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After the sunset: the residual effect of temporary legislation

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Abstract The difference between permanent legislation and temporary legislation is the default rule of termination: permanent legislation governs perpetually, while temporary legislation governs for a limited time. Recent literature on legislative timing rules considers the effect of temporary legislation to stop at the moment of expiration. When the law expires, so does its regulatory effect. This article extends that literature by examining the effect of temporary legislation beyond its expiration. We show that in addition to affecting compliance behavior which depends on statutory enforcement, temporary legislation also affects compliance behavior which does not depend on statutory enforcement, and more generally, organizational behavior after a sunset. When temporary legislation expires therefore, it can continue to administer regulatory and other effects. We specify the conditions for this process and give the optimal legislative response.

Keywords Timing rules · Temporary legislation · Sunset clauses · Statutory obsolescence

JEL Classification K23 · K42

1 Introduction

Legislatures can pass legislation temporarily by including a duration or "sunset" clause that automatically invalidates a statute on a specified date. These clauses

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allow the legislature to authorize a statute for a limited time and govern temporarily. In contrast to "normal" permanent legislation, temporary legislation does not require additional legislative action for its rescission. It loses any legally binding effect when it reaches its predetermined date of expiration and can only be extended if the legislature passes a new bill that specifies an additional period of legal validity. Recent literature on legislative timing rules treats the effect of temporary legislation as dependent upon the continued existence of a legally binding rule (Parisi et al. 2004; Gersen 2007; Gersen and Posner 2007; Luppi and Parisi 2009; Yin 2009). The discussion assumes that when legislation expires, any compliance effect associated with that legislation also expires. No explicit consideration is given to the possibility that legislation can produce effects independent of statutory enforcement. For example, temporary law can be expressive, and change the level of social sanctioning around the substance of a law (Cooter 1998; McAdams and Rasmusen 2005; Funk 2007; Feldman 2009). Temporary tariffs and industry regulations can lead to the permanent destruction of an industry or the emergence of substitute products (Nye 2007). Lobbies and coalitions can form around temporary policies, and can remain in place to seek other opportunities after a temporary policy expires (Rasmusen 1993; Grossman and Helpman 2001). Temporary polices that inform or create focal points can permanently change modes of coordination (Dharmapala and McAdams 2003). Generally, policies that change prevailing behavior can leave residual effects, even after those policies have expired.

This article extends the research on timing rules by examining the interrelation between the choice of temporary timing rule and its post-expiration effect. When temporary laws leave residual effects, the benefits of lawmaking that the literature has confined to the period of statutory enforcement can spill over into future periods, where statutory enforcement is no longer in place. If legislators can anticipate such a spillover, then they may choose a temporary timing rule instead of a permanent timing rule to save costs. Our model explicitly deals with their anticipation, and how they can save those costs.

2 The model

The model describes a unit measure of agents, with heterogeneous preferences independently drawn from an absolutely continuous distribution. Legislators minimize costs based upon their anticipation of the post-expiration effect of legislation.[1] We refer to the post-expiration effect generally as compliance for exposition.[2]

[1] Thus the model follows the existing literature on timing rules by examining the behavior of a majority group of legislators with heterogeneous preferences. Posner and Vermeule (2008) give several recent scenarios from the 107 and 110th Congresses. For a different approach, where timing rules are the outcome of gridlock within the legislature, see Auerbach (2006).

[2] Our use of compliance underscores that temporary lawmaking goals can continue to be realized after sunset. However, any post-expiration behavioral or organizational change may be supposed without affecting our results.

The model has a two period time-line. At the beginning of the game, the true state of the world is unknown, i.e. the actual effectiveness of the chosen policy in producing compliance is unknown. In period 1, the legislators move first to choose $\tau \in \{0,1\}$, the binary decision between a temporary timing rule (0) and a permanent timing rule (1). Agents then set their intra- and interagent relations and choose their compliance levels. In period 2, legislators decide either to reauthorize the temporary legislation or let it expire, or to repeal the permanent legislation or let it continue. In our formal model, period 2 is notional. Its significance is that at the beginning of the period, legislators can observe a signal related to the true state, i.e. they become better aware of the effectiveness of the policy in producing compliance. The precision of that signal is assumed to be increasing in the level of compliance chosen by the agents in period 1.[3]

Contingent on the assumption that signal precision is increasing in the level of compliance, it is reasonable to assume that a more precise signal will lead to a better decision. Hence the underlying premise of the model is that the value of a period 2 decision by legislators is increasing, for both the legislators and the agents, in the period 1 level of compliance by agents. We capture this aspect by introducing a "value of revealed information" term in the objective functions of the players. By backward induction, in any equilibrium, legislators will take into account the agents' best response and choose τ accordingly in period 1. The order of play can be summarized as:

(1) Legislators choose the timing rule, τ, from set $\{0,1\}$, where (0) is a temporary timing rule and (1) is a permanent timing rule.
(2) Agents are matched within period 1 to play a game where they set their intra- and interagent relations.
(3) At the end of that period, agents choose their compliance levels.
(4) Legislators observe the aggregate compliance level and decide either to reauthorize the temporary legislation or let it expire, or to repeal the permanent legislation or let it continue.

In the following section, we demonstrate how agents set their relations when legislators impose new legislation. The state of agent relations that prevails determines how agents choose their optimal compliance level, shown in Sect. 2.2. Lastly in Sect. 2.3, we show that by backward induction, legislators will take into account the agents' best response compliance level and choose to legislate temporarily or permanently.

