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Research Article

How Networks of Social Cooperation Scale into Civilizations

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Abstract: This article analyzes structure and function in the network design of historical regimes of China and Western Europe to build a theory for the development of societies and states from endogenous mechanisms of social change. It shows how their respective network structures evolved independently but share a global property: both are small worlds, meaning that any node in the network can reach any other node by a small number of steps. Probing the variations in network topologies and their role in diffusion and scaling, the author accounts for differences in formal institutions, interpersonal trust, cultural norms, and moral protocols. Network structure as an independent variable moves the discussion of the divergence of East and West beyond the conventional, centralized China versus decentralized Europe debate. It allows us to identify an overlooked driver of structural change in the polity, helping to discern better what sets the development of world civilizations apart.

Keywords: political economy, networks, comparative development, Europe, China, structural transformation.

Introduction

For decades, the socioeconomic models that tested cooperation predicted that it would only endure in groups that developed social norms of commitment, trust, and reciprocity.[1] But as Mathew Jackson noted, and what still holds, those predictions invariably have drawn from models that address small groups of agents

[1] For an overview of this literature see Mark S. Granovetter, "The Impact of Social Structure on Economic Outcomes," *Journal of Economic Perspectives* 19, no. 1 (2005): 33-50, https://doi.org/10.1257/0895330053147958.

and ignore questions of how communities build networks into historical regimes with the capacity to create bonds extending beyond kinship and lineage.[2] How, for example, did the cultural and historical assemblages of Europe and China form and survive millennia? How did they become capable of coordinating complex, multilayered functions of leadership succession, property transfer, the mobilization of revenue and arms, and the development of codes of conduct and moral persuasion? The advent of agent modeling on a massive scale enables the range of the analysis to extend to large networks from which we can collect global information about structures, such as the existence of underlying small-world or scale-free characteristics.

Scholars who focus on questions of long-term cultural differences between China and the West offer rival explanations based on economic, geographic, demographic, institutional, or political interpretations, but one theme is consistent: China was centralized, and Europe decentralized.[3] In this article, I examine China and Europe's economic trajectories by exploring their respective network structures and information-sharing mechanisms. Discoveries in network science have shifted the focus of social network analysis from single-node centrality and small-graph connection mapping to consideration of the large-scale properties of the graph (the network structure) itself. Researchers can now study how network mechanisms enable system-level connectivity and the diffusion of innovation for large-scale cooperation – and how the systems themselves coevolve with the communities they support. As I search for the network mechanisms that allow

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[2] Matthew O. Jackson, *Social and Economic Networks* (Princeton: Princeton University Press, 2008).

[3] The conventional view that attributes Europe's dynamism to its decentralized interstate competition is argued in: Marc Bloch, *Feudal Society* (Chicago: The University of Chicago Press, 2014), 431; Avner Greif and Guido Tabellini, "The Clan and the Corporation: Sustaining Cooperation in China and Europe," *Journal of Comparative Economics* 45, no. 1 (February 2017): 1-35, https://doi.org/10.1016/j.jce.2016.12.003; David S. Landes, "Why Europe and the West? Why Not China?" *The Journal of Economic Perspectives* 20, no. 2 (Spring 2006): 3-22, https://doi.org/10.1257/jep.20.2.3; Nathan Rosenberg and L.E. Birdzell Jr., *How the West Grew Rich. The Economic Transformation of the Industrial World* (New York: Basic Books, 1986); Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (Oxford: Oxford University Press, 1990), https://doi.org/10.1093/acprof:oso/9780195074772.001.0001, 231; Chiu Yu Ko, Mark Koyama, and Tuan-Hwee Sng (2018). Other prominent scholars reliant on the competitive state system vs. unified imperium paradigm include Montesquieu (trans. 1900), Karl Marx, *Division of Labour and Mechanical Workshop: Tool and Machinery*, Economic Manuscripts of 1861-63 (New York: International Publishers, 1991); Max Weber, *General Economic History* (London: Allen & Unwin, 1927); Jared M. Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W.W. Norton, 2005); Geoffrey Parker, *The Military Revolution: Military Innovation and the Rise of the West 1500-1800* (Cambridge: Cambridge University Press, 1996); Geoffrey Parker, *The Cambridge Illustrated History of Warfare: The Triumph of the West* (Cambridge: Cambridge University Press, 2008); and Immanuel Wallerstein, "The Rise of State-System: Sovereign Nation-States, Colonies and the Interstate System," in *World-Systems Analysis*, ed. Immanuel Wallerstein (Duke University Press, 2004), 42-59.

individuals and communities to engage in large-scale cooperation, I also want to find sources in network structures that help explain the diffusion of innovation. In this way, I can explore not only the shared properties of China and Europe but also the varieties of social organization that shaped their respective "innovation cultures" and permitted them to construct networks of scale to solve problems of social cooperation.[4]

A critical element of cooperation and diffusion of innovation in any network is the connectivity from one community to another. It is easy to see how modern information technologies link to the dynamics of interdependence within and among nations. Information sharing is everywhere around us. Yet, in many sparsely governed premodern polities, it was also possible for beliefs and institutions representing a unity of the collective to be woven together. Diffusion mechanisms also permitted the long-lived historical regimes in Europe and China to scale from their original tribal/village networks into broader communities, kingdoms, states, nations, and ultimately civilizations.[5]

The author proposes that long-enduring civilizations, states, and societies are of a universal class of systems whose network structures comprise many differing patterns of intersections but which share a global property: their ability to connect the parts—the hamlets, villages, and townships—and coordinate activities among them, no matter how remote or sparsely administered, through information-sharing networks that allow a collective memory and sense of common purpose. They are giant webs of communication in which, at some fundamental level, every node processes information from the other nodes that form the system. I turn to network science to explore how this information sharing came about in the absence of modern communication technologies.[6]

Western Europe and China's network structures, or topologies, evolved independently, yet as small-world networks, any node can reach any other node in the network in a small number of steps. Their small-world connectivity itself shares another property: in both, connectivity was historically embodied in a system of rule by hereditary kingship. As I examine differences in the two network

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[4] Complex networks are explored in Fernando Vega-Redondo, *Complex Social Networks*, Econometric Society Monographs, Series Number 44 (New York: Cambridge University Press, 2007); Mark E.J. Newman, "The Structure and Function of Complex Networks," *SIAM Review* 45, no. 2 (2003): 167-256, https://doi.org/10.1137/S003614450342480; and Mark Newman, Albert-László Barabási, and Duncan J. Watts, *The Structure and Dynamics of Networks*, Princeton Studies in Complexity (Princeton: Princeton University Press, 2006).

[5] Both early Europe and China sustained complex state-based social capacity that far exceeded the longevity of the Mongol, Ottoman, or Mughal empires found in the center of Eurasia.

[6] Information technologies link to broader national interest and international standing in contemporary political economy in *The Uses and Abuses of Weaponized Interdependence* (Daniel W. Drezner, Henry Farrell, and Abraham L. Newman, eds., *The Uses and Abuses of Weaponized Interdependence* (Washington DC: Brookings Institution Press, 2021).

structures, we will see how the diffusion of information within them afforded different advantages to each.

In Section 1, the author will explore how durable small-world networks come into being, their evolutionary convergence, and why they hold advantages for augmenting cooperation beyond the affinities of kinship and lineage. This section describes how societal structures network into complexity and includes descriptions and specific definitions of small and large worlds, concluding with a discussion of the role small-world connectivity plays in the formation of long-lived historical regimes. Section 2 addresses the system-level structures in the West and China and includes the role played by bridge nodes. The following two sections employ historical analogizing to discuss specific social institutions that support connectivity: Section 3 discusses an institution that China and the West shared, hereditary succession, and Section 4 examines institutional differences, such as religion, as well as social mobility, elite recruitment, and local governance. Section 5 explores how these network structures can also account for differing innovation systems, with inferences for the different economic structures of the two regimes. Section 6 discusses the network sources of interpersonal social trust and the embeddedness of cultural norms. The conclusion speculates on how longstanding differences in their network topologies may continue to shape the evolution of these two societies, taking into particular consideration the fact that China lacks any historical parallel to the trust-building networks and institutions that were fundamental to Western Europe's development.

