" (p. 772). This implies that regimes that choose greater transparency face a higher likelihood of revolution, generating a positive correlation between protest and transparency, which they find in their empirical analysis. However, focusing only

on the first part of Corollary 1 creates a dilemma: when higher transparency increases the risk of instability, why don't regimes *reduce* transparency?

“Why Do Autocrats Disclose?” (Hollyer et al. 2019a) addresses this. They argue that autocrats increase transparency (disclose) to reduce the likelihood of coups. To get this result, they *assume* (1) higher transparency increases the likelihood of protest, but (2) it increases this likelihood even more after coups. Thus, higher transparency hurts an autocrat, but it hurts those who coup even more. Some regimes then choose higher transparency than others for reasons that are exogenous to the model in Hollyer et al. (2015), i.e., due to the exogenous probability of coups in Hollyer et al. (2019a). This juxtaposition delivers the direction of causality from higher transparency to higher protest, justifying the regression of measures of stability on transparency in Hollyer et al. (2015, 2018). However, as we just showed, accounting for the logic of gambling for resurrection naturally generates the positive correlation between transparency and instability in their initial framework. This logic does not hinge on coordination, or the difference between public and private signals.

Obtaining a Unique Responsive Equilibrium

Hollyer et al. assume a binary state for the ruler, which means that responsive equilibria fail to exist when public signals are too high or too low, giving rise to a need to select among multiple possible equilibrium responses for these signals. To address this we extend their model so that rather than citizens receiving signals about a binary state (ruler's type), they receive signals about a continuously (normally) distributed state. We prove that, for any public signal, a unique responsive equilibrium exists in which a citizen revolts whenever his signal is below a (public-signal contingent) threshold (of course, there still exist a continuum of equilibria due to the state-independent payoff structure of the game). We then prove that this responsive equilibrium is unstable, and has perverse comparative statics—e.g., higher revolution costs increase the likelihood of revolution. This model allows for clean comparisons between marginal increases in the noise of public and private signals. We show that when the noise levels in the two signals are equal, the magnitude of the marginal impact of increased noise (higher variance) on a regime's probability of survival is *lower* for the public signal than for the private signals. That is, the publicness of the public signal, which one might interpret as facilitating coordination, does not amplify the impact of higher noise on the regime's stability.

To extend beyond a two-type ruler setting, we suppose that the ruler's type θ is drawn from a normal distribution which is common knowledge to citizens. We focus on equilibria in which, for a given public signal $y = \theta + \nu$, where $\nu \sim N(0, \tau)$, a citizen i revolts if and only if his private signal $x_i = \theta + \epsilon_i$ is below a (finite) threshold $x^*(y)$.

Proposition 3 *Suppose the ruler's type $\theta \sim N(0, \rho)$. For any public signal y , there is a unique equilibrium in which a citizen i revolts if and only if his signal is below a threshold, $x_i < x^*(y)$, and the regime changes if and only if $\theta < \theta^*(y)$. In equilibrium, more transparency increases the likelihood of regime change if the likelihood of regime change is below a threshold, but reduces the likelihood of regime change if the likelihood of regime change is above a threshold.*

We show in the proof that the equilibrium is unstable. In particular, if others raise their cutoff by δ , a citizen's best response is to raise his cutoff by more than δ . Because the equilibrium is unstable, making regime change more difficult (higher T) or increasing the costs of revolting (k/β) *increase* the likelihood of regime change. However, stability and these comparative statics do not change the basic logic of gambling for resurrection. The proof of Proposition 3 shows that when T or k/β are sufficiently high, so that the likelihood of regime change is sufficiently high, lower transparency (higher τ) increases the likelihood of regime change, hurting the regime. In contrast, when T or k/β are sufficiently low, so that the likelihood of regime change is sufficiently low, lower transparency (higher τ) reduces the likelihood of regime change, helping the regime.

