Understanding the Rhythms of History — Peter Turchin, Cliodynamics, and Their Most-Cited Studies

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The Wager

Every science begins with an act of audacity, and for the small band of scholars gathered around Peter Turchin that act was the claim that history — the rise and fall of states, the timing of revolutions, the recurrence of civil war — is not a parade of unique events but a process governed by regularities that can be measured, modeled, and, within limits, predicted. In 2008 Turchin gave the enterprise a name in the pages of *Nature*: cliodynamics, from Clio, the muse of history, and dynamics, the mathematics of change (Turchin 2008). The name was a wager. It promised that the theories of historians could be tested against data the way the theories of physicists are tested against experiments.

The manifesto opened with an indictment. More than two hundred explanations had been offered for the fall of Rome, Turchin observed — a profusion he called “as risible as if, in physics, phlogiston theory and thermodynamics coexisted on equal terms.” His counter was not another explanation but a pattern. Surveying eight secular cycles in agrarian states — England, France, the Roman Empire, Russia — he found that in every single case the number of instability events per decade during phases of population decline was several times higher than during phases of growth; “the probability of this happening by chance,” he wrote, “is vanishingly small.” The same signatures appeared in eight Chinese dynasties, from the Western Han to the Qing, and in Egypt from the Hellenistic period to the Ottomans. And in all eight case studies the same mechanism preceded the crisis: elite overproduction, the swelling of a privileged class beyond the positions available to it, typically alongside inflation that hollowed out the state’s finances until bankruptcy followed.

The anecdote that carried the argument was aimed at the present. When Tony Blair set a target of sending fifty percent of young Britons through higher education, Turchin pointed to a grim precedent: an overabundance of young people with advanced education had gone before the political crises of the age of revolutions in Western Europe — the French Revolution of 1789 and the pan-European revolutions of 1848–49 — of late Tokugawa Japan (the crisis decades before the Meiji restoration of 1868), of modern Iran (the revolution of 1979), and of the Soviet Union. The last case is Jack Goldstone's reading of the late-Soviet crisis: the USSR's postwar expansion of higher education had, by the 1970s and 1980s, produced an ever larger educated class faster than the planned economy could promote it, and this glut of the educated preceded the stagnation and collapse of the 1980s. His second example cut closer to the bone of revolution itself. When the Assembly of Notables refused the French crown's land tax in 1787, many of the notables themselves later lost their heads in the Revolution — an act of self-destruction they unwittingly set in motion. Even the United States, he noted, offered a natural experiment: political violence peaked around 1900, the 1930s were strikingly quiet, and the curve rose again through the 1960s (Turchin 2008).

The wager, Turchin was careful to say, was not a promise of prophecy. Cliodynamic theories never predict the future exactly — mathematical chaos, free will, and the self-defeating prophecy see to that — but the consequences of social decisions, he argued, are computable. What follows in this report is the record of how that wager has been tested: against the slow clocks of agrarian societies, against a forecast made in 2010 and audited in 2020, against the steppe nomads who unintentionally built the world's empires, against a databank that measures whole civilizations, and against the shocks — droughts, plagues, invasions — that some societies survive and others do not. It closes with the questions that remain open, and with the wager itself.

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The Clocks of History

Societies keep time. Their clocks are simply very slow, and most observers never stand back long enough to watch the hands move. The founding discovery of cliodynamics is that they do move, with periods of roughly two to three centuries, and that the hands are population and instability.

The claim sounds obvious, and for decades the evidence seemed to say otherwise. Anthropologists who tested cross-cultural samples found essentially no correlation between population density and warfare; Turchin and Korotayev's own test on the Standard Cross-Cultural Sample returned a correlation of 0.04, indistinguishable from zero (Turchin and Korotayev 2006). Yet a zero correlation is exactly what the theory predicts when two variables drive each other with a time lag, like predator and prey. Ecology had already learned this lesson: in the Swiss Alps the larch budmoth oscillates on an eight-to-nine-year cycle, and the parasitic wasps that explain ninety-five percent of the variation in caterpillar numbers lag the moth population by two years — so the direct correlation between the two is weak, and in fact negative (Turchin and Korotayev 2006). The counterintuitive implication is that the anthropologists' null result was not a refutation of the population–warfare hypothesis but a confirmation of its dynamics. Reanalyzed in rates of change rather than levels, the Han Chinese record gives up seventy-two percent of the variance in warfare to population; England explains eighty-five to ninety-three percent; and war chronicles from Korea show peaks roughly every two centuries, precisely as the models demand (Turchin and Korotayev 2006).

