SOCIAL MEDIA GAME

In this section, we model the interaction between informed voters as a coordination game and show that the results are essentially the same as the simplified model presented in the main text. Suppose there are complementarities in the sharing decision of informed voters: that the costs associated with sharing the bad signal about the incumbent is given by the expression $c(1-\nu)$. In other words, the costs of sharing are decreasing in the ratio of IV who share the news. Substantively, this is because even though the regime can plausibly scale up monitoring citizens' social media activity easily, it still faces constraints in how many social media users it can arrest or imprison in a given period, and so the probability that any given user is singled out for punishment falls as more people take an action.

As in the main text, we take connectedness to be of the form $\theta = \mu + \psi$, where μ is interpreted as the level of internet penetration. The error term, drawn from a normal distribution with mean zero and precision α (*i.e.* variance $1/\alpha$), is the uncertainty regarding social factors that influence information flows through the social network. Here, to capture the different online experiences individuals have depending on their social networks, we assume that each IV i receives a private signal regarding the level of connectedness. This can be interpreted as the volume and content of activity they observe on their social media feeds and the inferences they make from them about overall connectedness in the society. This signal is of the form $x_i = \theta + \epsilon_i$, where ϵ_i is a random draw from a normal distribution with mean zero and precision β. Conditional on θ, the signals are independent and identically distributed across voters, and μ, α, and β are all common knowledge. We assume that the incumbent and the media outlets rely on the common prior when they make decisions.[1]

Consider an informed voter $i \in V_A$ who has learned via the alternative outlet that the incumbent is bad. Given the prior distribution of connectedness, the distribution of private signals,

[1]This assumption is sufficient to avoid the multiplicity of equilibria that would arise because of the informativeness of equilibrium strategies of the incumbent and media outlets if they had information that voters do not. See Angeletos, Hellwig, and Pavan (2006) for a discussion on signaling in global games.

and the signal x_i informed voter i has received, her posterior belief is such that θ is distributed normally with mean: $\rho_i = \mathbb{E}[\theta|x_i] = \frac{\alpha\mu+\beta x_i}{\alpha+\beta}$ and precision $\alpha + \beta$ (DeGroot 2005).

The informed voters' decision on whether to share the news or not depends on the relative payoffs of the two. Within the social media game, the expected utility gain of sharing for an IV is $\mathrm{EU}_i(\text{share}|x_i) - \mathrm{EU}_i(\text{refrain}|x_i) = \rho_i - c(1-\nu)$.

There are three intervals in which we examine the best response of an informed voter:

- When $\rho_i < 0$, the expected utility of sharing is negative regardless of the actions of the other IV. Thus, refraining is a strictly dominant strategy.
- When $\rho_i \in [0, c]$, neither strategy is strictly dominant. The optimal strategy depends on players' beliefs on the value of connectedness and other players' strategies.
- When $\rho_i > c$, the expected benefit of sharing is always greater than its cost regardless of what the other IV do. Thus, sharing is a strictly dominant strategy.

A pure strategy for an IV in the social media game is a function specifying an action for each possible posterior, that is to say, $s_i(\rho_i) \in \{\text{share}, \text{ refrain}\}$ for all ρ_i. Because the benefit of sharing is monotonic in the posterior on connectedness, threshold strategies are natural candidates for an equilibrium. Here, if an IV shares the news at posterior expectation $\hat{\rho}$, she should share it at any $\rho \geq \hat{\rho}$. As shown below, in equilibrium each informed voter shares when their posterior expectation of connectedness is higher than some threshold ρ^* and refrains when it is lower.

Because the preferences of informed voters are identical, when they use a threshold strategy their thresholds must be equal. We show this is indeed the case, and that such a strategy profile is the only profile that survives iterated elimination of strictly dominated strategies. Consider an IV whose posterior expectation is exactly equal to ρ^*, the threshold. This means that she must be indifferent between sharing and refraining. This holds only when the expected benefit of sharing equals its expected cost, and so $\rho_i = c(1-\nu)$. To find the threshold, we must first calculate the expected value of ν in equilibrium: the expected proportion of IV who share the news on social media conditional on the posterior expectation ρ^*.

Lemma A.1. *An IV i with posterior ρ_i believes that a fraction $1 - \Phi\left(\sqrt{\eta}(\rho_i - \mu)\right)$ of other IVs share the news on social media in equilibrium, where Φ denotes the cumulative distribution function of the standard normal distribution and $\eta = \frac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)}$.*

By the above lemma, for an IV whose posterior is equal to the threshold ρ^*, it must be that $\mathbb{E}[\nu] = 1 - \Phi\left(\sqrt{\eta}(\rho^* - \mu)\right)$. This means that the equilibrium threshold must satisfy $\rho^* = c\left(1 - \left[1 - \Phi\left(\sqrt{\eta}(\rho^* - \mu)\right)\right]\right)$, or equivalently:

$$\rho^* = c\Phi\left(\sqrt{\eta}(\rho^* - \mu)\right). \tag{1}$$

Note that both sides of the above equation are increasing in ρ^*. For there to be a unique threshold where the IV choose to share if and only if their posterior is greater, the two sides of the above equation must cross exactly once. The slope of the left-hand side is one. The slope of the cumulative distribution function of the standard normal distribution is maximized when the probability distribution function is evaluated at its mean, at $\frac{1}{\sqrt{2\pi}}$. Thus, the slope of the right-hand side is at most $\frac{c\sqrt{\eta}}{\sqrt{2\pi}}$. We henceforth assume this is less than one, a sufficient condition for the uniqueness of ρ^*.