A natural question is the role of the public-ness of the public signal on the effect of changes in its variance. That is, would it be different if we changed the variance of private signals instead of the variance of the public signal? This question is intimately linked to the effect of coordination. If there was only one player, then all signals would be on equal standing, and there would be no difference between y and x_i when $\tau = \sigma$. To capture the effect of coordination and the role of public-ness of the public signal we calculate the ratio of the marginal impact of noise in the public signal on the probability of regime change to the marginal impact of noise in the private signal on this probability at $\tau = \sigma$:

Proposition 4 *The likelihood of regime change is less sensitive to marginal increases in the variance of the public signal than the variance of private signals:*

$$\left| \frac{\frac{\partial \Pr(\text{regime change})}{\partial \tau}}{\frac{\partial \Pr(\text{regime change})}{\partial \sigma}} \right|_{\tau=\sigma} = \frac{\rho^2}{\rho^2 + \tau^2}.$$

Appendix A: Proofs

Proof of Proposition 2: We seek equilibria in which for some realizations of the public signal y , a citizen i revolts whenever his signal is below a threshold $x^*(y) \in \mathbb{R}$. For such realizations, the fraction of revolters $l(\theta)$ is:

$$l(\theta; x^*(y)) = \begin{cases} \Phi\left(\frac{x^*(y)}{\sigma}\right) & ; \theta = 0 \\ \Phi\left(\frac{x^*(y)-1}{\sigma}\right) & ; \theta = 1. \end{cases}$$

Clearly, $l(1; x^*(y)) < l(0; x^*(y))$. Thus, if $l(0; x^*(y)) < T$, then the revolution surely fails, so no one revolts, and hence there is no finite-threshold equilibrium. Similarly, if $l(1; x^*(y)) \geq T$, then the revolution surely succeeds, and hence everyone revolts, and, again, there is no finite-threshold equilibrium. Thus, a necessary condition for a finite-threshold equilibrium is $l(1; x^*(y)) < T \leq l(0; x^*(y))$. In this equilibrium, the regime collapses if and only if $\theta = 0$. Thus, given public signal y , a citizen i with private signal x_i revolts if and only if $Pr(\theta = 0|x_i, y) > \frac{k}{\beta}$; the marginal citizen with threshold signal $x_i = x^*(y)$ must be indifferent between revolting and not. In sum, given a public signal y , the threshold $x^*(y)$ describes an equilibrium if and only if:

$$\begin{aligned} \Phi\left(\frac{x^*(y) - 1}{\sigma}\right) < T \leq \Phi\left(\frac{x^*(y)}{\sigma}\right) & \quad (\text{belief consistency}) \\ Pr(\theta = 0|x_i = x^*(y), y) = \frac{k}{\beta} & \quad (\text{indifference condition}) \end{aligned}$$

These equations can be satisfied by an x^* if and only if the public signal is neither too large, nor too small. To see this, suppose the public signal is very low. Then, indifference requires that $x^*(y)$ be very large: when the public signal is very low, a citizen believes that $\theta = 0$ is very likely, so he almost always revolts. But if everyone almost always revolts, the revolution succeeds even when $\theta = 1$, contradicting the equilibrium premise that the revolution succeeds if and only if $\theta = 0$. In particular, the public signal cannot be so low that $T \leq \Phi\left(\frac{x^*(y)-1}{\sigma}\right)$.

The public signal at which this happens makes $x^*(y)$ just large enough to hit $\Phi\left(\frac{x^*(y)-1}{\sigma}\right) = T$, i.e., $x^*(y) = 1 + \sigma\Phi^{-1}(T)$. From the indifference condition, it is the public signal y that satisfies $Pr(\theta = 0|x_i = 1 + \sigma\Phi^{-1}(T), y) = \frac{k}{\beta}$. Letting $\underline{y}$ be this unique solution, if $y \leq \underline{y}$, then the indifference condition and belief consistency cannot simultaneously be satis-

fied. After any given $y \leq \underline{y}$, there is an equilibrium in which players revolt, and one in which they do not revolt. Similarly, letting $\bar{y}$ be the unique public signal realization that satisfies $Pr(\theta = 0|x_i = \sigma\Phi^{-1}(T), y) = \frac{k}{\beta}$, if $y > \bar{y}$, the indifference condition and belief consistency cannot simultaneously be satisfied. After any given $y > \bar{y}$, multiple equilibria again exist.