2.1 Agent relations

Before agents choose their compliance levels, agents first set their intra- and interagent relations in response to new legislation which yields population state γ.

[3] This assumption rests on the reasoning that the higher the compliance level, the more visible is the policy outcome.

The introduction of γ allows us to account for how the prevailing state of behavior throughout the population affects an individual agent's choice of compliance. Thus, any payoff from compliance is dependent upon not only contemporary statutory enforcement, but upon any previous change in cost structure from past statutory enforcement in addition.

For example, a person may experience a change in their intrapersonal relations when the legislature passes a new law. One who has internalized an obedience to law norm permits the new law to change the magnitudes of their guilt cost for noncompliance or of their pride benefit from compliance. The fact that the behavior is now legally sanctioned produces new magnitudes. There can be preexisting levels of guilt and pride for the behavior embodied in the law, but upon being codified, those levels are increased if legislation is expressive. If the legislation is not expressive, then those levels remain unaffected (Cooter 2000). Similarly, a person can permit a new law to update their interpersonal relations which govern their willingness to disapprove or approve of another person's noncompliance or compliance. The fact that the behavior is now codified makes a person more willing to sanction others if the legislation is expressive. If it is not, their willingness remains at preexisting levels (Cooter 1998). While statutory enforcement may impact the cost of compliance, the law may additionally affect a change in the cost of compliance through its impact upon the constellation of intra- and interagent relations. A change in normative relations changes the cost structure of compliance, and the expiration of a temporary policy does not necessarily return those normative relations to their pre-policy levels.

In the case of temporary policies that inform, agent relations are updated when a person becomes aware of a new policy either through direct communication from lawmakers, or through interagent learning. Once the temporary policy expires, agents may retain coordinative information that continues to affect their choice of compliance. Or in the case of temporary tariffs or regulations, firms update their behavior when they expect the benefits of adapting to a temporary policy to outweigh the costs waiting for the policy to potentially expire. Also here, an update in behavior can continue to administer a regulatory effect after the sunset. For example, the firm may have incurred costs that restrain entry or exit through the adoption of a new production process or through other adaptations to the temporary legal environment. If the firm does not incur those costs and chooses to wait for the temporary policy to expire instead, we understand that no update has taken place.

In the case of resource allocation toward creating policies, the lobbies and coalitions that are updated or formed to create temporary policies may continue to seek other legislative or regulatory opportunities once a temporary policy has expired. If an existing lobby or coalition creates the new policy, or if the new lobby or coalition has no effect beyond the temporary policy, again we understand that no update has taken place. Generally, after the legislature passes a law the agent chooses $m \in \{U, -U\}$, where (U) denotes the decision to update some composite measure of their intra- and interagent relations and ($-U$) denotes the decision to not update.

2.1.1 Strategic agent relations

The agent relations game below maps the interaction between two agents after the legislature has passed a new law, and after each agent has chosen to update or not update. Each of the players has private knowledge regarding whether or not the new law has been caused an internal update. That knowledge is revealed when player 1 complies or does not comply with the behavior embodied in the new law when in the presence of the other agent. If she complies, player 1 reveals that she has updated her agent relations, always intrapersonally since she moves first in time with no knowledge of player 2's potential sanction by construction. Upon observing player 1's behavior, player 2 chooses to sanction or to not sanction player 1. If player 2 sanctions player 1, player 2 reveals that she has updated her interagent relations. Otherwise, she reveals that no interagent update has taken place.[4]

We examine the case where $((a - c)(d - b)) < 0$ and the game has a single dominant strategy equilibrium, and where $(a > c, d > b))$ and the game presents a problem of coordination. An aspiration an imitation model is used to examine repeated play.[5]

2.1.2 Dynamic agent relations

When player 1 is not sanctioned or player 2 observes noncompliance, they learn that one other agent has not permitted the new law to change their behavior. On the other hand, when player 1 is sanctioned or player 2 observes compliance, they learn that one other agent has permitted the new law to change their behavior. What they learn gives their actual payoff, ranging from the value of incurring no costs or receiving no benefits to the value of incurring some costs or receiving some benefits. Costs might reflect industry sanctioning from following or not following a temporary policy, especially when concerted action may lead to a temporary extension or expiration of a regulation (Coglianese et al. 2004). Benefits might reflect increased profits and enhanced government relations. In other contexts, costs may take the form of sanctioning from competitor lobbies or lost coalition opportunities, and benefits may take the form of rents extracted from legislative and regulatory opportunities. In the case of a temporary policy that is expressive, the costs of noncompliance may be understood as internal guilt and external disapproval from fellow citizens. The benefits of compliance may be understood as pride and approval.

Generally, the payoff from updating or not updating is interdependent. This actual payoff that agents learn from interacting with other agents is then compared to an

[4] For knowledge to be revealed to both players, it is necessary that the players interact. What the players observe or do not observe in each other reveals information. Zasu (2008) constructs a model that shows that higher levels of interaction, or connectivity within groups, can result in higher levels of sanctioning.

[5] Aspiration and imitation models are based upon processes where agents compare their actual payoff to an aspired payoff, and as a result of that comparison, sometimes choose a different strategy by imitating others. They are often employed for modeling the emergence of social norms. See Binmore and Samuelson (1997), Samuelson (1997), Benaim and Weibull (2003), Traulsen et al. (2005).