Connectivity: How System Topology Enables Communities to "Network" into Complexity

The original human communities were small-scale networks built on kinship and tribal affiliation. This homophily—the tendency to associate only with similar people—enabled them to survive.[7] Most ethnographic descriptions of early human settlements generalize that when homophily is prevalent, there also arise distinct traditions, e.g., particular gods, laws, and cultural norms. For example, some societies emphasize status by descent, while others emphasize achievement. Without shared beliefs, moral codes, or rules, the communities refrain from large-scale cooperation. Many primitive societies also maintained highly impermeable internal barriers that reinforced the stratification of members, further resulting in the disconnectedness of the whole.[8]

Yet homophily also made the greater system they inhabited a "large world," a theoretical term reflecting the reality that communications and interactions

[7] Miller McPherson, Lynn Smith-Lovin, and James M. Cook, "Birds of a Feather: Homophily in Social Networks," *Annual Review of Sociology* 27 (2001): 415-444, https://doi.org/10.1146/annurev.soc.27.1.415.

[8] Kent Flannery and Joyce Marcus, *The Creation of Inequality: How Our Prehistoric Ancestors Set the Stage for Monarchy, Slavery, and Empire* (Cambridge: Harvard University Press, 2012); Hilton L. Root, *Network Origins of the Global Economy: East vs. West in a Complex Systems Perspective* (Cambridge University Press, 2020), 115-119.

were primarily local and isolated. When depicted on a graph, a large-world network exhibits a high clustering coefficient but low network connectivity.[9,10] Thus, a large-world network can be made up of nodes that cluster in sizable groupings, but each node will link to only a few nearby nodes, and communities (nodes) do not link to one another. There are no long paths to reduce distances between various nodes within this highly decentralized structure.

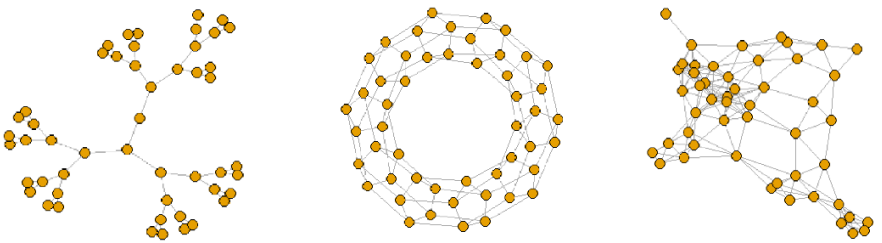

Figure 1: Three Diagrams of Large-world Networks.
These are highly decentralized systems with dense local connectivity; many steps will be necessary to move information across the system, creating a long average path length.

Where there are no long paths, there is a *long average path length*, another system-level property of large worlds. Path length is not a measure of length per se, but of efficiency. It determines how rapidly and through what channels information is distributed across the wider network. In a large world, information passes along short paths, from one node to the next and then to the next. Transmission across the entire system may require thousands of interactions between individual nodes—ergo, a long path length from any start point A to endpoint B—making diffusion costly, time-consuming, and prone to disruption and distortion. For this reason, the large world can support only limited communication, most of which stays local, and change is confined within the community where it first occurs; there was little systemic change, and what occurred would have been minuscule. Early communities were tightly clustered groups with few overlapping transactions or ties, and generated few advances in the technical or sociological environment. Evidently, being decentralized is an insufficient precondition to solve fundamental dilemmas of social coordination.

[9] The links of small-scale networks usually show a relatively even distribution to each other and aggregate into something that resembles the network of streets or subway stations in a city, roads in the countryside, or pixels in a digital image. A network of airline flights, by contrast, is small world in that it features many connected hubs that shorten paths and improve system-wide coordination.

[10] Thomas Michelitsch et al., *Fractional Dynamics on Networks and Lattices* (Wiley, 2019), https://doi.org/10.1002/9781119608165.

It was Granovetter[11] who introduced the importance "weak" ties might play because of their embedded links in social networks, and Watts and Strogatz,[12] who solved the puzzle of how to overcome local clustering constraints to enable information diffusion across a wider network. Their conceptual breakthrough, the creation of a ring model, shows how a large-world network can display both numerous local clusters, which they term its *high clustering coefficient*, and *short* average path lengths between clusters – and thus transform itself into a small-world network. They did this by adding a few random long links to bridge the circle.[13] It takes just a few such bridges between large clusters to facilitate information flow and help spread information from any part of the network to other parts of the network.[14,15] Introducing long paths into separate clusters, or communities, can dramatically reduce the "degrees of separation" of the population

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[11] Mark S. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology* 78, no. 6 (1973): 1360-80, www.jstor.org/stable/2776392.

[12] Duncan J. Watts and Steven H. Strogatz, "Collective Dynamics of 'Small-World' Networks," *Nature* 393 (6684) (1998): 440-42, https://doi.org/10.1038/30918.

[13] The idea of "six degrees of separation," memorialized on Broadway in the 1990s, is a small-world phenomenon common to social networks. Long before the idea became popularized, Traverse and Milgram showed that the modern communications infrastructure could be modeled as a "small world" (Jeffrey Travers and Stanley Milgram, "An Experimental Study of the Small World Problem," *Sociometry* 32, no. 4 (December 1969): 425-43). The model assumes first-world technology. We are concerned with the communication infrastructure before electrical circuitry or steamships.

[14] Albert-László Barabási, *Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life* (New York: Penguin Group, 2003); Duncan J. Watts, "The 'New' Science of Networks," *Annual Review of Sociology* 30 (2004): 243-70, https://doi.org/10.1146/annurev.soc.30.020404.104342.

[15] Centola and Macy model generative mechanisms that diffuse complex contagions along complex social topologies (Damon Centola and Michael Macy, "Complex Contagions and the Weakness of Long Ties," *American Journal of Sociology* 113, no. 3 (November 2007): 702-34, https://doi.org/10.1086/521848). Related work in computer science (Jon M. Kleinberg, "Navigation in a Small World," *Nature* 406, no. 6798 (2000): 845, https://doi.org/10.1038/35022643), epidemiology (M. J. Keeling, "The Effects of Local Spatial Structure on Epidemiological Invasions," *Proceedings of the Royal Society B Biological Sciences* 266, no. 1421 (1999): 859-867, https://doi.org/10.1098/rspb.1999.0716); and physics (Mark E.J. Newman, S.H. Strogatz, and Duncan J. Watts, "Random Graphs with Arbitrary Degree Distributions and Their Applications," *Physical Review E* 64 (2001): 026118, https://doi.org/10.1103/PhysRevE.64.026118) all reveal how randomly placed long-distance links can influence social diffusion processes. Structural properties affect communication as shown by Albert, Jeong, and Barabási (Réka Albert, Hawoong Jeong, and Albert-László Barabási, "Internet: Diameter of the World-Wide Web," *Nature* 401, no. 6749 (1999): 130-31) and Dodds, Muhamad, and Watts (Peter Sheridan Dodds, Roby Muhamad, and Duncan J. Watts, "An Experimental Study of Search in Global Social Networks," *Science* 301 (5634) (September 2003): 827-29, https://doi.org/10.1126/science.1081058). Influence dynamics across virtual networks are discussed in Backstrom et al. (Lars Backstrom et al., "Group Formation in Large Social Networks: Membership, Growth, and Evolution," In KDD'06: Proceedings of the 12th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, August 20-23, 2006, Philadelphia, Pennsylvania, USA, https://www.cs.

and thereby increase the speed of information diffusion across the greater network.[16]

When even a few pivotal hubs can act as bridge nodes, the long links they enable will shorten the average path length so that information can "bridge" distance and diffuse quickly. A large world becomes small when any node can reach other nodes via links and intermediate nodes. Bridges that shorten the average path length enable small worlds to form. The importance of this small-world connectivity in social organization and regime formation derives from its capacity to spread information while minimizing the number of links required to do so. The more numerous the *long* links, the more innovation can diffuse across the wider network. In this sense, states, nations, and civilizations are all different representations of a network with a small-world topology.