To deal with this multiplicity of equilibria, Hollyer et al. assume that citizens revolt after any given $y \leq \underline{y}$ and do not revolt after any given $y > \bar{y}$. $\square$

Proof of Corollary 1: Given state $\theta = 0$, the regime changes whenever $y \leq \bar{y}$; and given state $\theta = 1$, the regime changes whenever $y \leq \underline{y}$, yielding the unconditional ex-ante likelihood of regime change:

$$Pr(\text{regime change}) = (1 - p) \Phi(\bar{y}/\tau) + p\Phi((\underline{y} - 1)/\tau),$$

where $1 - p$ is the prior probability that $\theta = 0$. Differentiating with respect to τ yields:

$$\frac{\partial Pr(\text{regime change})}{\partial \tau} = (1 - p) \phi\left(\frac{\bar{y}}{\tau}\right) \frac{\partial}{\partial \tau} \left(\frac{\bar{y}}{\tau}\right) + p \phi\left(\frac{\underline{y} - 1}{\tau}\right) \frac{\partial}{\partial \tau} \left(\frac{\underline{y} - 1}{\tau}\right). \quad (2)$$

Using Bayes rule and the Normal distribution functional form,

$$Pr(\theta = 0|x_i, y) = \frac{1}{1 + \frac{p}{1-p} \frac{\phi\left(\frac{x_i - 1}{\sigma}\right) \phi\left(\frac{y - 1}{\tau}\right)}{\phi\left(\frac{x_i}{\sigma}\right) \phi\left(\frac{y}{\tau}\right)}} = \frac{1}{1 + \frac{p}{1-p} e^{\frac{2x_i - 1}{2\sigma^2}} e^{\frac{2y - 1}{2\tau^2}}}. \quad (3)$$

Substituting from (1) into (3) and simplifying algebra yields:

$$\begin{aligned} \underline{y} &= \frac{1}{2} \left(1 - \frac{\tau^2}{\sigma^2}\right) + \tau^2 \text{Log} \left(\frac{\beta - k}{k} \frac{1 - p}{p} \right) - \frac{\tau^2}{\sigma} \Phi^{-1}(T) \\ \bar{y} &= \frac{1}{2} \left(1 + \frac{\tau^2}{\sigma^2}\right) + \tau^2 \text{Log} \left(\frac{\beta - k}{k} \frac{1 - p}{p} \right) - \frac{\tau^2}{\sigma} \Phi^{-1}(T). \end{aligned}$$

Differentiating with respect to τ yields:

$$\begin{aligned} \frac{\partial \bar{y}}{\partial \tau} &= +\frac{1}{2} \left(\frac{1}{\sigma^2} - \frac{1}{\tau^2} \right) + \text{Log} \left(\frac{1 - p}{p} \right) - \left(\text{Log} \left(\frac{k}{\beta - k} \right) + \frac{\Phi^{-1}(T)}{\sigma} \right) = \frac{\bar{y} - 1}{\tau^2} \\ \frac{\partial \underline{y}}{\partial \tau} &= -\frac{1}{2} \left(\frac{1}{\sigma^2} - \frac{1}{\tau^2} \right) + \text{Log} \left(\frac{1 - p}{p} \right) - \left(\text{Log} \left(\frac{k}{\beta - k} \right) + \frac{\Phi^{-1}(T)}{\sigma} \right) = \frac{\underline{y}}{\tau^2}. \end{aligned}$$

Combining this with equation (2) yields:

$$\frac{\partial Pr(\text{regime change})}{\partial \tau} = (1-p) \phi\left(\frac{\bar{y}}{\tau}\right) \frac{\bar{y}-1}{\tau^2} + p \phi\left(\frac{y-1}{\tau}\right) \frac{y}{\tau^2}. \quad (4)$$

Thus, when k/β or T are sufficiently large, so that the revolution is sufficiently unlikely, $\max\{\bar{y}-1, y\} < 0$, and hence $\frac{\partial Pr(\text{regime change})}{\partial \tau} < 0$. In contrast, when k/β or T are sufficiently small, so that revolution is sufficiently likely, $\min\{\bar{y}-1, y\} > 0$, and hence $\frac{\partial Pr(\text{regime change})}{\partial \tau} > 0$. That is, when regime change is sufficiently unlikely, transparency raises the likelihood of regime change; when regime change is sufficiently likely, transparency reduces the likelihood of regime change. $\square$

