Hustle and Flow: A Social Network Analysis of the American Federal Judiciary

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Scholars have long asserted that social structure is an important feature of a variety of societal institutions. As part of a larger effort to develop a fully-integrated model of judicial decision making, we believe that judicial social structure—operationalized as the professional and social connections between judicial actors—partially directs outcomes in the hierarchical federal judiciary.

Since different social structures impose dissimilar consequences upon outputs, the precursor to evaluating the doctrinal consequences that a given topology imposes is a descriptive effort to characterize its physical properties. Given the difficulty associated with obtaining appropriate data for federal judges, it is necessary to rely upon a proxy measure to paint a picture of the social landscape. In the aggregate, we believe the flow of law clerks reflects a reasonable proxy for social and professional linkages between jurists. Having collected available information for all federal judicial law clerks employed by an Article III judge during the "natural" Rehnquist Court (1995–2004), we use these roughly 19,000 clerk events to craft a series of network-based visualizations.

Using network analysis, our visualizations and subsequent analytics provide insight into the possibility of peer effects in the federal judiciary. For example, we find the distribution of "degrees" is highly skewed, implying the social structure is dictated by a small number of socially-prominent actors. Using a variety of centrality measures, we identify these socially-prominent jurists. Next, we draw from the extant complexity literature and offer a possible generative process responsible for producing such inequality in social authority. While the complete adjudication of a generative process is beyond the scope of this article, our results contribute
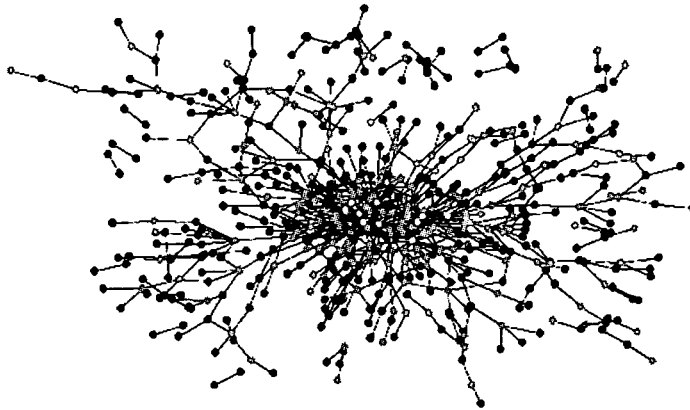
to a growing literature documenting the highly-skewed distribution of authority across the American common law and its constitutive institutions.

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Scholars have long asserted that social structure is an important feature of a variety of societal institutions.[1] Whether analyzing private or public, non-professional or professional organizations, the existing literature consistently asserts how social factors and not necessarily expertise dictate both directives and an organization's substantive institutional practices.[2] Extrapolating to law-giving institutions—most notably the aggregate outputs of the federal judiciary—we believe social structure, and the formal and informal interactions between judicial actors, at least in part, charts the

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[1] *See, e.g.*, EMILE DURKHEIM, THE DIVISION OF LABOR IN SOCIETY (W.D. Halls trans., The Free Press 1984) (1893); REID HASTIE, STEVEN D. PENROD & NANCY PENNINGTON, INSIDE THE JURY (1983) (providing insight into the role of social influence in jury decision making); DAVID KNOKE, POLITICAL NETWORKS: THE STRUCTURAL PERSPECTIVE (1990); ARTHUR L. STINCHCOMBE, SOCIAL STRUCTURE AND ORGANIZATIONS (1965); Brian Colwell, *Deference or Respect? Status Management Practices Among Prison Inmates*, 70 SOC. PSYCHOL. Q. 442 (2007) (analyzing the social structure of a California prison and determining that social standing among the prisoners derives from interpersonal dynamics); Kenneth A. Frank & Jeffrey Y. Yasumoto, *Linking Action to Social Structure Within a System: Social Capital Within and Between Subgroups*, 104 AM. J. SOC. 642 (1998); David Knoke, *Networks as Political Glue: Explaining Public Policy-Making, in* SOCIOLOGY AND THE PUBLIC AGENDA 164–184 (William Julius Wilson ed., 1993); Edward O. Laumann, Peter V. Marsden & Joseph Galaskiewicz, *Community-Elite Influence Structures: Extension of a Network Approach*, 83 AM. J. SOC. 594 (1977); Michael Lounsbury & Marc J. Ventresca, *Social Structure and Organizations Revisited, in* SOCIAL STRUCTURE AND ORGANIZATIONS REVISITED 3–38 (Michael Lounsbury & Marc J. Ventresca eds., 2002); Barry Markovsky, David Willer & Travis Patton, *Power Relations in Exchange Networks*, 53 AM. SOC. REV. 220 (1988).

[2] Of great interest to the study of legal institutions are the early network-based studies of the medical profession and their subsequent extensions. *See generally* JAMES S. COLEMAN, ELIHU KATZ & HERBERT MENZEL, MEDICAL INNOVATION: A DIFFUSION STUDY (1966) (finding the implementation of new medical technology more closely tracks a network-based upon the social connections between doctors than a network based upon expertise); James Coleman, Elihu Katz & Herbert Menzel, *The Diffusion of an Innovation Among Physicians*, 20 SOCIOMETRY 253 (1957).

course of doctrinal development. Specifically, if when considering a given legal decision jurists either formally or informally consider the views of their colleagues, then properly, conceptualizing the nature and mapping the dynamics of such "peer effects" would appear to be a critical task for public law scholarship.[3] In other words, if legal outcomes are at least in part socially constituted, then an effort to characterize the relevant social architecture should complement the existing public law literature, perhaps helping to bridge divides among the behavioral, strategic, and historical institutionalist decision making theories.[4]

Of course, acknowledging a role for "judicial peer effects" does not itself produce a social-scientific approach designed to isolate the social linkages between jurists. Prior studies relying upon academic ratings[5] or citation counts find institutional authority alone does not explain the prestige and influence across judges.[6] Instead, this literature documents great variance in

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[3] From a game theoretic perspective, this is akin to arguing that the 'judicial game' is a game on a graph. While there has been little formal work applying a game or games on graphs approach, a small but growing segment of the public law literature is devoted to devoted to more contextual understandings of judicial decision making. *See* LAWRENCE BAUM, JUDGES AND THEIR AUDIENCES: A PERSPECTIVE ON JUDICIAL BEHAVIOR (2006); Charles M. Cameron & Craig P. Cummings, Diversity and Judicial Decision-Making: Evidence from Affirmative Action in the Federal Courts of Appeals, 1971–1999 (Mar. 30, 2003) (unpublished manuscript, on file with author) (applying a "social economics approach" to the behavior of judges on the U.S. Courts of Appeals). Cameron and Cummings cite a number of studies which taken together "cast considerable doubt on what might be called the traditional political science approach to decision-making on collegial courts." *Id.*; *see, e.g.*, Sean Farhang & Gregory Wawro, *Institutional Dynamics on the U.S. Court of Appeals: Minority Representation Under Panel Decision Making*, 20 J.L. ECON. & ORG. 299 (2004); Gerald S. Gryski, Eleanor C. Main & William J. Dixon, *Models of State High Court Decision Making in Sex Discrimination Cases*, 48 J. POL. 143 (1986); Richard L. Revesz, *Environmental Regulation, Ideology, and the D.C. Circuit*, 83 VA. L. REV. 1717 (1997); *see also* Christina L. Boyd, Lee Epstein & Andrew D. Martin, *Untangling the Causal Effects of Sex on Judging* (July 19, 2007) (on file with author), *available at* http:ssrn.com/abstract=1001748.

[4] For a very brief introduction to some of these approaches, see generally *infra* Part II.A.

[5] *See, e.g.*, Gregory A. Caldeira, *In the Mirror of the Justices: Sources of Greatness on the Supreme Court*, 10 POL. BEHAV. 247 (1988) (describing the literature using subjective evaluations); *see also* Rodney L. Mott, *Judicial Influence*, 30 AM. POL. SCI. REV. 295 (1936).

[6] *See, e.g.*, David Klein & Darby Morrisroe, *The Prestige and Influence of Individual Judges on the U.S. Courts of Appeals*, 28 J. LEGAL STUD. 371 (1999); William M. Landes, Lawrence Lessig & Michael E. Solimine, *Judicial Influence: A Citation Analysis of Federal Courts of Appeals Judges*, 27 J. LEGAL STUD. 271 (1998); Richard A. Posner, *What Do Judges and Justices Maximize? (The Same Thing Everybody Else Does)*, 3 SUP. CT. ECON. REV. 1 (1993); William G. Ross, *The Ratings Game: Factors That Influence Judicial Reputation*, 79 MARQ. L. REV. 401 (1996).

judicial esteem even across judges with equal formal authority. Building on the themes of this largely non-Supreme Court centric scholarship, this study uses network analysis to visualize the social topology of the overall federal judicial branch.

Although network analysts often rely upon survey data to build the connections between actors,[7] in the context of the federal judiciary, there is significant reason to believe that survey-based network data collected from federal judges would suffer from rampant non-response or other systematic biases. Thus, in order to develop a picture of the social landscape, it is necessary to rely upon a proxy measure for social connectivity. We believe the revealed preferences displayed in the aggregate flow of law clerks between judges reflect a proxy for social and professional esteem.[8] While not conclusive, the use of this proxy in a network analysis provides an approximate snapshot of the social structure of the federal judiciary.

This study visualizes the traffic of law clerks over the decade-long period of the "natural" Rehnquist Court (1995–2004).[9] As operationalized herein, judges who share clerks may be both socially connected and highly regarded within the relevant community. Thus, the structural prestige derived from our analysis is not separable into its social and professional components. Of course, it is likely that jurists who are best able to persuade the aggregate institution to support their specific doctrinal vision are those who jointly maximize across the social and professional dimensions.

The precursor to evaluating the policy consequences that a given social structure imposes is an effort to characterize its nature. While we do not directly map doctrinal outputs and only generate a static picture of the landscape, we recognize there is no "pause button" in the external environment. Therefore, reputation effects, esteem, prestige, and influence are undoubtedly generated through dynamic processes that include negative and positive feedback.[10] What is needed is a methodology that can capture

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[7] *See* STANLEY WASSERMAN & KATHERINE FAUST, SOCIAL NETWORK ANALYSIS: METHODS AND APPLICATIONS 45–48 (1994) (noting that the questionnaire is the data collection method "most commonly used (especially when actors are people)").

[8] For the argument supporting the use of this proxy, see *infra* Parts II.B, II.C.

[9] The "natural Rehnquist Court" is typically defined as the period from 1994–2005 where the composition of judges remained unchanged. To synergize this period with the clerk hiring calendar, our data is restricted to the 1995–2004 time period. For use of the term in another empirical context see, for example, Lori A. Ringhand, *Judicial Activism: An Empirical Examination of Voting Behavior on the Rehnquist Natural Court*, 24 CONST. COMM. 43 (2007).

[10] It is worth emphasizing the consistently changing composition of the aggregate institution. Namely, actors enter and exit the network; thus within the newly constituted social world, their doctrinal legacy may or may not sustain. Although our current effort is not suited to capture notions of legacy, even a casual observer would recognize that

the richness of this adaptive landscape. Complexity generally, and network analysis more specifically, may help harness this dynamism, thereby allowing for unique insight into the mechanics of social persuasion within the aggregate federal judiciary.

To motivate the use of network analytics, the article begins in Part I with a description of the science of networks as a subset of the larger field of complexity.[11] With homage to Moreno, Milgram, Grannovetter, Watts, and Strogatz as well as others, it describes how network analysis,[12] the long-

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although many jurists' views are quickly forgotten, the views of a selected few persist. Federal judges such as Learned Hand, Jerome Frank, Henry Friendly, and J. Skelly Wright, as well as state supreme court justices such as Cornelius Moynihan, Hans Linde, Roger Traynor, and Stanley Mosk, impose distinctive legacies.

[11] While not yet part of the mainstream legal literature, complexity theory has made important contributions to legal scholarship. *See, e.g.,* Barbara A. Cherry, *The Telecommunications Economy and Regulation as Coevolving Complex Adaptive Systems: Implications for Federalism,* 59 FED. COMM. L.J. 369 (2007); Lawrence A. Cunningham, *From Random Walks to Chaotic Crashes: The Linear Genealogy of the Efficient Capital Market Hypothesis,* 62 GEO. WASH. L. REV. 546 (1994); Vincent Di Lorenzo, *Complexity and Legislative Signatures: Lending Discrimination Laws as a Test Case,* 12 J.L. & POL'Y 637 (1996); Daniel A. Farber, *Earthquakes and Tremors in Statutory Interpretation: An Empirical Study of the Dynamics of Interpretation,* 89 MINN. L. REV. 848 (2005); Greg Todd Jones, *Dynamical Jurisprudence: Law as a Complex System,* 24 GA. ST. L. REV. 873 (2008); David G. Post & Michael B. Eisen, *How Long is the Coastline of the Law? Thoughts on the Fractal Nature of Legal Systems,* 29 J. LEGAL STUD. 545 (2000); Mark J. Roe, *Chaos and Evolution in Law and Economics,* 109 HARV. L. REV. 641 (1996); J.B. Ruhl, *The Fitness of Law: Using Complexity Theory to Describe the Evolution of Law and Society and Its Practical Meaning for Democracy,* 49 VAND. L. REV. 1407 (1996); J.B. Ruhl, *Law's Complexity: A Primer,* 24 GA. ST. U. L. REV. 885 (2008); J.B. Ruhl, *Regulation by Adaptive Management —Is It Possible?,* 7 MINN. J. L. SCI. & TECH. 21 (2005); Daniel F. Spulber & Christopher S. Yoo, *On the Regulation of Networks as Complex Systems: A Graph Theory Approach,* 99 NW. U. L. REV. 1687 (2005); Bernard Trujillo, *Patterns in a Complex System: An Empirical Study of Valuation in Business Bankruptcy Cases,* 53 UCLA L. REV. 357 (2005); For an extensive list of scholarship, see J.B. Ruhl, Complex Adaptive Systems Literature for Law and Social Sciences, http://law.vanderbilt.edu/seal/resources/readingscomplex.htm (last visited Jan. 11, 2010).

[12] Formal network analysis—or invocation of its core concepts—has recently been witnessed within legal, social science, and physics literatures. *See, e.g.,* Frank B. Cross, Thomas A. Smith & Antonio Tomarchio, *The Reagan Revolution in the Network of Law,* 57 EMORY L. J. 1227 (2008); James H. Fowler & Sangick Jeon, *The Authority of Supreme Court Precedent,* 30 SOC. NETWORKS 16 (2008); James H. Fowler et al., *Network Analysis and the Law: Measuring the Legal Importance of Precedents at the U.S. Supreme Court,* 15 POL. ANALYSIS 324 (2007); Daniel M. Katz, Derek K. Stafford & Eric Provins, *Social Architecture, Judicial Peer Effects and the "Evolution" of the Law: Toward a Positive Theory of Judicial Social Structure,* 24 GA. ST. U. L. REV. 977 (2008); E. A. Leicht et al., *Large-Scale Structure of Time Evolving Citation Networks,* 59 EUR. PHYSICAL J. B 75 (2007); Anthony Paik, Ann Southworth & John P. Heinz, *Lawyers*

standing but recently popularized methodology, allows for the insightful study of a variety of social systems.

In an effort to justify the use of law clerk traffic as a proxy for social connectivity, Part II of this Article reviews two major strains of the extant legal literature. After briefly introducing the larger field of public law, it demonstrates how the behavior of actors within the law clerk market might, in part, help reveal the social structure of the federal judiciary. Concepts such as social influence are fairly difficult to operationalize and, in response, scholars have developed an array of diverse approaches to consider such questions.[13] We believe that a promising addition to the literature would be a graph theoretic approach. Specifically, notwithstanding any allocative inefficiencies present in the judicial law clerk market, it is highly probable that, in the aggregate, judicial reputation significantly affects the matching of law clerks with their employers. Thus, as applied to the marriage of these two literatures, the network analysis advanced here relies upon the displayed preferences of both judges and clerks, embedded within law clerk traffic, to provide a partial picture of the institution's aggregate topology.

