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The local dynamics of institutional change

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“Endogenous Dynamics of Institutional Change” explores the conditions in which new institutional arrangements emerge locally and then spread widely: “when individuals perceived decoupling as a more rewarding alternative than following the established order; where local concentrations and arrangements facilitated communication and coordination; and where state actors were—for different reasons—slow in sanctioning deviators.” These conditions are illustrated with a computational model and two empirical case studies of endogenous institutional change—the rise of private manufacturing in the Yangzi Delta and the opening of gay bars in San Francisco.

The backdrop that makes this study compelling is that institutions are, by definition, highly resistant to change. “We define institutions as relatively enduring social structures comprised of interrelated informal and formal elements—beliefs, norms, rules, and organizations—governing social, political and economic life.” Institutions endure for two main reasons. First, they are self-reinforcing in that the dynamics of institutional conformity entail positive network externalities. The individuals governed by the institution are usually better off complying when others do the same, given that the benefit of institutional conformity increases and the cost decreases with the number who conform. Second, institutional arrangements are often

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sanctioned by the state, with the cost to deviants often greatest when conformity is near universal.

Nevertheless, endogenous change is possible when the conditions that sustain institutions erode over time and when new institutional arrangements emerge that confer a comparative advantage. By endogenous, the authors mean that new institutional rules emerge through individual decisions to deviate from existing institutional arrangements in favor of a preferred alternative. This contrasts with exogenous institutional change imposed by state actors, other enforcement agencies or environmental forces.

Note that the claim is not that the state does not support the change; on the contrary, in all of the listed examples, the state eventually enacts laws or regulations that formalize the new institutional arrangements, but only after these arrangements have already become well established from "the bottom up."

The authors use a computational model of diffusion across Moore neighborhoods on a regular lattice to show that it is not just state action that matters but also state inaction—the failure of the state to vigorously suppress challenges to the status quo. "In order for successful emergence of a new institutional innovation to occur, potential deviators must overcome not only the problem of coordination with other agents, but also potential opposition from state authorities invested in the status quo." The model shows that endogenous institutional change is possible when institutional innovators are spatially concentrated and state actors are unable or unwilling to enforce compliance with existing arrangements. "When agents are embedded within neighborhoods, it becomes possible for deviation to emerge in local clusters and spread rapidly across the entire population."

Positive network externality means the perceived comparative utility from adopting an innovation increases with the proportion of network neighbors observed to adopt. This happens for two reasons, the positive externality from coordination and the declining probability of state sanctions as the number of deviants increases. "Agents assess the likelihood of sanctions by looking around their neighborhood to gauge other agents' states and their outcomes. Those who see abundant evidence of sanctioned deviation are more fearful than those who do not." If the state fails to nip emergent innovation in the bud, the willingness and capacity for enforcement can be overwhelmed by the rapid diffusion of deviant behavior:

> The emergence of a stable cluster of deviators further amplifies the gains of coordination and pulls even more neighbors into the fold in a self-reinforcing "tipping" dynamic (Nee and Opper, 2012: 24–32). Others who may not have been willing to take the initial step of risky experimentation will nonetheless join

> the local bandwagon begun by their more entrepreneurial neighbors as collective action gains self-reinforcing momentum.

The study concludes that "the theory and cases laid out here undermine the widely held belief that collective action problems will ultimately impede institutional change from below."

The limited effectiveness of the state

In the authors' model, the capacity and will of the state to prevent institutional change can be quickly overwhelmed by a cascade. In cascade models of diffusion on networks, there is typically an initial period of slow, local diffusion followed by the emergence of persistent clusters that precipitates rapid diffusion (Cameron, 2016), a pattern that corresponds closely with the four stages of diffusion enumerated by the authors: emergence of isolated deviance, cluster formation, broader diffusion and finally saturation. It is instructive to consider the effectiveness of sanctions in each of these phases.

Isolated deviance

Stochastic decisions allow for spontaneous innovation in a population with universal compliance. For example, with the authors' parameters and $B=2$, the chance of spontaneous innovation is .007. Although the rate is low, the eventual emergence of isolated deviants is inevitable and increasingly likely as the size of the population increases. Sanctions play no role in the incidence of isolated deviants because only agents that are punished or observe punishment expect to be sanctioned. The innovation rate is entirely independent of state-imposed sanctions.