The mechanism behind the lag is generational. When Turchin modeled the coupled oscillations of population and instability in England between 1450 and 1800, in Han and Tang China, and in Rome, a smoothing window of about fifty years — two generations — fit best, and he justified it with a psychological rule: "if fathers participate in bitter internal fightings, their sons tend to value stability at almost any cost, while the grandsons exhibit a renewed willingness to revolt" (Turchin 2005). England's own history supplied a brutal illustration. During the Hundred Years War, historians have argued, the export of "surplus elites" to the French campaigns kept England calm; by 1450 the overflow had stopped, and the Wars of the Roses broke out almost immediately. Here Turchin also settled a score with Jack Goldstone, whose demographic-structural theory he extends rather than repeats: Goldstone had postulated that population growth produces instability, but, as Turchin put it, "he did not close the causal loop" — instability must feed back on population, and it was Turchin's contribution to make that feedback endogenous (Turchin 2005).

The clocks can be read in improbable instruments. In Novgorod, streets were paved with wooden planks, repaved every twenty to thirty years for six centuries, and the strata can be dated by tree rings to the year; the accumulated refuse shows two clean population peaks, one in the twelfth century and one around 1400 (Turchin 2009). In the western Roman Empire, settlement archaeology records two great oscillations in

five centuries, and African red slip ware found in Etruria — datable to the decade — traces the same curve (Turchin 2009). The statistics across seven cycles are stark: instability events averaged 0.6 per decade during growth phases and 3.8 per decade during decline phases, a difference far beyond chance; in China across eight dynasties the figures are 3.4 and 11.3 (Turchin 2009). Theory matches: second-order feedback models with human reproductive rates predict oscillations of 120 to 450 years, most probably two to three centuries (Turchin 2009). The lesson is that slow violence is not noise. It is rhythm.

Even a census controversy can be settled by the rhythm. Did the citizen population of Roman Italy double in the first century BCE, as the raw census figures seem to say, or did it shrink, as almost everything else about the age suggests? Turchin and the ancient historian Walter Scheidel let buried coins answer (Turchin and Scheidel 2009). A coin hoard is buried in danger and recovered only if its owner survives; hoards therefore function as a seismograph of civil violence. The two scholars fitted a population model to the census data before 100 BCE, then drove it forward with the hoard record alone: the model predicts decline, and the “low count” of Roman demography matches the modeled values closely. Three facts dispose of the “high count”: it would have packed Italy with nearly twenty million people, a density the peninsula reached again only in the mid-nineteenth century; it would have required millions of imported slaves; and it sits awkwardly beside the greatest instability century in Roman history, from 130 to 30 BCE. The hoard peaks line up with the Second Punic War, the Social War and the age of Marius, Sulla, and Spartacus, and the civil wars of Caesar, Pompeius, and the Triumvirs — one thousand bootstrap repetitions confirm the trajectory. The coins speak of war, and war speaks of a population in decline.

Literature for this section:

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Peter Turchin and Andrey Korotayev. 2006. Population Dynamics and Internal Warfare: A Reconsideration. *Social Evolution & History* 5(2): 112–147. URL: https://www.sociostudies.org/journal/articles/140535/

Peter Turchin. 2009. Long-Term Population Cycles in Human Societies. *Annals of the New York Academy of Sciences* 1162: 1–17. DOI: 10.1111/j.1749-6632.2009.04447.x

Peter Turchin and Walter Scheidel. 2009. Coin Hoards Speak of Population Declines in Ancient Rome. *PNAS* 106. DOI: 10.1073/pnas.0904576106

The Forecast

A theory that can only explain the past explains nothing. In February 2010 cliodynamics put its explanation where its mouth was. The journal *Nature* had asked twenty scientists for their visions of the 2020s, and nearly all of them promised progress of one kind or another; Turchin, in a one-page correspondence, dissented from almost every colleague on the page. The coming decade, he wrote, would likely be one of growing instability in the United States and Western Europe (Turchin 2010).