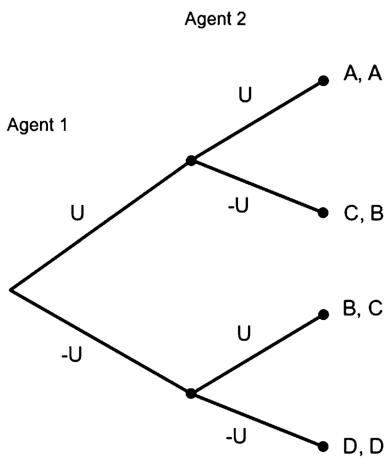

Fig. 1 A stylized model of agent relations

aspired level of what the agent thinks is appropriate.[6] If the actual payoff deviates from an aspired payoff, players may be motivated to choose to update or to not update by imitating their previous opponent in the next iteration of the game. For this reason, we are particularly interested in examining the cases where the levels of A, B, C and D result in each coordination profile (U, U) and ($-U$, $-U$) as Nash equilibria.[7]

Consider the symmetric 2×2 game given in Fig. 1 where there is a single finite population of N agents. Let time be discretely divided into intervals of length t. During each iteration, an agent is characterized by their pure strategy (U) or ($-U$) that she implements in that iteration. During each iteration of length t, pairs of agents are randomly drawn to play one game. They are drawn independently and without replacement, and the various ways that they can be matched are equally probable. Their payoffs A, B, C and D are expected. Actual realized payoffs are random, given by the expected payoff of A, B, C or D plus the outcome R of a random variable $\tilde{R}$. This variable has an expected value of 0. It is included to capture any random shock that disturbs the player's payoffs, and is intended to highlight any complication that the players may encounter in identifying their payoffs precisely, apart from simply choosing between (U) and ($-U$).[8]

[6] The aspired level can be based upon their prior levels of guilt, pride, disapproval, and approval before interacting. Other likely bases for aspiration levels include higher-order expectations such as what an agent thinks some outside authority thinks the payoff should be (Lewis 1969). For our results to hold, it is sufficient to assume that only some type of comparison is taking place.

[7] In the context of new expressive laws or industry regulations particularly, it may be that the strategy distribution is relatively unknown until a sufficient level of interaction has taken place. What one learns from interaction, namely the other person's strategy to update or to not update, can serve as a metric for the general level of receptivity to the new law throughout the community. Moreover, since coordination around updating or not updating leads to higher levels of guilt, pride, disapproval, and approval, imitation profiles (U, U) and ($-U$, $-U$) are likely to emerge.

[8] While Fudenberg and Harris (1992) build a model where is correlated across agents, that is, where environmental factors impose a common risk to all agents, we treat the distribution of $\tilde{R}$ as independently and identically distributed. In this case its distribution does not depend on the selection of strategy.

When an agent plays update and meets another agent who plays update, her expected payoff is A and her realized payoff is $A + R$. If she updates her agent relations in a population where a proportion k is also updating, then her expected payoff is given by

$$\pi_U(k) = kA + (1 - k)C \tag{1}$$

where her expectation is taken with respect to both the likely identity of her opponent and the likely realization of $\tilde{R}$. If she chooses to not update in a population where a proportion k is updating, then her expected payoff $\pi_{-U}(k)$ is given by

$$\pi_{-U}(k) = kB + (1 - k)D \tag{2}$$

During each iteration t, each person draws from an independently distributed Bernoulli random variable. Let the time units of measure be chosen so that with probability t, the distribution yields the outcome learn. With the probability $1 - t$, the distribution yields the outcome not learn. A person who receives a learn draw remembers her realized payoff of the previous iteration and evaluates it as satisfactory or unsatisfactory. If her realized payoff exceeds her aspiration level, then she evaluates her strategy as satisfactory and maintains that strategy in the following iteration of the game. If her realized payoff does not exceed her aspiration level, she loses confidence in her current strategy and abandons it. When for example, a person plays update in a population in which everyone plays update, and then receives a learn draw, the corresponding probability that she abandons the update strategy is

$$g(A) = prob(A + R < \Delta) = F(\Delta - A) \tag{3}$$

where Δ is her aspiration level, R is the realization of random payoff variable $\tilde{R}$, and F is the cumulative distribution of $\tilde{R}$. Similar expressions can be given for payoffs B, C and D.

Following Samuelson (1997), we assume F is uniform along the interval $[-\omega, \omega]$, where payoffs $\{A, B, C, D\} \subset [\Delta - \omega, \Delta + \omega]$.[9] The Uniform distribution's linearity permits the passing of a player's expectations through function g given by Eq. 3. Hence, when a person plays update and a proportion of the population playing update is k, then the probability that she abandons update is given by

$$g(\pi_U(k)) = F(\Delta - \pi_U(k)). \tag{4}$$

If agent i evaluates her payoff as unsatisfactory and abandons it in the next iteration of the game, she must now choose a strategy. We assume that she randomly selects another member j from the population. With probability $1 - \lambda$, she imitates j's strategy.[10] With probability λ, agent i chooses to not imitate j. In this case, she is a "mutant" or "asocial", and chooses to play the opposite strategy of j.

[9] The Uniform distribution satisfies the monotone likelihood ratio property, which is necessary and sufficient for it to be more likely that low average expected payoffs produce low average realized payoffs. This condition allows realized payoffs to provide a useful basis for strategy evaluation.

[10] It is possible that she may play the same strategy that she played in the game's first iteration, after receiving confirmation from j that update or not update may in fact be the best reply.