Proposition A.1. *When $\frac{c\sqrt{\eta}}{\sqrt{2\pi}} < 1$, there is a unique equilibrium of the social media game. In this equilibrium, every IV shares the information on social media if and only if their posterior is greater than the threshold ρ^* that solves the indifference condition in Equation (1).*

In the unique equilibrium of the social media game, every IV whose posterior is greater than ρ^* share the news on social media, and every IV whose posterior is below refrain from sharing. It is clear from Equation (1) that ρ^* is increasing in c, meaning that greater the costs associated with sharing anti-government news on social media, fewer informed voters do so. This is not very surprising. The more important observation from Equation (1) for our purposes is that ρ^* is decreasing in μ. This means that a larger fraction of informed voters share the news on social media as internet penetration goes up, holding everything else constant. Thus, in addition to the first-order effect of increasing the value of sharing for each informed voter, higher connectedness has a positive second-order effect on sharing due to strategic complementarity (Granovetter 1978; Jackson and Yariv 2007).

Since θ is distributed normally with mean μ and precision α, we can write this as:

$$p(\mu) = 1 - \Phi\left(\left(f^{-1}\left(\frac{\zeta - \sigma_A}{1 - \sigma_A}\right) - \mu\right)\alpha\right). \tag{2}$$

Because both $p(\mu)$ and $q(\mu) \equiv \mathbb{E}[f(\nu(\theta), \theta)|\mu]$ are increasing in μ, the rest of the analysis in the main text follows.

Formal Statement of the Equilibrium

Before we present the formal proposition summarized in the analysis section, we first define the following to simplify the notation. Let us denote by $r_{pn}(\mu)$ the critical value of r at which the incumbent is indifferent between partial capture, and no capture given μ. Formally:

$$r_{pn}(\mu) = \frac{\sigma_A q(\mu)}{1 - p(\mu)} \tag{3}$$

Further denote by $r_{cp}(\mu)$ the critical value of r at which the incumbent is indifferent between complete capture and partial capture. Formally:

$$r_{cp}(\mu) = \frac{\sigma_M q(\mu)}{p(\mu)} \tag{4}$$

Finally, denote by $r_{cn}(\mu)$ the critical value of r at which the incumbent is indifferent between complete capture and no capture:

$$r_{cn}(\mu) = q(\mu). \tag{5}$$

Note that $r_{pn}(\mu) > r_{cp}(\mu)$ if and only if the probability of overturn is large, in particular $p(\mu) > \sigma_M$. When this is the case for all μ, partial capture is never optimal for the incumbent. Throughout, we assume that $p(\mu) < \sigma_M$ for some μ so that all three strategies are optimal for some values of connectedness.

With that, we are ready to formally state the main proposition of the paper.

Proposition A.2. *The following constitutes an equilibrium:*

a) Beliefs of Voters:

The audience of M believe:

$$\Pr(\textit{incumbent is good}|s_M) = \begin{cases} 0 & \textit{if } s_M = b \\ \hat{\gamma}_M & \textit{if } s_M = \varnothing \end{cases}$$

where

$$\hat{\gamma}_M = \begin{cases} \gamma & \textit{if } r \geq \max\{r_{pn}(\mu), r_{cp}(\mu)\} \\ \frac{\gamma}{\gamma+(1-\gamma)(1-\mathbb{E}[q(\nu,\theta)|\rho])} & \textit{if } r_{cp}(\mu) > r \geq r_{pn}(\mu) \\ 1 & \textit{if } r < r_{pn}(\mu), \end{cases}$$

and the audience of A believe:

$$\Pr(\textit{incumbent is good}|s_A) = \begin{cases} 0 & \textit{if } s_A = b \\ \hat{\gamma}_A & \textit{if } s_A = \varnothing \end{cases}$$

where

$$\hat{\gamma}_A = \begin{cases} \gamma & \textit{if } r \geq \max\{r_{pn}(\mu), r_{cp}(\mu)\} \\ 1 & \textit{if } r < \max\{r_{pn}(\mu), r_{cp}(\mu)\}. \end{cases}$$

b) Strategies of Informed Voters:

When $\frac{c\sqrt{\eta}}{\sqrt{2\pi}} < 1$*, each informed voter* i *shares if* $\rho_i > \rho^*$*, and refrains otherwise, where* ρ^* *is the unique solution to:*

$$\rho^* = c\Phi\left(\sqrt{\eta}(\rho^* - \mu)\right).$$

c) Strategies of Voters:

Voter i *votes for the challenger if and only if she observes the signal the incumbent is bad. Otherwise she voters for the incumbent.*

d) Strategies of the Incumbent:

Incumbent offers:

$$(t_M, t_A) = \begin{cases} t_M = \sigma_A q(\mu) \textit{ and } t_A = \sigma_M q(\mu) & \textit{if } r \geq \max\{r_{cn}(\mu), r_{cp}(\mu)\} \\ t_M = \sigma_M q(\mu) \textit{ and } t_A = 0 & \textit{if } r_{cp}(\mu) > r \geq r_{pn}(\mu) \\ t_M = 0 \textit{ and } t_A = 0 & \textit{if } r < r_{pn}(\mu). \end{cases}$$

e) Strategies of Media Outlets:

Outlet k accepts offer t_k if $t_k \geq \sigma_{-k} q(\mu)$ and $-k$ suppresses, or if $t_k \geq \sigma_k q(\mu)$ and $-k$ publishes. Otherwise it rejects.