Part III represents this Article's core contribution. It begins with a description of the significant data collection effort undertaken to support our findings. Our research team collected available information for every federal judicial law clerk employed by an Article III judge[14] during the full term of the "natural" Rehnquist Court (1995–2004). Holding the United States Supreme Court constant and drawing from a base of nearly 19,000 clerk events,[15] Part III provides a series of visualizations and corresponding network statistics. Such statistics are critical because they help identify critical actors and illuminate the class of generating processes that are likely responsible for the observed network. For example, we hypothesize that a

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of the Right: Networks and Organization, 32 LAW & SOC. INQUIRY 883 (2007); Thomas A. Smith, *The Web of Law*, 44 SAN DIEGO L. REV. 309 (2007); Katherine J. Strandburg et al., *Law and the Science of Networks: An Overview and an Application to the "Patent Explosion,"* 21 BERKELEY TECH. L.J. 1293 (2006); David J. Walsh, *On the Meaning and Pattern of Legal Citations: Evidence from State Wrongful Discharge Precedent Cases*, 31 L. & SOC'Y REV. 337 (1997); Frank B. Cross, Thomas A. Smith & Antonio Tomarchio, *Determinants of Cohesion in the Supreme Court's Network of Precedents* (Aug. 14, 2006), *available at* http://ssrn.com/abstract=924110.

[13] For a discussion of these approaches, see *infra* Part II.A.

[14] As available clerk information for Senior Status Judges is far less extensive, we choose to omit Senior Status Judges from this study.

[15] Hereinafter, a "clerk event" is defined as a given clerk employed by an individual judge for a given year. For example, a clerk hired for a two-year interval constitutes two clerk events. A permanent clerk employed for k years would have k law clerk events.

process of preferential attachment, similar to that described by physicists Barabási and Albert, likely generates the federal judicial social network.[16]

Part IV provides some concluding thoughts about emergence, convergence, peer effects, and legal change in the federal judicial hierarchy. Although our effort is first-order, the structure of the network visualized herein provides significant insight into how the local actions of a series of micro-motivated judicial actors maps to the judiciary's macro-jurisprudential outputs.[17]

I. THE SCIENCE OF NETWORKS: FROM MORENO TO MILGRAM TO WATTS AND STROGATZ AND BEYOND

Built upon the combination of linear algebra, graph theory, and traditional statistical approaches, network analysis should help illuminate the social structure of the federal judiciary. Using *nodes* to represent actors and *ties* to represent relations between actors, network analysis differs from traditional statistical models as it attempts to determine not only properties of an individual's relationships to his or her peers, but also the larger social structure in which that individual operates.[18] As the techniques of network science and complex systems are often unfamiliar, we proceed with a broad introduction to both fields. Such an introduction should motivate our larger project of building a picture of the social landscape using the information embedded in the law clerk labor market.

A. *Emergence in a Broad Class of Complex Systems Models*

Network analysis is a disciplined scientific approach used to understand the interactions between agents in a complex system.[19] Although the

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[16] As described *infra* Part III, we lack the necessary evidence to definitively characterize the generative process. Based upon the currently available quantitative and qualitative evidence, we believe a process akin to Barabási and Albert's preferential attachment represents a good working hypothesis.

[17] *See generally* THOMAS C. SCHELLING, MICROMOTIVES AND MACROBEHAVIOR (1978).

[18] *See* WASSERMAN & FAUST, *supra* note 7, at 17–21.

[19] Drawn from core concepts developed within the academy, a host of recent literature has popularized the study of network analysis. The devotion of the ninetieth anniversary of Forbes magazine to network analysis is one of many indications that this is a renaissance period for the science of networks. *See* Tom Post, *The Power of Networks*, FORBES, May 7, 2007, at 49 (devoting its ninetieth anniversary issue to the "new" age of networks). For a non-exhaustive list of recent popular books in the subject, see ALBERT-LÁSZLÓ BARABÁSI, LINKED: THE NEW SCIENCE OF NETWORKS (2002); MARK BUCHANAN, NEXUS: SMALL WORLDS AND THE GROUNDBREAKING SCIENCE OF NETWORKS (2002);

definition of a "complex system" is awkward and can seem nebulous, nearly all definitions would specify that the system must exhibit *emergent* behavior.[20] Traditionally, systems display emergence when the micro-study of individual actors in a given system yields incomplete information about the entirety of the organization.[21] Instead, interactions between the components, at least in part, structure the outputs of the system.[22] As Peter Corning describes, "[a]mong other things, complexity theory gave mathematical legitimacy to the idea that processes involving the interactions among many parts may be at once deterministic yet for various reasons unpredictable."[23]

Common examples of emergence include the study of ecosystems where order emerges from the interspecies interactions. Emergent systems do not

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MALCOLM GLADWELL, THE TIPPING POINT: HOW LITTLE THINGS CAN MAKE A BIG DIFFERENCE (2000); DUNCAN J. WATTS, SIX DEGREES: THE SCIENCE OF A CONNECTED AGE (2003).

[20] For more detailed discussion of emergence including applications to a variety of disciplines, see generally JOHN H. HOLLAND, EMERGENCE: FROM CHAOS TO ORDER (1998); STEPHEN WOLFRAM, A NEW KIND OF SCIENCE (2002); David J. Chalmers, *Strong and Weak Emergence, in* THE RE-EMERGENCE OF EMERGENCE: THE EMERGENTIST HYPOTHESIS FROM SCIENCE TO RELIGION 245 (Philip Clayton & Paul Davies eds., 2006); Tom De Wolf & Tom Holvoet, *Emergence Versus Self-Organisation: Different Concepts but Promising When Combined, in* ENGINEERING SELF-ORGANISING SYSTEMS: METHODOLOGIES AND APPLICATIONS 1 (Sven A. Brueckner et al. eds., 2005).

[21] *See generally* HOLLAND, *supra* note 20. De Wolf and Holvoet provide a more detailed working definition of emergence. They argue that "[a] system exhibits emergence when there are coherent emergents at the macro-level that dynamically arise from the interactions between the parts at the micro-level. Such emergents are novel w.r.t. the individual parts of the system." *See* De Wolf & Holvoet, *supra* note 20, at 3.

[22] For an illuminating discussion of emergence and its historical origin, see Peter A. Corning, *The Re-Emergence of "Emergence": A Venerable Concept in Search of a Theory,* 7 COMPLEXITY 18–19 (2002); *see also* BRIAN GOODWIN, HOW THE LEOPARD CHANGED ITS SPOTS: THE EVOLUTION OF COMPLEXITY (1994); STEVEN JOHNSON, EMERGENCE: THE CONNECTED LIVES OF ANTS, BRAINS, CITIES, AND SOFTWARE (2001). The last decade witnessed the creation of an academic journal devoted to exploring the concepts of emergence. *See generally* EMERGENCE, http://emergence.org/index.html (last visited Jan. 13, 2010).

[23] *See* Corning, *supra* note 22, at 21. There is not a uniform agreement regarding the appropriate definition of emergence. *See* JOSHUA M. EPSTEIN & ROBERT AXTELL, GROWING ARTIFICAL SOCIETIES: SOCIAL SCIENCE FROM THE BOTTOM UP 35 (1996) (defining emergent phenomena to be "stable macroscopic patterns arising from the local interactions of agents.") (emphasis omitted). Outlining a variety of rationales including the anti-scientific history of British emergentism, Professor Epstein offers deep concerns regarding its continued use in the field of complex systems. *See* Joshua M. Epstein, *Agent-Based Computational Models and Generative Social Science, in* GENERATIVE SOCIAL SCIENCE 31–37 (2006). While we do not take a pass on its continued use, we recognize the merit of Professor Epstein's argument.

necessarily have logical or deterministic properties. Thus, their outputs cannot always be deduced or predicted. Consider H_2O phase transitions. Water boils and freezes at very specific temperatures under controlled conditions, but nothing about the change in temperatures affects the actual water molecules.[24] At precisely 100°C and 0°C the molecules begin to interact differently; and thus, from liquid, new macro-worlds of solid ice and water vapor emerge.[25] An extensive study of the chemical characteristics between these moments of transition would not predict the discontinuity that occurs at these threshold points.

Automobile traffic is another example of a complex system.[26] To characterize the global properties of a traffic system, one could code a set of individual-level variables, including the horsepower of the respective vehicles, the disposition of the drivers, and a host of decisional rules employed by the driver, including the leave space and a driver's ideal speed and lane. Even with an understanding of all of these properties, it is ultimately the interactions between actors that structure outputs for the overall system. Whether flow or bottleneck will emerge is a function of the intermingling of individuals, each of whom possesses a host of these attributes and decisional rules. Thus, it depends upon the precise spatial distribution of agents and the nature of their local interactions.

Returning to the matter of inquiry, the federal judiciary exhibits behavior that might be considered emergent. While a judge in a given case may rule in isolation of other judges, jurists generally do not exist in a state of complete social and professional isolation from their peers. The socialization and training of the legal community occurs through various repeated interactions with one's current or future peers at moments and places throughout the hierarchy.[27] In some cases, social interactions begin in law school[28] and in

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[24] *See, e.g.*, PIERRE PAPON, JACQUES LEBLOND & PAUL H. E. MEIJER, THE PHYSICS OF PHASE TRANSITIONS: CONCEPTS AND APPLICATIONS 1 (S.L. Schnur trans., Springer-Verlag Berlin Heidelberg 2d ed. 2006).

[25] *See* Corning, *supra* note 22, at 24.

[26] There exists a broad host of scholarship modeling the dynamics of traffic. For a cursory sample, see Ofer Biham, A. Alan Middleton & Dov Levine, *Self-Organization and a Dynamical Transition in Traffic-Flow Models*, 46 PHYSICAL REV. A 6124 (1992); Debashish Chowdhury, Ludger Santen & Andreas Schadschneider, *Statistical Physics of Vehicular Traffic and Some Related Systems*, 329 PHYSICS REP. 199 (2000); Henryk Fukś & Nino Boccara, *Generalized Deterministic Traffic Rules*, 9 INT'L J. MODERN PHYSICS C 1 (1998); Kai Nagel & Michael Schreckenberg, *A Cellular Automaton Model for Freeway Traffic*, 2 J. DE PHYSIQUE 2221 (1992); Shin-ichi Tadaki & Macoto Kikuchi, *Jam Phases in a Two-Dimensional Cellular-Automaton Model of Traffic Flow*, 50 PHYSICAL REV. E 4564 (1994).

[27] *See, e.g.*, DUNCAN E. KENNEDY, LEGAL EDUCATION AND THE REPRODUCTION OF HIERARCHY: A POLEMIC AGAINST THE SYSTEM (1983).

others they begin even sooner. Accordingly, if judicial perceptions and outcomes are at least, in part, the by-product of these interactions, then larger interpretative frames, themselves the aggregation of various individual decisions, assuredly are emergent. As such, the federal judiciary is a "complex system" and would benefit from methodologies reserved for the study of complexity.

B. *A Brief Introduction to Social Network Analysis*

One method of studying a complex system is network analysis, an approach which maps the aggregate topology by quantifying the local interactions between agents.[29] In the early twentieth century, researchers such as Jacob Moreno used network analysis to compile sociograms that diagramed social relationships and identified individuals who held structural positions that were indicative of leadership.[30] Following this early work, Stanley Milgram did much to advance the popularity of network analysis. Through his study of communal relationships in society in the 1960s, the "small worlds" or "six degrees of separation" conception entered the popular

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[28] *See* ELIZABETH MERTZ, THE LANGUAGE OF LAW SCHOOL: LEARNING TO "THINK LIKE A LAWYER" 210 (2007) (citing Christa McGill, Producing Lawyers: Institutional Hierarchy and the Social Structure of Law Schools (2002) (unpublished Ph.D. dissertation, Duke University)).

[29] The origins of network science are closely linked to the development of graph theory. Leonhard Euler, whose major contributions include the first theorem in graph theory, developed his work in an effort to solve the Konisberg Bridge Problem. In reduced form, the Konigsberg Bridge Problem asks whether it is possible to traverse the town of Konigsberg, while both crossing each of its seven bridges only once and closing the circuit by returning to one's point of origin. Euler demonstrated this was not possible. With reference to the Konisberg Bridge Problem, mathematicians ask whether "there exists any *Eulerian path* on the network." *See* THE STRUCTURE AND DYNAMICS OF NETWORKS 2 (Mark Newman, Albert-László Barabási & Duncan J. Watts eds., 2006). For more on the life and work of Leonhard Euler, see C. EDWARD SANDIFER, THE EARLY MATHEMATICS OF LEONHARD EULER (2007). For more information on graph theory, see, for example, GARY CHARTRAND, INTRODUCTORY GRAPH THEORY (1977) and FRANK HARARY, GRAPH THEORY (1969).

[30] It is hard to overstate the contribution of Jacob Moreno to the development of social network analysis. Along with Kurt Lewin and Fritz Heider, the first half of the twentieth century witnessed dramatic developments in the science of networks. For example, Moreno developed the "sociogram," an apparatus that allows social relationships to be drawn using analytic geometry. *See* J. L. MORENO, WHO SHALL SURVIVE? A NEW APPROACH TO THE PROBLEM OF HUMAN INTERRELATIONS 86, 153 (1934). Kurt Lewin extended Moreno's work, arguing that the structural properties of social space could be uncovered using a host of mathematical techniques including graph theory, topology, and set theory. *See, e.g.,* KURT LEWIN, FIELD THEORY IN SOCIAL SCIENCE: SELECTED THEORETICAL PAPERS 64, 92 (Dorwin Cartwright ed., 1951).

lexicon.[31] In his experiment, Milgram sent letters to a sample of people in Kansas and Nebraska and asked the subjects if they would attempt to send these letters to a stockbroker in Boston, Massachusetts.[32] On average, the letters who reached the target only passed through the hands of 6.5 people, and thus Milgram argued that the social world was quite small, with only six degrees of separation between a random selection of people.[33]

The logic supporting the original Milgram experiment was fairly straightforward. If every individual each knows 150 people and each of those 150 people know 150 others, the size of the network exceeds the total world population before the sixth order of magnitude. Such a hypothesized network, however, was a random network where the interrelations between an individual's second-degree friends were not explicitly modeled. In subsequent work, Mark Granovetter argued that world social connections do not emerge randomly.[34] People cluster and organize in cliques; thus, if two people are strong friends the likelihood that they have shared friends is fairly high.[35] This commonality between connections of people in similar groupings would not allow the macro-network to exhibit the exponential growth suggested by Milgram's theory. Since Milgram's experiment and

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[31] *See* Stanley Milgram, *The Small-World Problem*, 1 PSYCHOL. TODAY 61 (1967). Milgram is often credited with coining "six degrees of separation." However, many attribute the term to a Hungarian author, Frigyes Karinthy, whose volume of short stories, *Everything Is Different*, invoked such concepts.

[32] Milgram, however, did not provide the subjects with the address of the stockbroker; he instead insisted individuals send the letter to someone they thought would be socially closer to the man in Boston. *See* Milgram, *supra* note 31, at 64.

[33] *See id.* at 65; *see also* Charles Korte & Stanley Milgram, *Acquaintance Networks Between Racial Groups: Application of the Small World Method*, 15 J. PERSONALITY & SOC. PSYCHOL. 101 (1970) (replicating the small world experiment between different racial groups); Jeffrey Travers & Stanley Milgram, *An Experimental Study of the Small World Problem*, 32 SOCIOMETRY 425, 428 (1969) (varying the starting populations and providing "a first technical report on the small world method").

[34] Mark S. Granovetter, *The Strength of Weak Ties*, 78 AM. J. SOC. 1360 (1973).

[35] *Id.* at 1362. Granovetter did not argue that this empirical fact completely undercut widespread connectivity; rather, he argued only that widespread societal links are an artifact of one's weak connections. *Id.* at 1378. In his seminal article *The Strength of Weak Ties*, Granovetter provided an addendum to Milgram's theory. *See generally id. See also* Mark Granovetter, *The Strength of Weak Ties: A Network Theory Revisited*, 1 SOC. THEORY 201 (1983). Granovetter understood that if Person A was close friends with Persons B and C, then Persons B and C were also likely friends with one another. *See* Granovetter, *supra* note 34, at 1362. Accordingly, the stronger the bonds between individuals, the more likely their first degree nodes are also connected. In network analysis, this is known as balance theory. *See* Fritz Heider, *Attitudes and Cognitive Organization*, 21 J. PSYCHOL. 107, 107 (1946) (asserting in part the idea of balance); *see also* WASSERMAN & FAUST, *supra* note 7, at 220–32.

subsequent replications[36] still demonstrated a "small world," Granovetter worked to develop an alternative causal account that would sustain the empirical phenomena. He noticed the weaker the ties between individuals the more likely those connections would not coincide. Hence, these weak ties maintained the small-world characteristics observed by Milgram. Accordingly, Granovetter supplemented Milgram's work by categorizing the connections between individuals by the strength of those bonds, while also placing more realistic restraints on Milgram's random networks.