The skeleton of the forecast was the fifty-year clock of American violence. Instability spikes had occurred around 1870, 1920, and 1970 — another was due around 2020. The supporting diagnosis was structural, not astrological: every major indicator of the American system — stagnating real wages, the widening gap between rich and poor, the overproduction of graduates, the explosive growth of state debt — had turned downward in the 1970s. Added to this were the forty-to-sixty-year economic cycle, then entering a trough from which “future recessions will be severe,” and a youth bulge like that of the 1960s. “All these cycles look set to peak in the years around 2020,” he concluded — and prescribed, in the same breath, the remedy: more progressive taxation, and no further expansion of higher education beyond what the economy absorbs, since “an excess of young people with advanced degrees has been one of the chief causes of instability in the past.” The closing sentence held the door open: “Records show that societies can avert disaster” (Turchin 2010).

The forecast required nerve, because the data of the moment pointed the other way. The United States of 2010 was measurably calmer than the America of 1970; the long study of American violence, based on a database of 1,590 political violence events between 1780 and 2010, documented per-capita death rates that had risen more than a hundredfold between 1820 and 1860 and had fallen roughly fiftyfold between 1920 and 1950 (Turchin 2012). The same study cataloged the texture of the old waves: the Red Summer of 1919, with no fewer than twenty-six major race riots and more than a thousand deaths; the Battle of Blair Mountain in 1921, the largest organized armed uprising in American labor history and the only time the United States government has used military aircraft against its own people. The method itself was refined here: Turchin counts events rather than bodies, be-

cause a single Oklahoma City bombing in 1995 distorts the death toll of an otherwise modest decade. And the waves, he argues, are immunized against immediate repetition by their own survivors — the fathers-and-sons dynamic again — which is why they recur at intervals of roughly two generations rather than continuously (Turchin 2012).

The audit came in 2020, and it went to the forecaster. Anti-government demonstrations and riots in the United States and the United Kingdom increased by an order of magnitude after 2010, and several Western European countries followed a strikingly similar curve — this at the end of a decade during which instability in the large Western countries had, until 2010, been genuinely declining, so that, as Turchin and Korotayev put it, “seemingly nothing presaged the outbreak of violence that we saw after 2010” (Turchin and Korotayev 2020). The retrospective was submitted in January 2020, before anyone had heard of Covid-19; its postscript, written that summer, noted the death of George Floyd as a trigger of the May–June unrest and the pandemic as a further destabilizer, and added the sobering statistic that periods of elevated instability typically last ten to fifteen years. The decade had also falsified a fashionable pessimism of another kind: Steven Pinker’s “end of violence,” written in the calm 2000s, was contradicted, on decadal scales and for collective domestic violence, by the very years it claimed to summarize (Turchin and Korotayev 2020). One structural detail is worth its own sentence: after 2010, peaceful demonstrations outnumbered violent riots five to one — a different profile from the 1960s, and a hint that the models track more than mere anger. The methodological moral the authors draw is the one that separates cliodynamics from prophecy: do not count the years since the last outbreak; measure the structural pressures underneath.

The deepest test of the theory, however, is not the United States but a case that has no living witnesses: the collapse of the Qing dynasty. Orlandi and colleagues gave the Qing the full structural-demographic treatment, and the result is a museum of the theory’s mechanism (Orlandi et al. 2023). Between 1700 and 1850 China’s population nearly quadrupled, from 125 to over 400 million, while cultivated land per head fell from 7.87 to 2.78 mu — a mu is 614.4 square meters. The examination system, the ladder of the elite, jammed: the success rate from the lowest to the highest degree was 1.6 percent, the number of highest degrees barely exceeded that of the preceding Ming dynasty, which ruled China from 1368 to 1644, despite a fourfold population, and in 1796 the number of admissions to the top palace exam fell to a mere eighty-one, the lowest ever recorded. The state’s response was to sell what it could no longer grant — between 1820 and 1850 more than 315,000 degrees — and the buyers, holding titles without offices,