PROOFS

Proof of Lemma A.1. Note that the proportion of IV who share is equal to the probability that any individual shares. Since each IV uses ρ^* as the cutoff rule, the probability that any one of them shares is equal to the probability that she has a posterior greater than ρ^*.

Recall that voter i believes that θ is distributed normally with mean ρ_i and precision $\alpha + \beta$. Symmetrically, voter j has posterior:

$$\rho_j = \frac{\alpha\mu + \beta x_j}{\alpha + \beta}$$

where $x_j = \theta + \epsilon_j$. Voter i's expectation of x_j is then normally distributed with mean ρ_i, and variance $\frac{1}{\alpha+\beta} + \frac{1}{\beta}$. Hence we write:

$$\rho_j > \rho_i \iff \frac{\alpha\mu + \beta x_j}{\alpha + \beta} > \rho_i \iff x_j > \rho_i + \frac{\alpha}{\beta}(\rho_i - \mu)$$

Voter i believes that voter j has a posterior expectation ρ_j greater than ρ_i with probability:

$$1 - \Phi\left(\sqrt{\frac{\beta(\alpha+\beta)}{\alpha+2\beta}}\left(\rho_i + \frac{\alpha}{\beta}(\rho_i - \mu) - \rho_i\right)\right) = 1 - \Phi\left(\frac{\alpha}{\beta}\sqrt{\frac{\beta(\alpha+\beta)}{\alpha+2\beta}}(\rho_i - \mu)\right)$$

where Φ denotes the cumulative distribution function of the standard normal distribution. Defining $\eta = \frac{\alpha^2(\alpha+\beta)}{\beta(\alpha+2\beta)}$ we can rewrite the expression above as:

$$1 - \Phi\left(\sqrt{\eta}(\rho_i - \mu)\right)$$

$\square$

Proof of Proposition A.1. Denote by $u(\rho, \hat{\rho})$ the expected utility of an informed voter with the posterior expectation ρ of sharing when all other informed voters use the cutoff $\hat{\rho}$. The expected proportion of informed voters who refrain is equal to:

$$\Phi\left(\sqrt{\eta}\left(\hat{\rho} + \frac{\alpha}{\beta}(\hat{\rho} - \mu) - \rho\right)\right) = \Phi\left(\sqrt{\frac{\alpha(\alpha+\beta)}{(\alpha+2\beta)}}\left(\hat{\rho} - \mu + \frac{\beta}{\alpha}(\hat{\rho} - \rho)\right)\right)$$

Hence:

$$u(\rho, \hat{\rho}) = \rho - c\Phi\left(\sqrt{\frac{\alpha(\alpha+\beta)}{(\alpha+2\beta)}}\left(\hat{\rho} - \mu + \frac{\beta}{\alpha}(\hat{\rho} - \rho)\right)\right)$$

When $\theta \leq 0$, sharing is weakly dominated. Let $\rho_1 = 0$. Then, any IV with $\rho \leq \rho_1$ refrains since $u(\rho_1, \rho_1) = c\Phi\left(\sqrt{\frac{\alpha(\alpha+\beta)}{(\alpha+2\beta)}}(\rho_1 - \mu)\right) < 0$. This gives us the first round of elimination of dominated strategies for low values of ρ. But notice that if everyone who has posteriors lower than ρ_1 refrain, sharing can never be optimal for an IV whose posterior is lower than ρ_2, where ρ_2 solves $u(\rho_2, \rho_1) = 0$.

The above equality implies that ρ_2 is the best response threshold strategy to ρ_1. Since u is increasing in its first argument and decreasing in the second, and $u(\rho_1, \rho_1) < 0$, it must be that $\rho_2 > \rho_1$. This and the fact that payoffs are symmetric means that the proportion of IV who refrain is higher than that implied by the cutoff strategy at ρ_1. The expected utility of sharing decreases in the expected proportion of IV who refrain, hence for any value $\rho < \rho_2$, sharing is dominated. This gives us the second round of elimination of dominated strategies for low values of ρ. By iterating, we have a sequence:

$$\rho_1 \leq \rho_2 \leq \ldots \leq \rho_k \leq \ldots$$

where sharing is eliminated for values of posterior $\rho < \rho_k$ in period k of iterated elimination of dominated strategies. The lowest posterior ρ_m which solves $u(\rho_m, \rho_m) = 0$ is the least upper bound of this sequence.

A symmetric argument for high values of ρ establishes a similar sequence:

$$\rho^1 \geq \rho^2 \geq \ldots \geq \rho^k \geq \ldots$$

where refraining is eliminated for values of posterior $\rho > \rho_k$ in period k of iterated elimination of dominated strategies. The largest posterior ρ^m which solves $u(\rho^m, \rho^m) = 0$ is the greatest lower bound of this sequence.