The historical patterns of connectivity often form macroscopic patterns of unintended order whose logic lies outside the intentions and precognition of the individual agents. Although human action is purposeful, and individuals do not make social ties at random, the actions of many can produce coherent wholes that serve important purposes without having been designed for that end.

The System-Level Structure of Social Relations in Europe and China

Watts and Strogatz[17] show that a ring network transforms from a large world into a small-world network by adding a few random links to a regular network. The key to using their analysis for understanding the course of regime growth is to identify the pivotal bridge nodes or path shorteners and what they represent, the particularistic forms they may take, and the mechanisms that explain their growth.[18] In the historical regimes of both China and Europe, the royal houses, secured as they were by accepted customs and rules, were the primary system spanning bridges. I map the network structure of the European leadership hierarchy and, with historical analogizing, compare it with that of China.

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cornell.edu/~lars/kdd06-comm.pdf, 44-54) and Centola (Damon Centola, "The Spread of Behavior in an Online Social Network Experiment," *Science* 329 (5996) (2010): 1194-97, https://doi.org/10.1126/science.1185231; Damon Centola, "An Experimental Study of Homophily in the Adoption of Health Behavior," *Science* 334 (6060) (2011): 1269-72, https://doi.org/10.1126/science.1207055). Node distance is compared to the size of the network in Mitleton-Kelly, Paraskevas, and Day (Eve Mitleton-Kelly, Alexandros Paraskevas, and Christopher Day, eds., *Handbook of Research Methods in Complexity Science* (London: Edward Elgar, 2018), https://www.e-elgar.com/shop/usd/handbook-of-research-methods-in-complexity-science-9781785364419.html, 413).

[16] Centola and Macy, "Complex Contagions and the Weakness of Long Ties."

[17] Watts and Strogatz, "Collective Dynamics of 'Small-World' Networks."

[18] Peter Hedström and Richard Swedberg, eds., *Social Mechanisms: An Analytical Approach to Social Theory* (Cambridge University Press, 1998), https://doi.org/10.1017/CBO9780511663901; Peter Hedström, *Dissecting the Social: On the Principles of Analytical Sociology* (Cambridge University Press, 2005), https://doi.org/10.1017/CBO9780511488801.

Figure 2.1 is a composite representation of European dynastic marriages from the fourteenth through the twentieth centuries. The network exhibits mixed features of small-world and scale-free networks. It has a highly skewed degree distribution, with a few large hubs, prevalent in scale-free models, though it is not a perfect power law distribution (Figure 2.2). It also exhibits small-world characteristics because it has an average shortest path length comparable to random networks but with a much higher clustering coefficient. In the network, communication channels to larger nodes or hubs are highly skewed, with a few highly connected hubs linking the smaller nodes with one another. Identifying these critical properties of the network helps explain why describing Europe solely in terms of decentralization gives short shrift to the patterns of hub-based communication that enabled lateral transmission across the network. We hope to better visualize how the connectivity of periphery nodes to the core nodes follows discreet patterns that produce cohesion throughout the entire network.

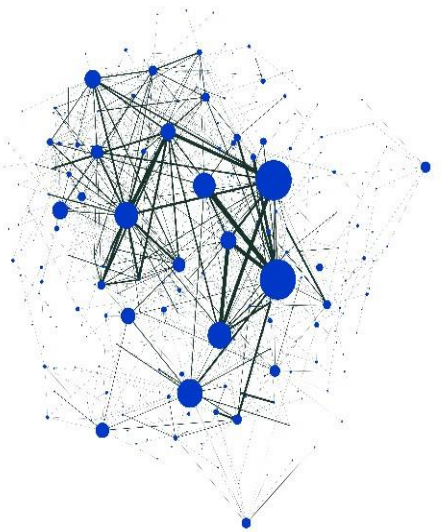

Figure 2.1: The Marriage Network between European Royal Houses from the Fourteenth through the Twentieth Centuries.
An edge is established when there is a marriage between two royal houses. The thickness of the edges represents the number of marriages between two royal houses (ranging from 1 to 92). The size of a node represents its degree, the number of houses with which it has a marriage relationship (ranging from 0 to 41). The network includes 239 nodes and 622 edges, excluding self-loops (marriages among members in the same house). The nodes also include nobility, popes, bishops, and electors. Bishops and popes were expected to be celibate, but some had children for the express purpose of establishing alliances, and these were included. The marriage network resembles a small-world network. Using Python, 100 random networks with the same number of nodes and edges are generated, and the clustering coefficient and the average shortest path are calculated for each simulated network. The European network has the average shortest path length of 3.3857, comparable to that of a random network of 3.4844, but with a much higher clustering coefficient of 0.2010 in comparison with 0.0218 of a random network.

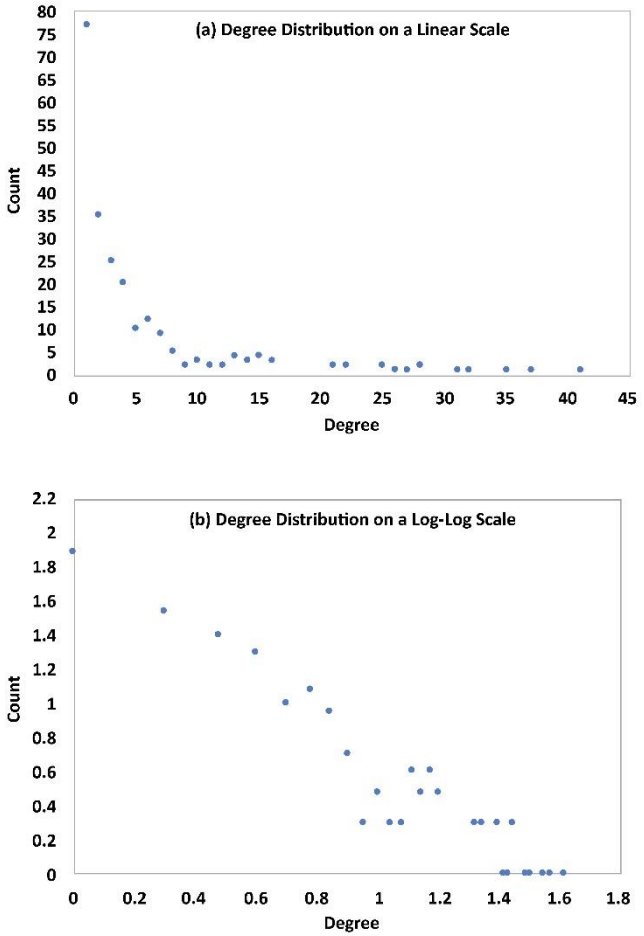

Figure 2.2: The Degree Distribution of the European Marriage Network between Royal Houses (a) on a Linear Scale, and (b) on a Log-Log Scale
The marriage network resembles a scale-free network to some degree. A scale-free network is, strictly speaking, supposed to have a highly skewed degree distribution with a long tail, following a power law distribution that is expected to be linear on a log-log scale.

Motives that Influence the Formation of Ties in Royal Networks

Distributed across Western Europe, the continent's numerous royal houses built out macro linkages in a polycentric institutional context that relied on persuasion and alliance building to solve problems of collective action.[19] This kind of *distributed network* actually gains stability by adding new nodes. Some of the nodes will

[19] Elinor Ostrom, *Understanding Institutional Diversity* (Princeton University Press, 2005).

remain random, "lonely outposts," so to speak. Some will themselves become hubs that attract numerous links throughout the system and play a critical role in its resilience. The hubs continuously change their relative importance in the system, and as each seeks advantage by attracting new nodes, system-level dynamism is amplified. To thrive, a royal lineage would have to become adept at harnessing local clustering to its advantage. Kings required the skill to assemble a patchwork of multiple jurisdictions with pledges to protect administrative, fiscal, legal, and linguistic liberties from challengers. This way of attracting potentially useful allies preserved subsidiary connectivity and a diversity of local economic contexts. Throughout medieval and early-modern European history, this process was at work, creating political boundaries and cultural identities. An unintended consequence was that as one connected cluster vied for dominance over another, innovation thrived; without the connectivity, there would not have been the same dynamism within the system.