Cluster formation

It is in this phase that sanctions have the largest effect, as punishment reduces the attractiveness of deviance for agents with deviant neighbors. Nevertheless, cascades remain possible. With $B=2$, about 10% of isolated innovators avoid punishment, giving each of their eight neighbors a $p=.13$ chance of activation. At least one of these neighbors can be expected to join the deviant innovator, at which point all their common neighbors become indifferent, making the formation of a small cluster highly likely. Although the probability of a particular cluster forming is very low, this only needs to happen a very few times, regardless of population size. The larger the population, the higher the probability that a critical number of clusters will form.

Broader diffusion and saturation

The formation of deviant clusters reduces the state's probability to sanction. With $B=2$, once 25% of the population has adopted the innovation, the punishment rate drops to 50%. Sanctions have declining effect on agent behavior during the phase of broader diffusion and little or no effect during saturation.

In sum, sanctioning plays no role in the innovation of deviance and becomes inconsequential during and after the phase of broader diffusion. Sanctions have the greatest impact during cluster formation, by suppressing the number of viable clusters that form around spontaneous innovators.

We found the argument convincing and the cases illustrative. The authors wisely seek to avoid unnecessary complications in the specification of the computational model, a modeling strategy they explicitly endorse. In particular, the model makes important simplifying assumptions, most of them conservative. It is useful to identify and unpack these assumptions for three reasons: to assess the robustness of the results should the assumptions be relaxed, to consider what different results we might expect and how these might alter the authors' conclusions, and to consider possible directions for future research that pursues some of the implications of complications that might be introduced.

The importance of local clustering

The authors' model assumes that network externalities are local. That is reasonable when applied to institutional arrangements for interpersonal communication since the utility increases with the proportion of users with whom one will be able to communicate. Local externality also seems plausible in the authors' two case studies. However, in other cases, the externality is global, such as the development of infrastructure to support growing adoption of new institutional practices or the lowering of the cost of production through economies of scale.

Classic studies of diffusion on networks (Axelrod, 1984; Granovetter, 1978; Schelling, 1969) have shown the dependence of cascades on local clustering, for two reasons: local structure and local information. Local structure means that agents are embedded in densely connected neighborhoods. Local information means that agents base the decision to deviate on the number of their neighbors who innovate, without regard to the global rate.

Just as a random spark requires the clustering of tinder to trigger a forest fire, so too the diffusion of innovation requires the clustering of decision making to trigger a cascade. The authors address this point by randomly perturbing the regular lattice. In line with Centola and Macy's (2007) study of complex contagions, they show that there is a phase transition as local structure erodes beyond a critical value. Regular Moore neighborhoods have three overlapping members, which means that contagions can spread so long as agents require no more than three adopting neighbors before they are willing to adopt. This overlap is eroded by random rewiring. For example, with only two overlapping neighbors, a contagion that requires three adopting neighbors cannot spread.

However, local structure alone is not sufficient for a cascade. Local information exposes actors to adoption rates that are potentially far higher than the global average across a large population. Simulation is not required to demonstrate the dependence of cascades on local information. Take the limiting condition in which only one out of eight Moore neighbors needs to deviate in order to trigger a cascade. (In fact, their simulations show that more than one adopting neighbor is needed, but one is the lower limit for positive integers, and we know there is some value of B that is large enough to make cascades possible with only a single deviant neighbor.) In a population of 1000 agents, each with a .007 probability of adoption when no one has adopted, the probability that at least one out of 1000 will adopt is larger than .99999999999. In other words, a successful cascade is effectively guaranteed. That is no surprise.

But now, consider another limiting case in which the decision to innovate depends on the global number of adopters. A successful cascade now requires exposure not to 1/8th of eight neighbors; rather, it requires 1/8th of 999 neighbors, or 125 spontaneous adopters, each with an individual probability to adopt of .007. The probability of 125 spontaneous adopters is smaller than 0.000000000001.

Simply put, endogenous institutional change would not be possible in their model if the decision to innovate were based on the global rate of adoption instead of the local. The key to endogenous institutional change is not just accommodation by the state, *it is the local clustering of information that influences decision making*.