Finally, our assumption $\eta \leq \frac{2\pi}{c^2}$ ensures that there is a unique value of ρ such that $u(\rho, \rho) = 0$, and therefore $\rho_m = \rho^m$. The discussion in the paper following Lemma 1 shows that this unique cutoff must satisfy $\rho^* = c\Phi\left(\sqrt{\eta}(\rho^* - \mu)\right)$, which concludes our proof. □

Proof of Lemma 1. The first strategy ($t_M = \sigma_M q(\mu)$ and $t_A = \sigma_A q(\mu)$) leads to the capture of both outlets. This is because when one outlet suppresses the news, the other chooses between publishing and taking some audience share from its competitor and repressing and receiving transfers from the incumbent. The incumbent's offers in this strategy exactly correspond to the expected increase in audience related revenues if an outlet were to publish while its competitor suppresses. Because we assumed that when indifferent outlets accept the offer from the incumbent, here both outlets accept their offers and suppress the news. More precisely, if A suppresses but M were to deviate and publish, its audience would grow by $\sigma_M q(\mu)$. The incumbent must transfer an equal amount in equilibrium in order to capture M. Symmetrically, if A deviates and publishes while M suppresses, A's audience would grow by fraction $q(\mu)$ of its audience, and the incumbent must transfer an equal amount to A to capture it as well. Note that any larger offer is dominated by $\{\sigma_M q(\mu), \sigma_A q(\mu)\}$, as they are also accepted but more expensive.

The second strategy ($t_M = \sigma_A q(\mu)$ and $t_A = 0$) leads to M's capture, but since $t_A = 0$, A rejects the offer and publish the bad signal. In this case the mainstream outlet loses some fraction of its audience to the alternative outlet, and the incumbent must compensate M for the lost audience share, which is equal to $\sigma_A q(\mu)$. Note that these offers lead to the same outcome as any other offer that A rejects, but we focus on this one for ease of notation.

In the third strategy ($t_M = 0$ and $t_A = 0$) the expected payoff of publishing is normalized to zero for both outlets; this is when both publish and keep their respective audiences. This is strictly greater than the payoff of accepting the incumbent's offer of zero and losing some audience to the other outlet. Again, this is in effect the same as any offer that is rejected by both outlets, but for ease of exposition we suppose that the incumbent offers zero whenever he does not intend to capture an outlet.

Note that the strategy $t_M = 0, t_A = \sigma_M q(\mu)$ is dominated by $t_M = 0, t_A = 0$. When only A is captured the audience of M still learn the incumbent's type, and their votes are enough to overturn the incumbent. □

Proof of Lemma 2. Since the voters can base their votes only on the information they have, and we have that $\sigma_M > \sigma_A$, the strategy of $\mathrm{V_M}$ are decisive on the outcome of the election. Hence, whenever the mainstream outlet is not captured and publishes the bad signal about the incumbent, the incumbent is overturned with certainty. In this case the expected utility of the incumbent is zero.

If the incumbent chooses to capture both outlets by offering $t_M = \sigma_M q(\mu)$ and $t_A = \sigma_A q(\mu)$, then there is complete capture, and the incumbent is reelected for sure. His expected utility in this case is $r - q(\mu)$. Finally, if only the mainstream outlet is captured, the incumbent is reelected with probability $1 - p(\mu)$, and therefore his expected utility is equal to $r(1 - p(\mu)) - \sigma_A q(\mu)$. □

Proof of Proposition A.2. **a)** Any voter who observes the bad signal believes that the incumbent is good with probability zero because bad signals are verifiable. A voter who observes the null signal believes that the incumbent is good with probability one if the outlet she follows is never captured in equilibrium, with probability γ if her outlet is always captured in equilibrium and she has no chance of being informed via social media, or with some intermediate probability if her outlet is captured in equilibrium but there is a positive probability that she is informed via social media. In any case, her posterior belief that the incumbent is good is at least as high as her belief that the challenger is good when she observes no signal.

b) Follows from Proposition A.1.

c) We assume that voters use undominated pure strategies. If a voter observes $s = b$ and therefore deduces that the incumbent is good with probability zero, then the expected payoff of reelection is also zero, whereas the expected utility when a new challenger wins the election is γ. Therefore a voter who observes $s = b$ strictly prefers the challenger and votes against the incumbent.

If a voter observes $s_k = \varnothing$ for $k \in \{M, A\}$, she believes that the incumbent is good with probability $\hat{\gamma}_k \geq \gamma$. If $\hat{\gamma}_k$ is strictly greater than γ, then the expected utility of voting for the incumbent is also $\hat{\gamma}_k > \gamma$, and the voter votes for the incumbent.

To see why a voter who observes $s_k = \varnothing$ votes for the incumbent when $\hat{\gamma}_k = \gamma$, assume for a contradiction that she votes against. Then the bad incumbent has no incentive to pay a transfer to media outlet k, because the audience of k vote against the incumbent even when the signal $s_k = \varnothing$. Therefore the incumbent offers $t_k = 0$ and the outlet k publishes the bad signal whenever the incumbent is bad. But then, outlet k is never captured in equilibrium, and it must be that $\hat{\gamma}_k = 1$, a contradiction.