When hubs and their accumulated nodes, i.e., communities with similar interests or functions, form subsystems without dissolving the underlying structure, this can trigger coevolutionary change. In Europe, networks bridging political and culturally disparate regions grew, enabling scientific, cultural, and technological innovation to spread across the continent. Intermittent, episodic rewiring did not fundamentally alter the defining properties of the network of international royal houses, and the network's durability enabled economic and legal change to occur within a common European context.

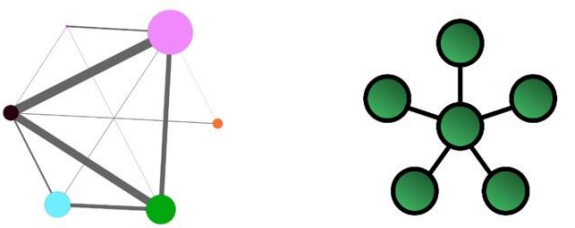

Figure 2.3: Contrasting Structure of Core-Periphery Connectivity of European and Chinese Royal Networks.
Western Europe (a) evolved into a distributed network with some nodes growing into hubs as they attracted more connections. Simplified relationships between power clusters. The node size represents betweenness centrality, or how often a given node falls along the shortest path between any two other nodes. Line thickness is proportional to the number of marriages between two houses. China's network structure (b) resembles a star, with the emperor and court at the center controlling whether or not to share information originating from other hubs. The core-periphery structure is elaborated in more detail in the text via historical analogizing, contrasting the idealized model above with observations of network behavior from historical sources.

In China, the emperor was the central hub of a *star-shaped network*, and he alone had linkages with all other nodes. His power derived from conquest rather than alliances, giving him enhanced discretion over the network's subsequent growth processes by means of that hub-and-spoke connectivity with the periphery.[20] The throne was supported by the state system of Confucian officialdom, the mandarinate, which was recruited by a civil service examination system and made important official appointments, managed systemwide feedback, and transported information from one point to the next across the far-flung empire. This network structure reduces redundancies and retains resources. So, the central node can guide network growth in accordance with principles that enhance its supervision over the nodes. Its efficient top-down distribution allows rapid diffusion of approved innovations. System stability relies upon the capacity of the imperial court to perform nationwide tasks of public administration, defend its commanding position in relation to local leadership, constrain the formation of rival elites that might challenge the center, and establish regime boundaries.

Dynasty after dynasty of Chinese monarchs relied on the same recruitment, indoctrination, and examination system as a means to control the flow of ideas and preserve authority.[21] When a dynasty collapsed by war or internal corruption, the new dynasty reinstituted the examination system so that it, too, would have information brokers who spanned the empire. The network approach helps us to understand better how this civil service system contributed to the stability of imperial rule. Knowledge of small-world topology, and the reciprocal influence and coevolution of individual action and network structure, will help us infer how historical institutions are woven into the structure and to identify clues to the course of their evolution.[22]

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[20] During certain periods, the China's political unification faced challenges similar to the European experience. Just as royal administrations in Europe had to battle with the aspirations of regional elites, Chinese elites held views about centralization that were at odds with those of imperial administrators. This was especially true, economic historian Eric Jones points out, during the 9th through 13th century, when innovation in China flourished due to a sociopolitical likeness with Europe. Jones attributes this flourishing to the competition of multiple sources of institutional legitimacy that were eventually eliminated by the process of Imperial unification (Eric L. Jones, *The European Miracle: Environments, Economies and Geopolitics in the History of Europe and Asia* (Cambridge, UK: Cambridge University Press, 1981).

[21] Frederic Wakeman Jr., *The Great Enterprise: The Manchu Reconstruction of Imperial Order in Seventeenth-Century China*, Vol. 1 (Berkeley, CA: University of California Press, 1986).

[22] Individual actions and network structure coevolve in a dynamic process of reciprocal influence – see Stefano Tasselli, Martin Kilduff, and Jochen I. Menges, "The Microfoundations of Organizational Social Networks: A Review and an Agenda for Future Research," *Journal of Management* 41, no. 5 (2015): 1361-87, https://doi.org/10.1177/0149206315573996.

Shared Institutions in China and the West: Hereditary Succession and Primogeniture

Of note, in both China's star-shaped and Europe's more distributed network structure, there arose institutional synchronicity: hereditary lordship. In both regions, monarchs acquired the right to bequeath their status and privileges to their children, usually via primogeniture. This sets both systems apart from other known historical meta-regimes, such as the Roman, Ottoman, or Mughal empires, which failed to codify the rules for dynastic succession.[23] In regions that did not solve succession, disputes among distant relatives were more likely to end in conflict, either civil war or invasion by a rival power. In Rome, for example, while there was a general inheritance to male heirs, emperors typically chose a successor, usually a family member, sometimes an adopted heir – and the symbolic consent of the Senate and the generals was a critical factor. Neither an emperor nor his heir acquired an intrinsic "right" to rule, opening the door to contestation.[24]

In Europe, predominant *nonroyal* social networks were also based on hereditary privilege. In China, the governing elite was selected in a recruitment system that emphasized individual achievement and, as a consequence, was more favorable to social mobility. This promotion of achievement-based bureaucracy might seem ironic if we consider that Europe developed democracy sooner. But the irony dissipates when we take into account David Bien's explorations of Old Regime France,[25] in which he found that democracy first developed within the privileged orders and then spread to the broader society.[26] Consistent with Bien's reasoning, this analysis substantiates that democratic pluralism originated in Europe's aristocratic corps and spread out over time to subsidiary systems within the larger decentralized whole. It sprang from the interplay of many competing monarchies and their ties to a subsystem of relatively autonomous aristocratic retainers, each seeking some form of collective representation in the decisions that concern the whole.

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[23] While imperial rule has a 4000-year history in China, the successful usurpation from inside ended after the Sung dynasty (960-1279). From that point onward, clear rules for dynastic succession were adhered to and dynastic cycles were generally the result of external conquest.

[24] Keith Hopkins, "The Political Economy of the Roman Empire," in *The Dynamics of Ancient Empires: State Power from Assyria to Byzantium*, ed. Ian Morris and Walter Scheidel Morris (Oxford: Oxford University Press, 2009), 178-204.

[25] Rafe Blaufarb, Michael S. Christofferson, and Darrin M. McMahon, eds., *Interpreting the Ancien Régime: David Bien* (Oxford: Voltaire Foundation, 2014).

[26] Noble privilege and state modernization often went hand in hand (David Bien, "Offices, Corps, and a System of State Credit: The Uses of Privilege under the Ancient Regime," in *The French Revolution and the Creation of Modern Political Culture: The Political Culture of the Old Regime*, Vol. 1, ed. Keith Michael Baker et al. (Oxford: Pergamon Press, 1987), 89-115). Bien argues that the struggle for democracy and participation occurs within state institutions and is not only a contest of state versus society. See also Blaufarb, Christofferson, and McMahon, eds., *Interpreting the Ancien Régime*.

In both China and Western Europe, lordship succession was usually via agnatic, or patrilineal, primogeniture. In Europe, primogeniture stabilized the feudal system and facilitated its spread during the eleventh century from the polities of the former Carolingian empire, then eastward in the twelfth and thirteenth centuries.[27] Shielding the estates of feudal lords from fragmentation, the primogeniture system bolstered their ability to fulfill their military obligation to the king. But this geopolitical security came at the price of perpetuating the wealth, power, and social standing of noble lineages.[28] It also made state building and capacity dependent upon the cooperation of noble families, enabling their rights to be memorialized in constitutional settlements that constrained the scope of royal discretion. Democracy sprang from these compacts between elites and rulers. In China, such families were more likely to be viewed as potential threats to the particular imperial line. There was no institutionalization of formal consultative procedures, although there were treatises on morality and ethics like the *Ancestral Injunctions* (1375) that served for the Ming Dynasty, but these are not constitutions.[29]

Nevertheless, hereditary lordship did not eliminate every category of disputed succession for Europe's feudal rulers. The Church had its own rules and did not tolerate divorce or concubinage or recognize illegitimate offspring. This made

[27] Over the course of medieval history, the former regions of the Carolingian Empire, including Aragon, Austria, Bavaria, the Duchy of Milan, Florence, France, Navarre, and Prussia, adopted primogeniture.