Following on these themes of prior scholars, the latest wave of network science is attributable to a host of scholars in the physical sciences including Watts and Strogatz[37] as well as Barabási and Albert.[38] Motivated by the organizational behavior of a certain species of fireflies in Southeast Asia, Watts and Strogatz demonstrated how a relatively small amount of random wiring can allow a network simultaneously to hold the small world properties hypothesized by Milgram and the high clustering described by Granovetter.[39] Apparently, fireflies in this region have the rather unusual habit of flashing in unison.[40] However, neurological analysis of the fireflies indicated that they should not have the mental faculty necessary to coordinate this effort. Although the fireflies may take cues from their neighbors, this alone was not enough to generate the witnessed behavior. Namely, in the early evening, witnesses commonly observe one firefly light and then another. Suddenly, groups of fireflies flash. Finally, concentrations of hundreds of fireflies on the same tree synchronize their flashes in unison.

In the initial moments at dusk when the fireflies are randomly flashing, these uncoordinated flashes could be considered possible offerings of timing.

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[36] *See* Korte & Milgram, *supra* note 33; Travers & Milgram, *supra* note 33.

[37] *See* Duncan J. Watts & Steven H. Strogatz, *Collective Dynamics of 'Small-World' Networks*, 393 NATURE 440 (1998).

[38] *See* Albert-László Barabási & Réka Albert, *Emergence of Scaling in Random Networks*, 286 SCIENCE 509 (1999); *see also* Réka Albert & Albert-László Barabási, *Statistical Mechanics of Complex Networks*, 74 REVS. OF MODERN PHYSICS 47 (2002). Although outside the scope of this article, it is worth noting that network science has also developed a variety of models of network evolution. For example, Professor Smith introduces legal scholars to the Bose-Einstein condensation (BEC) approach to studying the evolution of networks where nodes are permitted to possess differential levels of fitness. *See* Smith, *supra* note 12, at 322–23 (citing Ginestra Bianconi & Albert-László Barabási, *Bose-Einstein Condensation in Complex Networks*, 86 PHYSICAL REV. LETTERS 5632 (2001)); *see also* Alain Barrat, Marc Barthélemy & Alessandro Vespignani, *Weighted Evolving Networks: Coupling Topology and Weight Dynamics*, 92 PHYSICAL REV. LETTERS 228701-1 (2004).

[39] *See* Watts & Strogatz, *supra* note 37, at 440.

[40] *See, e.g.*, STEVEN STROGATZ, SYNC: THE EMERGING SCIENCE OF SPONTANEOUS ORDER 11 (2003).

Think of applause in an auditorium.[41] Since only one sequence ultimately emerges, it is important to understand how the landscape moves from divergence to convergence, from randomness to some sense of relative order.[42]

Watts and Strogatz used computational models to simulate the fireflies' flashing based upon different rules about how the insects could react to cues from their neighbors. However, the initial simulations failed to reproduce the simultaneous flashing. Even with near immediate reaction time to the fireflies in close proximity, the overall pattern was still too protracted. Thus, Watts and Strogatz added one more component to their model: they gave a small proportion of fireflies the ability to see and thus react to a random firefly. This simulation worked in an egalitarian network because each of the dyads[43] is relatively equal in its number of connections but with a select few connections across great distances. This approach reflected a successful replication and provided an explanation for the observed empirical phenomena.

Extrapolating from the fireflies and returning to the social world, there are many phenomena that display similar properties. In reduced form, a cascade is essentially emergent behavior upon which there is enough initial convergence by certain actors to see it take hold. Depending upon the orientation of the relevant landscape, it is possible to generate a cascade using a small number of structurally important or prestigious actors. Existing network statistics are designed to identify such critical actors. Ultimately, these network statistics are only as reliable as the interactions they attempt to represent. Developing appropriate connections between nodes is the critical step in the analysis. Thus, in Part II we devote significant attention to describing our measure of connectivity.

II. DEVELOPING A PROXY FOR THE SOCIAL LANDSCAPE: THE PUBLIC LAW AND CLERKS MARKET LITERATURES

Among the immense public law literature analyzing the operation of the American Federal Judiciary are two important strands that together with the greater body of available work advance our understanding of the operation of this important political institution. The first line of scholarship considers the relative prestige and influence of various judges and Justices.[44] Specifically,

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[41] *See, e.g.,* John H. Miller & Scott E. Page, *The Standing Ovation Problem,* 9 COMPLEXITY 8 (2004).

[42] *Id.*

[43] While mathematicians might provide a more formal definition of the dyad, involving vectors, tensors and vector space, it can loosely be considered as two individuals or units considered as a pair.

as a variety of commentators note, the views of some courts and some jurists seem to be uniquely privileged while others are not nearly as well-regarded.[45] In order to understand the impact this empirical fact imposes upon the legal landscape, the literature has been consumed with innovative methods to help adjudicate questions of relative esteem.[46] However, regardless of the approach employed and any methodological disagreements, virtually all scholarship finds significant variance in prestige across jurists.

Also under the large umbrella of the public law literature is a largely different group of individuals who devote attention to the study of federal law clerks.[47] This "clerks" scholarship includes analysis of the process governing their selection as well as their impact upon judicial outputs. At first glance, this strain of scholarship might appear wholly unrelated to the question of relative prestige and influence. However, a careful review counsels otherwise. There is important information regarding judicial reputation embedded within the market for judicial law clerks. Namely, despite any existing allocative inefficiencies in the clerk market, clerks more or less seek to work for the most prestigious judges and judges seek the "best" clerks. While not conclusive, we believe the movement of law clerks provides a significant observable measure of the social and professional linkages between jurists. Later, we will explicitly develop this link—but first, we provide introduction to both literatures.

A. *From Qualitative Supreme Court Studies to Decision Making in a Hierarchal Federal Judiciary*

Throughout its long history, the judicial politics subfield has embraced a variety of substantive questions and methodological approaches. Early work in the subfield emphasized the decision making of the United States Supreme Court and privileged the use of qualitative methods. However, these approaches were largely jettisoned as the rise of behavioralism ushered in the

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[44] *See, e.g.*, RICHARD A. POSNER, CARDOZO: A STUDY IN REPUTATION 74–91 (1990); Klein & Morrisroe, *supra* note 6; Montgomery Kosma, *Measuring the Influence of Supreme Court Justices*, 27 J. LEGAL STUD. 333 (1998); Landes, Lessig & Solimine, *supra* note 6.

[45] *See* sources cited *supra* note 44. For a study using an entire court as the unit of analysis, see Michael E. Solimine, *Judicial Stratification and the Reputations of the United States Courts of Appeals*, 32 FLA. ST. U. L. REV. 1331 (2005).

[46] Solimine, *supra* note 45, at 1343–50. Professor Solimine provides a very detailed description of the various approaches used to consider the question. Discussing the existing studies, he notes "[r]eputation is a difficult subject to objectively study. Couple that with the snapshot quality of most of the studies; they usually cover a relatively short period of time or only samples of the judges who constitute a circuit." *Id.* at 1350.

[47] *See infra* Part II.B.

use of quantitative models across a variety of intellectual domains. Following their prior embrace by allied disciplines, large N empirical approaches were initially adopted in neighboring political science subfields such as legislative politics[48] and political participation.[49]

Public law behavioralism is epitomized by *The Attitudinal Model*, in which Professors Segal and Spaeth derive judicial preferences through attention to the objective voting behavior of members of the United States Supreme Court.[50] Analyzing aggregate voting data, attitudinalists argue Justices vote in a manner to maximize their individual partisan policy preferences. Thus, in broad stroke their model asserts "Rehnquist votes the way he does because he is extremely conservative; Marshall voted the way he did because he is extremely liberal."[51] While a significant amount of the current scholarship still embraces behavioral studies of the High Court, recent years witnessed the increasing use of alternative methods as well as the study of other judicial actors. For example, the past two decades saw the

[48] In legislative politics, for example, many studies embracing the behavioralist paradigm use outputs, in this case roll call votes of members of Congress to characterize and predict legislative behavior. Suffice to say, the literature is vast. *See, e.g.,* RICHARD L. HALL, PARTICIPATION IN CONGRESS (1996); Christopher Achen, *Measuring Representation*, 22 AM. J. POL. SCI. 475 (1978); John E. Jackson & John W. Kingdon, *Ideology, Interest Group Scores, and Legislative Votes*, 80 AM. J. POL. SCI. 805 (1992); Keith Krehbiel, *Where's the Party?*, 23 BRIT. J. POL. SCI. 235 (1993); Keith T. Poole & R. Steven Daniels, *Ideology, Party, and Voting in the U.S. Congress, 1959–1980*, 79 AM. POL. SCI. REV. 373 (1985).

[49] *See, e.g.,* ANGUS CAMPBELL ET AL., THE AMERICAN VOTER (1960); SIDNEY VERBA & NORMAN H. NIE, PARTICIPATION IN AMERICA: POLITICAL DEMOCRACY AND SOCIAL EQUALITY (1972); RAYMOND E. WOLFINGER & STEVEN J. ROSENSTONE, WHO VOTES? (1980); Paul R. Abramson & John H. Aldrich, *The Decline of Electoral Participation in America*, 76 AM. POL. SCI. REV. 502 (1982).

[50] *See* JEFFREY A. SEGAL & HAROLD J. SPAETH, THE SUPREME COURT AND THE ATTITUDINAL MODEL (1993). For a discussion of early behavioral work in the judicial politics subfield, see generally NANCY MAVEETY, THE PIONEERS OF JUDICIAL BEHAVIOR (2003). Behavioralism generally and attitudinalism more specifically have been criticized by other scholars. For a sample of critiques of the attitudinal model, see, for example, LAWRENCE BAUM, THE PUZZLE OF JUDICIAL BEHAVIOR (1997); FORREST MALTZMAN, JAMES F. SPRIGGS & PAUL J. WAHLBECK, CRAFTING LAW ON THE SUPREME COURT: THE COLLEGIAL GAME (2000); Richard A. Brisbin, Jr., *Slaying the Dragon: Segal, Spaeth and the Function of the Law in Supreme Court Decision Making*, 40 AM. J. POL. SCI. 1004 (1996); Howard Gillman & Cornell W. Clayton, *Beyond Judicial Attitudes: Institutional Approaches to Supreme Court Decision-Making, in* SUPREME COURT DECISION-MAKING: NEW INSTITUTIONALIST APPROACHES (Howard Gillman & Cornell Clayton eds., 2001). For a discussion of the misuse of the Spaeth dataset, see Carolyn Shapiro, *Coding Complexity: Bringing Law to the Empirical Analysis of the Supreme Court*, 60 HASTINGS L.J. 477 (2009).

[51] *See* SEGAL & SPAETH, *supra* note 50, at 65.

rise of a variety of neo-institutional decision making theories,[52] as well as extensive study of the decision making of the state supreme courts[53] and the lower federal courts.[54]

This recent work is important as both the industrial organization of the Judicial Branch and its norms and variant institutional rules undoubtedly exert influence upon its final outcomes. With the wide variety of actors and institutions, the precise trajectory of American common law is difficult, if not

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[52] *See, e.g.,* SUPREME COURT DECISION-MAKING: NEW INSTITUTIONALIST APPROACHES (Cornell W. Clayton & Howard Gillman eds., 1998); LEE EPSTEIN & JACK KNIGHT, THE CHOICES JUSTICES MAKE (1998); MALTZMAN, SPRIGGS & WAHLBECK, *supra* note 50; Rogers Smith, *Political Jurisprudence, the 'New Institutionalism,' and the Future of Public Law*, 82 AM. POL. SCI. REV. 89 (1988) (previewing some of the future developments in the public law field). It is important to note how institutional theories take a variety of flavors, including strategic institutionalism and historical institutionalism. Furthermore, the methods employed by these respective camps range from formal theory to qualitative historical methods. For an attempt to use qualitative historical methods to support a strategic account, see Daniel M. Katz, *Institutional Rules, Strategic Behavior, and the Legacy of Chief Justice William Rehnquist: Setting the Record Straight on* Dickerson v. United States, 22 J.L. & POL. 303 (2006).

[53] *See, e.g.,* Paul Brace, Melinda Gann Hall & Laura Langer, *Placing State Supreme Courts in State Politics*, 1 ST. POL. & POL'Y Q. 81 (2001); Paul Brace, Laura Langer & Melinda Gann Hall, *Measuring the Preferences of State Supreme Court Judges*, 62 J. POL. 387 (2000); Gregory A. Caldeira, *The Transmission of Legal Precedent: A Study of State Supreme Courts*, 79 AM. POL. SCI. REV. 178 (1985); Lawrence M. Friedman et al., *State Supreme Courts: A Century of Style and Citation*, 33 STAN. L. REV. 773 (1981); Melinda Gann Hall, *Electoral Politics and Strategic Voting in State Supreme Courts*, 54 J. POL. 427 (1992); F. Andrew Hanssen, *Learning About Judicial Independence: Institutional Change in the State Courts*, 33 J. LEGAL STUD. 431 (2004); Donald R. Songer & Kelley A. Crews-Meyer, *Does Judge Gender Matter? Decision Making in State Supreme Courts*, 81 SOC. SCI. Q. 750 (2000).

[54] While there certainly exists important early work on lower courts, recent years witnessed a substantial amount of high quality scholarship on lower courts. *See, e.g.,* VIRGINIA HETTINGER, STEFANIE LINDQUIST & WENDY MARTINEK, JUDGING ON A COLLEGIAL COURT: INFLUENCES ON FEDERAL APPELLATE COURT DECISION MAKING (2006); DAVID E. KLEIN, MAKING LAW IN THE UNITED STATES COURTS OF APPEALS (2002); DONALD R. SONGER, REGINALD S. SHEEHAN & SUSAN B. HAIRE, CONTINUITY AND CHANGE ON THE UNITED STATES COURTS OF APPEALS (2000); Charles M. Cameron, Jeffrey A. Segal & Donald Songer, *Strategic Auditing in a Political Hierarchy: An Informational Model of the Supreme Court's Certiorari Decisions*, 94 AM. POL. SCI. REV. 101 (2000); Frank Cross, *Appellate Court Adherence to Precedent*, 2 J. EMPIRICAL LEGAL STUD. 369 (2005); Frank Cross & Emerson Tiller, *Judicial Partisanship and Obedience to Legal Doctrine: Whistleblowing on the Federal Courts of Appeals*, 107 YALE L.J. 2155 (1998); Susan B. Haire, Stefanie A. Lindquist & Donald R. Songer, *Appellate Court Supervision in the Federal Judiciary: A Hierarchical Perspective*, 37 L. & SOC'Y REV. 143 (2002); Donald R. Songer, Jeffrey A. Segal & Charles M. Cameron, *The Hierarchy of Justice: Testing a Principal-Agent Model of Supreme Court–Circuit Court Interactions*, 38 AM. J. POL. SCI. 673 (1994).

impossible, to predict, as a host of interactive parameters, including legal doctrine and partisanship, work to shape the path of American jurisprudence. Yet, the increasing nuance and diversity[55] of the judicial politics literature certainly brings scholars closer to understanding the complicated landscape in which judicial decision making is undertaken.

In addition to all of the aforementioned decisional factors, judicial "peer effects" are one additional element that received recent study.[56] Of course, it is hardly new or novel to assert that, in general terms, maintaining high status among one's peers as well as sustaining relationships with one's close colleagues might, together with other factors, impact an individual's decision calculus. Legal formalists, however, long denied such influence, instead arguing judicial decision making was the by-product of the technocratic application of neutral legal principles. With respect to crafting law, a number of important scholars assert a strong role for social factors. Consider Judge Posner's book *Overcoming Law*, where he identifies a host of variables that together define the judicial utility function.[57] Among these core parameters, Judge Posner argues that a judge's reputation among his or her fellow judges affects the types of judicial outputs he or she would be willing to support.[58]

Reputational effects are difficult to operationalize. However, this has not prevented scholars from developing methodological approaches to measure the relative prestige and influence of federal judicial actors.[59] While early work on prestige relied upon ratings by academics and other court observers,[60] recent efforts use more objective measures to gain leverage on such questions. For example, Landes, Lessig, and Solimine operationalize

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[55] The "logic of diversity" invoked herein is drawn from the work of Scott Page. *See* SCOTT PAGE, THE DIFFERENCE: HOW THE POWER OF DIVERSITY CREATES BETTER FIRMS, SCHOOLS, AND SOCIETIES (2007) (explaining the conditions under which diversity can create better public and private institutions).

