Skocpol T (1979) *States and Social Revolutions: A Comparative Analysis of France, Russia and China*. Cambridge: Cambridge University Press.
Soule SA (1997) The student divestment movement in the United States and tactical diffusion: the shantytown protest. *Social Forces* 75: 855–883.
Strang D and Macy MW (2001) In search of excellence: fads, success stories, and adaptive emulation. *American Journal of Sociology* 107: 147–182.
Streeck W (2009) *Re-Forming Capitalism: Institutional Change in the German Political Economy*. Oxford: Oxford University Press.
Tesfatsion L (2002) *Agent-Based computational economics: growing economies from the bottom up*. ISU economics working paper, no. 1, 15 March. Ames, IA: Iowa State University.
Thelen K (1999) Historical institutionalism in comparative politics. *Annual Review of Political Science* 2: 369–404.
Tolbert PS and Zucker LG (1983) Institutional sources of change in the formal structure of organizations: the diffusion of civil service reform, 1880–1935. *Administrative Science Quarterly* 30: 22–39.
Tsai K (2002) *Back Alley Banking: Private Entrepreneurs in China*. Ithaca, NY: Cornell University Press.
Von Neumann J (1966) *Theory of Self-Reproducing Automata*. Urbana, IL: University of Illinois Press.
Watts DJ and Strogatz SH (1998) Collective dynamics of "small-world" networks. *Nature* 393: 440–442.
Wenzhou City Statistical Yearbook (various years) Accessed via *China Data Online*, China Data Center, University of Michigan.
Whittington KB, Owen-Smith J and Powell WW (2009) Networks, propinquity, and innovation in knowledge-intensive industries. *Administrative Science Quarterly* 54: 90–122.
Young HP (1993) The evolution of conventions. *Econometrica* 61: 57–84.
Young HP (1998) *Individual Strategy and Social Structure: An Evolutionary Theory of Institutions*. Princeton, NJ: Princeton University Press.
Young HP (2011) The dynamics of social innovation. *Proceedings of the National Academy of Sciences* 108: 21285–21291.
Young HP (2015) The evolution of social norms. *Annual Review of Economics* 7: 359–387.
Zald MN and Berger MA (1978) Social movements in organizations: coup d'etat, insurgency, and mass movements. *American Journal of Sociology* 83: 823–861.
Zhang J (2007) Marketization, class structure, and democracy in China: contrasting regional experiences. *Democratization* 14: 425–445.
Zilber TB (2002) Institutionalization as an interplay between actions, meanings, and actors: the case of a rape crisis center in Israel. *Academy of Management Journal* 45: 234–254.

Commentary

RATIONALITY AND SOCIETY

Rationality and Society
2017, Vol. 29(1) 49–54
© The Author(s) 2017
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/1043463116685665
journals.sagepub.com/home/rss
SAGE

Notes toward a macro version of the Nee–DellaPosta–Opper model of institutional change

Robert Solow
MIT, USA; Russell Sage Foundation, USA

One of the virtues of the Visiting Scholars program of the Russell Sage Foundation is that someone like me, a card-carrying macroeconomist by trade, came to read this paper by Victor Nee (co-authored with Daniel DellaPosta and Sonja Opper). The S-curves in Figure 3 triggered the natural reaction of the proverbial child with a hammer (or a model of a hammer): there is a purely aggregative way to get to this outcome, and it tells an interesting story on its own. So here are some preliminary notes toward a macromodel corresponding to the nearest-neighbor micromodel of the DellaPosta, Nee, and Opper's paper. In their paper, chance innovations give rise to utility gains that through positive externalities diffuse through networks and communities. "The greater the utility gain and larger the network externalities, the more likely political actors will accommodate endogenous institutional change." This "bottom-up" approach highlights the importance of understanding the forces that give rise to innovation and deviance, as well as the motives.

Let N(t) be the number of deviants at time t. I will treat time as continuous, though everything could easily be translated to discrete time, which would be more convenient for computer simulation and for adding random fluctuations.

Corresponding author:
Robert Solow, 1010 Waltham Street, Apt 328, Lexington, MA 02421-8057, USA.
Email: barbmlewis@hotmail.com

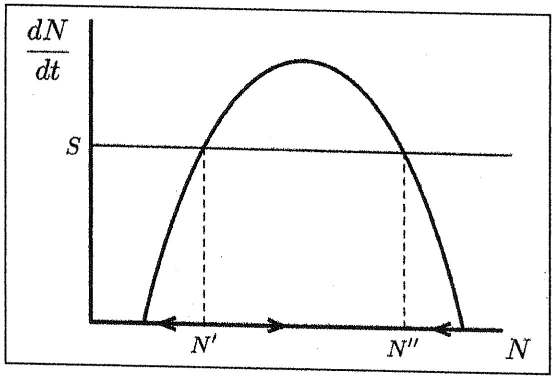

Figure 1. Here, the number of deviants suppressed per unit time is a constant. N′ is an unstable equilibrium. Any displacement to the left leads to the disappearance of deviants. Any displacement to the right leads to an S-curve ending at N″.