[28] The Western Church also recognized nonroyal primogeniture, thereby strengthening these elite lineages. In *An Inquiry into the Nature and Causes of the Wealth of Nations*, Adam Smith explains the political economy logic of primogeniture: "When land was considered as the means, not of subsistence merely, but of power and protection, it was thought better that it should descend undivided to one. In those disorderly times, every great landlord was a sort of petty prince. His tenants were his subjects. He was their judge, and in some respects their legislator in peace and their leader in war. He made war according to his own discretion, frequently against his neighbors, and sometimes against his sovereign. The security of a landed estate, therefore, the protection which its owner could afford to those who dwelt on it, depended upon its greatness. To divide it was to ruin it, and to expose every part of it to be oppressed and swallowed up by the incursions of its neighbors." (Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*, ed. Edwin Cannan (London: Methuen & Co., 1904), 306).

[29] Designating clear lines of dynastic succession became an essential contribution to the formation of durable regimes and therefore to the scaling up of social complexity. In Kokkonen and Sundell, primogeniture is more stable than alternative succession arrangements in a sample of contemporary authoritarian regimes (Andrej Kokkonen and Anders Sundell, "Delivering Stability – Primogeniture and Autocratic Survival in European Monarchies 1000-1800," *American Political Science Review* 108, no. 2 (April 2014): 438-53, http://dx.doi.org/10.1017/s000305541400015x). The introduction of automatic hereditary succession in an autocracy limits the number of coups conducted by challenger. See Peter Kurrild-Klitgaard, "Autocratic Succession," in *The Encyclopedia of Public Choice* (Boston, MA: Springer, 2004), 358-62, https://doi.org/10.1007/978-0-306-47828-4_39.

royal lineages vulnerable if there was no male heir, creating a category of contention—female-line heirs with competing claims—that triggered frequent succession disputes and wars.[30]

Yet, for reasons we are about to explore, European succession conflicts were generally localized without threat to the stability of the system of intermarried royal lineages that crisscrossed the continent at large.[31] In many instances, disputes resulted in alliances between the lineages that had advanced rival claims to the unoccupied throne. Even when failure to produce an heir resulted in the extinction of an entire lineage, connectivity among the remaining royal houses would simply reroute, enabling macro-level continuity of the system.

When an imperial dynasty collapsed in China, it was usually not for lack of a male heir. Emperors could amass extensive harems to breed male successors. Concubinage contributed to intermediate regime durability, reducing the danger of a succession crisis.[32] What is commonly referred to as the "dynastic cycle" would more often reassert itself when military victory swept out one dynastic line and ushered in another via rebellion or conquest. And because the peripheral nodes connected primarily through a centrally positioned hub, they too collapsed, making the repercussions far more devastating and widespread.[33] There are two key points here: Crises of dynastic succession were less frequent in China, which enabled stability and prosperity over a large territory and longer periods. On the other hand, Europe's succession conflicts, although more frequent, were more localized and had a less dramatic effect on regime stability or on continent-

[30] A smooth leadership transition reduces conflicts that place existing institutional and social balance at risk with harmful effects on economic development. See Avidit Acharya and Alexander Lee, "Path Dependence in European Development: Medieval Politics, Conflict, and State Building," *Comparative Political Studies* 52, no. 13-14 (2019): 2171-2206, https://doi.org/10.1177/0010414019830716. The Norman kingdom of Italy owes its decline to an inability to produce male heirs. The Hundred Years War (1337-1453) between England and France was precipitated by a dispute over female inheritance. Most succession conflicts were generally short affairs until the Wars of Religion (1562-98), which ruptured the Church and raised the stakes of obtaining the throne, adding another dimension to the quest for power since it gave royals more control over the appointment of bishops within their jurisdiction, as well as greater sway over confessional matters.

[31] Royal families connected by living ties were less likely to fight wars. See Seth G. Benzell and Kevin Cooke, "A Network of Thrones: Kinship and Conflict in Europe, 1495-1918," *American Economic Journal: Applied Economics* 13, no. 3 (July 2021): 102-33, https://doi.org/10.1257/app.20180521.

[32] The longevity of Chinese rulers exceeded that of their European counterparts, providing stability and prosperity over a large territory. See Yuhua Wang, "Sons and Lovers: Political Stability in China and Europe before the Great Divergence," *SSRN Electronic Journal* (October 2018), http://dx.doi.org/10.2139/ssrn.3058065.

[33] Albert-László Barabási, Réka Albert, and Hawoong Jeong, "Scale-Free Characteristics of Random Networks: The Topology of the World-Wide Web," *Physica A: Statistical Mechanics and Its Applications* 281, no. 1-4 (2000): 69-77, https://doi.org/10.1016/S0378-4371(00)00018-2.

wide demographic or economic trends. I revisit the long-term dynamical effects of this network property in Section 5.

The Western Church, Confucian Ethics, and the Network Dynamics of Social Change

This section is concerned with the bridge nodes that accelerate the spread of beliefs and behaviors that form notions of shared identity and common destiny. While religion played an important system-preserving and boundary-spanning role in both China and Europe, reducing the degrees of separation among socially, geographically, and culturally distant groups, it was also the source of different conceptions of political and social order that were to bear fruit over successive centuries. In terms of network structure in Europe, religion, i.e., the Roman Catholic Church, gained an institutional foothold as an independent hub in the continent's distributed network. It coevolved with other nodes, also exhibiting highly skewed degree distributions, similar to the interconnected royal families, eventually becoming a powerful force with which even the mightiest had to reckon. The span of the Church's far-reaching authority and responsibilities reached from the highest centers of power, where priests were confessors to royalty, to the local parishes, where country friars mingled with the peasantry. From the early Middle Ages, the legitimation of dynastic lordship by divine right required kings to receive holy anointment, and the Roman Catholic Church came to play a major role in the evolution of the European state system.[34] Although a symbiotic relationship was of benefit to both religious and secular leadership, both sides continually jockeyed to get the better of the other. As conditions fluctuated, their mutualistic relationship was held together by a shared interest in grounding the population's overarching unity upon a common faith and a desire by each lineage to avoid being compressed into a network dominated by a single lineage. Thus both lay and clerical state actors accepted and benefitted from the symbiosis of their long-term relationship.

As an institution, the Western Church enjoyed relative autonomy in recruiting its officials and running its courts and parishes according to its own procedures. During the High Middle Ages (1000-1250), "[t]he lay power might draw its authority from God, but only in subordination to the sacerdotal power embodied in its head, the Pope, the successor of St. Peter."[35] Secular rulers were vassals of God who exercised their dominion as servants of the Church, under the aegis of

[34] When Pope Leo III crowned Charlemagne Emperor of the Romans in 800, he established the precedent in the West that an emperor must be anointed by a pope, and all kings by the pope's representatives, the archbishops. A few centuries later, the coronation of William in the Norman conquest of England provides a notable but rare example of the Church according recognition to a newborn royal lineage. The difficulty of gaining Church acquiescence discouraged nonroyal challengers and made it especially difficult for a non-Christian to aspire to a European throne.

[35] Henry Orton Wiley, *Christian Theology*, Vol. 3 (Kansas City, MO: Beacon Hill Press, 1951), 941.

the pope, who was the Vicar of God. Since the aim of the Christian life is salvation, the *sacerdotium* occupied the higher plane, above secular rulers.

No equivalent of the Roman Church, with its independent hierarchy and sources of legitimacy, can be found in China's religious history. The emperor alone was the embodiment of Heaven's will; his mandate descended directly from Heaven. At no time was divine unction (anointment) required from an independent religious body to legitimate the investiture. Religious practice, like all other matters in China, was subordinated to the authority of the state. Even the rites of accession that sanctified the emperor's office were guided by government regulations and promulgated key elements of state ideology.