Within this framework, various relational outcomes can be imagined. For example, upon learning of a new law, a person may not have developed a new source of guilt for noncompliant behavior. Thus she does not experience a normative update. Suppose she comes into contact with another person who has experienced a normative update. She approaches the interaction with an aspiration payoff in mind, justified in part by her own level of guilt (in this case it can be 0). If her payoff is unsatisfactory because, for example, the other person disapproved of her noncompliance and made her feel guilt, she may abandon her strategy to not update her normative relations. Given a learn draw, she may instead choose to imitate j (i.e. update her normative relations) with probability $1 - \lambda$, leading to compliance or noncompliance independent of her initial reaction to an expressive law.

2.1.3 *Infinite population*

Let $\hat{\gamma}$ be a replicator of the form

$$\hat{\gamma} = \gamma(\pi_u(\gamma) + \lambda(1 - 2\gamma)(K - \bar{\pi})) \tag{5}$$

where $\gamma \in [0,1]$ is the fraction of an infinite population playing update, $\bar{\pi} = \gamma\pi_u(\gamma) + (1-\gamma)\pi_{-U}(\gamma)$ is the expected payoff, K is a constant which does not depend on the prevailing state of agent relations, and where

$$\pi_U(\gamma) = \gamma A + (1-\gamma)C \tag{6}$$

$$\pi_{-U}(\gamma) = \gamma B + (1-\gamma)D. \tag{7}$$

These two equations are similar to Eqs. 1–2 in that they replace k with γ. $\pi_U(\gamma)$ gives the expected payoff to an agent playing update when the proportion γ of her opponents play update. If a finite population were at state γ, meaning that proportion γ of the population were playing update, then a person playing update faces a population that also plays update in a slightly smaller proportion γ. As the population reaches infinity, this distinction disappears and γ becomes both the proportion playing update and the current state of agent relations.

For a population of size N and a time period length t, the aspiration and imitation model is a Markov process with $N + 1$ population states $u \in \{0, v, 2v,\ldots,1\}$, where $v = 1/N$ and uN is the number of agents playing update in state u. By examining the double limit as N gets large and t gets small, we allow the aspiration and imitation model to be governed by the replicator given in Eq. 5. Now, instead of state $u(t)$ describing the number of agents playing update at moment t defined on discrete points $\{0, t, 2t,\ldots,\}$, state $\gamma(t)$ describes a deterministic solution to the differential equation γ, which takes on values in [0,1]. This permits the probabilities from moving one step to the right or left to be calculated for a given state u, which in turn, can be used to construct an approximation of the behavior of the agent relations game over time.[11]

[11] By focusing on short time periods, the probability that two persons receive the learn draw, potentially moving u by more than one step, is negligible.

Fig. 2 Phase diagram for the agent relations game with replicator dynamics

Suppose $\gamma(t)$ is governed by the replicator given in Eq. 5 with the boundary condition that $\gamma(0) = u(0)$. When Γ is a coordination game such that $(a > c, d > b)$, there are three Nash equilibria, two in pure strategies given by (U, U) and $(-U, -U)$, and one in mixed strategies. Three stationary states ϑ, $\imath$, and κ exist, satisfying $0<\vartheta<\imath<\kappa<1$ (Samuelson 1997, Proposition 3.1). The inner stationary state $\imath$ is unstable, but ϑ and κ are asymptotically stable with attraction basins $[0, \imath)$ and $(\imath, 1]$. As $\lambda \to 0$, each of the stationary states converge to the three Nash equilibria of Γ (Fig. 2). Stationary state ϑ converges to the equilibrium where all agents play (U). Stationary state κ converges to the equilibrium where all agents play $(-U)$. Stationary state $\imath$ converges to the mixed equilibrium.

Suppose the legislator observes a stationary state of agent relations $\gamma(0) = u(0)$ within the basin $[0, \imath)$. The replicator will move close to ϑ where the agents are playing the profile (U, U), and remain in its vicinity forever. Similarly, when the legislator observes state $\gamma(0) = u(0)$ within the basin $(\imath, 1]$, the replicator will move close to k where the agents are playing the profile $(-U, -U)$, and remain in its vicinity forever.

When payoffs are such that strategies (U) or $(-U)$ dominate, we will see that lawmakers can more easily evaluate period 2 legislation costs. On the other hand, we would have to impose very strong informational assumptions for players to be able to clearly identify dominant strategies in the agent relations game that is procedurally time consistent. Agents are likely to remain ignorant of the strategy distribution throughout the population until some level of interaction with other agents occurs. Moreover, when agent relations are characterized by coordination, it is likely that no strategy yet dominates and multiple equilibria still exist. Although period 2 legislation costs are more ambiguous in this scenario, legislators may still be able to optimize on timing rule selection. If legislators observe a stationary state within either coordination basin, the replicator dynamics will move close to ϑ or κ and remain in either vicinity forever. We only need to suppose that players reject strategies that yield payoffs that fall short of an aspired level, and instead imitate.

2.2 Agent's optimal compliance

Once agents set their relations, they choose their optimal compliance level for the new legislation. An individual agent's utility function is given by

$$u_i(\mu_{\gamma i}, \alpha_i, \tau) = -(\mu_{\gamma i}, \alpha_i)^2 - p_\gamma(x - \alpha_i)^2 - c_{\gamma\tau}(\alpha_i)^2 + \beta W(\alpha_i) \qquad (8)$$

where $\mu_{\gamma i}$ is the ideal policy position for the individual i and x is the policy location of the proposed legislation. Both lie anywhere on the real line. Each agent chooses an action, α_i, which again lies on the real line. The distance $|x - \alpha_i|$ is the measure of a person's lack of compliance, which has a proportional penalty attached, due to sanctioning from first-, second-, and third-party enforcement. The magnitude of the penalty is dependent upon the prevailing state of agent relations γ, i.e. the portion of the population playing update. On the other hand, compliance itself is costly since it requires adjustment away from the status quo. These costs, denoted here by the function $c_{\gamma\tau}(\cdot)$ are dependent upon the state of agent relations γ, the length of the legislation τ, and the difference between the policy location of the original legislation, i.e. the status quo that is normalized to be 0, and the chosen action α_i.