In the absence of any suppression of deviance by the state (or anyone else), N(t) evolves according to

$$\frac{dN}{dt} = a(N-m)(M-N)\ (m<M) \tag{1}$$

So any small N (<m) will decay back to zero, but if N should happen to exceed m, it will trace out a standard logistic curve with upper asymptote M. In the paper by Nee et al., M is the population size, but it could be determined in some other way; it is the largest sustainable number of deviants.

The state can choose to suppress an arbitrary number S of deviants per unit time in which case N evolves according to

$$\frac{dN}{dt} = a(N-m)(M-N)-S \tag{1'}$$

If S is constant in time, the phase diagram is simple and familiar. Draw the parabola given by the right-hand side (RHS) of equation (1) and superimpose a horizontal line at height S. It will normally intersect the parabola at two points, N′ and N″, say N′<N″. If N takes a value to the left of N′ or to the right of N″, N will decrease with time (because, as Figure 1 shows, dN/dt<0 there). At any value between N′ and N″, N will increase. So if N ever gets above N′; it will follow a logistic-like path to a stable equilibrium at N″<M. At N″ the natural endogenous rate of increase in N is S and is just offset by the suppressive activities of the state. (Notice that if the horizontal

at S lies above the peak of the parabola, the state snuffs out all deviance as soon as it appears, and N is always zero except for occasional random bursts, immediately suppressed.)

Of course, S(t) = constant is not an intelligent policy. It makes more sense that the state has a policy S = s(N): the amount of suppression is tuned to the amount of deviance. (More complicated policies are possible.) What should be assumed about the function s(N)? How might a policy be determined in this abstract world?

Suppose the state has an implicit valuation function defined on N: V(N). The state can assign a numerical value to the (lack of) desirability of a situation with N deviants. So V is a decreasing function of N. Also suppose that the cost to the state of suppressing S deviants per unit time is c(S). (The cost of suppression might also depend on N. This is only a minor complication and I avoid it.) Then, a fairly rational (though not hyper-rational) policy for the state might be to choose S at every time t to

$$\text{Maximize } V(N-S)-c(S)$$

If the state did nothing, there would be N deviants, and the state wouldn't like that. It would feel better if there were fewer deviants, but bringing that about is costly. (Note the tacit assumption that V and c are commensurable. The Office of Management and Budget [OMB] will have to figure it out.) If that is the policy, the appropriate S will satisfy

$$V'(N-S)-c'(S)=0 \tag{2a}$$

and

$$V''(N-S)-c''(S)<0 \tag{2b}$$

The conventional assumption is that c″ > 0 (increasing marginal cost) so equation (2b) does not fix the sign of V″(N − S). Now equation (2a) implicitly determines the function S = s(N); it gives the maximizing S for any value of N. It does this by finding the value of S such that the marginal gain from suppressing one more deviant is just equal to the marginal cost of suppressing that deviant. I warned you that I am an economist.

Should S be larger for larger N? One might think so, but there are those increasing marginal costs of suppression to worry about. Harsh suppression may be very costly in terms of resources and/or discontent. We can calculate dS/dN by implicit differentiation of equation (2a)

$$\frac{dS}{dN} = \frac{V''(N-S)}{[V''(N-S) - c''(S)]} \tag{3}$$

The denominator of the RHS of equation (3) is negative, by equation (2b). So the sign of dS/dN is the opposite of the sign of $V''(N-S)$: the "optimal" S increases with N if V is concave at $N-S$ and decreases if V is convex at that point. This makes sense: S increases with N if the incremental "harm" done by an additional deviant gets bigger as there are more deviants to begin with. Alternatively, it may be that once there are a lot of deviants, another deviant doesn't make much difference (V is convex); in that case, once N gets large, the state may suppress less. The shape of V(N) describes how and how much the authorities care about deviance from approved social norms. That will depend on the nature of "the authorities" and probably on the nature of the deviation. In any case, specification of V(N) and therefore s(N) has to be an important part of a theory of institutional change.

Whatever one thinks about that, once $S = s(N)$ is determined from equation (2a), it can be plotted along with the underlying parabola and the path of N (and S) read off. There are many possibilities. If suppression is valuable and cheap, the state may always choose to drive N to zero. Or the situation may be like the case of constant S described earlier: Figure 2 illustrates a stable equilibrium at N″, kept there because $s(N'') = dN/dt$ at N″. Or, if $s'(N) < 0$, the state may sort of "give up" if N gets large, and let N go all the way to M. This last case is illustrated in Figure 3.