One example of such subordination developed during the Han dynasty (206-220), when a Ministry of Ceremonies, one of the nine imperial ministries, was established. The office was responsible for ceremonial observances, as well as custody of the sacred Mount Tai, recognized as a holy site for three thousand years. Ming and Qing emperors worshipped Heaven and Earth at the Temple of Heaven not far from the Forbidden City. The Ministry of Ceremonies, in effect, integrated the emperor with the natural and transcendent worlds. It also had supervision over education, which eventually included the civil service examinations. The mandarins of the imperial court, trained in classical Confucian education, alone made all important appointments to officialdom and set educational standards for the imperial university, including the appointment of academic chairs that interpreted the Confucian canons.

This subordination was reinforced by a philosophical turning point in Chinese cultural history that occurred very early on, in the fourth century BCE, with the rise and fall of Mohism, a philosophy based on the teachings of the philosopher Mo Ti (or Mozi, c. 470-c. 391 BCE). Mohism arose during the same period and from the same region as its major rival, Confucianism, during the war-torn era of the Hundred Schools of Thought. With a message of egalitarian and impartial caring for all, discouraging excessive attachment to family and clan, it had the potential to encourage individuals to invest in social organizations outside of the lineage. The tenets of Confucius prevailed, and the Confucian modeling of national community on filial piety translated into allegiance to the emperor and lent legitimacy to the throne.

Before Confucian thought proliferated throughout the empire, ancestor worship and lineage were the basis of social order, but it lacked an explicit ideology. Confucian doctrine complemented pervasive clan-based cultural norms that were widely accepted in ancient China. Because Confucianism lacked formal institutions of its own, it was readily subordinate to the state, providing a social and moral underpinning that made it appealing to the emperor.[36]

[36] Zhuo Xinping, "Spiritual Accomplishment in Confucianism and Spiritual Transcendence in Christianity," In *Confucianism and Spiritual Traditions in Modern China and Beyond*, Vol. 3, ed. Fenggang Yang and Joseph Tamney (Leiden and Boston: Brill, 2011), 280-81.

Network Growth, Innovation, and Regime Longevity

Despite the small-world properties of high local connectivity and relatively short average path length shared by both China and Europe, differences in the organizational structure—the topology—shaped their respective cultures of innovation, resulting in divergent economic trajectories.

Comprised of many hubs with highly skewed degree distributions, the West's small-world network left Europe's monarchs with limited capacity to stem the spread of innovation that challenged their authority or to control systems of production that would ensure their grip over the economy. But it offered great vitality from the recurrence of revolutions and social movements, each built upon earlier accomplishments, creating something new and different, yet retaining the context of a shared European tradition.[37]

The ability of the hierarchical linkages, beliefs, and institutions to support the hubs in accommodating rapid changes at lower levels without affecting the overall topology bolstered system-level resilience. Understanding this resilience informs us about accelerated ideological adaptations and technology diffusion that occurred via continent-wide movements, such as the Renaissance, the Reformation, the Enlightenment, and industrialization. Each started in one part of Europe, eliminating some nodes in its wake; nevertheless, the surviving hubs could self-organize into new formations. As a consequence, Europe has been more successful than China at harnessing the drivers of innovation; its interconnected governing elites are able to survive waves of cultural, institutional, and technological change, and its social development could travel far beyond where it began from the start of the Early Medieval Period, despite disruptions caused by novel social forces.

In imperial China, where systemwide connectivity emanated from the central hub, potential new hubs were discouraged from gaining footholds. Merchant guilds, charitable confraternities, and other local-level civic communities rarely gained institutional autonomy either, since new links would dilute central control. Along with limits to internal mobility via family registration in the ancient *hukou* system, this gave the central hub great capacity to determine which innovations entered the mainstream and which were to be filtered out. The *hukou* system, for example, was used to control internal migration and predated even the imperial era. Its sophisticated mechanisms for exploiting collective vulnerabilities advanced the interest of the state and its agents, but it also reduced the reservoir of potential creativity for disruptive innovation. When there was a significant shift in world views, it generally stemmed from a mandate promulgated by an imperial sponsor, often in association with a dynastic transition, rather than being a self-organizing or emergent property of agent interactions.

[37] Harold J. Berman, *Law and Revolution: The Formation of the Western Legal Tradition* (Cambridge, MA: Harvard University Press, 1983), 19.

The imperial court had absolute control over the mandarinate via the classical curriculum in which candidates were educated from an early age, the examination system to which they were subjected, and the regions to which they were posted. China's network distribution made unity more complete, but the cohesion of the entire network depended on the durability of the central hub. Whenever the center fell, so too did the system's remaining nodes, which were connected only to it. Each dynastic collapse meant that the bureaucracy had to be restored and the systemwide connectivity reassembled.

Yet reconstitution of the mandarinate in each dynasty is not the whole story of how Chinese cultural norms persisted over millennia. Local networks that operated on the basis of kinship and clan linkages played an essential connective role in China's history. In the next section, we will explore how such networks were possible.

Cultural Diffusion and Persistence

With network science as a methodology to discover both the global rules and change mechanisms that pervade the entire social system, I have identified an underlying dynamic of small-world connectivity at the macro level that is replicated in the historic regimes of both Europe and China. Applying the small-world approach heralded by Granovetter[38] and formalized by Watts and Strogatz,[39] the author has uncovered predominant patterns of large-scale network design, but this does not provide a full description of the system's evolution over time. Nor does it effectively account for cultural persistence. In this section, I will first examine local patterns in Europe and then disclose what the small-world approach misses as we look more deeply at China – and probe how its religious and civic institutions are linked to deep structural differences in its economic organization.

Path length within the large-scale network is key for understanding the dynamics of how information and technological change spread, i.e., as hubs form and path length within the system decreases, diffusion increases. But what about the connectivity at lower levels, i.e., among local nodes? There the successful spread of innovative behaviors requires reinforcement from multiple sources, including across community groups, requiring intersecting bonds that Damon Centola calls *bridge wideners*.[40] Individuals had to make significant investments to create these enduring pathways of social coordination across groups.[41] An ideal from religion encouraged their spread.

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[38] Granovetter, "The Strength of Weak Ties."

[39] Watts and Strogatz, "Collective Dynamics of 'Small-World' Networks."

[40] Social diffusion in large, complex societies may depend on socially "intermediate" groups that bind socially remote groups together. See Damon Centola, *How Behavior Spreads: The Science of Complex Contagions* (Princeton: Princeton University Press, 2018), 34-62.

[41] Centola, *How Behavior Spreads*, 133.

Throughout the Medieval Period, the Church as an institution and a system of beliefs was instrumental in reinforcing new ad hoc groups for the common benefit. Fustel de Coulanges, in the mid-nineteenth century classic "The Ancient City," explained that Christianity introduced the idea that "It was not the domestic religion of any family, the national religion of any city, or of any race. It belonged neither to caste nor to a corporation."[42] The idea of generalized morality made the government of medieval towns different from ancient Greece and Rome, in which every family and community worshipped its own gods. It allowed voluntary associations to flourish and build webs of organized cooperation beyond kinship. The institutional frameworks and customs they inspired supported economic opportunity in a decentralized environment.

As an advocate of norms that prescribed fairness toward strangers, the Church doctrine of brotherly love underpinned the common ideal of cities as moral communities. It shaped attitudes toward migrants and played a role in how towns dealt with migration processes, enabling strangers to obtain rights.[43] Common interest organizations require generalized morality to thrive. Greif and Tabellini offer an explanation for the role of Christian humanism in building the civil society of early medieval towns.[44] The networks of guilds, monastic orders, and other voluntary societies that Christian humanism inspired helped accelerate the spread of new behaviors, especially after the periods of massive migration and population replacement following the Black Death (1346-48), and enabled the towns to become seedbeds of innovative behaviors.

The multiple voluntary communities and common interest organizations, such as the *Lex mercatoria*, that built their own institutional infrastructures to manage a wide range of risks were Centola's "bridge wideners." The assurances they provided reduced the risk of exchanging with strangers so that groups of people who had no prior relationships could pool resources and build large private firms and markets.