Proof of Proposition 3: Equilibria are symmetric, and are characterized by cutoff pairs (θ^*, x^*) that satisfy:

$$\begin{aligned} Pr(x_i < x^*(y) | \theta^*(y)) &= T \quad (\text{belief consistency}) \\ Pr(\theta < \theta^*(y) | x_i = x^*(y), y) &= \frac{k}{\beta} \quad (\text{indifference condition}) \end{aligned}$$

That is,

$$\begin{aligned} \Phi\left(\frac{x^* - \theta^*}{\sigma}\right) &= T \quad (\text{belief consistency}) \\ \Phi\left(\frac{\theta^* - \frac{\tau^2 \rho^2 x^* + \sigma^2 \rho^2 y}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2}}{\sqrt{\frac{\tau^2 \sigma^2 \rho^2}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2}}}\right) &= \frac{k}{\beta} \quad (\text{indifference condition}) \end{aligned} \quad (5)$$

The equilibrium is unstable: if others raise their cutoff by δ , a citizen's best response is to raise his cutoff by more than δ . To see this, suppose all citizens $j \neq i$ raise their threshold from x^* to $x^* + \delta$. Then, the belief consistency condition implies that θ^* increases to $\theta^* + \delta$. But then, the indifference condition implies that player i raises his threshold by $(1 + \sigma^2 \frac{\rho^2 + \tau^2}{\rho^2 \tau^2})\delta > \delta$. Thus, as we will show, the equilibrium features perverse comparative statics.

From (5),

$$\begin{aligned} x^* &= \theta^* + \sigma \Phi^{-1}(T) \quad (\text{belief consistency}) \\ \theta^* - \frac{\tau^2 \rho^2 x^* + \sigma^2 \rho^2 y}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2} &= \sqrt{\frac{\tau^2 \sigma^2 \rho^2}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2}} \Phi^{-1}\left(\frac{k}{\beta}\right) \quad (\text{indifference condition}) \end{aligned}$$

Substitute belief consistency into the indifference condition and group the θ^* terms to obtain:

$$\frac{\sigma^2 \rho^2 + \tau^2 \sigma^2}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2} \theta^* = \frac{\tau^2 \rho^2}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2} \sigma \Phi^{-1}(T) + \frac{\sigma^2 \rho^2 y}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2} + \sqrt{\frac{\tau^2 \sigma^2 \rho^2}{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2}} \Phi^{-1}\left(\frac{k}{\beta}\right).$$

Solving for θ^* yields:

$$\theta^* = \frac{\tau^2 \rho^2}{(\rho^2 + \tau^2) \sigma^2} \sigma \Phi^{-1}(T) + \frac{\rho^2 y}{\rho^2 + \tau^2} + \frac{\sqrt{\tau^2 \sigma^2 \rho^2 (\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2)}}{(\rho^2 + \tau^2) \sigma^2} \Phi^{-1}\left(\frac{k}{\beta}\right).$$

Re-arranging to put in standard normal form:

$$\frac{\theta^* - \frac{\rho^2 y}{\rho^2 + \tau^2}}{\sqrt{\frac{\rho^2 \tau^2}{\rho^2 + \tau^2}}} = \sqrt{\frac{\tau^2 \rho^2}{\rho^2 + \tau^2}} \frac{1}{\sigma} \Phi^{-1}(T) + \sqrt{\frac{\tau^2 \rho^2 + \sigma^2 \rho^2 + \tau^2 \sigma^2}{\rho^2 + \tau^2}} \frac{1}{\sigma} \Phi^{-1}\left(\frac{k}{\beta}\right). \quad (6)$$

Thus, substituting from equation (6),

$$\begin{aligned} P \equiv Pr(\text{regime change}) &= \int Pr_{\theta|y}(\theta < \theta^*(y)) pdf(y) dy \\ &= \int \Phi\left(\frac{\theta^* - \frac{\rho^2 y}{\rho^2 + \tau^2}}{\sqrt{\frac{\rho^2 \tau^2}{\rho^2 + \tau^2}}}\right) pdf(y) dy \\ &= \Phi\left(\sqrt{\frac{\rho^2}{\rho^2 + \tau^2}} \left(\frac{\tau}{\sigma}\right)^2 \Phi^{-1}(T) + \sqrt{1 + \frac{\rho^2}{\rho^2 + \tau^2}} \left(\frac{\tau}{\sigma}\right)^2 \Phi^{-1}\left(\frac{k}{\beta}\right)\right). \end{aligned}$$