W, since realized in the second period, is discounted by the factor β, which represents the impatience of the populace. In our two-period formulation of the game, the adjustment cost is incurred by the agents in the first period only. We do not model any strategic interaction in the second period explicitly. Instead, we make the simplifying assumption that the socially optimal decision will be made in period 2 given the information revealed in period 1. By introducing a term that captures the value generated by revealed information in the form of the socially optimal decision and including it in the objective functions of the agents, we abstract away from modeling future periods repeatedly.

Rewriting the function above with $d = x{-}\alpha_i$, which is the distance between the new legislation and the actual action chosen by an agent, and, which can be interpreted as the level of disobedience, we get

$$u_i(\mu_{\gamma i}, d_i, \tau) = -(\mu_{\gamma i}, -x + d_i)^2 - p_\gamma(d_i)^2 - c_{\gamma\tau}(x - d_i)^2 + \beta W(x - d_i) \qquad (9)$$

Let $c_{\gamma\tau}$ be a quadratic cost function, consisting of both fixed and marginal costs of moving away from the status quo

$$c_{\gamma\tau}(\alpha_i) = a_{\gamma\tau} + b_{\gamma\tau}\alpha_i^2 = a_{\gamma\tau} + b_{\gamma\tau}(x - d_i)^2 \qquad (10)$$

We substitute in Eq. 10 and get

$$-(\mu_{\gamma i}, -x + d_i)^2 - p_\gamma(d_i)^2 - a_{\gamma\tau} - b_{\gamma\tau}(x - d_i)^2 - \beta W(x - d_i) \qquad (11)$$

Maximizing gives an individual optimal level of d_i

$$d_i = \frac{x - \mu_{\gamma i}}{1 + p_\gamma + b_{\gamma\tau}} + \frac{b_{\gamma\tau}x}{1 + p_\gamma + b_{\gamma\tau}} - \frac{1}{2(1 + p_\gamma + b_{\gamma\tau})}\beta W_\alpha \qquad (12)$$

where W_α is the partial derivative of W with respect to α.

Now, looking at the expression for optimal disobedience chosen, we can clearly see the various forces at play. First and foremost, as expected, disobedience is higher, the further away the new policy is from the agent's preferred position. But the penalty p_γ, exerts a downward pressure on this response. More importantly, the second term in the expression suggests, disobedience is higher the more radical the policy is, i.e. the further away it is from the status quo. But again, the effects are dampened by the penalty imposed. The marginal cost of obedience, $b_{\gamma\tau}$ has a significant influence on it as well. Particularly, as

$$\frac{\partial}{\partial b_{\gamma\tau}}\left[\frac{b_{\gamma\tau}}{1 + p_\gamma + b_{\gamma\tau}}\right] > 0 \qquad (13)$$

disobedience is higher if the marginal cost of compliance is higher. The last term indicates that, the higher the marginal value of information revealed by first period obedience, the lower will be disobedience.

The location of the state of agent relations γ affects the agent's disobedience in three ways. First, updates in intra- and interagent relations increase the amount of guilt and disapproval or other sanctioning for disobedience. Penalty p_γ then, increases as the replicator moves toward ϑ where agents are playing the profile (U, U). Second, updates in intra- and interagent relations increase the amount of pride and approval or other benefits for obedience. The cost of compliance $c_{\gamma\tau}$ decreases as the replicator moves toward ϑ. Lastly, updates shift the ideal policy position toward new legislation. That is, the distance $\left|x - \mu_\gamma\right|$ decreases as γ approaches ϑ. Otherwise, if γ is in the vicinity of κ and no updating prevails, existing levels of intra- and interagent relations remain unchanged, and p_γ, $b_{\gamma\tau}$ and $\left|x - \mu_\gamma\right|$ remain unchanged.

Integrating over the whole distribution of individual choices gives the aggregate d for any given distribution, among agents, of ideal policy positions μ. For any given distribution of μ, say $f(\mu)$, the aggregate level of noncompliance is given by

$$\bar{d} = \int d_i f(\mu) d\mu. \tag{14}$$

Note that since integration is a linear operation, the various parameters effect $\bar{d}$ the same way as discussed above for individual d_i.

2.3 Legislature's optimal timing rule

Given the agents' anticipated aggregate disobedience level $\bar{d}$, the legislators respond by minimizing transaction costs, i.e. maximizing the objective function.

$$v(\tau, \bar{d}) = -\phi_\tau |x| - \delta\psi_\tau |\bar{d}| + \delta V(x - \bar{d}) \tag{15}$$

The first term indicates the enactment cost of the proposed legislation which is directly proportional to the absolute distance from the status quo. The second term, discounted at rate $\delta \in (0, 1)$, is the future extension or repeal costs, which we generally refer to as legislative maintenance costs. Let ψ_τ be a quadratic cost function, consisting of both fixed and marginal costs of maintaining legislation with respect to the aggregate compliance level.