[56] *See, e.g.*, Cameron & Cummings, *supra* note 3.

[57] *See* RICHARD A. POSNER, OVERCOMING LAW (1995). The chapter on the judicial utility function is based upon important earlier work. *See* Posner, *supra* note 6.

[58] *See* POSNER, *supra* note 57, at 119; *see also* LAWRENCE BAUM, JUDGES AND THEIR AUDIENCES: A PERSPECTIVE ON JUDICIAL BEHAVIOR (2006); Jason Whitehead, Cynics and Rogues: How "Bad" Judges Can Help Us Better Understand the Rule of Law (2008) (unpublished manuscript on file with authors) (offering qualitative evidence that judges consider the views of other judges when rendering their decisions).

[59] Although largely focused upon the entire circuit, for a helpful discussion of these approaches see generally Solimine, *supra* note 45.

[60] *See, e.g.*, ALBERT BLAUSTEIN & ROY MERSKY, THE FIRST ONE HUNDRED JUSTICES: STATISTICAL STUDIES ON THE SUPREME COURT OF THE UNITED STATES (1978); Albert Blaustein & Roy Mersky, *Rating Supreme Court Justices*, 58 A.B.A. J. 1183 (1972); Mott, *supra* note 5 (using rating by academics to analyze the reputations of state supreme courts). For a more general discussion of the reliance upon qualitative ratings see Caldeira, *supra* note 5.

prestige using the total citations to opinions produced by a given judge.[61] These scholars support the use of this proxy for prestige and influence by arguing that judges who garner high citation counts do so because their brethren either hold them in high regard or otherwise feel some social obligation to cite the opinion of their close colleague.[62]

Klein and Morrisroe resist this assertion, arguing that the raw citations, relied upon by Landes, Lessig, and Solimine, do not adequately capture the question at issue.[63] Namely, "it is not at all clear what citations measure."[64] For example, raw citations might capture an entire host of factors unrelated to prestige and influence including panel assignment, case effects, as well as other stochastic elements. To combat these concerns, Klein and Morrisroe offered a modified citation analysis—limited to instances where individual judges are cited by name. They assert "more prestigious judges should more often be cited by name and, therefore, citations by name should be a valid indicator of a judge's prestige."[65] The Klein and Morrisroe approach provides a list of ultra-prestigious jurists whose views might be more likely to be followed than less socially prominent colleagues.[66]

These lists are important as socially elite opinion regarding what constitutes a sound legal rule is not static. At the same time, given that the judicial social world displays significant adherence to particular interpretative approaches, a robust theory of change should describe which actors, if any, are disproportionately likely to garner acceptance from their colleagues. Specifically, at first pass, it would appear no individual jurist could, through his or her mere pronouncement, induce acceptance of a given legal rule by his or her colleagues. Yet this may depend upon the social position of the actor making the pronouncement. If certain jurists in the judicial hierarchy possess a greater level of prestige and influence than their surrounding peers, then only a small number of diffuse but socially important agents might actually be necessary to induce widespread convergence from their less prominent colleagues. The popular literature calls this threshold a "tipping point."[67] In more formal terms, it is the relative measures of social

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[61] *See* Landes, Lessig & Solimine, *supra* note 6.

[62] *Id.* at 318–20.

[63] Klein & Morrisroe, *supra* note 6, at 376.

[64] *Id.*

[65] *Id.*

[66] *Id.* at 381 tbl.2.

[67] *See generally* GLADWELL, *supra* note 19. Popular science author Malcolm Gladwell and networks scientist Duncan Watts disagree about the applicability of this hypotheses. *See* Clive Thompson, *Is the Tipping Point Toast?*, FAST COMPANY, Jan. 28, 2008, http://www.fastcompany.com/node/641124/print (quoting Professor Watts: "'If society is ready to embrace a trend, almost anyone can start one—and if it isn't, then almost no one can.' . . . . To succeed with a new product, it's less a matter of finding the

structure developed within the networks literature that may yield information about the conditions under which one might observe a doctrinal phase transition.[68]

The growing work employing the citation methodology offers significant insight into questions of judicial esteem.[69] Building upon the themes of this scholarship, we believe a mapping of the judicial social landscape, using a measure other than citations, should supplement this literature by visualizing the relative position of both individuals and communities of judicial actors. Additionally, such an analysis should uncover the structural properties of interactions across the aggregate federal judiciary. While our measures are admittedly partial and do not completely adjudicate all questions, we hope this article, taken together with the scholarship will motivate a wide host of additional "network analysis and law" scholarship.

B. *The Market for Federal Judicial Law Clerks*

Federal judicial clerkships are desirable employment opportunities to which many individuals aspire. For the successful applicant, an elite clerkship provides personal prestige as well as a series of tangible

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perfect hipster to infect and more a matter of gauging the public's mood."). With this in mind, it is important to note how idea salience together with social structure and exogenous forces ultimately dictate whether a cascade around a particular trend will follow.

[68] It is exceedingly difficult for phenomena drawn from the social world to meet the precise conditions defined for a phase transition. Therefore, given the currently available empirical evidence, our use of the term is designed to be metaphoric.

[69] There is a growing domestic and international literature analyzing judicial citations. *See, e.g.*, Mita Bhattacharya & Russell Smyth, *The Determinants of Judicial Prestige and Influence: Some Empirical Evidence from the High Court of Australia*, 30 J. LEGAL STUD. 223 (2001); Stephen Choi & Mitu Gulati, *Bias in Judicial Citations: A Window into the Behavior of Judges?*, 37 J. LEGAL STUD. 87 (2008); Stephen Choi & Mitu Gulati, *Choosing the Next Supreme Court Justice: An Empirical Ranking of Judicial Performance*, 78 S. CAL. L. REV. 23 (2004); Peter McCormick, *The Supreme Court Cites the Supreme Court: Follow-up Citation on the Supreme Court of Canada, 1989–1993*, 33 OSGOODE HALL L.J. 453 (1996); *see also supra* note 44 and accompanying text. Critiques of citation counts assert that the randomness associated with case assignment, as well as other factors, injects a stochastic component into such analysis. We believe that our effort, taken together with the citation count scholarship, should yield strong insight into the path of information flow. For a sample of the critiques of citation analyses, *see* Arthur Austin, *The Reliability of Citation Counts in Judgments on Promotion, Tenure, and Status*, 35 ARIZ. L. REV. 829 (1993); Steven Goldberg, *Federal Judges and the Heisman Trophy*, 32 FLA. ST. U. L. REV. 1237 (2005); James Gordon, *Cordozo's Baseball Card*, 44 STAN. L. REV. 899 (1992). For a counter-argument see Richard Posner, *An Economic Analysis of the Use of Citations in the Law*, 2 AM. L. & ECON. REV. 381 (2000).

dividends.[70] In addition to the immediate financial rewards, such positions are linked to advancement in a variety of hierarchies—including advancement within the legal profession, the legal academy and in some instances future elevation to the bench. The financial and professional rewards are not the only attractive elements. Commentators assert that law clerks exert an increasing influence over both the agenda[71] and the substantive content of judicial outcomes.[72] For a law student or freshly minted lawyer, the opportunity to participate in the shaping of the law, taken together with the social prestige and labor market dividends, incentivize a qualified individual to seek such employment.

Following an initial sorting process, including in most cases a personal interview, a judge may tender an offer to a selected applicant.[73] Such an offer

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[70] A series of recent reports note that the bonuses offered by law firms seeking to employ a Supreme Court law clerk now reach as high as $250,000. Taken together with their base salary such individuals can expect to earn in excess of $400,000. *See, e.g.,* David Lat, *The Supreme Court's Bonus Babies,* N.Y. TIMES, June 18, 2007, at A19 (asserting that these bonuses are good for the legal system as they incentivize talented young lawyers to provide service to the Court).

[71] *See, e.g.,* TODD PEPPERS, COURTIERS OF THE MARBLE PALACE: THE RISE AND INFLUENCE OF THE SUPREME COURT LAW CLERK (2006); ARTEMUS WARD & DAVID L. WEIDEN, SORCERERS' APPRENTICES: 100 YEARS OF LAW CLERKS AT THE UNITED STATES SUPREME COURT (2006); Barbara Palmer, *The "Bermuda Triangle?" The Cert Pool and Its Influence over the Supreme Court's Agenda,* 18 CONST. COMMENT. 105 (2001); Jan Palmer & Saul Brenner, *The Law Clerks' Recommendations and the Conference Vote On-the-Merits on the U.S. Supreme Court,* 18 JUST. SYS. J. 185 (1995).

[72] *See, e.g.,* PEPPERS, *supra* note 71; WARD & WEIDEN, *supra* note 71; Jim Chen, *The Mystery and the Mastery of the Judicial Power,* 59 MO. L. REV. 281, 302 (1994) (arguing that clerk involvement in opinion drafting "can supply all the agenda control that is needed to swing outcomes and rationales in individual cases."); J. Daniel Mahoney, *Law Clerks: For Better or for Worse?,* 54 BROOK. L. REV. 321, 339 (1998).

[73] While there are important variations in hiring practices, such as the timing of an offer, there is also substantial consistency in approaches. With some limited variation, for those judges who hire permanent clerks, the basic selection process follows a consistent pattern. Law students or young lawyers submit an application of materials including their resume, transcripts, writing sample and letters of reference. *See generally* Ruggero J. Aldisert, Ryan C. Kirkpatrick & James R. Stevens III, *Rat Race: Insider Advice on Landing Judicial Clerkships,* 110 PENN. ST. L. REV. 835 (2006). As there is significant uncertainty regarding the prospects for placement, it is quite common for aspirants to submit tens or even hundreds of such applications. *Id.* at 837–38 (noting that the average applicant sends materials to sixty-five judges but "[i]t is not atypical for a qualified applicant to apply to over 150 judges."). In a manner similar to other hiring practices, judges, often with the assistance of current clerks, filter the large sea of applicants and contact a selected few for an individual interview. Applicants as well as judges typically schedule a battery of such interviews. The interview is often a face-to-face interaction with the judge as well as members of the judge's staff. Assuming basic intellectual merit,

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could be extended immediately following the interview or could come at a future moment. The content of the offer is exceedingly similar across judges at a given level of the judicial hierarchy.[74] The salary is determined exogenously and "fixed."[75] As Professor Priest notes, "even where there are differences across clerkships, their expected value is low because of the short tenure of the job."[76] There is very little range for negotiation over the terms of the position. Essentially, the offer is dichotomous.[77]

While this description of the clerk selection process might appear innocuous, a substantial amount of recent scholarship argues otherwise. The past two decades witnessed a burgeoning literature devoted to analyzing both the role of as well as the labor market for federal judicial law clerks.[78] It is this latter commentary regarding clerk hiring that is most germane to this article. Although not completely attributable to any single source, Judge Wald's 1990 essay is the probable origin of recent commentary discussing the selection mechanism for federal law clerks.[79] The former Chief Judge of the D.C. Circuit Court of Appeals describes the clerk hiring process as undignified and cites others who characterize it as "frenzied,"[80] "ludicrous,"[81] and "madcap decision making."[82] While her essay is a call for reform, she offers some keen observations about the conditions underlying the nature of the law clerk market.

She observes that an "excellent versus a mediocre team of clerks makes a huge difference in the judge's daily life and in her work product."[83] Thus, judges, in part, seek strong clerks as it lightens their workload or allows them more effectively to advance their substantive agenda. As Judge Wald notes, "a judge sometimes decides whether to file a separate opinion or to dissent in

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many judges use the interview to determine whether the individual's temperament properly interfaces with the chamber's. *See generally id.*

[74] *See, e.g.*, George L. Priest, *Reexamining the Market for Judicial Clerks and Other Assortative Matching Markets*, 22 YALE J. ON REG. 123, 154–55 (2005) ("Although individual judges will have different temperaments and will work their clerks more or less intensively, job conditions themselves are fungible over a large range.").

[75] *See* Christopher Avery, Christine Jolls, Richard A. Posner & Alvin E. Roth, *The Market for Federal Judicial Law Clerks*, 68 U. CHI. L. REV. 793, 799 n.14 (2001); Priest, *supra* note 74, at 154 ("Salaries are fixed, set by Congress.").

[76] *See* Priest, *supra* note 74, at 154.

[77] In other words, it is a zero or one—a take it or leave it offer.

[78] For a small slice of this literature *see supra* notes 71–73 and accompanying text.

[79] *See* Patricia M.Wald, *Selecting Law Clerks*, 89 MICH. L. REV. 152 (1990).

[80] *See id.* at 152 (citing David Margolick, *At the Bar: Annual Race for Clerks Becomes a Mad Dash*, N.Y. TIMES, Mar. 17, 1989, at B4).

[81] *Id.*

[82] *See* Wald, *supra* note 79 (citing internal correspondence).

[83] *Id.* at 153.

a case based—at least in part—upon the support she can anticipate from her clerks."[84] In addition to internal administrative motivations, external reputational considerations also encourage artful hiring practices. In a commonly quoted sentence, Judge Wald asserts, "A judge's reputation among his own colleagues may in part reflect his ability to garner the most highly-credentialed clerks under his banner so that he can maintain a reputation as a 'feeder' of clerks to the Supreme Court."[85]

It is the strong demand for stellar clerks that in large part fueled the "frenzied mating ritual."[86] The process, as described by Wald, includes "short fuse" offers and "[e]arly–bird judges skim[ming] off those applicants with the brightest credentials."[87] Despite various efforts to cajole their colleagues to adhere to a consistent hiring date, reform efforts consistently unraveled. While unraveling is a source of distress for Judge Wald, it is the behavior produced by the market for clerks and its reflection upon the judicial branch that is her greatest concern.[88]

While Judge Wald's position is certainly shared by some of her colleagues, her position has not received uniform support. For example, the following year witnessed a rejoinder offered by Ninth Circuit Judge Alex Kozinski.[89] Through his 1991 article, Judge Kozinski acknowledges that in reaction to "complaints about 'badmouthing, spying and even poaching among judges'. . . we should all try to do better."[90] Despite this concession, Judge Kozinski otherwise states that "there is nothing at all wrong with the current law clerk selection process; everything is hunky dory."[91] Instead of reform, he passionately argues, "federal judges should get off their pedestals and compete . . . ."[92] For Judge Kozinski, reform proposals simply stymie upstarts by advantaging judges with geography, seniority and existing high levels of prestige.[93]

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[84] *Id.* Judge Wald additionally notes, alternatively, that "she may ask for, or beg off, responsibility for a particular opinion assignment because of the availability or nonavailability of a particular clerk to work on the case." *Id.*

[85] Wald, *supra* note 79, at 154.

[86] *Id.* at 152 (citing David Margolick, *supra* note 80, at B4).

[87] *Id.* at 156.

[88] *Id.* at 152. "[T]he law of the jungle reigns and badmouthing, spying and even poaching among judges is rife." *Id.*

[89] Alex Kozinski, *Confessions of a Bad Apple*, 100 YALE L.J. 1707 (1991).

[90] *Id.* at 1715.

[91] *Id.* at 1707.

[92] *Id.* at 1714.

[93] "Judges with many years on the bench naturally have an advantage over *upstarts* like me who have to work hard at achieving a national reputation. The problem with many reform proposals is that they tend to *reinforce these patterns* by decreasing the

This first round of commentary, including efforts by the aforementioned jurists as well as others,[94] brought a variety of unique reform proposals and provided a wealth of qualitative insight into the state of the law clerk hiring process. The second strand of "clerk market" scholarship advanced an economic solution to the discontents of the clerk market. Most notably, Professors Avery, Jolls, Roth and Judge Posner produced what has been called the Harvard-Chicago analysis of the law clerk market.[95] Using detailed survey data, the Harvard-Chicago study provided extensive, empirical insight into the experience of judges and clerks in the hiring process.[96] Their data, taken together with subsequent economic analysis, argued the clerk selection process failed to maximize "the sum of satisfaction" of judge and clerk matches. Namely the clerk market, like other markets with timing problems, is plagued with unraveling. Individual judges have substantial incentive to deviate from agreed hiring dates as the existing regulatory mechanisms did not impose enforceable timing regulations.[97] Judges who might otherwise be inclined to abide with a given hiring date are forced to defect from that date to avoid the "sucker payoff."[98] Therefore, in only a few iterations such conditions invariably produce widespread non-compliance.