To compare the effect of τ and σ , when differentiating with respect to τ , it is convenient to differentiate with respect to (τ/σ) while holding $\tau\sigma$ outside (τ/σ) fixed, and then do the opposite. Thus, abusing notation,

$$\frac{dP}{d\tau} = \phi(Z) \left(\frac{\partial Z}{\partial(\tau/\sigma)} \frac{1}{\sigma} + \frac{\partial Z}{\partial\tau} \right),$$

where Z is the argument of Φ :

$$Z = \sqrt{\frac{\rho^2}{\rho^2 + \tau^2}} \left(\frac{\tau}{\sigma}\right)^2 \Phi^{-1}(T) + \sqrt{1 + \frac{\rho^2}{\rho^2 + \tau^2}} \left(\frac{\tau}{\sigma}\right)^2 \Phi^{-1}\left(\frac{k}{\beta}\right).$$

Calculating $\frac{\partial Z}{\partial(\tau/\sigma)}$ and $\frac{\partial Z}{\partial\tau}$ yields:

$$\begin{aligned}\frac{\partial Z}{\partial(\tau/\sigma)} &= \sqrt{\frac{\rho^2}{\rho^2 + \tau^2}} \left(\Phi^{-1}(T) + \frac{\tau}{\sigma} \sqrt{\frac{\frac{\rho^2}{\rho^2 + \tau^2}}{1 + \frac{\rho^2}{\rho^2 + \tau^2} \left(\frac{\tau}{\sigma}\right)^2}} \Phi^{-1}\left(\frac{k}{\beta}\right) \right) \\ \frac{\partial Z}{\partial\tau} &= -\frac{\tau}{\sigma} \frac{\tau}{\rho^2 + \tau^2} \sqrt{\frac{\rho^2}{\rho^2 + \tau^2}} \left(\Phi^{-1}(T) + \frac{\tau}{\sigma} \sqrt{\frac{\frac{\rho^2}{\rho^2 + \tau^2}}{1 + \frac{\rho^2}{\rho^2 + \tau^2} \left(\frac{\tau}{\sigma}\right)^2}} \Phi^{-1}\left(\frac{k}{\beta}\right) \right).\end{aligned}$$

Substituting for $\frac{\partial Z}{\partial(\tau/\sigma)}$ and $\frac{\partial Z}{\partial\tau}$ into $\frac{dP}{d\tau}$ yields:

$$\frac{dP}{d\tau} = \phi(Z) \frac{1}{\sigma} \left(\frac{\rho^2}{\rho^2 + \tau^2} \right)^{3/2} \left(\Phi^{-1}(T) + \frac{\tau}{\sigma} \sqrt{\frac{\frac{\rho^2}{\rho^2 + \tau^2}}{1 + \frac{\rho^2}{\rho^2 + \tau^2} \left(\frac{\tau}{\sigma}\right)^2}} \Phi^{-1}\left(\frac{k}{\beta}\right) \right). \quad \square$$

Proof of Proposition 4: Using the same notation as in Proposition 3,

$$\frac{dP}{d\sigma} = \phi(Z) \frac{\partial Z}{\partial(\tau/\sigma)} \left(-\frac{\tau}{\sigma^2} \right). \quad (7)$$

Substituting the equations (7) and (7) for $\frac{dP}{d\tau}$ and $\frac{dP}{d\sigma}$ to calculate their ratio yields

$$\left| \frac{\frac{dP}{d\tau}}{\frac{dP}{d\sigma}} \right|_{\sigma=\tau} = \frac{\frac{1}{\tau} \left(\frac{\rho^2}{\rho^2 + \tau^2} \right)^{3/2}}{\frac{1}{\tau} \sqrt{\frac{\rho^2}{\rho^2 + \tau^2}}} = \frac{\rho^2}{\rho^2 + \tau^2} < 1.$$

□

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