$$\psi_\tau |\bar{d}| = y_\tau + q_\tau + (z_\tau - r_\tau)\bar{d}^2 \tag{16}$$

The fixed portion represents transaction costs that are independent of compliance and include such costs as adhering to rules that stipulate legislative voting procedures or presentment of the legislation before the executive. These costs are constitutionally fixed and increase linearly in the number of times that the legislation is extended or repealed. Each fixed cost extension or repeal is normalized to be 1. Since permanent legislation cannot be extended, fixed extension costs $y_1 = 0$ by definition. On the other hand, temporary legislation can either expire or be extended one or more times, and $y_0 \geq 0$. Both temporary and permanent legislation may be repealed, therefore fixed repeal costs $q_\tau \leq 1$.[12] The marginal portion of ψ_τ represents those costs dependent upon the aggregate compliance level attained in period 1, where z_τ denotes extension costs and r_τ denotes repeal costs. Because permanent legislation cannot be extended, $z_1 = 0$ by definition. Lastly, the third term of Eq. 16 represents the value of revealed information in making an optimal decision in period 2. This again is a function of aggregate compliance $\bar{d}$.

We want to focus on the choice between temporary or permanent legislation for any given new policy x. The legislature chooses the optimal τ, from the two possible values 0 or 1. We denote 0 as the decision to legislate temporarily, and 1 as the decision to legislate permanently. Hence, the legislators will choose to legislate temporarily if

$$-\phi_0|x| - \delta\psi_0|\bar{d}| + \delta V(x - \bar{d}) > -\phi_1|x| - \delta\psi_1|\bar{d}| + \delta V(x - \bar{d}) \tag{17}$$

Substitute in Eq. 10 and get

$$\begin{aligned} &-\phi_0|x| - \delta(y_0 + q_0 + (z_0 - r_0)\bar{d}^2) + \delta V(x - \bar{d}) > \\ &-\phi_1|x| - \delta(y_1 + q_1 + (z_1 - r_1)\bar{d}^2) + \delta V(x - \bar{d}) \end{aligned} \tag{18}$$

3 Comparing welfare

As mentioned above, the location of agent relations γ in Markov state space affect the penalty, the marginal cost of compliance, and the location of the ideal policy position. Each of these affect aggregate compliance. For example, when γ approaches the update profile basin ϑ, the penalty is increased, the marginal cost of compliance is decreased, and the ideal policy position moves toward the location of the new legislation. Compliance is therefore increased, and thus the overall value of information revealed regarding the optimal location of the legislation is increased. This plays a significant role in the legislature's strategic choice. The legislature induces higher levels of compliance by passing new legislation that updates agent relations, but is only able to realize that value under a temporary timing rule. At the same time, new legislation may fail to update agent relations and may require high fixed extension costs. We begin by characterizing the optimal timing rule when legislation fails to update agent relations.

Proposition 1. *If the profile* $(-U, -U)$ *of the agent relations game obtains in dominant strategies, social welfare is maximized with permanent timing rules when the difference in permanent and temporary enactment costs are less than any potential savings of permanent maintenance costs, i.e.* $(\phi_1 - \phi_0)|x| < \delta y_0$. *Social welfare is maximized with temporary timing rules when* $(\phi_1 - \phi_0)|x| > \delta y_0$, *and either timing rule maximizes social welfare when* $(\phi_1 - \phi_0)|x| = \delta y_0$.[13]

When $(-U, -U)$ obtains in dominant strategies, the location of agent relations γ is κ. Agent relations within the population do not undergo updating, and existing

[12] Legislation cannot be repealed twice. If the same legislation is reenacted and repealed at some point in the future, it is understood as new legislation.

[13] All proofs are given in the "Appendix".

levels of guilt, pride, disapproval, approval and other costs and benefits dependent upon agent relations prevail, irrespective of new legislation. Therefore, penalty p_γ and the marginal cost of compliance $b_{\gamma\tau}$ remain unchanged. The location of the ideal policy position μ_γ, remains unchanged as well. It follows that agent utility and aggregate compliance levels remain unaffected by new legislation, and that marginal maintenance costs $(z_\gamma - r_\gamma)$ remain at existing levels for both temporary and permanent legislation. However, the fixed portion of maintenance costs can differ. When temporary legislation is extended at least once, $y_0 > 0$, and fixed maintenance costs for temporary timing rules are strictly greater than fixed maintenance of permanent timing rules. Legislators therefore, are faced with the choice between any additional costs of enacting legislation permanently instead of temporarily, and any potential cost savings of permanent maintenance. When the difference in enactment costs is less than any fixed temporary extension costs, social welfare is maximized with a permanent timing rule.

Corollary 2. *If Γ is a coordination game with payoffs $(a > c,\ d > b)$ and the stationary state of agent relations γ is within the basin $(\iota, 1]$, social welfare is maximized with permanent timing rules as $\lambda \to 0$ and when $(\phi_1 - \phi_0)|x| < \delta y_0$. Social welfare is maximized with temporary timing rules as $\lambda \to 0$ and when $(\phi_1 - \phi_0)|x| > \delta y_0$, and either timing rule maximizes social welfare as $\lambda \to 0$ and $(\phi_1 - \phi_0)|x| = \delta y_0$.*

Proposition 3. *If the profile (U, U) obtains in dominant strategies, social welfare is maximized with temporary timing rules when any savings in marginal maintenance costs plus the difference in permanent and temporary enactment costs are greater than temporary fixed maintenance costs, i.e. $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| < \delta y_0$. Social welfare is maximized with permanent timing rules when $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| > \delta y_0$, and either timing rule maximizes social welfare when $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| = \delta y_0$.*

When (U, U) obtains in dominant strategies, the location of agent relations γ is ϑ. Agent relations in the population undergo updating, and the existing levels of guilt, pride, disapproval, approval and other costs and benefits dependent upon agent relations increase. Therefore, penalty p_γ, which exerts a downward pressure on optimal disobedience, increases; the marginal cost of compliance $b_{\gamma\tau}$, which exerts an upward pressure on optimal disobedience, decreases. The distribution of ideal policy positions μ_γ, also in response to updating, shifts toward the location of new legislation. This shift decreases the absolute distance $x - \mu_\gamma$, which dampens disobedience. It follows that agent utility and aggregate compliance levels increase, and unlike the scenario where no updating takes place, marginal maintenance costs are affected.