China's distinctive pattern of organizing cooperation can also be traced to longstanding historical patterns. Their relational networks became embedded and then predominant in trade and local problem solving throughout its history, even to this day. There was no body of religious thought in China that might induce individuals to trust in social ties beyond those of parochial origin like the family or village. There was no institution either that devolved from a central place like the parish that impacted the quotidian needs of the population. China's star-shaped network structure, which relied on ancient Confucian moralism, ultimately provided inadequate formal problem-solving capacity at the local levels. The state bureaucracy was too thinly spread to penetrate local society to the level of the village, causing civil service officers to depend upon lineage leaders

[42] Numa Denis Fustel de Coulanges, *The Ancient City: A Study on the Religion, Laws and Institutions of Greece* (Garden City, N.Y.: Doubleday and Co., 1956), 391.

[43] Miri Rubin, *Cities of Strangers: Making Lives in Medieval Europe* (Cambridge: Cambridge University Press, March 2020), https://doi.org/10.1017/9781108666510.

[44] Greif and Tabellini, "The Clan and the Corporation."

to carry out instructions that needed local support. This resulted in negative effects on governance functions ranging from tax collection to irrigation management.[45]

Cooperation or assistance via civic organization among individuals, families, and groups sharing common interests was rarely encouraged. When there was self-sponsored, self-help action by communities to solve local problems, membership was based on kinship rather than on generalized common interests. China grew relationship-based *guanxi* networks, richly endowing Chinese society with a circle culture of small groups and personal cooperation and exchange in small communities. The high moral obligations inculcated within such parochial groups rarely extended to external dealings, either with the government or, more generally, with strangers.

Assessments of kinship-intensive governance throughout the world and in contemporary settings have found that when lineage leaders held predominant roles in community organization, an inhospitable environment for behavioral innovations and cultural inertia resulted. In addition, greater kinship intensity correlates with less attention to universal morality and less generosity for those outside the group; this strengthens loyalty to family members even when they break covenants with society at large.[46] Strong in-group loyalty and a sharp distinction between in- and out-groups contribute to a general distrust of strangers with negative impacts on the quality of governance.[47]

Contemporary research on China continues to find that clans sharing patrilineal ancestry are the most important social groups in Chinese villages.[48] Xu and

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[45] Joseph Esherick and Mary Backus Rankin, *Chinese Local Elites and Patterns of Dominance* (Berkeley: University of California Press, 1990), 3; James Kai-sing Kung, and Chicheng Ma, "Friends with Benefits: How Political Connections Help Sustain Private Enterprise Growth in China," *Economica* 85, no. 337 (January 2018): 41-74, https://doi.org/10.1111/ecca.12212; Ting Chen, James Kai-Sing Kung, and Chicheng Ma, "Long Live Keju! The Persistent Effects of China's Imperial Examination System," *SSRN*, June 2017, http://dx.doi.org/10.2139/ssrn.2793790.

[46] Jonathan F. Schulz, Duman Bahrami-Rad, Jonathan P. Beauchamp, and Joseph Henrich, "The Church, Intensive Kinship, and Global Psychological Variation," *Science* 366, no. 6466 (2019): 5141, https://doi.org/10.1126/science.aau5141; Joseph Henrich, *The WEIRDest People in the World: How the West Became Psychologically Peculiar and Particularly Prosperous* (New York: Farrar, Straus and Giroux, 2020), 196.

[47] Jonathan F. Schulz, "Kin Networks and Institutional Development," *SSRN*, September 1, 2016, http://dx.doi.org/10.2139/ssrn.2877828; Mahsa Akbari, Duman Bahrami-Rad, and Erik Kimbrough, "Kinship, Fractionalization and Corruption," *Journal of Economic Behavior & Organization 166* (C) (2019): 493-528, https://doi.org/10.1016/j.jebo.2019.07.015.

[48] Hsiao-Tung Fei, "Peasantry and Gentry: An Interpretation of Chinese Social Structure and Its Changes," *American Journal of Sociology* 52, no. 1 (July 1946): 1-17, https://www.jstor.org/stable/i328827; Francis L. K. Hsu, *Under the Ancestors' Shadow: Chinese Culture and Personality* (New York: Columbia University Press, 1948); Maurice Freedman, *Lineage Organization in Southeastern China* (London: University of London and Athlone Press, 1958); Maurice Freedman, "Ancestor Worship: Two Aspects of the Chinese Case," in *Social Organization: Essays Presented to Raymond Firth*,

Yao[49] report that when one of the two largest family clans in a village is in charge, local public investment will increase, but at a price; the clans line their own pockets while colluding with local officials. Greif and Tabellini[50] show clan influence apparent not only in the resolution of civil and commercial disputes but also in the provision of welfare, securing property rights, protecting locals from official abuse, and even in contributions to public projects.[51] Private firms today are mainly clan businesses, notes Zhang,[52] who argues that "clan culture" is weakest in regions with a better market environment. Peng[53] records a strong and significant correlation of village-level kinship with the number of private enterprises, and Zhang, like Peng, suggests that this linkage contributes to the success of the pro-market reforms after 1979 by supplementing weak legal institutions. Foltz, Guo, and Yao[54] demonstrate that lineage connections help increase migration and public goods creation in fast-growing, newly populated areas. He, Pan, and Sarangi[55] report that lineage-homogenous villages are more likely to engage in

ed. Maurice Freedman (Chicago, IL: Aldine, 1967); James J. Watson, "Chinese Kinship Reconsidered: Anthropological Perspectives on Historical Research," *The China Quarterly* 92 (December 1982): 589-622, https://doi.org/10.1017/S0305741000000965; Prasenjit Duara, *Culture, Power, and the State: Rural North China, 1900-1942* (Stanford: Stanford University Press, 1988); Myron L. Cohen, "Lineage Organization in North China," *The Journal of Asian Studies* 49, no. 3 (1990): 509-34, https://doi.org/10.2307/2057769; Lily L. Tsai, "Solidary Groups, Informal Accountability, and Local Public Goods Provision in Rural China," *American Political Science Review* 101, no. 2 (May 2007): 355-72, https://doi.org/10.1017/S0003055407070153.

[49] Yiqing Xu and Yang Yao, "Informal Institutions, Collective Action, and Public Investment in Rural China," *American Political Science Review* 109, no. 2 (2015): 371-91, https://doi.org/10.1017/S0003055415000155.

[50] Greif and Tabellini, "The Clan and the Corporation."

[51] Relying on the China Social Survey, 2005 (Greif and Tabellini, "The Clan and the Corporation.") calculate that "almost 70 percent of the population live in a county with positive sample probability of a village having a [clan] organization, and in 41 percent of the counties the village-probability of having a clan organization is at least 50 percent. The percentage of clans that held common property ranged from 21% to 28%." Their assessment of the role of clans in Chinese history mirrors the one set out here: clans shape the evolution of Chinese social organization and render its culture quite different from that of Western countries.

[52] Chuanchuan Zhang, "Clans, Entrepreneurship, and Development of the Private Sector in China," *Journal of Comparative Economics* 48, no. 1 (March 2020): 100-123, https://doi.org/10.1016/j.jce.2019.08.008.

[53] Yusheng Peng, "Kinship Networks and Entrepreneurs in China's Transitional Economy," *American Journal of Sociology* 109, no. 5 (March 2004): 1045-74, https://www.journals.uchicago.edu/doi/10.1086/382347.

[54] Jeremy Foltz, Yunnan Guo, and Yang Yao, "Lineage Networks, Urban Migration and Income Inequality: Evidence from Rural China," *Journal of Comparative Economics* 48, no. 2 (June 2020): 465-82, https://doi.org/10.1016/j.jce.2020.03.003.