became frustrated competitors of the very state that had enfranchised them. The composite Political Stress Indicator — a single number combining the theory's three structural pressures: mass pressure, elite competition, and the state's fiscal distress — tracks internal war with high significance; it is also a leading indicator, since the stress measured in one decade predicts the internal war of the next. Ecological disasters and external wars, by contrast, show no significant relationship, whether synchronous or lagged (Orlandi et al. 2023). The trigger logic could not be cleaner: the Taiping Rebellion, the bloodiest civil war in recorded human history with over twenty million dead, was led by Hong Xiuquan, a man who had failed the examinations four times — "an extreme example of what can happen when frustrated aspiring elites have at their disposal the discontented masses." The Dungan revolts that followed were nearly as destructive, costing twenty-one million lives and leaving Gansu and northern Xinjiang with about three quarters of their population gone. The dynasty had entered the century as a fiscal giant — in 1820 China produced 32.9 percent of world GDP — and left it broken by war indemnities and sold degrees. And the end, when it came in 1911 after 276 years, was set off not by famine or flood but by a dispute over railway nationalization in Sichuan, which cascaded through Wuchang to Lhasa, Xinjiang, and Outer Mongolia. Structural pressure, then a trigger: the Qing is the theory's ideal case, with the caveat, noted by Orlandi and colleagues, that Romanov Russia escaped the nineteenth century's civil wars through the Great Reforms — reform, not luck, can damp the mechanism.

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The Steppe as the Cradle of Empires

The horse did not create empires on its own, but it altered the strategic landscape in which empires formed. That sentence is the organizing insight of a whole wing of cliodynamics: the great hierarchical societies of the Old World were, in a sense no one intended, the products of the Eurasian steppe.

The argument begins with a puzzle. Why did large, hierarchical, cooperative societies arise at all from small egalitarian bands, when life in a large hierarchy demands costly prosociality — discipline, honesty, loyalty to strangers — that any individual would profit from shirking? Turchin's answer runs through multilevel selection: prosocial traits spread where cultural variation between groups is large and warfare between them is intense, and both conditions were maximized in one place, the frontier zones between steppe nomads and agrarian states (Turchin 2010b). The numbers are as grim as they are precise. When a city was taken in a steppe-frontier war, more than ten percent of its inhabitants were killed in sixty-three percent of the cases; in internal wars among agrarian states, the figure is 1.4 percent. And over ninety percent of the preindustrial megaempires, those exceeding a million square kilometers, arose in or beside the arid belt where horses and camels roamed. The decisive technology arrived in the ninth century BCE, when Iranian-speaking nomads perfected mounted archery — the "weapon of mass destruction" of nomadic pastoralists. Against it, agrarian societies had only one defense: grow bigger, grow more disciplined, grow more bureaucratic. The result is the pattern Turchin calls mirror empires — the Hunnu and Han China, the Turks and Sui-Tang China, the Mongols and Song China, each pair rising together on opposite sides of the same frontier. Nor was the steppe's gift to civilization exhausted by one lineage: Temujin — the man whom history knows as Chinggis Khan, founder of the Mongol Empire — "did not invent the recurved bow, the decimal organization system, or Tengrism," the sky-god religion of the steppe; he built on two millennia of steppe evolution (Turchin 2010b). The dark side of the frontier has a modern sequel that Turchin documents without flinching: the United States as a metaethnic frontier, with more than sixteen thousand recorded atrocities against Native Americans between 1622 and 1890. Reviewers, it should be said, did not welcome the argument: the manuscript was rejected by *Current Anthropology* under the eyes of seven reviewers.

Whether cooperation can really evolve from nothing is an empirical question, and it was answered in silico. Maxim Burtsev and Peter Turchin built a world of agents capable only of elementary actions — eating, sharing, attacking — with no prescribed strategies and no

known payoffs, and let evolution run (Burtsev and Turchin 2006). Without any way to tell friend from stranger, the simulation rediscovered the classic hawk–dove repertoire on its own. But when the agents could perceive heritable external markers of group membership, three cooperative strategies evolved that the textbooks did not contain: a cooperative dove that yields to insiders; a “raven” that leaves its own group to attack foreigners (“a raven will not peck out the eye of another raven,” as the Russian proverb runs); and a “starling” that jointly defends its cell against intruders. Among the surprises is the desperado effect, in which starving agents abandon their cell to face almost certain death rather than deplete it further, and the counterintuitive behavior of the peaceful cooperative dove, which shuns precisely its own relatives — marker-based cooperation creates solidarity that is not sharing. The comparison is the point: cooperation is not an axiom of human nature but a structure that war and identity built together. The model’s honesty is equally instructive: with only vertical transmission, its groups are kin groups, and the ultrasociality of strangers — the kind that holds millions together — remains outside its reach.