It follows that all voters vote for the incumbent if and only if their posteriors of the incumbent are at least as high as their priors on the challenger, γ. Then, every voter who observes the signal that the incumbent is bad votes for the challenger and every voter who does not observe any signal votes for the incumbent.

d) Recall that the incumbent must choose from one of the three strategies in Lemma 1.

When rents are sufficiently high so that $r \geq \max\{r_{cp}, r_{cn}\}$, the incumbent's expected utility is maximized when there is complete capture. If rents are in an intermediate range, namely $r_{cp}(\mu) > r > r_{pn}(\mu)$, then the incumbent's expected utility is maximized when only M is captured. This happens when the probability of overturning the incumbent via the social media game is sufficiently small and rents are not high enough to justify capturing both outlets. On the other hand, when $r < r_{pn}$, the incumbent's optimal strategy is to capture neither outlet because the rents from office are not high enough to cover the expenses of capture.

e) If $-k$ publishes, k receives zero if it publishes, and $t_k - \sigma_{-k}q(\mu)$ if it suppresses. Therefore, k accepts any offer $t_k \geq \sigma_{-k}q(\mu)$ whenever $-k$ publishes, and rejects any offer below.

If $-k$ suppresses, k receives $\sigma_k q(\mu)$ if it publishes, and t_k if it suppresses. Therefore, k accepts any offer $t_k \geq \sigma_k q(\mu)$ whenever $-k$ suppresses, and rejects any offer below. □

Proof of Proposition 1. Suppose $p(\mu) < \sigma_M$ so that partial capture is optimal for some μ. Recall Condition 1: $\frac{d\frac{p(\mu)}{q(\mu)}}{d\mu} > 0$. When this is true, it follows from Equation 4 that $\frac{\partial r_{cp}(\mu)}{\partial \mu} < 0$. Thus, the level of office $r_{cp}(\mu)$ that leaves the incumbent indifferent between complete and partial capture is decreasing in internet penetration. This means that for some levels of office rent, increased internet penetration causes incumbents to switch from partial capture to complete capture.

Note also from Equation 3 that $\frac{\partial r_{pn}(\mu)}{\partial \mu} > 0$. Thus, the level of office $r_{cp}(\mu)$ that leaves the incumbent indifferent between partial and no capture is increasing in internet penetration. Thus, for some levels of office rent, as internet penetration goes up incumbents switch from partial capture to no capture.

It follows that for a fixed value of office rents r, an increase in μ can change the incumbent's optimal strategy from partial capture to complete capture, leading to less press freedom; or from partial capture to no capture, leading to more press freedom.

More press freedom allows voters to recognize bad incumbents and overturn them more often. The voter's expected payoff is 2γ under complete capture, $2\gamma + p(\mu)\gamma(1-\gamma)$ under partial capture, and $2\gamma + \gamma(1-\gamma)$ under no capture. Thus, voter welfare is higher, more press freedom there is. □

Empirics

In this section we describe our data and empirical specifications. Our primary dependent variable is the Freedom of the Press index by Freedom House (`freedomhouse.org`) between 2000 and

2015. Each year every country is given a score from 0 (best) to 100 (worst) according to various questions and indicators. We invert this scale so that higher values correspond to more press freedom. After our inversion, countries that have scores between 70 and 100 are regarded to have "Free" press; 40 to 69, "Partly Free" press; and 0 to 39, "Not Free" press. We believe that the Freedom of the Press index is a good measure for this analysis because the scores are based on a range of factors, including indirect forms of repression. Figure 1 shows the cross-country distribution of this score through our period of study. The median Freedom of the Press score shows remarkable stability around 50 between 2000 and 2015. The largest changes occurred in Thailand and Venezuela, both of which observed dramatic declines in press freedom over this period (48 and 47 points respectively, almost half the entire range of possible scores), followed by Libya and Tunisia whose press freedom scores improved significantly after regime changes during the Arab Spring. The countries that had the minimum variation in their press freedom scores in this period were Belgium, Ireland, and Sweden.

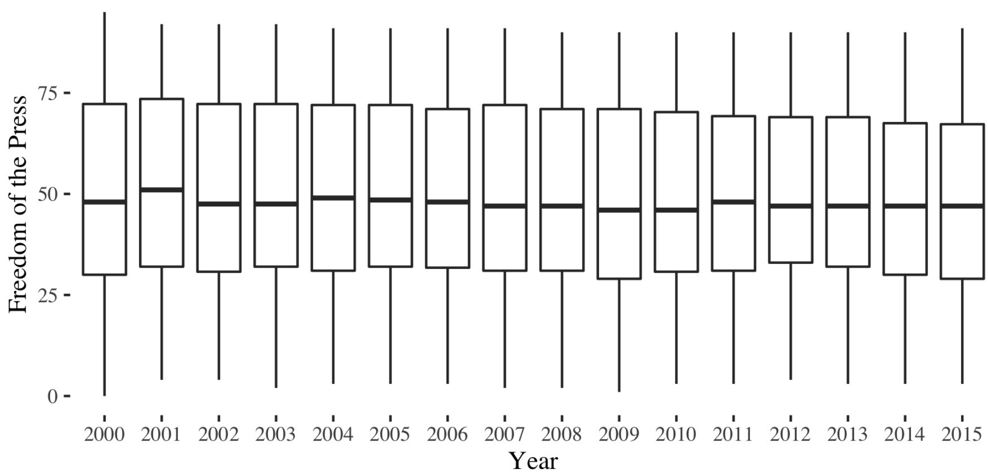

Figure 1: Distribution of Freedom of the Press scores across time. The thick horizontal bars correspond to the median Freedom of the Press score in each year, and the boxes cover from the 25% to 75% percentiles.