Now marginal maintenance costs are affected for both permanent and temporary timing rules, but permanent legislation can not be extended. This means that permanent legislation only realizes any effect from an increase in aggregate compliance for repeals, while temporary legislation realizes any effect for extensions and repeals. Particularly, an increase in compliance increases marginal repeal costs r_τ, but decreases marginal extension costs z_0. Therefore, temporary marginal maintenance costs are strictly less than permanent marginal maintenance costs when aggregate compliance $\bar{d}$ increases. However, since a temporary timing rule can require multiple extensions, fixed temporary maintenance costs are weakly greater than fixed permanent maintenance costs. As a result, social welfare is maximized with temporary timing rules when any savings in marginal maintenance costs plus any savings in temporary enactment costs are greater than any additional fixed extension costs. Otherwise, if numerous extensions are sufficiently costly, social welfare is maximized when legislators forgo the savings of that portion of extensions costs which are dependent upon $\bar{d}$ and legislate once and for all with a permanent timing rule.

Corollary 4. *If Γ is a coordination game with payoffs $(a > c,\ d > b)$ and the stationary state of agent relations γ is within the basin $[0, \imath)$, social welfare is maximized with temporary timing rules as $\lambda \to 0$ and when $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| < \delta y_0$. Social welfare is maximized with permanent timing rules as $\lambda \to 0$ and when $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| > \delta y_0$, and either timing rule maximizes social welfare as $\lambda \to 0$ and when $-\delta z_0 \bar{d}^2 + (\phi_1 - \phi_0)|x| = \delta y_0$.*

4 Discussion

The preceding analysis demonstrates how agent relations influence a population's choice of compliance, and how the consequence of that choice affects the legislature's strategic decision to legislate temporarily or permanently. The analysis highlights an important dimension of the timing rule decision that has been unaddressed in the literature, namely the residual effects of a temporary policy. Legislation can update agent relations and increase compliance levels after the law has expired. It may be rare that temporary legislation so decisively moves a population to an update or no update equilibrium. For this reason, we show that the results still hold when the agents are in a basin of attraction near either equilibrium. Imitation moves them toward a state in which everyone plays (U) or ($-U$) as a best response amongst each other, and once they are in the vicinity of either of these equilibria, they will tend to stay there. The legislator's best response in this scenario is nearly the same as when everyone plays (U) or ($-U$) in dominant strategies.[14] There are two additional elements in her decision however: (1) how likely is movement away from the stationary state and (2) how long will movement take.

As a Markov process, the likelihood from moving from any given state to another is strictly positive. This is verified by noting that in any state, there is a positive probability after learning has occurred that all players are drawn to be mutants and choose the strategy that gives the new state in question. How long it takes for the population to move from one equilibrium to the other, or from any point $\gamma(0)$ to any equilibrium, depends on how quickly learning proceeds and how soon it leads to consistent behavior. This in turn, depends on three aspects of the new law.

First, to what extent does the law reinforce what has governed intra- and interagent relations in the past? A large deviation from existing levels of internal cost and benefit bases for noncompliant and compliant behavior may be more difficult to learn. Similarly, it may be more difficult to adjust to a large deviation from existing levels of willingness to sanction or reward others for noncompliance

[14] It is precisely the same as λ goes to 0.

and compliance. Gradual adjustments to the law, and hence to what is required of agent relations for compliance, may increase the pace of learning. Second, learning will be faster the more intelligible and simpler is the new law. When agents are vaguely aware of a substantive legal change, or cannot process it easily due to its complexity, the length of time required to update to optimal agent relations may be very long. To this end, direct and simple communication from lawmakers can eliminate the need for agents to learn new sanction and reward levels from each other, which can take additional iterations of the game to process. Simpler behaviors may be learned more quickly for similar reasons. Generally, learning will proceed faster when less accumulation of experience at playing the game is required to arrive at an optimal level of agent relations. Lastly, the more important the law is to the players the more likely they will commit their decision-making resources toward socially interacting around its substance. Consideration of what level of internal costs and benefits that one assigns to a behavior, or learning what level of costs and benefits other agents assign to a behavior is more likely to occur for behaviors that the agent considers consequential.

5 Conclusion

We have considered how the post-expiration effect of temporary legislation impacts the legislature's choice of temporary or permanent timing rule. Although permanent statutes can be repealed and temporary statutes can be extended, each allocates legislation costs differently. This difference permits legislators to optimize on the choice of timing rule when legislation produces residual effects, which we have generally described as updates in agent relations. Updates increase compliance, which in turn, reveal more information about the optimal location of the legislation for both agents and legislators.

When agents do not undergo updating, the costs of complying with temporary and permanent legislation are the same and the optimal location of legislation remains the same. However, the fixed costs of legislating temporarily are weakly greater than the fixed costs of legislating permanently since temporary legislation may require numerous extensions. In this case, legislators weigh the difference in permanent and temporary enactment costs against fixed temporary extension costs, and maximize social welfare by choosing the timing rule that minimizes costs.