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means by which less-favored clerkships can compete for desirable applicants." *Id.* at 1719 (emphasis added).

[94] With a debate in full force, the years that immediately followed witnessed a number of judges and commentators entering the fray. For example, Judge Oberdorfer and his former clerk filed a response to Judge Kozinski arguing his objections are misplaced and that a medical style matching system would improve the state of affairs. Louis F. Oberdorfer & Michael N. Levy, *On Clerkship Selection: A Reply to the Bad Apple*, 101 YALE L.J. 1097 (1992). Trenton Norris offered a clerk's perspective on the discontents of the current market. *See* Trenton H. Norris, *The Judicial Clerkship Selection Process: An Applicant's Perspective on Bad Apples, Sour Grapes, and Fruitful Reform*, 81 CAL. L. REV. 765 (1993). Judge Becker, Justice Breyer, and Judge Calabresi set forth their "Modest March 1 solution" to the clerk hiring process. Edward R. Becker, Stephen G. Breyer & Guido Calabresi, *The Federal Judicial Law Clerk Hiring Problem and the Modest March 1 Solution*, 104 YALE L.J. 207 (1994). In the period between crafting and final publication of this article Judge Breyer became Justice Breyer.

[95] Avery, *supra* note 75.

[96] "A fundamental goal of our project has been to gain an improved understanding of how the market for federal judicial law clerks actually operates. There are many rumors and opinions about this market, and few hard facts." *Id.* at 796.

[97] *Id.*

[98] The Harvard-Chicago study offers a partial solution to the problem of enforceability. It argues that "the Supreme Court could play an important and productive role in helping to organize and improve the market for federal law clerks" and "suggest[s] a partial solution, which would require judges who wish their clerks to be eligible for United States Supreme Court clerkships to enroll in a centralized matching system . . . ." *Id.* at 885. The proposal is well conceived as it realigns the incentives by sanctioning the very individuals who are most inclined to engage in early exploding offers.

Although disagreeing with a number of conclusions of the Harvard-Chicago study, Professor Priest, as quoted earlier, observes that "job conditions themselves are fungible over a large range . . . . [e]ven where there are differences across clerkships, their expected value is low because of the short tenure of the job."[99] Since less prestigious judges cannot offer a compensating wage differential "[t]he timing of the offer, thus, becomes a term of trade in the clerkship market transaction."[100] Thus, "first movers" such as Judge Kozinski are able to increase their relative standing through strategic behavior early in their career.

Of course, if timing of offer was the sole sorting mechanism in the clerk market, the traffic of law clerks might be a poor proxy from which to operationalize the aggregate social structure. Some portions of the literature, if reviewed in isolation, imply that the strategic behavior of judges simply overwhelms law clerks and precludes them from obtaining their optimal match. For example, the Harvard-Chicago data indicates a majority of respondents who received an offer did so either during or within two days of their interview.[101] At the same time, judges often expected quick or even immediate responses to such offers.[102]

Given these conditions, clerks face significant pressure to avoid an "exploding" offer from a less preferred judge. Yet, a number of clerks, often with guidance from their professors and law school career services offices, use compensating techniques to resist a sub-optimal match. For example, Judge Wald notes "[s]avvy clerk applicants . . . called chambers in advance to announce that that particular judge was the first choice."[103] In addition, strategic scheduling is another important compensating technique. Strategic schedulers organize their interviews in relationship to their choices over judges. Specifically, if clerks schedule interviews in strict association to their preference ordering, then an exploding offer, of course, would not be problematic but rather a welcome event.[104]

C. A Marriage of Convenience?

The purpose of this article is not to engage the debate over the proper regulatory mechanism, if any, which should govern the clerk market. The

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[99] See Priest, supra note 74, at 154.

[100] Id. at 155.

[101] See Avery, supra note 75, at 814 tbl.1.

[102] Id. at 814 tbl.2.

[103] See Wald, supra note 79, at 158.

[104] See Aldisert, Kirkpatrick & Stevens, supra note 73, at 848 (quoting an unnamed Fifth Circuit judge: "If an applicant really wants a position with a particular judge, he can signal that by offering to do an interview the first day.")

recent hiring moratorium, for example, may limit some of the discontentment experienced under the prior regime.[105] We will leave the evaluation of such questions to more qualified scholars.[106] Our interest in law clerks and the respective labor market is simply to study and visualize their traffic to gain insight into questions of inter-judge connectivity. The hiring of clerks is an intimate act,[107] one where deliberation or forethought should attach. While it is a choice under uncertainty, a significant number of signals are available. Some signals, such as grade point average, law review membership, or personal background, are intrinsic to the individual clerk. Other cues come from third parties. As the foregoing analysis is limited to law clerks flowing between various judicial actors, judges who previously employed the given clerk provide either an explicit or implicit signal to the subsequent hiring jurist. In general, judges and communities of jurists who consistently share clerks probably do so because the receiver either respects the judgment of his or her colleagues or otherwise shares a social connection with the senders.

Thus, embedded in the immensely interesting literature analyzing the market for federal law clerks is language and commentary that should be of particular interest to the larger public law scholarship. Notwithstanding their critiques of the efficiency of a number of allocative elements of the clerk market, many authors observe it is prestige that in large part motivates both the judges and their would-be apprentices.[108] Consider Judge Wald as quoted earlier[109] and Professor Priest who notes "other things equal, prominent judges are able to secure the most qualified clerks."[110] Of course, the Harvard-Chicago findings counsel some degree of caution from reliance upon clerk traffic as the perfect measure for the relative social position of federal judges. However, even their proposal for reform, centered upon restricting feeding to the United States Supreme Court, acknowledges that social prestige and influence is attached to the ability to attract and feed "star" clerks.[111]

In all, despite the caveats the literature on the clerk market might impose, there remains significant information embedded in the market for judicial

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[105] For a detailed analysis of the effects of the hiring moratorium see generally Christopher Avery, Christine Jolls, Richard A. Posner & Alvin E. Roth, *The New Market for Federal Judicial Law Clerks*, 74 U. CHI. L. REV. 447 (2007).

[106] *Id.*

[107] *See* Wald, *supra* note 79, at 153 (arguing "[t]he judge-clerk relationship is the most intense and mutually dependant one I know of outside of marriage, parenthood, or a love affair.").

[108] The term "sorcerers' apprentice" is borrowed from a well-received recent book on Supreme Court Law Clerks. *See* WARD & WEIDEN, *supra* note 71.

[109] *See* Wald, *supra* note 79, at 153.

[110] Priest, *supra* note 74, at 162.

[111] *See* Avery et al., *supra* note 75.

clerks that should help inform the greater public law literature. While a simple descriptive account or tabulation of so called "feeder" judges would certainly demonstrate which individuals consistently sent their law clerks to the levels above, such analysis fails to characterize communities and capture concepts such as social position and attraction. While some of the clerk moves may be wholly unrelated to our question of inquiry, we believe in the aggregate, the majority of such moves are related to social advancement. In general, clerks move from judges with a lower social position to those with a higher social standing. Given the clear labor market payoffs available in the private market, many clerks who remain in the network in order to flow between judges often do so in order to increase their personal position.[112] In the face of significant opportunity costs for remaining a public employee, clerks are voting with their feet, and their traffic—particularly in the aggregate—says something important.

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[112] At least some number of clerks who remain and move from the Federal Circuit Court to the Federal District Court may do so in order to offer potential employers a better portfolio of experience. In fact, it is also possible that clerks who move downward in the hierarchy may do so in order to work in geographic locations that they consider more attractive. Recognizing this caveat we still believe, all things being equal, as a clerk searches for an additional clerkship, imposing whatever limiting parameters he or she chooses, to the extent the individual selects among judges, prestige is an important part of the decisional calculus.

III. THE VISUALIZATION AND CHARACTERIZATION OF THE JUDICIAL SOCIAL NETWORK

Inspired by our desire to better understand its social topography, we used the tools of network analysis to visualize the structure of the federal judiciary. To build the connections between actors, we collected a decade's worth of federal law clerk information and used this data to visualize the flow of clerks between judges. Bolstered by subsequent analytics, our visualizations yield some interesting findings. First, while the notion of a "feeder judge" is commonly invoked, this study visualizes the concept. Visualization displays a host of secondary movers who "feed" the feeders thereby increasing their centrality within the network. The overall structure of the network, visualized in Figures 1–4 *infra*, is also intriguing. Despite the presence of clear cliques or communities, the center of the network is dense and clustered enough to keep interconnected most of the members of the federal judiciary.[113]

A. *Data Collection: Sources and Approach*

With the assistance of our research team,[114] we collected available information for every federal law clerk employed by an Article III judge during the "natural" Rehnquist Court (1995–2004). This process proved challenging as no particular data source contained a complete listing of such information. However, our data set combines a diverse set of sources and reflects nearly all law clerks at all levels for the relevant years.[115]

Given its extensive treatment, we began our effort by consulting *The Judicial Yellow Book* published by Leadership Directories, Inc.[116] This tri-annual serial publication contains extensive biographic information on virtually every state and federal judge in the United States. Included within this broad range of information are the names, and in most cases, educational history of various members of the judges' chambers. Using the fall edition in

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[113] Figures 1–4 *infra* do not contain every member of the federal judiciary. Although nearly six hundred members are present, the visualizations omit judges who over the decade-long period failed to send a single clerk to another federal judge.

[114] We would be remiss if we did not take the opportunity to thank Eric Provins, Steven Schwartz, Courtney O'Brien, Pamela Kiel, Stephen Janos, Eitan Ingall, Daniel Schwartz, Art Reyes, Jon Tshiamala, Alex Hughes, Noah Korn, Neil Tambe, Nicole Tyrna, Erin Copland, Matthew Smith, Darin Goldstein, Alex Satanovsky, Benjamin Ruano, and Alex Karpowitz for their assistance with data coding.

[115] By our estimate, the data collection effort yielded approximately 95.2% of all law clerk events during the decade-long period.

[116] The volumes of the *Judicial Yellow Book* that we consulted were Fall 1995–Fall 2004.

each year, our team collected all available identifying information including the clerk's full name, educational background, and year of service. Across the decade-long period, this process yielded a significant amount of the desired data.

Despite the extensive amount of information contained in *The Judicial Yellow Book*, our primary data collection effort left a non-trivial number of "missing" clerk values. In order to bolster the comprehensiveness of our dataset, we searched and filled missing values using *The Judicial Staff Directory*[117] produced by CQ Press as well as selected years of the *National Association for Law Placement* (NALP) Judicial Clerkship directory.[118] This second level was largely successful and moved the dataset near completion. Yet, as we reviewed the totality of the dataset, it was clear that the set still contained some systematic bias with a large number of the missing values drawn from a discrete number of judges. In order to obtain these public but otherwise unavailable "clerk values," our team searched for missing clerk values using Martindale-Hubbell[119] as well as the websites of various prominent law firms. To the extent the sum of these combined efforts also proved unavailing, we contacted both the judge's former law clerks as well as the career services offices at a number of law schools located near the particular judge's chambers.

In sum, while the dataset does not contain every discrete clerk value, the dataset reflects all reasonably available law clerk information for a decade long period. Appendix I displays some sample lines of code drawn from the dataset. As displayed *infra*, a given line of code contains not only the clerk's full name, but also the clerk's educational background, year of service, and the judge's name.[120] Furthermore, in order to link our set to existing data sources and to aid in future research, each "clerk event" reflected as an individual line of code contains judge identification and seat numbers drawn from the Gary Zuk, Deborah J. Barrow, and Gerard S. Gryski Attributes of Federal Court Judges dataset.[121]

A complete version of the dataset contains in excess of 25,000 law clerk events drawn from not only Article III judges but also Article I Bankruptcy

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[117] Specifically, we collected available copies the Judicial Staff Directory that covered the 1995–2004 window.

[118] While full coverage was not available, we collected available copies of the National Association for Law Placement (NALP) Judicial Clerkship Directory that covered the 1995–2004 window.

[119] Missing values were filled either using both the current as well as older version of the Martindale-Hubbell Directory.

[120] For an example of the information contained in this dataset, see *infra* Appendix I.

[121] The dataset is housed at Judicial Research Initiative at the University of South Carolina. The page contains both the district and circuit court datasets. *See* http://www.cas.sc.edu/poli/juri/index.php (last visited Jan. 2, 2009).

Court Judges. As the available data sources maintain the greatest degree of accuracy for the law clerks of non-senior status Article III judges,[122] we restricted our analysis to these jurists. Even with the clerks of Bankruptcy and Senior Status Judges removed, the dataset does not suffer from a want of information. Namely, the remaining dataset, as restricted, still contains nearly 19,000 total law clerk events for the decade-long period. These events are distributed across the federal judicial hierarchy with the majority of clerk events attributed to federal district courts.

Many of the clerks who appear in our dataset occupy exactly one line of code. Typically, such singletons are employed by a judge immediately following law school and exit the data-set at the completion of their discrete term. So called "permanent" law clerks reflect another subset of individuals in the dataset. Such individuals reflect multiple lines of code because a given individual judge employs them over a number of years. Our analysis is not directly focused upon either of these subgroups. Instead, it is directed at clerks who flow between judges.

To find clerk "movers," we sorted the dataset by *clerk name* and then by *year*. This displayed clusters of individual clerk names. Using limiting properties such as middle initial, law school, and undergraduate institution,[123] we differentiated cases involving similar names. To qualify as a clerk move, an individual employed in a given period must have been hired by a different judge in a subsequent period. As such, it requires two lines of code to qualify as a clerk move. While we placed no precise limitation upon the timing of the subsequent interval, the vast majority of the clerk moves involved transfers in the year immediately following the first clerkship.

From our nearly 19,000 clerk events, we detected nearly 950 movements. As our analysis is exceedingly conservative in its willingness to validate a "mover," the number of connections present in the true population likely exceeds the connections in our visualization of the social landscape. To execute the visualizations and craft the corresponding network statistics, we converted the lines of code representing "movers" into connections between

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[122] For a detailed discussion of senior judges including a claim that Senior Judges are unconstitutional, see generally David R. Stras & Ryan W. Scott, *Are Senior Judges Unconstitutional?*, 92 CORNELL L. REV. 453 (2007). "Senior judges are the product of a patchwork of several statutes governing judicial retirement, the most significant of which is 28 U.S.C § 371. Federal judges become eligible for retirement benefits upon satisfying the "Rule of Eighty"—when the sum of their age and years of service on the federal bench reaches eighty. At that point, the judge has two retirement options: outright retirement, which for the sake of clarity we will call 'resignation,' and the form of semiretirement known as 'senior status.'" *Id.* at 460.

[123] We relied upon the values in this cell to the extent available. Often a clerk's J.D.-granting institution was available to aid in the delimiting process while much of the undergraduate institutional information was unavailable.

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judges. For example, if law clerk Doe_John moved between Judge A and
Judge B, then we tallied a connection between those two jurists. Of the close
to 950 total connections, nearly 500 represented discrete paths. In other
words, the repeated connections concentrated on a very limited number of
judicial actors. We entered this final dataset of clerk connections into
Pajek.[124] Using *Pajek*, we produced the visualizations and generated the
analysis contained *infra*.

B. *The Visualization of the Judicial Social Network*

The nodes are the individual judges and, as operationalized, the edges
reflect a weighted measure of shared clerks between the jurists. Although the
traffic is directed, we explicitly choose to model the network as undirected
because we believe the influence is bidirectional.[125] Manually generating
consistent and unbiased visualizations of a network of this size is a nearly
impossible task. Automated drawing procedures developed in computer
science, however, can be used to generate clear and transparent depictions of
networks such as the federal judicial network. The two automated drawing
procedures used in this article, Kamada-Kawai[126] and Fruchterman-
Reingold,[127] are spring-embedded, force-directed placement algorithms.
Although the technical characterization is discussed further in Appendix II,
an analogy may help characterize the drawing process.