The distinction between local and global externalities extends to the parallel assumption that agents' expectations of being sanctioned are also locally based. When deviance is rare, stochastic innovators are punished with a probability greater than 90% with the authors' parameters, but that still leaves open a reasonable chance for a lone deviant in some neighborhood to escape notice. That deviant's neighbors conclude that deviance is tolerated, no matter how many deviants outside the neighborhood are being punished.

Figure 1 shows the probability that a currently conforming agent will adopt a deviant innovation based on local versus global information about the probability that a deviant will be punished. If agents in compliant

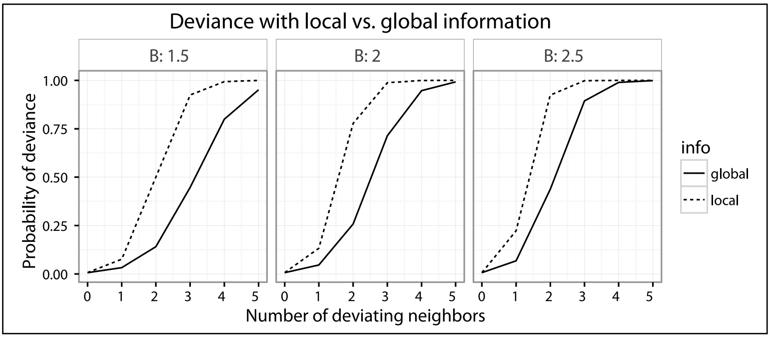

Figure 1. The probability that a currently conforming agent will adopt a deviant innovation using global or local information about the probability of punishment. The local case reflects the incentives in a neighborhood where deviance has gone unpunished by chance. The global case reflects what the incentives would have been had agents been aware of global rates of punishment. Although rare, these punishment-free neighborhoods facilitate the development of a local critical number of deviants.

neighborhoods had realistic expectations about the chance of punishment based on global information, the probability of adopting deviant behavior with one active neighbor would fall from .13 to .04; with two active neighbors, the adoption probability would drop from .78 to .26.

In short, endogenous institutional change depends on the assumption that innovators have naive assumptions about the risk of punishment, based on a lack of interest or ability to access global information. This distinction between locally perceived and actual global probabilities of being sanctioned helps to explain the reliance of repressive regimes on public punishment. In populations with easy access to global probabilities of punishment, the authors' argument regarding state accommodation gains considerable strength: *Endogenous institutional change is highly unlikely if it is opposed by the state*.

But why does the state oppose institutional change that would benefit everyone were it to become widely adopted? The authors assume the state has a "vested interest in defending a dominant norm," even though the innovation would benefit every member of the population (presumably including incumbents of state positions) were it to be universally adopted. However, "the fraction *A/B* in the denominator" means that "the state's propensity to sanction deviators increases with the relative utility of compliance." In other words, the greater the potential benefit of the innovation to the entire population, the weaker the state's incentive to punish adopters.

The state's incentive to sanction also illustrates the importance of the distinction between local and global information. The state defends the status quo because it alone views innovation from a global perspective, while everyone else assesses utility locally. For example, suppose three neighbors were to adopt the innovation while 997 do not. Locally, these neighbors perceive utility based on a .375 adoption rate while the state assesses utility based on a .003 adoption rate. This would explain why the state imposes sanctions most vigorously when deviance is globally rare and then backs off as the global rate increases, even if the state has ample resources to sanction more broadly.

Alternatively, one might assume instead that the state also adopts a local perspective and views an innovative neighborhood as a highly successful field experiment that demonstrates locally positive externality. The state would then see its role as the coordinating mechanism for highly desirable institutional changes. This implies that endogenous institutional change is more likely where democratic institutions not only hold officials accountable to the public interest but, perhaps more importantly, *give voice to local experience through granular parliamentary representation of local neighborhoods*.