When agents undergo updating, compliance is less costly for both legislation types and the optimal location of legislation changes. Marginal maintenance costs are decreased, but only temporary timing rules can benefit from the reduction in cost. In this case, legislators maximize social welfare by weighing any savings in temporary marginal maintenance costs plus any savings in temporary enactment costs against fixed temporary extension costs. More generally, this article contributes to a growing body of literature on timing rules. While previous theories have demonstrated the usage of timing rules in uncertain regulatory environments in order to minimize transactions cost, our theory demonstrates their general usage to minimize transactions cost, especially where legal impact is certain, but agent adaptation is gradual.

Appendix

Proof of Proposition 1

Legislators are faced with the decision

$$\begin{aligned} & -\phi_0|x| - \delta(y_0 + q_0 + (z_0 - r_0)\bar{d}^2) + \delta V(x - \bar{d}) \\ & \gtrless -\phi_1|x| - \delta(y_1 + q_{1+}(z_1 - r_1)\bar{d}^2) + \delta V(x - \bar{d}) \end{aligned}$$

Recall that an agent chooses disobedience such that

$$d_i = \frac{x - \mu_{\gamma i}}{1 + p_\gamma + b_{\gamma\tau}} + \frac{b_{\gamma\tau} x}{1 + p_\gamma + b_{\gamma\tau}} - \frac{1}{2(1 + p_\gamma + b_{\gamma\tau})}\beta W_\alpha$$

and that aggregate disobedience is given by $\bar{d} = \int d_i f(\mu) d\mu$ for any distribution of ideal policy positions. Because the profile ($-U$, $-U$) obtains in dominant strategies, the location of normative relations γ is κ and p_γ and $b_{\gamma\tau}$ remain unchanged by definition. Moreover, as agent relations are not updated, ideal positions μ_γ remain unchanged. This implies that $(z_0 - r_0)\bar{d}^2 = (z_1 - r_0)\bar{d}^2$. Because the fixed cost of a repeal is the same for temporary and permanent legislation, $q_0 = q_1$, and because permanent legislation cannot be extended, $y_1 = 0$.

Legislators are therefore faced with

$$-\phi_0|x| - \delta(y_0) \gtrless -\phi_1|x|$$

and maximize social welfare by setting $\tau = 1$ when $(-\phi_1 + \phi_0)|x| < -\delta y_0$, $\tau = 0$ when $(-\phi_1 + \phi_0)|x| > -\delta y_0$, and $\tau = 1$ or 0 when $(-\phi_1 + \phi_0)|x| = -\delta y_0$. □

Proof of Proposition 2

Because the profile (U, U) obtains in dominant strategies, the location of agent relations γ is ϑ. Therefore, the penalty p_γ increases and the marginal cost of compliance $b_{\gamma\tau}$ decreases by assumption. Recall that an agent chooses disobedience such that

$$d_i = \frac{x - \mu_{\gamma i}}{1 + p_\gamma + b_{\gamma\tau}} + \frac{b_{\gamma\tau} x}{1 + p_\gamma + b_{\gamma\tau}} - \frac{1}{2(1 + p_\gamma + b_{\gamma\tau})}\beta W_\alpha$$

Clearly, an increase in p_γ decreases disobedience. And since

$$\frac{\partial}{\partial b_{\gamma\tau}}\left[\frac{b_{\gamma\tau}}{1 + p_\gamma + b_{\gamma\tau}}\right] > 0$$

a decrease in $b_{\gamma\tau}$ also decreases disobedience. By assumption, the location of γ at ϑ shifts the ideal policy $\mu_{\gamma i}$ towards the new legislation x. This means that the distance

$|x - \mu_{\gamma i}|$ decreases and as a result, disobedience d_i decreases. It follows that aggregate disobedience, given by $\bar{d} = \int d_i f(\mu) d\mu$, decreases for profile $\{U, U\}$.

Legislators are faced with the decision

$$- \phi_0|x| - \delta(y_0 + q_0 + (z_0 - r_0)\bar{d}^2) + \delta V(x - \bar{d})$$
$$\gtrless - \phi_1|x| - \delta(y_1 + q_1 + (z_1 - r_1)\bar{d}^2) + \delta V(x - \bar{d})$$

Aggregate disobedience $\bar{d}$ effects both $z_0 - r_0$ and $z_1 - r_1$, but recall that $z_1 = 0$ because permanent legislation is not extended by definition. In contrast, $z_0 \geq 0$.

Now decreasing $\bar{d}$ increases the absolute value of both marginal repeal costs r_0 and r_1. Therefore, $-\delta(z_0 - r_0) \leq -\delta(z_1 - r_1)$.

Because the fixed cost of a repeal is the same for temporary and permanent legislation, $q_0 = q_1$, and because permanent legislation cannot be extended, $y_1 = 0$.

Legislators are therefore faced with

$$-\phi_0|x| - \delta y_0 - \delta z_0\bar{d}^2 \gtrless - \phi_1|x|$$

and maximize social welfare by setting $\tau = 0$ when $-\delta z_0\bar{d}^2 + (\phi_1 + \phi_0)|x| < \delta y_0$, $\tau = 1$ when $-\delta z_0\bar{d}^2 + (\phi_1 + \phi_0)|x| > \delta y_0$, $\tau = 0$ or 1 when $-\delta z_0\bar{d}^2 + (\phi_1 + \phi_0)|x| = \delta y_0$. □

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