Imagine that the judge nodes are steel rings with opposing magnetic
charges working to repel one another. Now visualize springs connecting the
steel rings as the edges in the network. The longer a spring must stretch to
connect the steel rings, the more energy is required to stretch the spring. The
closer the positions of rings without connections are to one another, the

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[124] *Pajek* is one of the competing network software packages used by network
scholars to generate visualizations. More information is available at
http://pajek.imfm.si/doku.php (last visited Jan. 2, 2009).

[125] Our judicial social network based upon clerk traffic, displayed *infra* Figures 1–4,
is thorny as the traffic is clearly directed, but we believe the social importance associated
with the linkage travel in both directions. All modeling choices explicitly imply a
weighting scheme. Our decision to assign equal directional weights seemed to be the
most sensible approach. Possible extensions of this article might consider alternative
theoretically motivated weighting schemes.

[126] *See generally* Tomihisa Kamada & Satoru Kawai, *An Algorithm for Drawing
General Undirected Graphs*, 31 INFORMATION PROCESSING LETTERS 7 (Apr. 12, 1989);
see also Tomihisa Kamada & Satoru Kawai, *Automatic Display of Network Structures for
Human Understanding*, University of Tokyo Department of Information Science,
Technical Report No. 88-7 (1988).

[127] *See generally* Thomas M.J. Fruchterman & Edward M. Reingold, *Graph
Drawing by Force-Directed Placement*, 21 SOFTWARE: PRACTICE AND EXPERIENCE 1129
(1991).

greater is the energy required to hold those positions.[128] The aforementioned algorithms seek to minimize the energy required to balance these attracting and repelling forces.[129] After applying either Kamada-Kawai or Fruchterman-Reingold, the result is a graph that generally distributes vertices evenly, minimizes edge crossings, uses the planar area, reflects inherent symmetry, and minimizes differences in edge lengths.[130]

In terms of visualization, Fruchterman-Reingold tends to increase the difficulty of remaining in the center, pushing less connected nodes to an orbit with a larger circumference. Nevertheless, in overall structure and clustering, no substantive difference exists. Some network scholars believe the choice of algorithms should be determined by the size and density of the graph with 500 nodes as the recommended cut-point.[131] Since the federal judicial network contains roughly 600 nodes, we included visualizations of both types of automated drawing. While the Kamada-Kawai energizing algorithm provides a nice visual of the overall structure of the network, the Fruchterman-Reingold automated drawing provides greater clarity of the interconnectedness of the network's core.

With this introduction, consider the foregoing series of networks visualizations. Figures 1 and 3 use the Kamada-Kawai algorithms, while Figures 2 and 4 employ Fruchterman-Reingold. Figures 1 and 3 provide a wide view of the energized network while Figures 2 and 4 provide a close-up view including the network's core. A careful review of the Supreme Court Justices displays a familiar ideological distribution. As this effort is primarily directed at classifying social structure and differentiating among lower court judges, what is of greater interest are the communities of both circuit and district court judges who cluster around and feed these Justices. For ease, we rotated the foregoing figures so as to hold the traditional left to right ideological distribution.[132]

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[128] Peter Eades, *A Heuristic for Graph Drawing*, 42 CONGRESSUS NUMERANTIUM 149–50 (1984).

[129] *Id.* at 149.

[130] *See* Fruchterman & Reingold, *supra* note 127, at 1129.

[131] *See* WOUTER DE NOOY, ANDREJ MRVAR & VLADIMIR BATAGELJ, EXPLORATORY SOCIAL NETWORK ANALYSIS WITH PAJEK 17 (Cambridge Univ. Press 2005).

[132] Rotation imposes no substantive consequences. If the graphics were rotated 90°, the relative positions of the nodes would remain unchanged. Rather, the Supreme Court Justices would simply be distributed North to South rather than East to West.

Figure 1: A Wide View of the Kamada-Kawai Energized Judicial Social Network
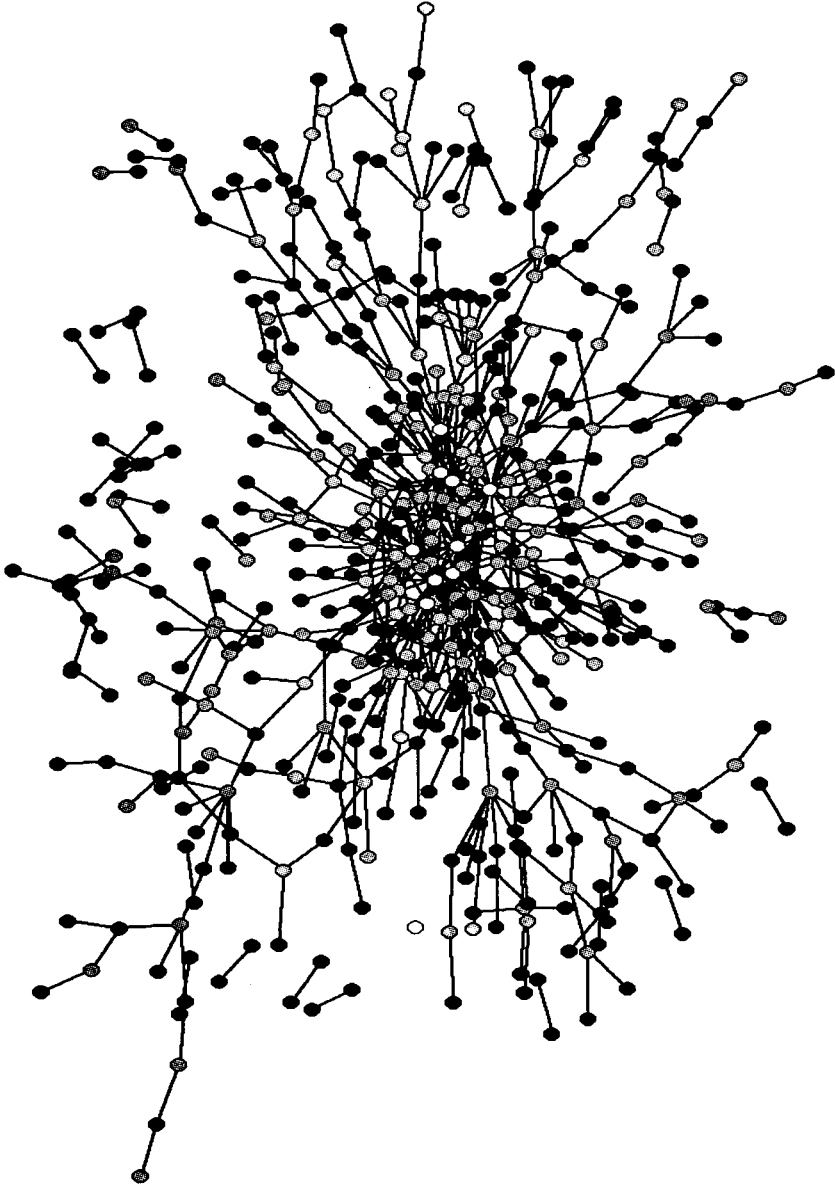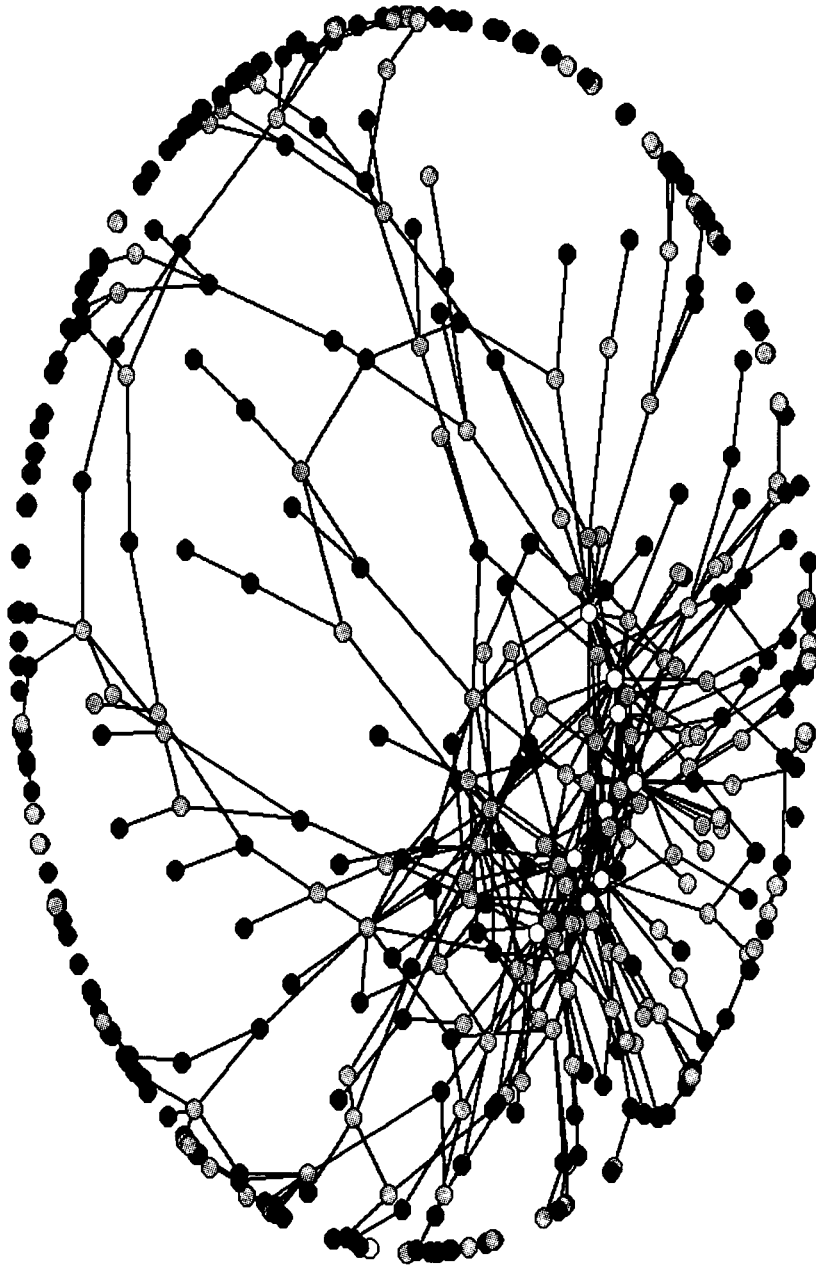
Figure 2: A Wide View of the Fruchterman–Reingold Energized Judicial Social Network

Figure 3: A Close View of the Kamada-Kawai Energized Judicial Social Network

Figure 4: A Wide View of the Fruchterman-Reingold Energized Judicial Social Network

The judicial social network displays a densely connected center with clusters around the Supreme Court Justices. Each visual includes a partition for the formal distinctions between members of the Supreme Court (white); circuit court (gray); and district court (black). Although the formal institutional authority of each federal judge is essentially identical across actors holding the respective circuit/district distinction, our visuals support the finding of previous scholars who assert that the informal prestige and influence of various jurists is far from equal.[133]

With respect to broad structure and consistent with their relative institutional position, district court judges are primarily located at the periphery of the network. However, a few selected judges sitting on the district court do persist and are located in close proximity to or the center of the network.[134] Although a non-trivial subset of the circuit court population finds itself at the boundary of the network, in general, a greater population of circuit court judges find themselves concentrated at the network's core. Thus, while institutional authority is certainly important, our analysis indicates that a mixture of formal and informal authority determines the placement of each judicial actor.

While the visualizations help display the social standing of various jurists as well as the broad structure of the network, it is ultimately the network statistics that offer clean, replicable depictions of the network and its various components. A wide variety of statistical approaches have been developed in the network science literature to consider such questions. Thus, in the proceeding sections we offer such analysis.

C. Identifying Central Actors in the Judicial Social Network

The extant social networks literature contains a wide number of statistical approaches designed to identify such prominent actors. Networks scholars place many concepts under the broad umbrella of centrality. The simplest form of centrality is a tally of the "degree" of each vertex, which refers to the number of connections to and from a given vertex. Although degree can be a useful measure of centrality, this simple aggregation of an actor's connections does not take into account the differences in the prominence of a given actor's connections. For example, a simple degree score implies that a social connection to Merrick Garland will increase that

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[133] It is likely of little surprise to observe prolific judges such as the Honorable Richard Posner, Harry T. Edwards, Samuel Alito, Merrick Garland, J. Harvie Wilkinson, Michael Luttig, and Guido Calabresi located in the core of the network.

[134] Included among these district court judges located close to the core of the network is Judge Michael Mukasey of the Southern District of New York. In late 2007, Judge Mukasey was confirmed as the eighty-first Attorney General of the United States.

judge's centrality score by the same increment as a connection to some less socially important jurist. Thus, while the definition of centrality is often elusive and different measures trade upon different analytics, we avoid much of the centrality debate by presenting herein three well-established centrality rankings—hubs and authority scores, closeness, and betweenness.

Originally derived for navigating the internet with text-based queries, the Hubs and Authorities (HITS) algorithm created by computer scientist Jon Kleinberg offers one manner of identifying important nodes in a network.[135] The HITS algorithm assumes that in a large network there are two important types of nodes that serve different functions in the network based on their structural positions. The key distinction is the direction of their relation to other central nodes. A vertex with strong hub score displays connections *towards* important authorities, while a vertex with a strong authority score features connections *from* important hubs. As applied to the judicial network, a hub is a jurist who sends his/her clerks *to* prominent judges, while an authority would be a judge who accepts clerks *from* prominent judges.[136] We exclude hub scores from the analysis because many of the most prominent district and circuit court judges rarely select clerks with prior clerkship experience. For this reason, otherwise highly prominent jurists such as Alex Kozinski and Richard Posner have authority scores that are low. Furthermore, given the specific proxy measure employed herein, we remove the nine Supreme Court Justices from the authority scores in Table 1 because their prestige is institutionally determined. Accordingly, our authority scores are exclusively limited to the lower court jurists.

Closeness centrality measures the normalized shortest distance from a given node to all other nodes.[137] More simply stated, consider the node with

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[135] *See* Jon M. Kleinberg, *Authoritative Sources in a Hyperlinked Environment*, 46 J. ACM 604 (1998).

[136] Prominent networks scholar James Fowler and his co-authors offer a very useful description of the Kleinberg algorithm. Applying their description to the judicial social network, let each judge's hiring capacity scores be $x_i = a_1y_1 + a_2y_2 + ... + a_ny_n$ and let each jurist's sending capacity be $y_i = a_1x_1 + a_2x_2 + ... + a_nx_n$. These equations produce $x = A^Ty$ and $y=Ax$ in matrix format. These equations converge to the fixed points $\lambda x^* = A^TAx^*$ *and* $\lambda y^* = AA^Ty^*$ where λ is the principle eigenvector. *See* James Fowler et al., *Social Networks in Political Science: Hiring and Placement of Ph.D.s, 1960–2002*, 40 PS: POL. SCI. & POL. 729, 730 (2007).

[137] *See* Dirk Koschützki et al., *Centrality Indices*, in NETWORK ANALYSIS: METHODOLOGICAL FOUNDATIONS 16 (Ulrik Brandes & Thomas Erlebach eds., 1998). If one denotes the sum of the distances from "a vertex u to any other vertex in a graph $G = (V, E)$ as the squared total distance: $c_c(u) = \sum_{v \in V} d(u,v)$." *Id.* at 22. The most commonly employed definition of closeness is a "vertex centrality" built upon the reciprocal of the total distance: $c_c(u) = \left[\sum_{v \in V} d(u,v) \right]^1$. *Id.* at 23.

the highest closeness score as the median of a network, because if the graph were represented as a number line like a chain, then the median would have the highest closeness centrality score. In the context of the federal judiciary network, this statistic will be highest when a judge is on average nearer to the rest of the jurists than any other judge.

Finally, betweenness centrality is often used to identify the bridges between different communities and clusters. To identify these gatekeepers, betweenness calculates the shortest paths (known as geodesics) between all pairs of vertices, identifies the frequency of each node appearing on those paths, then normalizes the statistic.[138] Jurists that exhibit high betweenness scores are not necessarily likely to be individuals that connect ideologically different groups together. These judges may act as gatekeepers that connect communities in a bowtie-like fashion. These jurists are, however, important in maintaining the connectivity of the network.