The important distinction between local and global processes applies as well to peer sanctioning. The state is a global actor, while neighbor-imposed sanctions are local. The authors assume there are no peer sanctions, which they justify as follows:

> For convenience, we have assumed the state to be the only actor formulating explicit sanctions against deviators. While this is consistent with the view of the state as the central arbiter of formal institutions, deviators may also face some form of sanction from other groups in civil society. These sanctions could include social disapproval, negative gossip, or outright avoidance of deviators in certain social encounters. Such additional social sanctions could warrant specific modeling of inter-group conflicts. However, since our focus is on the identification of mechanisms for successful bottom-up changes, and not on dynamics of inter-group relations, such conflicts can be conveniently interpreted as one factor influencing the shape of network externalities. With strong societal opposition, expected positive externalities could be miniscule or even negative.

Their reference to top-down "social opposition" indicates that the authors imagine peer sanctioning not as interpersonal but as inter-group, that is, between groups with opposing preferences. While we agree that inter-group conflict would be an unnecessary distraction and should not be included in the model, there is an alternative interpersonal specification of peer sanctioning that they do not consider and which has effects that are the opposite of network externality and state-imposed sanctions. Peer sanctions cannot be inter-group in their model because the model assumes a population with homogenous preferences—everyone prefers the new institutional arrangements over the old once a critical mass of neighbors has adopted the innovation. Hence everyone has the same "regulatory interest," to use Heckathorn's (1988) term, in pressuring their neighbors to adopt the innovation.

Although the authors justify the exclusion of peer sanctioning based on their focus on "bottom up" processes, we reach the opposite conclusion. Peer enforcement of regulatory interests is every bit as "bottom up" as the diffusion of the target behavior. That does not mean the dynamics of sanctioning and compliance with sanctions are the same. In the absence of peer pressure, agents only adopt the innovation once a sufficient number of their neighbors have adopted, but the decision to pressure one's neighbors to adopt does not require that anyone has adopted. Moreover, assuming peer sanctions have a non-trivial cost to the sanctioner, the incentive to exert pressure can be expected to decline as the rate of adoption increases, thereby offsetting the positive externality in the utility gain from adoption.

The dynamics of peer sanctioning also differ from those of state-imposed sanctions. For the latter, agents estimate the probability of state sanctioning based on what they observe in their local neighborhood. The more neighbors who deviate, the higher the probability that they will observe a neighbor being sanctioned. Thus, the expected cost of sanctioning must be deducted from the expected utility of innovation. However, social approval and disapproval depend on regulatory interest in the behavior of neighbors. The greater the marginal utility of each additional deviant, the greater the regulatory interest in approving deviance and disapproving conformity. Positive network externality in turn means that marginal utility increases with the level of deviance, hence also the social approval for deviance and punishment of compliance. Had the authors incorporated peer sanctioning based on regulatory interests, the case for endogenous institutional change would be stronger, not weaker. In other words, the decision to omit peer sanctioning from their model can be viewed as an appropriately conservative simplification.

Another simplifying assumption is that all agents assign identical costs to state-imposed sanctions. The agents' estimates of the probability of being sanctioned vary with the observation of local sanctioning but these estimates are not weighted by the perceived severity of sanctions. This assumes away a widely used state strategy of making examples out of a hapless few whose punishment is both severe and widely observable. This also assumes away heterogeneity in what the actors have to lose by being sanctioned. For those who have nothing to lose, the probability of being sanctioned becomes irrelevant compared to those who might be risking lucrative careers. In the Yangzi delta case study, widespread subsistence level poverty in Wehzhou made private manufacturing relatively more attractive than in wealthier Shanghai. It may well be the case that citizens of Wehzhou perceived official punishment for deviance as less severe than did their counterparts in Shanghai. While it is of little consequence to the model under uniform distributions of perceived severity, distributions where some actors are relatively insensitive to official sanctions could lead to different model dynamics, with testable predictions about which actors would be expected to innovate illegitimate practices. While it might be interesting to explore the implications of heterogeneity in the effectiveness of sanctions, we should keep in mind that the authors' point is not that positive network externality can always overcome state opposition; on the contrary, their cases illustrate conditions in which institutional innovation becomes possible when the state accommodates change.