[55] Quqiong He, Ying Pan, and Sudipta Sarangi, "Lineage-Based Heterogeneity and Cooperative Behavior in Rural China," *Journal of Comparative Economics* 46, no. 1 (March 2018): 248-69, https://doi.org/10.1016/j.jce.2017.10.006.

reciprocal behavior with their lineage members and to contribute to the provision of public goods jointly shared across lineages than with people living in lineage-heterogeneous villages. Village-wide lineage groups are significantly correlated with the provision of public goods and with holding public officials accountable in Tsai.[56] Kinship-based organizations have survived reforms of the communist revolution. From 1949 to 1979, clans were officially disbanded, their property taken, their rules invalidated, and their genealogies burned. Yet once prohibitions were removed, their cultural sway over the social norms of the population resurfaced. All told, recent scholarship demonstrates that reliance on informal institutions of lineage groups solves collective action problems by facilitating the mobilization of local resources and the provisioning of local public goods – but at the risk of collusion and with a negligible impact on local government accountability. This replicates the patterns of ancient times.

The *Charities Aid Foundation* (CAF) World Giving Index[57] ranks China lowest of all 128 countries on willingness to help a stranger, donate money, or volunteer time. The CAF report describes how official decision-making does not meaningfully engage local communities. Civil society organizations are under strict surveillance, lack consistent regulation, rarely speak out independently on public issues, and garner only low levels of trust. All told, impersonal trust-building institutions in China, along with the codification of contractual relations, have lagged behind analogous European institutions by almost a millennium. Centola's approach suggests an answer to these examples of cultural persistence. Information can travel along long paths that span the system, but behavioral change requires bridge wideners that enable strong social reinforcement when significant personal investment is needed for adoption to occur.[58]

Although kinship intensity is a characteristic that China shares with many other low-performing regimes, the weakness of civic bonds across communities did not prevent the emperors from ruling over the vast empire. In this regard, imperial China was not unlike the Roman and Ottoman empires and many other historical regimes operating with complex macro coordination while depending on lineage organization at the micro level. Yet its meritocratic and relatively inclusive civil service system is an attribute that has few parallels in world history or among developing nations today.

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[56] Tsai, "Solidary Groups, Informal Accountability, and Local Public Goods Provision in Rural China."

[57] Charities Aid Foundation (CAF), "CAF World Giving Index: Ten Years of Giving Trends," Report, 10th Edition (London, UK: Charities Aid Foundation, October 2019), https://www.cafonline.org/about-us/publications/2019-publications/caf-world-giving-index-10th-edition.

[58] Damon Centola, *Change: How to Make Big Things Happen* (Little, Brown Spark, January 2021), 95-109.

State, Nation or Civilization: Cultural Sources of Chinese Longevity

How could two seemingly contradictory forces—the meritocratic civil service system and lineage and ancestor worship—operate in one system? These two conflicting characteristics of China's development have long baffled scholars. Clearly, China's extraordinary longevity cannot be credited to the long linkages of the political regime alone, as dynasties were shattered many times. I suggest that during periods of state decline and imperial collapse, the stability of the system derives from its hyperlocal networks and the lineage ordering of the grassroots society. They became a temporary system of "life support" that sustained the long-term continuity of Chinese culture. When the benefits of path-shortening infrastructure were undermined, communities depended on the most basic units of the society until the system-spanning order, the bureaucratic infrastructure, could be rebuilt. Although hyperlocal connectivity did not enable sustainable *system-spanning* connectivity, it did not allow imperial collapse to cause the death of Chinese culture. The idea of China as a civilization survived even as the state receded.

The different roles of voluntary civic associations have had another long-term effect in both regions: National identity among the populations of Western Europe is today expressed in terms of the Enlightenment – in the construction of individualism and law. In China, nationalism still finds expression in the heuristics of kinship and ancestor worship. Appeals to national unity are premised on ties of ethnic origin rather than a political choice or social contract, pitting its "humanism" against Europe's.[59] Considering these tendencies that characterize Chinese ethical thinking, it is difficult to identify a Chinese philosophical tradition that would encourage a belief in a continual cultural advance towards a common law of human rights founded upon the principles of human nature and human reason.

Conclusion

In *Analyzing Social Networks*, Borgatti, Everett, and Johnson write: "Investigations into small-world and scale-free networks are usually confined to describing these properties, that is, deciding whether a network is a scale-free or small-world. The consequences of such structures are not well understood, and it would be difficult to draw conclusions about individual actors or even small groups of actors in such networks. The main goal is to gain some understanding of the overall network structure."[60] This inquiry is a pioneering effort to apply

[59] Chinese Communist Party's claims over Taiwan stress their same "blood" connection and it has launched an information campaign to overcome the marginal existence of the blood tie in Taiwanese national identity (*guojia rentong*). See Gang Lin and Weixu Wu, "Chinese National Identity under Reconstruction," in *Taiwan and China: Fitful Embrace*, ed. Lowell Dittmer (Oakland: University of California Press, 2017), 75-92.

[60] Stephen P. Borgatti, Martin G. Everett, and Jeffrey C. Johnson, *Analyzing Social Networks*, 2nd ed. (London, UK: Sage Publications, 2017), 303.

models of the overall network structure to the circumstances and social organization of actual historical regimes and has uncovered patterns of relevance to network scientists, political economists, and scholars seeking to identify the fundamental characteristics of world civilizations. It has afforded new insights into recurrent, recognizable, and familiar patterns observed in historical political economy, such as the persistent trending of Chinese regimes toward authoritarian centralization. Why, in its transition to the impersonal complexity of a modern economy, does China still rely less on private markets and organizations and more on the state?[61] What structural features support the persistently low levels of prosocial trust and high levels of *guanxi*, or relationship-based exchange?

China and the European West have social networks to solve problems such as information asymmetry in the economy. These can be sources of informal constraints that either discourage or boost cooperation and can hinder or build bonds and communities beyond kinship. The differences in how informal norms are disseminated and embedded in formal structures are recognizable with the help of network science. We have seen that during the urbanization of Europe's medieval period, the spread of voluntary civic associations increased the number of nodes in one community that had links to nodes in another, weakening lineage communities and homophily. Christian doctrine and institutions abetted this process. As community partitions were removed, connectivity increased across the system, producing a "metropolitan" ethos. In China, Confucian ethics reinforced partitions between homogenous communities with strong relational ties to lineage but weak moral obligations to other communities. This parochialism limited the spread of behavioral innovation between communities and instead created a "village" ethos in which relationship-based solutions preside over anonymous market exchanges.[62] The emphasis on being centralized vs. decentralized is an insufficient framework to explain these patterns. My explanation for these longstanding differences with the West is that China had its own path shorteners—the system of mandarin bureaucracy with recruitment from across the empire—that enabled it to reach scale as a state and provided system-spanning connectivity but limited means to penetrate the parochial networks that enforced local norms.

My claim—that pattern of connectivity among the high-degree hubs fundamentally affects the system's robustness and that China's star-shaped topology is more vulnerable to major and immediate fragmentation if the center collapses—does not mean that China's leadership cannot overcome its deep-seated conservatism and aversion to cultural and technological transformation. On the

[61] John Ray Bowen II and David C. Rose, "On the Absence of Privately Owned, Publicly Traded Corporations in China: The Kirby Puzzle," *The Journal of Asian Studies* 57, no. 2 (1998): 442-52, https://doi.org/10.2307/2658832.

[62] Samuel Bowles and Herbert Gintis, "Persistent Parochialism: Trust and Exclusion in Ethnic Networks," *Journal of Economic Behavior & Organization* 55, no. 1 (September 2004): 1-23, https://doi.org/10.1016/j.jebo.2003.06.005.

contrary, the regime in Beijing is confident that it will maintain social order without constraining its mastery of the disruptive technologies of the future, nor does it recoil from the ethical implications of developing technologies that exploit the individual to benefit the collective. In fact, leadership would argue that the regime is pursuing the "higher ethical good." In the West, the legacy of rights-granting norms shapes how the higher ethical good is defined. Differences in network topology provide both societies with differing capacities for monitoring and regulation, as well as durability and the ability to integrate new nodes and embody self-organization. With these insights derived from network science about connectedness, components, and the processes of change, researchers have a new approach to how cooperation scales in historical regimes and how cultural variations among populations form. They can now include network structure as an independent explanatory variable to the list of endogenous factors that sets world civilizations on different development trajectories.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon request.

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