Centrality measures must be interpreted contextually as their meaning can vary across bipartite networks, directed networks, and negative affective networks. Table 1 presents the jurists ranked in terms of authority scores, closeness, and betweenness. The judges are presented in order of their scores. The first ranking is given to the jurist with the most prominent structural position based on the respective statistic. We exclude Supreme Court Justices from Table 1, given their institutionally imposed structural position within the judicial social network.

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[138] If one denotes the "fraction of shortest paths between s and t that contain vertex v" as $\delta_{st}(v) = [\sigma_{st}(v)]/(\sigma_{st})$, then betweenness centrality of a given vertex is given by: $c_b(v) = \sum_{s \neq v \in V} \sum_{t \neq v \in V} \delta_{st}(v)$. *Id.* at 29–30.

Table 1: Ranking Jurists Using Various Measures of Centrality

Rank	Authority	Closeness	Betweenness
1	Luttig, J. Michael	Ginsburg, Douglas H.	Sotomayor, Sonia
2	Wilkinson, J. Harvie	Wilkinson, J. Harvie	Brunetti, Melvin T.
3	Kozinski, Alex	Silberman, Laurence H.	Gillmor, Helen W.
4	Silberman, Laurence H.	Randolph, A. Raymond	Straub, Chester J.
5	O'Scannlain, Diarmuid	Tatel, David S.	Henderson, Karen LeCraft
6	Calabresi, Guido	Jacobs, Dennis G.	Gilman, Ronald Lee
7	Tatel, David S.	Luttig, J. Michael	Tjoflat, Gerald B.
8	Posner, Richard	Calabresi, Guido	Gibbons, Julia Smith
9	Ginsburg, Douglas H.	Williams, Stephen F.	Randolph, A. Raymond
10	Sentelle, David B.	Kozinski, Alex	Tatel, David S.
11	Boudin, Michael	Winter, Ralph K.	Gleeson, John
12	Edwards, Harry T.	Gleeson, John	Black, Susan Harrell
13	Williams, Stephen F.	Cabranes, José A.	Arnold, Morris S.
14	Garland, Merrick B.	O'Scannlain, Diarmuid	Walker Jr., John M.
15	Jones, Edith Hollan	Garland, Merrick B.	Sentelle, David B.
16	Leval, Pierre N.	Leval, Pierre N.	Ross, Allyne R.
17	Niemeyer, Paul V.	Edwards, Harry T.	Timlin, Robert James
18	Winter, Ralph K.	Henderson, Karen LeCraft	Bybee, Jay S.
19	Randolph, A. Raymond	Boudin, Michael	Jacobs, Dennis G.
20	Reinhardt, Stephen R.	Niemeyer, Paul V.	Brody, Anita B.
21	Cabranes, José A.	Sotomayor, Sonia	White, Jeffrey S.
22	Higginbotham, Patrick E.	Posner, Richard	Ginsburg, Douglas H.
23	Wallace, J. Clifford	Fletcher, William A.	Benavides, Fortunato P.
24	Rymer, Pamela A.	Wald, Patricia M.	Robertson, James
25	Fletcher, William A.	Higginbotham, Patrick E.	Hornby, David Brock

D. *Classifying the Physical Properties of the Judicial Social Network*

In addition to indentifying central nodes, network scientists are often interested in classifying the structural properties of a given network. Namely, with a conception of the network's physical characteristics, it is possible to consider the class of micro-level generative processes plausibly responsible for the observed macro-structure. One manner to classify the aggregate structure of a network is to tally the number of degrees between the actors and determine the distribution of such connections. There exist many potential forms this distribution of authority could assume.[139] For example, the distribution could be relatively uniform—with a wide number of actors possessing a moderate level of connections. The distribution could be distributed normally or alternatively could be centered upon a small number of socially prominent actors.

In a large number of social and physical networks, including the judicial social network, the degree distribution follows this latter orientation. The concentration of degrees over a small subset of actors yields a heavy-tailed distribution. While the "fat-tailed" distribution of degrees is most commonly associated with the power law distribution, a wide array of other closely linked distributions including the exponential, the power law with cutoff and log-linear distribution are also possible.[140]

Figure 5 is a frequency distribution plot of the number of judges by the degree of each judge (the degree is simply the measure of how many edges are incident with each node), the L-shaped curve consistent with extreme skewing emerges. The log/log graph offers a cleaner view of the tail of the degree distribution. As before, the Supreme Court Justices are excluded from this analysis because their structural position relative to degree distribution is a construct of their institutional position. Namely, each year, each Justice accepts a defined number of clerks, virtually all of whom have served as a clerk for one of their lower court colleagues.[141]

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[139] For an extended discussion of these various "states of the world" as applied to the federal judiciary, see Katz, Stafford & Provins, *supra* note 12.

[140] *See* Aaron Clauset, Cosma Rohilla Shalizi, & M. E. J. Newman, *Power-Law Distributions in Empirical Data*, 51 SIAM REV. 661 (2009), *available at* http://arxiv.org/PS_cache/arxiv/pdf/0706/0706.1062v1.pdf. The authors define the Power Law, Exponential, and Log-Normal Distributions as generated by the following equations respectively $p(x) = \left[(\alpha - 1) x_{min}^{\alpha-1} \right] x^{-\alpha}$, $p(x) = \left[\lambda e^{\lambda x_{min}} \right] e^{-\lambda x}$,   and

$$p(x) = \sqrt{\frac{2}{\pi\sigma^2}} \left[erfc \left(\frac{\ln x_{min} - \mu}{\sqrt{2}\sigma} \right) \right]^{-1} \left[\frac{1}{x} \exp \frac{-(\ln x - \mu)^2}{2\sigma^2} \right]. \; Id. \text{ at } 665.$$

[141] In the period 1995–2004, we find that nearly 99% of the Supreme Court law clerks were drawn from lower courts. Professor W. William Hodes, law clerk to Justice Ginsburg during the 1996 term, represents a rare exception to this global trend. A former

Figure 5: The Highly Skewed Degree Distribution of the Judicial Social Network
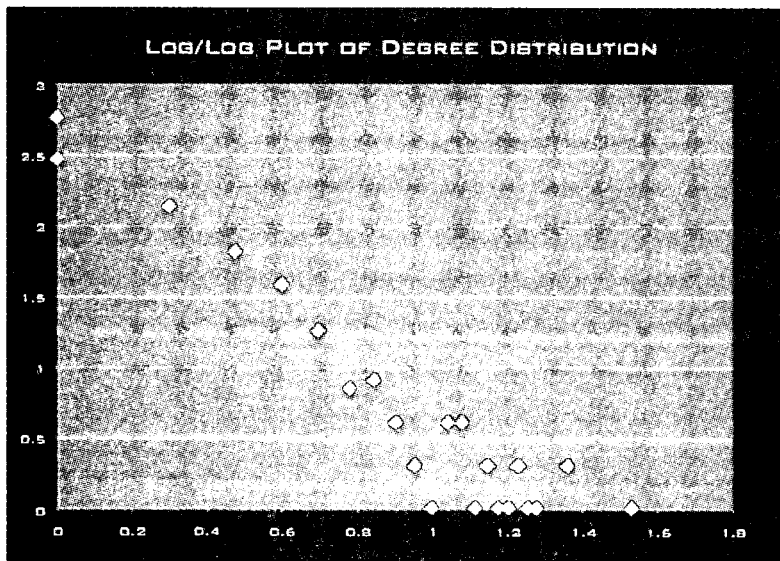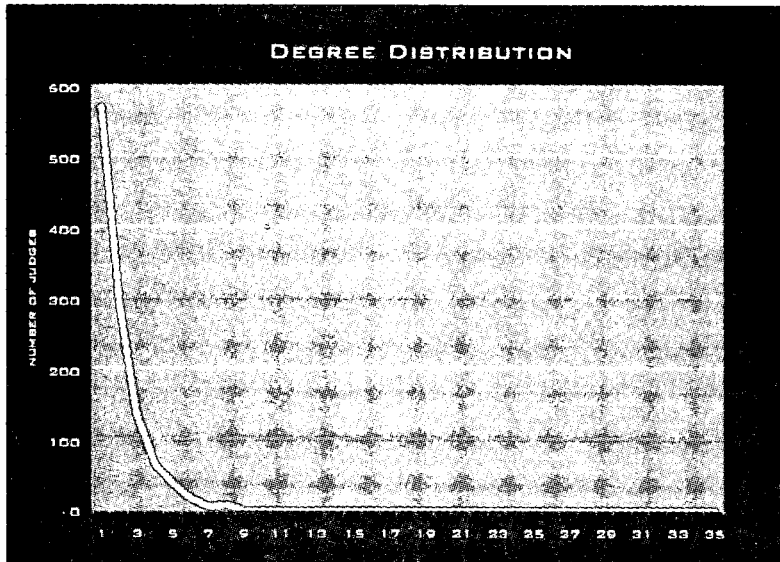
student of Justice Ginsburg from her tenure as a law professor at Rutgers, Mr. Hodes served as her law clerk without first serving for a lower court judge. Other exceptions include individuals such as Rachael L. Brand, who clerked for the Honorable Charles Fried of the Massachusetts Supreme Court prior to her service to Justice Kennedy, and Adam M. Samaha, who clerked for the Honorable Alexander Keith of the Minnesota Supreme Court prior to clerking for Justice Stevens.

Table 2 provides an alternative presentation of the degree skewing in the judicial social network.[142] We excluded the Supreme Court Justices from the analysis for previously stated reasons. Although the district and circuit partitions may be of individual interest, the aggregate frequency distribution provides the most useful information about the entirety of the interactions. For instance, the "aggregate" column exhibits a rapid decline of degree frequency over the first five classifications.

Table 2: Degree Distribution

% of Judges	District Judges	Circuit Judges	Aggregate
with Degree 0	57.43%	23.20%	**50.04%**
	(522)	(58)	**(580)**
with Degree 1	25.85%	21.60%	**24.16%**
	(235)	(54)	**(280)**
with Degree 2	9.90%	18.40%	**11.73%**
	(90)	(46)	**(136)**
with Degree 3	3.96%	11.60%	**5.61%**
	(36)	(29)	**(65)**
with Degree 4	1.87%	8.40%	**3.28%**
	(17)	(21)	**(38)**
with Degree 5	0.33%	6.00%	**1.56%**
	(3)	(15)	**(18)**
with Degree 6– 10 inclusively	0.55%	6.80%	**1.90%**
	(5)	(17)	**(22)**
with Degree greater than 10	0.11%	7.6%	**1.73%**
	(1)	(19)	**(20)**
Total	**909**	**250**	**1159**

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[142] *See* Clauset et al, *supra* note 140, at 661. These scholars observe that "the best we can typically do is to say that our observations are consistent with a model of the world in which x is drawn from a distribution of the form $p(x) = \alpha x^{-\alpha}$." Rather than definitively conclude the degree distribution mimics the power law distribution, we adopt a grounded approach, arguing the judicial social network is highly skewed.

While both Figure 5 and Table 1 offer an initial indication of the properties of the degree distribution, the use of maximum likelihood estimation (MLE) allows for differentiation between possible distributions.[143] Using MLE approach, the *alpha* for the judicial social network is {-2.38}, placing it in the traditional $2 < \alpha < 3$ interval for a power law. However, given the relatively small size of the network, it is not possible to conclusively assert that the distribution follows a power law as we cannot reject the possibility that it mimics an alternative type of highly skewed distribution.[144] Despite this shortcoming, the empirical evidence presented herein is consistent with prior scholarship describing and documenting the fractal nature of the American common law and its constitutive institutions.[145] Thus, we believe the extreme skewing of the judicial social network motivates the consideration of a generative process responsible for producing such inequality in social authority.

E. *Preferential Attachment as a Possible Generative Process?*

Most networks form, grow and change in relationship with their respective environments. Network creation is commonly referred to as a generative process. Given the dynamic nature of network formation and information flow, static network visualizations such as those offered herein represent a mere snapshot of a more dynamic landscape.[146] Although this dynamism complicates the identification of the process responsible for producing particular networks, there exist several common generative processes, each of which have characteristics that are observable in the snapshots of the network structures.[147] Namely, there are distinct micro-mechanisms that produce classic structures such as Erdos-Renyi random

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[143] *See* Clauset et al., *supra* note 140.

[144] For a history and description of a subset of possible distributions, see Michael Mitzenmacher, *A Brief History of Generative Models for Power Law and Lognormal Distributions*, 1 INTERNET MATHEMATICS 226 (2004).

[145] For the original invocation of the concepts of fractal geometry, see J. M. Balkin, *The Promise of Legal Semiotics*, 69 TEX. L. REV. 1831, 1835–36 (1991); J. M. Balkin, *The Crystalline Structure of Legal Thought*, 39 RUTGERS L. REV. 1 (1986). While Professor Balkin limits his analysis to the structure of legal argumentation, a growing set of empirical scholarship documents this fractal or crystalline nature of self-organization within legal systems. *See, e.g.*, Leicht et al., *supra* note 12; Post & Eisen, *supra* note 111; Smith, *supra* note 12.

[146] For more of an applied description of how those dynamics could influence common law development, see generally Katz, Stafford & Provins, *supra* note 12.

[147] *Id.*

graphs, small-world networks, highly clustered graphs, and scale-free networks grown through processes of preferential attachment.[148]

If our micro-level clerk movements reasonably operationalize social prestige, then the highly skewed degree distribution is substantively interesting because it helps identify the probable generating process responsible for producing the judicial social network. Given the skewing of the degree distribution and the aforementioned alpha level, we believe a process of preferential attachment analogous to the model outlined by physicists Barabási and Albert (BA) is a possible mechanism responsible for generating the judicial social network. Namely, graphs generated using the BA model display a particular type of extreme skewing similar to Figure 5.[149] The specific process described by Barabási and Albert yields a "scale-free" network whose degree distribution is power law distributed.[150]

In the BA model, the number of connections a node displays at a given moment is a function of the number the node possessed in earlier time periods.[151] Thus, the distribution of connections in a system organized under

[148] *Id.*

[149] For a simulation of a preferential attachment process written in Net Logo, see http://ccl.northwestern.edu/netlogo/models/PreferentialAttachment.

[150] Preferential attachment is exceedingly similar to a Yule-Simon process. For primary materials on Yule-Simon processes, see, for example, Herbert A. Simon, *On a Class of Skew Distribution Functions*, 42 BIOMETRIKA 425 (1955); George Udny Yule, *A Mathematical Theory of Evolution, Based on the Conclusions of Dr. J. C. Willis, F.R.S.*, 213 PHIL. TRANSACTIONS OF THE ROYAL SOC'Y OF LONDON 21 (1925). In a "rich get richer" Yule process the percentage of return an individual receives is positively related the quantity of money that person is able to invest. Thus, a system organized under such conditions is often described as extremely sensitive to its initial starting conditions as those with large initial endowments are able to extend their relative advantage over those at a lower initial starting investment. With respect to the federal judicial actors, it appears that social or professional influence may in part grow in this manner. Namely, individual agents who stochastically or strategically garner initial advantage in social standing appear able to extend that advantage in subsequent periods. In a manner similar to that depicted herein, a Yule process generates a relatively small number of agents occupying vastly disproportionate influence to their colleagues. As described in the literature, there are slight differences between the original Yule process and the BA preferential attachment model. However, as physicist Mark Newman explains, "the important point is that the Yule process is a plausible and general mechanism that can explain a number of the power-law distributions observed in nature and can produce a wide range of exponents to match the observations by suitable adjustments of the parameters. For . . . citations, city populations and personal income, it is now the most widely accepted theory." *See* M. E. J. Newman, *Power Laws, Pareto Distributions and Zipf's Law*, 46 CONTEMP. PHYSICS 323, 343 (2005).