Finally, the model assumes that the social network is an unperturbed regular lattice in which every agent has the same number of neighbors. Nearly all observed social networks have a degree of distribution that approximates a power law (Barabási, 2002), so the assumption of uniform degree needs to be carefully tested for robustness. With invariant degree, it makes no difference whether the utility from adopting the innovation depends on the proportion of adopting neighbors or the absolute number. However, if degree varies, then the proportion captures the assumption that compliant neighbors exert a countervailing influence, while specifying utility as a function of the absolute number of compliant neighbors means that utility is affected only by the number of deviants (Centola and Macy, 2007). It is reasonable to assume that countervailing influence applies to institutional change, hence the assumption of degree homogeneity could be relaxed without introducing any logical contradictions.

To sum up, the computational model in this study entails a number of assumptions that might lead skeptical readers to suspect the results are "wired in." Although these concerns are to be expected for any formal model that imposes empirically implausible simplifying assumptions, in this case, a careful review indicates that the simplifications are a strength of the model, not a weakness.

Nevertheless, we conclude that the authors focused too heavily on the need for state accommodation, and failed to place sufficient emphasis on the dependence of institutional change on local network structure and local information. Few social networks in the real world look anything like an unperturbed regular lattice, and social media make it increasingly difficult even for authoritarian states to block access to information from afar. The empirical illustrations should include careful consideration of the local and global sources and quality of information used by individuals and the structures that constrain access to the information that generates observed population behavior.

Generalizing the model

While the dependence on local externality constrains the scope of the model, there is another assumption that unnecessarily limits the scope—that agents are utility maximizers. Previous research (Centola and Macy, 2007) on contagion dynamics enumerated three mechanisms in addition to positive externalities by which the probability to adopt an innovation might increase with the number of others observed to have already adopted: credibility, legitimacy, and emotional contagion. "Credibility" refers to the confidence in the validity of a belief that may depend on epistemic social confirmation, as in "this many people can't be wrong." For example, in Coleman's classic study of medical innovations, doctors were reluctant to adopt until they saw their colleagues using it. The credibility of an urban legend also depends on hearing others repeat it. "Legitimacy" refers to perceptions of propriety rather than validity. Examples include "decisions about what clothing to wear, what hairstyle to adopt, or what body part to pierce." "Emotional contagion" refers to the self-reinforcing diffusion of affective responses in densely connected network clusters. Examples range from cheering fans to mass hysteria to mob violence.

There is no a priori reason to privilege positive externality as the explanatory mechanism in the dynamics of contagion, or to shoehorn the other three mechanisms into a utility maximizing narrative. Consider the authors' list of prominent examples of endogenous institutional change: "the legalization of drugs, civil rights, women's rights, abortion rights, gay rights, anti-apartheid and dissident movements," the rapidly expanding sharing economy for lodging and transportation, and "hockey players [who] wear helmets knowing that others will do the same." The protective benefit of a helmet does not increase with its adoption. What changes is the legitimacy of the norm and the credibility of the belief in the danger of concussions. Those same mechanisms better explain the rapid diffusion of Couchsurfing, not the change in economic savings. Changes in the credibility and legitimacy of traditional beliefs also fuel the tipping process that is evident in the rapid transformation of moral and religious regulations of sexual behavior, racial and ethnic segregation, the propriety of body modification, the banishment of smokers, and the list goes on.

Affective and normative responses apply not only to the motivation to deviate but also to state-imposed sanctions. The authors focus exclusively on the cognitive deterrent effect created by probabilistic estimates of state-imposed sanctions. However, state crackdowns can also incite anger and righteous indignation with the opposite consequence for the contagion dynamics. State sanctions (such as police shootings of unarmed civilians) backfire when they trigger an emotional cascade that leads to willingness to take risks that would otherwise be unacceptable. Having said that, we hasten to add that this incitement effect would strengthen the authors' conclusions, by reducing the ability of the state to prevent the spread of institutional innovations.

In short, the scope of the model can be extended to any institutional change in which the probability to adopt an innovation increases with the local proportion of adopters, regardless of the motivation, be it utility maximization, emotional arousal, or normative influence. This might include the diffusion of taboos, conventions, regulations, technologies, religions, moral injunctions, manners, traditions, and protocols. The authors may believe that customizing their model to better fit their empirical cases makes the demonstration more convincing. We suggest it is the other way around. What we find most compelling is that a general model can help to explain not only these two empirical cases but countless others.

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