One could complicate the model by supposing that the state cannot perform even this fairly myopic but instantaneous optimization, and instead

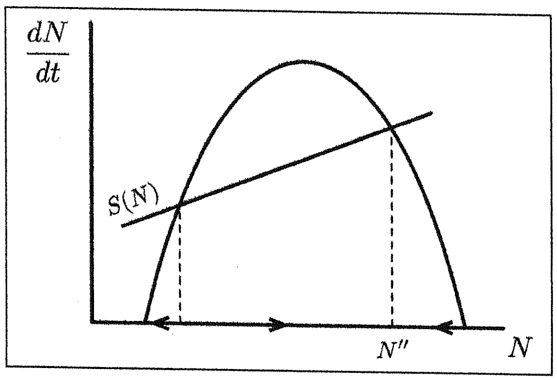

Figure 2. Here, the suppression of deviance is more intense the more deviants there are. Qualitatively, the model behaves much as in Figure 1.

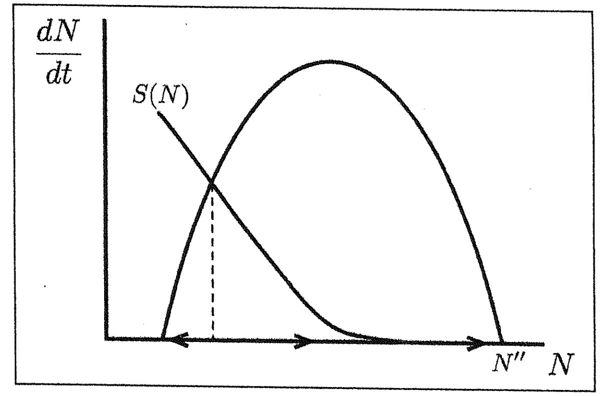

Figure 3. Here, the presence of more deviants discourages suppression. Once N exceeds N′, deviance increases, suppression is eventually abandoned as too costly, and the number of deviants grows to include all M eligibles.

merely gropes its way toward an optimum. Then, one could add another differential equation

$$\frac{dS}{dt} = b[s(N) - S] \tag{4}$$

This says that if at any time S is less than the optimum for the current N, S will increase; if S exceeds the current optimum, it will decrease. The parameter b is a speed of adjustment. Nothing basic changes. The main effect is that the more complicated dynamics—two variables—may cause the path to the ultimate equilibrium to overshoot and then reverse course. This phenomenon can easily be illustrated on (considerably busier) phase diagrams, but is not worth the trouble at this stage.

It should be kept in mind that the optimization described here is very short-sighted. The state reacts only to the current state of the system, making no attempt at a long-run policy. Even at this simpler level, we (or at least I) have little grasp of what V(N) should look like. The key issue, so far as this simple model is concerned, is whether dislike of and resistance to deviance increase as the number of deviants increase or whether this effect eventually attenuates as deviance becomes commonplace. (And in a model with foresight, would this consequence be anticipated? And if so, what then?) This (dubious?) higher level of rationality would require the state to have a long-run goal and to formulate a plan to achieve it in the most useful satisfying way. To model that situation would require a much more elaborate formulation.

Sticking with the myopic model, it's easy to work out special cases, for example, when $V(N)$ is quadratic (and, say, $c(S)=cS^2$). Then, $s(N)$ is linear. If $V(N)=p-qN^2$, $s(N)$ slopes upward, various pictures are possible. On the other hand, if $V(N)=p-qN+rN^2$ (downward-sloping part only), $s(N)$ can have negative slope, allowing still further possibilities.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Commentary

RATIONALITY AND SOCIETY

Rationality and Society
2017, Vol. 29(1) 55–62
© The Author(s) 2017
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/1043463116685664
journals.sagepub.com/home/rss
SAGE

Ecological and rational choice models of endogenous change

Martin Ruef
Duke University, USA

DellaPosta et al. (2017; hereafter DNO) offer an intriguing model of endogenous institutional change, rooted in the premise that deviations from existing social institutions occur when agents see utility gains from deviation, when network externalities contribute to the diffusion of those deviations, and when political actors tend to accommodate (rather than sanction) deviations that are adopted by a large number of agents. In this brief essay, I will compare their rational choice model with another model of bottom-up change rooted in organizational ecology and evolutionary theory (Aldrich and Ruef, 2006; Carroll and Hannan, 2000; Hannan and Freeman, 1977). I highlight common ground between the models and note where technical differences might contribute to new insights.

Despite superficial distinctions in perspective, DNO's rational choice model shares a number of conceptual parallels with ecological models. First, both models emphasize endogenous dynamics within populations as the basis for macro-level change, thereby distinguishing them from sociological theories that begin with an exogenous shock as an initial impetus to contention (e.g. Fligstein and McAdam, 2012). Second, both rational choice and ecological models recognize that agents' reactions to their "neighbors"—whether defined in spatial, network, or categorical terms—represent a crucial aspect of endogenous change. Finally, both models are well-suited to explain the rise of an institutional innovation or new organizational form as

Corresponding author:
Martin Ruef, Department of Sociology, Duke University, Box 90088, Durham, NC 27708-0088, USA.
Email: martin.ruef@duke.edu