[151] Consider the approach offered by Nadine Baumann and Sebastian Stiller, *Network Models*, *in* NETWORK ANALYSIS: METHODOLOGICAL FOUNDATIONS 341 (Ulrik Brandes & Thomas Erlebach eds., 2005). Namely, if (G_t^m) represents the history of some

such conditions is highly susceptible to its initial starting conditions. For example, consider a network that has only four nodes: A & B and C & D, where A is connected to B and C is connected to D. Next, assume node E enters the network and its probability of attachment to the AB community is equal to that of the CD community. The key to the model is the role of subsequent entrants such as node F, G, H, and beyond. As these later nodes enter the network, their probability of attachment is directly impacted by the community initially selected by node E.[152]

The precise conditions contained in the Barabási & Albert model are, of course, highly stylized.[153] One of the points of departure between the BA model and an empirical network, such as the judicial social network, is the interaction between motivations of actors and the institutions that govern the entrances and exits. Additionally, most social networks do not grow from initially random conditions. For instance, over the time period in question, the number of federal judges is roughly static and entry and exit from the network is fairly rare. As the network changes over time, agents enter and exit the network and connections form and dissolve. Additionally, when new jurists enter the network, it is unlikely they can directly connect to socially

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graph, whereby G is the structure of that graph at every point in time (t) when some vertex (v) is added to the graph with a given number of connections (m) to a vertex (i) in the set of all vertices (V) driven by a probability distribution based on the degree distribution of the graph at the previous point in time (t-1). (G_t^m) offers a state to state framework which can recursively define the sets and distributions of moments in time of a dynamic network. Following Baumann and Stiller, we can use to probabilistically classify the generative processes of network snapshots. *Id.* at 349.

[152] For further information on this generative process and the ubiquity of highly skewed networks see Albert-László Barabási & Eric Bonabeau, *Scale-Free Networks*, 288 SCI. AM. 60 (2003); Chavdar Dangalchev, *Generation Models for Scale-Free Networks*, 338 PHYSICA A 659 (2004); S. N. Dorogovtsev, J. F. F. Mendes, & A. N. Samukhin, *Structure of Growing Networks with Preferential Linking*, 85 PHYSICAL REV. LETTERS 4633 (2000); M. E. J. Newman, *The Structure and Function of Complex Networks*, 45 SOC'Y INDUS. & APPLIED MATHEMATICS REV. 167 (2003).

[153] Following its publication, several interesting extensions of the initial preferential attachment model have been offered. With respect to initial attractiveness, Buckley and Osthus assigned measures of attractiveness that increase or decrease the likelihood of a new connection. Initial attractiveness is a useful manner to operationalize the additional characteristics that may affect the likelihood of gathering connections. *See* Pierce G. Buckley & Deryk Osthus, *Popularity Based Random Graph Models Leading to a Scale-Free Degree Sequence*, 282 DISCRETE MATHEMATICS 53 (2004). Consider also the copying model where vertex (v) is selected and a clone of that vertex, (v'), is made. While v' initially possesses all of the connections held by vertex v, the model probabilistically rewires v'. The copying model and its extensions implement a rich-get-richer processes where explicit knowledge of degree is not required. *See, e.g.*, Jon M. Kleinberg et al., *The Web as a Graph: Measurements, Models, and Methods*, in 1627 LECTURE NOTES IN COMPUTER SCIENCE 1 (G. Goos et al. eds., 1999).

prominent actors. Thus, while it is rare to observe empirically a social system that meets the strict BA criteria, the model still offers insights that are useful for considering processes that generate highly skewed degree distributions.

On the key dimensions, there are significant similarities between the micro-level mechanism outlined in the BA model and the process that appears to generate the distribution of authority within judicial social network. Namely, the driving force generating the observed structure is the micro-motivations of the actors. In general, all else equal, both jurists and clerks are upwardly mobile and direct their efforts toward connections with socially prominent agents. The skewed degree distribution is an artifact of this effort. In sum, if social connections among federal judicial agents are generated through preferential attachment or some allied process, this implies social prestige is sensitive to initial conditions where jurists will tend to connect to the set of jurists who are already socially prominent. If those empirically modeled connections are professional relationships that connote substantive influence, this will produce a small number of jurists with substantive authority that dramatically exceeds their institutional position.

F. *Doctrinal Phase Transition . . . Is the Common Law a System Self-Organized at a Position of Criticality?*

While the use of our proxy measure and our static representation of the judicial social network limits our ability to formally adjudicate questions of growth and influence, the findings offered herein should motivate further empirical investigation—particularly analysis incorporating jurist citations and decisions. Among possible research questions, one worthy of detailed investigation is whether the American common law is a system self-organized at a position of criticality.

Self-organized criticality (SOC) has been linked to earthquake magnitude, the size of forest fires, turbulence in financial markets, and biological evolution. SOC describes a process whereby social and physical systems organize on the precipice of great change.[154] Such self-organization does not require an exogenous authority to structure the system. Instead, the structure that manifests is the emergent property of the local interactions between individual agents.

The sand pile model described in the work of the late physicist Per Bak offers one classic illustration of the phenomena.[155] Imagine randomly

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[154] *See* PER BAK, HOW NATURE WORKS: THE SCIENCE OF SELF-ORGANIZED CRITICALITY (1996); Per Bak et al., *Self-Organized Criticality: An Explanation of 1/f Noise*, 59 PHYSICAL REV. LETTERS, 381–84 (1987).

[155] PER BAK, *supra* note 154, at 52.

dropping grains of sand onto a flat surface.[156] Eventually, a pile will form which will start flat, but with time will grow steeper. At irregular intervals, avalanches of sand will flatten the base allowing the pile to grow again. In their work, Bak and colleagues kept track of the size of such avalanches and determined there was no typical or average size of an avalanche because the avalanche sizes followed a power law distribution.[157] Although the most frequent avalanches involved a single grain or two, the avalanche could also encompass thousands or tens of thousands of grains. Given such large avalanches were rare, significant numbers of computational trials were necessary in order to properly specify the underlying probability distribution.

Through these trials, certain informative trends became evident. The steeper the angle of the sand pile and the greater the amount of sand, the more likely a catastrophic avalanche would occur. To better illustrate the model, Bak and colleagues offered a contour plot where the pile was shaded according to steepness. As the angle increased the computer shaded the hill red to indicate a critical state. When the pile stood in some sort of equilibrium and thus was less likely to be subject to greater avalanches, the computer shaded the pile green. In general, the piles would begin green and then gradually shade red in advance of an avalanche. As the number of grains increased, so too would the number of red spots. If a grain were to fall on the green plateaus, the likelihood of a cataclysmic avalanche was small, but if that same grain were to fall near the bright red peak, an avalanche could spread to other peaks, flattening the entire pile.

The sand pile example is illuminating as the static, instantaneous representation of the model might indicate a system in equilibrium. However, time revealed a dynamic non-linear landscape—one that would eventually jettison anything that might be characterized as equilibrium—and exposed a system on the precipice of great change. Given that highly skewed system level characteristics tend to emerge in systems self-organized criticality, we pose the question of whether SOC represents a possible evolutionary model for the American common law and its constitutive institutions.

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[156] For a computational simulation see http://vlab.infotech.monash.edu.au/ simulations/non-linear/dendritic-growth/ (last visited Jan. 2, 2009).

[157] It is worth noting that subsequent scholarship has challenged the sand pile model, arguing only rice piles where rice demonstrates a large aspect ratio actually display SOC. *See* Vidar Frette et al., *Avalanche Dynamics in a Pile of Rice*, 379 NATURE 49, 49 (1996).

IV. FROM MICRO TO MACRO AND BACK AGAIN: PEER EFFECTS, EMERGENCE AND CONVERGENCE IN A FEDERAL JUDICIAL HIERARCHY

Whether the actors in the federal judiciary self-organize at positions of criticality or whether preferential attachment or some allied process is responsible for generating the distribution of social authority, the evidence of extreme skewing presented herein is consistent with a system in which "peer effects" are likely to influence substantive outcomes. Whether invoking illusions to fireflies, sand piles, or automobile traffic, the overall goal of this endeavor is to enrich existing theories of judicial decision making through a formal discussion of judicial "peer effects." While there are important properties drawn from each major judicial decision making theory, better understanding of the manner in which social factors structure the global outputs for the federal judicial hierarchy is arguably needed. As discussed in allied work, we believe "the manner which doctrine changes cannot be divorced from the manner of self-organization that judicial actors embrace. The micro-motives of federal jurists and the professional and social interactions between jurists, at least in part, help generate systemic changes in the common law."[158]

Judicial decision-making is decision-making in a hierarchy. Across all the actors and opinions, particularly those produced by lower courts, understanding why certain individuals and cases come to be privileged is a non-trivial enterprise. An important precursor to gaining leverage on "peer effects" is characterizing the social structure in which actors operate. Following on Judge Posner's discussion of "reputation," as well as other literature discussing prestige and influence, it is difficult to deny a role for social factors. Simply put, social factors "matter" and as such the federal judiciary is simultaneously marked by both emergence and convergence. Despite the widespread agreement, within the bounded range of legal discourse, there are still periods of non-linear change where the rise of new interpretative approaches is almost certainly supported by structurally important actors who champion a particular legal rule.[159] Table 1 *infra* offers a list of such structurally important actors as measured through different network statistics.

In all, despite the sorting issues associated with the law clerk market, we believe the traffic of law clerks provides significant insight into the relative clout of actors in the judicial hierarchy. While existing methods relying exclusively upon citation counts or subjective evaluations certainly furthered collective understanding about questions of social stature, these approaches did not bring complete closure to the debate. We recognize that this article

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[158] *See* Katz, Stafford & Provins, *supra* note 12, at 979.

[159] *See* Leicht, *supra* note 12.

also fails to completely adjudicate all open questions. However, it advances the literature by offering a graph-theoretic approach to formalize discussion of concepts such as social position and social structure.

A significant number of individual-level theories of judicial decision-making—including behavioral and strategic theories—purport to provide a complete view of judicial decision-making. Other scholarship, such as those offered by the historical institutionalists, emphasizes the Court's constitutive features and challenges strategic theories arguing that macro patterns of judicial decisions are inconsistent with observed macro-level judicial outputs. Our emphasis on judicial "peer effects" is an attempt to fill the void in these respective theories, arguing the existing social structure of the hierarchical federal judiciary in part explains how an existing set of individual micro-motives map to the aggregate macro-behavioral judicial outcomes.[160] Namely, while partisan policy preferences, strategic and other considerations are certainly important, so too are social factors. If judicial decision-making is in part socially constituted, then consider this an investigation of the relevant architecture. Scaffolding comes in a variety of flavors and different structures consequence outcomes in different manners. As such, we believe the public law literature should embrace a variety of complex systems based approaches including, but not limited to, network analysis.

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[160] *See* Schelling, *supra* note 17.

APPENDIX I: A SAMPLE FROM THE KATZ, STAFFORD & PROVINS LAW CLERK DATASET

Year	Clerk Name	Under-graduate	Law School	Judge Name	Judge ID
1995	Yoo, Christopher S.	Harvard	Northwestern	Randolph, A. Raymond	12109
1995	Metzger, Gillian E.	Yale	Columbia	Wald, Patricia M.	18260
2000	Van Houwelling, Molly S.	Michigan	Harvard	Boudin, Michael	22750
2000	Seinfeld, Gil	Harvard	Harvard	Calabresi, Guido	23155
2000	Stras, David	Kansas	Kansas	Luttig, J. Michael	22225
2002	Prescott, J. J.	Stanford	Harvard	Garland, Merrick B.	30168
1998	Tushnet, Rebecca L.	Harvard	Yale	Becker, Edward R.	590
1996	Gulati, Mitu	Chicago	Harvard	Alito, Samuel A.	127
1998	Zearfoss, Sarah	Bryn Mawr	Michigan	Ryan, James L.	13110
2000	Milani, Anup	Georgetown	Chicago	Williams, Stephen F.	20460

APPENDIX II: FROM A RING LATTICE TO AN ENERGIZED NETWORK

Given the number of nodes in the judicial social network, the applied graph theory literature is somewhat indifferent[161] as between the application of the Kamada-Kawai[162] or Fruchterman-Reingold[163] visualization algorithms. In Figures 1–4, we provided both a wide and close view of the network following the application of the respective algorithm. While there exist a number of nuanced distinctions between placement algorithms, the primary differences in their approaches lie in their calculation of the optimal distance for edge length, interpretation of Hooke's Law,[164] and the time iterations until the automated drawings cease.

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[161] *See* WOUTER DE NOOY, ANDREJ MRVAR & VLADIMIR BATAGELJ, EXPLORATORY SOCIAL NETWORK ANALYSIS WITH PAJEK 17 (2005) (discussing the proper application of competing graph visualization algorithms).

[162] *See* Kamada & Kawai, *supra* note 126, at 3–5. Kamada-Kawai define energy as follows:

$$E = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} 1/2 \, k_{i,j} \left(\left| p_i - p_j \right| - l_{ij} \right)^2$$ *where p_k is the position of vertex k, $l_{ij} = c \cdot d_{ij}$ is* proportional to the topological distance d_{ij} of vertex i and j. *Id.* at 3. Kamadi- Kawai uses a heuristic approach that individually selects vertices with the maximum gradient value of

$$\Delta_m = \sqrt{\left(\frac{\partial E}{\partial x_m} \right)^2 + \left(\frac{\partial E}{\partial y_m} \right)^2}$$. *Id.* at 5.

[163] *See* Fruchterman & Reingold, *supra* note 127. Fruchterman & Reingold use an alternative heuristic approach to force-directed layout. The basic idea is to just calculate the attractive and repulsive forces at each node independently and to update all nodes iteratively.

The Attractive Force is defined as: $f_a(x) = \frac{x^2}{k}$ where k is selected as $k = \sqrt{\frac{area}{|V|}}$.

The Repulsive Force is defined as: $f_r(x) = \frac{k^2}{x}$.

The maximum displacement for each node in a given iteration of the algorithm is limited through a constant. To account for the removal of nodes at each iteration, this constant is consistently decreased.

[164] Using Hooke's Law, a spring force can be approximated by $F_s = -k_s(len - len_0) = -k\Delta len$ where *len₀* is the length of the spring at rest.

Energizing Algorithm Drawing Stages
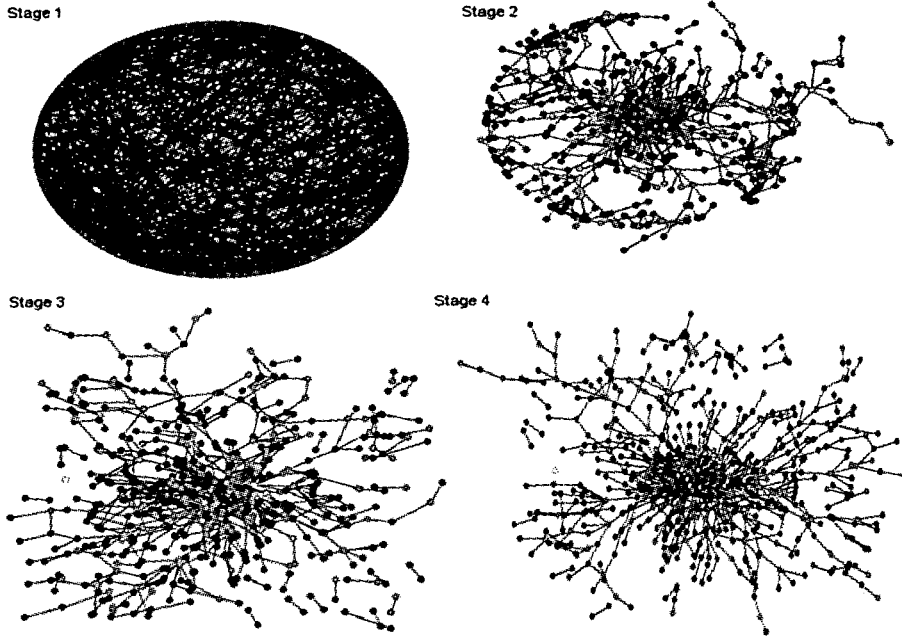
The above Kamada-Kawai visual is a useful depiction of how the energizing algorithms process the information contained in the adjacency matrix to produce the visual depiction of a network. Stage 1 reflects an initial representation of the information on a random circular ring lattice. Stage 2 represents the early stage of the Kamada-Kawai spreading algorithm where certain nodes are fixed based on their centrality. Additionally, nodes that are highly connected are pulled together while other less connected nodes begin to repel. Although the graph is in flux, a subset of the graph still maintains its initial circular structure. By Stage 3, the graph is no longer circular. However, the connections appear long and are thus strained according to Hooke's Law. In Stage 4, the graph has reached a degree of equilibrium as connection lengths are balanced between the forces that attract and repel.