As our main independent variable, we use the the internet penetration data provided by International Telecommunication Union (ITU) (`itu.int`). ITU aggregates data collected by national telecommunication regulatory authorities or statistical offices. Figure 2 shows that internet use expanded dramatically over our period of study. According to ITU, the median internet penetration was barely above 1% in 2000, but increased to 45% in 2015. The country with the highest internet penetration in 2000 was Norway with 52%, which gradually increased to 97% in 2015. In contrast, Eritrea went from 0.1% in 2000 to only 1.1% in 2015. The largest change occurred in Qatar, which went from 5% in 2000 to 93% in 2015. Summary statistics are presented in Table 1.

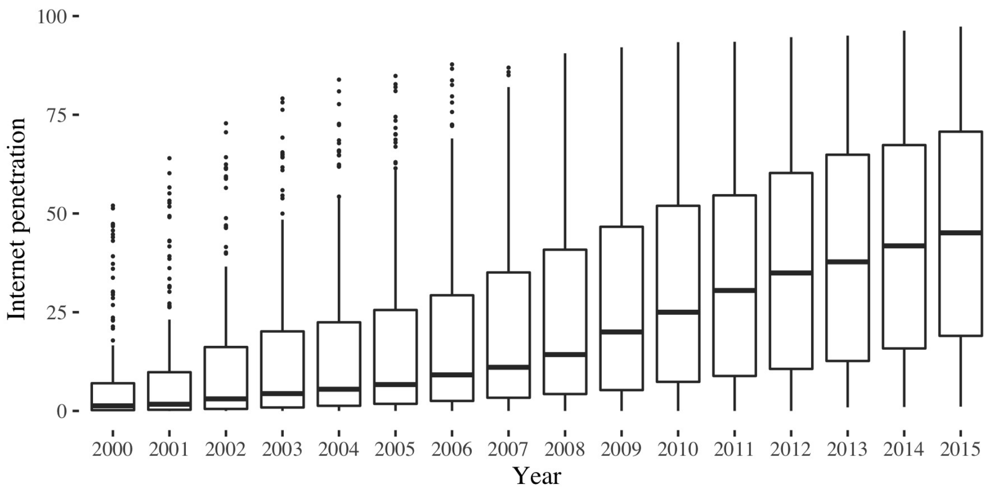

Figure 2: Distribution of internet penetration across time. The thick horizontal bars correspond to the median internet penetration in each year, and the boxes cover from the 25% to 75% percentiles. Dots refer to countries whose internet penetration is more than 1.5 times the interquartile range above the box.

Our empirical specifications are

$$\mathit{PressFreedom}_{it} = \delta_i + \delta_t + \beta \mathit{InternetPenetration}_{it} + X'_{it}\gamma + \varepsilon_{it}$$

$$\mathit{PressFreedom}_{it} = \delta_i + \mathit{PressFreedom}_{it-1} + \beta \mathit{InternetPenetration}_{it} + X'_{it}\gamma + \varepsilon_{it}$$

where $\mathit{PressFreedom}_{it}$ is the press freedom score of country i in year t. δ_i and δ_t correspond to country and year fixed effects respectively. $\mathit{InternetPenetration}_{it}$ is our independent variable of interest and is equal to internet penetration in country i in year t. The time varying controls X'_{it} are the number of checks on the executive, logarithm of GDP, and logarithm of population. The number of checks on the executive comes from the Database of Political Institutions by the World

TABLE 1: Mean, standard deviation, and the quartiles of variables.

	Mean	Std. Dev.	Min	1st	2nd	3rd	Max
Internet penetration	25.43	27.27	0.00	2.66	13.55	43.62	97.33
Freedom of the Press	50.67	23.87	5.00	29.00	53.00	69.00	100.00
Press Freedom Index	31.06	24.23	0.00	12.43	26.53	42.00	142.00
Media self-censorship	0.73	1.33	-3.27	0.00	0.98	1.69	3.28

TABLE 2: There is a robust negative association between internet penetration and press freedom scores.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Internet penetration	-0.090***	-0.070***	-0.059**	-0.040	-0.027***	-0.022**
	(0.016)	(0.023)	(0.029)	(0.029)	(0.007)	(0.009)
Checks		0.829***		0.858***		0.225***
		(0.310)		(0.311)		(0.083)
ln(GDP per capita)		-0.828		0.637		-0.248
		(0.767)		(1.245)		(0.293)
ln(Population)		-0.879		2.094		-0.331
		(2.702)		(2.678)		(0.943)
Lagged DV					-0.750***	-0.741***
					(0.024)	(0.025)
Num.Obs.	2521	2406	2521	2406	2364	2257
R2	0.067	0.097	0.010	0.035	0.656	0.649
R2 Adj.	0.003	0.031	-0.064	-0.042	0.631	0.622
Country FE	✓	✓	✓	✓	✓	✓
Year FE			✓	✓		
Lagged DV					✓	✓

Standard errors are clustered at the country level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Bank (Beck et al. 2001), democracy scores from the Polity IV dataset (Marshall, Gurr, and Jaggers 2016), and GDP per capita and population data from the World Bank (`data.worldbank.org`). All standard errors are clustered at the country level.

As can be seen in Table 2, with country fixed effects there is a statistically significant negative relationship between internet penetration and press freedom scores. This relationship is robust to inclusion of controls, year fixed effects, or a lagged dependent variable.

In Table 3, we run the full specification with controls and country and year fixed effects on the subsamples of countries with different press freedom status in 2000. Column 1 shows that among the countries that had a "Free" press (i.e. press freedom scores between 70-100) in 2000, internet penetration is associated with more press freedom. In contrast, internet penetration has the opposite sign in countries that had a "Partly Free" press in 2000 (i.e. scores between 40-69). Finally, Column 3 shows that internet penetration is associated with less press freedom in countries that had a "Not Free" press in 2000, but the relationship is not statistically significant at conventional levels.

In the last two columns we split the dataset by countries' Polity scores. Polity scores are a composite indicator that measure where a country in a given year falls on a scale between +10 (strongly democratic) to -10 (strongly autocratic). Due to the potential of reverse causality, we use Polity scores in 2000; the start of our dataset.[2] We split the dataset by countries whose Polity scores are below and above 6. Sub-sample analysis shows that for countries whose Polity scores were above 6 in 2000 the coefficient of internet penetration is positive and statistically significant. The opposite holds for countries whose Polity scores were below 6 in 2000. There, the coefficient of internet penetration is negative and statistically significant.

Out of concerns about Freedom House's methodology (Solis and Waggoner 2020), in Tables 4 and 5 we repeat our regressions in Table 2 using the Press Freedom Index released annually by Reporters Without Borders (`rsf.org`) (Reporters Without Borders 2016) and the media self-censorship indicator from the Varieties of Democracy Dataset (Coppedge et al. 2021).[3] Our findings are robust to the use of these alternative indicators.

Simulations

For our simulations, we assume that the fraction of uninformed voters who switch to the informative outlet is drawn from the inverse logit function: $q(\mu) = \frac{e^{\mu}}{1+e^{\mu}}$. We set $\sigma_A = 1/4$. Office rents r are

[2]Because internet penetration was very low in almost all countries in 2000, internet penetration is unlikely to have driven Polity scores in 2000. Our results are unchanged when we use Polity scores in each year instead.

[3]Varieties of Democracy has another indicator on government censorship effort of the media whose definition is closer to media capture as defined in our paper. Unfortunately, the ordering of this indicator is somewhat ambiguous, and as such we elect to use the self-censorship indicator which is similar and whose values are clearly ordinal.

TABLE 3: Subgroup analysis reveals that the negative relationship between internet penetration and press freedom scores is driven by countries with Partly Free press in 2000, and countries whose Polity scores were less than 6 in 2000.

	Free	Partly Free	Not Free	Polity > 6	Polity $\leq$ 6
Internet penetration	0.094**	-0.125*	-0.072	0.105**	-0.090***
	(0.044)	(0.074)	(0.051)	(0.052)	(0.034)
Checks	0.661	0.707**	1.197	0.420*	1.294**
	(0.429)	(0.327)	(0.832)	(0.221)	(0.519)
ln(GDP per capita)	0.503	6.724**	-4.611**	2.765	-2.334
	(1.583)	(2.607)	(2.319)	(1.732)	(1.854)
ln(Population)	0.515	-11.921	-1.061	-17.302*	-0.915
	(7.824)	(8.782)	(4.236)	(9.335)	(3.629)
Num.Obs.	826	743	837	1021	1361
R2	0.063	0.109	0.085	0.124	0.076
R2 Adj.	-0.025	0.023	-0.006	0.047	-0.006
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓

Standard errors are clustered at the country level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TABLE 4: The negative association between internet penetration and press freedom is also present when Reporters Without Borders' Press Freedom Index is used.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Internet penetration	-0.243***	-0.166***	-0.075	-0.053	-0.155***	-0.127***
	(0.026)	(0.037)	(0.049)	(0.052)	(0.022)	(0.027)
Checks		0.996***		1.056***		0.940***
		(0.340)		(0.373)		(0.242)
ln(GDP per capita)		-2.609*		1.045		-0.481
		(1.558)		(1.779)		(1.051)
ln(Population)		-7.624		1.541		-7.167**
		(5.328)		(5.224)		(3.255)
Lagged DV					-0.369***	-0.352***
					(0.039)	(0.039)
Num.Obs.	1998	1906	1998	1906	1838	1754
R2	0.097	0.125	0.004	0.015	0.222	0.240
R2 Adj.	0.018	0.043	-0.090	-0.084	0.148	0.162
Country FE	✓	✓	✓	✓	✓	✓
Year FE			✓	✓		
Lagged DV					✓	✓

Standard errors are clustered at the country level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TABLE 5: The negative association between internet penetration and press freedom is also present when the media self-censorship indicator from Varieties of Democracy is used.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Internet penetration	-0.002*	-0.004**	-0.005**	-0.004**	-0.001***	-0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.000)	(0.001)
Checks		0.058***		0.059***		0.011
		(0.020)		(0.021)		(0.007)
ln(GDP per capita)		0.037		0.000		-0.022
		(0.054)		(0.100)		(0.021)
ln(Population)		0.291		0.264		0.059
		(0.188)		(0.220)		(0.070)
Lagged DV					0.797***	0.775***
					(0.024)	(0.030)
Num.Obs.	2522	2407	2522	2407	2366	2259
R2	0.008	0.042	0.016	0.040	0.648	0.620
R2 Adj.	-0.059	-0.027	-0.058	-0.036	0.623	0.590
Country FE	✓	✓	✓	✓	✓	✓
Year FE			✓	✓		
Lagged DV					✓	✓

Standard errors are clustered at the country level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

drawn from the standard uniform distribution and internet penetration μ across observations come from a beta distribution with shape parameters 1 and 5. We draw 2560 values of μ, corresponding to 160 countries over 16 years. We draw 160 values of r, one for each simulated country.

For Figure 3, to ensure Condition 1 holds for all μ, we assume $\psi \sim \mathcal{N}(0, 1/2)$; and we shift internet penetration so that $\mu \in [-0.8, -0.2]$. That is, we let $\mu \sim B(1, 5)(0.6) - 0.8$. To ensure Condition 1 fails for all μ for Figure 4, we assume $\psi \sim \mathcal{N}(0, 2)$, and we let $\mu \sim (B(1, 5) - 0.4)(2)$ so that $\mu \in [-0.8, 0.6]$.

Given the parameter σ_A, the distribution of ψ, and randomly drawn values of r and μ, we calculate the incumbent's optimal strategy for capture. We order observations in increasing press freedom: 0 refers low press freedom or complete capture, 1 is intermediate press freedom or partial capture, and high press freedom/no capture is denoted by 2. We add jitter drawn from a normal distribution with mean zero and standard deviation 0.3 to enhance readability. Our simulated plots have μ on the horizontal axis and press freedom on the vertical axis. We color observations by which tercile of r they fall in: blue for high office rents, yellow for intermediate office rents, and green for low office rents.

References

Angeletos, George-Marios, Christian Hellwig, and Alessandro Pavan. 2006. "Signaling in a Global Game: Coordination and Policy Traps." *Journal of Political Economy* 114 (3): 452–484. ISSN: 0022-3808, accessed June 7, 2016. doi:10.1086/504901. http://www.jstor.org/stable/10.1086/504901.

Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh. 2001. "New Tools in Comparative Political Economy: The Database of Political Institutions." *The World Bank Economic Review* 15, no. 1 (June 1): 165–176. ISSN: 0258-6770, accessed August 18, 2017. doi:10.1093/wber/15.1.165. https://academic.oup.com/wber/article/15/1/165/1682021/New-Tools-in-Comparative-Political-Economy-The.

Coppedge, Michael, John Gerring, Carl Henrik Knutsen, Staffan I. Lindberg, Jan Teorell, David Altman, Michael Bernhard, Agnes Cornell, M. Steven Fish, and Lisa Gastaldi. 2021. "V-Dem Codebook v11."

DeGroot, Morris H. 2005. *Optimal Statistical Decisions.* John Wiley & Sons, January 28. ISBN: 978-0-471-72614-2.

Granovetter, Mark. 1978. "Threshold models of collective behavior." *American journal of sociology:* 1420–1443. Accessed July 19, 2016. http://www.jstor.org/stable/2778111.

Jackson, Matthew O., and Leeat Yariv. 2007. "Diffusion of Behavior and Equilibrium Properties in Network Games." *American Economic Review* 97, no. 2 (May): 92–98. ISSN: 0002-8282, accessed April 9, 2020. doi:10.1257/aer.97.2.92. http://www.aeaweb.org/articles?id=10.1257/aer.97.2.92.

Marshall, Monty G., Ted Robert Gurr, and Keith Jaggers. 2016. "Polity IV project: Political regime characteristics and transitions, 1800–2015." *Center for Systemic Peace.*

Reporters Without Borders. 2016. "The World Press Freedom Index | Reporters without borders." RSF. Data collected from https://en.wikipedia.org/wiki/Press_Freedom_Index on April 11, 2020. April 19. Accessed March 15, 2021. https://rsf.org/en/world-press-freedom-index.

Solis, Jonathan A., and Philip D. Waggoner. 2020. "Measuring Media Freedom: An Item Response Theory Analysis of Existing Indicators." Edition: 2020/06/22 Publisher: Cambridge University Press, *British Journal of Political Science:* 1–20. ISSN: 0007-1234. doi:10.1017/S0007123420000101. https://www.cambridge.org/core/article/measuring-media-freedom-an-item-response-theory-analysis-of-existing-indicators/4A6D5AE5E6F4E78D0642BFF882C1FBF6.