From cooperation to hierarchy is another jump: six orders of magnitude, from groups of hundreds to polities of hundreds of millions — one of the greatest puzzles of human history, in Turchin and Gavrilets’s phrasing (Turchin and Gavrilets 2009). Their answer is the same selection pressure, now with data attached. Across six well-documented empires, each additional order of magnitude of population required roughly one additional administrative level, and the span of control — how many subordinates each official managed — clusters at eight, comfortably within the range modern organizational research predicts. Geography tells the same story with unsettling regularity. China was unified fourteen times, and all but one unification — the Ming — came out of the north; South Asia was unified nine times, and never from its northeastern or southern quarters; Egypt’s four native unifications all came out of southern Egypt. The direction of conquest is the signal here: unification was achieved not by the richest region but by the one that centuries of intense frontier warfare had forged into the largest and most cohesive state — in China, the side that faced the steppe; in South Asia, never the sheltered far south or northeast; in Egypt, the south. Unification, in other words, was done by the region under the heaviest military selection pressure, wherever that happened to lie. An agent-based model reproduces the logic: at low war intensity, chiefdoms merely cycle; at high intensity, hierarchies of six or more levels emerge — and expansive states arise only after roughly three centuries of frontier contact, a delay visible in both Europe and India. History then preserves the architecture like paving stones. The roughly three hundred

Roman *pagi* of Gaul became counties, then bailiwicks, then some thirty thousand parishes; the Arverni still sound in Auvergne; France counted five administrative levels until 1789. Disintegration is just as layered: at the end of the ninth century France held at least twenty-nine independent polities, and a century later, fifty-five. Even the European Union maps almost perfectly onto the founding six of the Carolingian empire — a charter state that, after 1989, lacked the external disciplining pressure that built its predecessors, its twenty-seven members stacked without a new level of hierarchy.

The mirror-empires model was then tested against the empire list itself. Over ninety percent of the sixty-odd megaempires founded between 3000 BCE and 1800 CE lie within or beside the arid belt running from the Sahara to the Gobi — and the decisive variable is not aridity but proximity to pastoral societies, for on other continents, without the steppe, no such empires arose (Turchin 2009b). The largest of all, the Mongol Empire of 1270, covered twenty-four million square kilometers. The costs of the frontier were paid in slaves as well as soldiers: between 1600 and 1650 the Crimean Tatars sold 150,000 to 200,000 captured Russians, at a time when Russia’s entire population was four and a half to five million. Against the view that nomadic empires were mere shadows of agrarian ones, the record is blunt: the Gök-Türk Khaganate arose a generation before the Sui unification of China, and the Ming followed the Mongol conquest rather than preceding it. Two natural experiments close the case. When the Sahara dried out around 1000 BCE, Egypt’s steppe frontier moved away — and although Egypt gained dramatically in security from nomadic attack, it “never again gave rise to a native empire.” And the Great Plains of North America replayed the logic in miniature: the Comanches, never more than about forty thousand people, became hegemonic over the southern plains once horses arrived, raided to within a hundred and thirty-five miles of Mexico City, and framed their tribute demands as fictional vassalage to the Spanish king — just as the Xiongnu had once been “subject” to the Chinese emperor. Even a founding parable of the steppe recurs: the quarreling sons who cannot break a bundle of arrows, told four times in the *Secret History of the Mongols*. One sentence from the same frontier’s older age deserves its place here — the pharaoh Senwosret’s counsel on Nubia, around 1850 BCE: “Attack him, he will turn his back. Retreat, he will start attacking.”

Geography has one more regularity up its sleeve, and it is almost comic. The sixty-two largest historical empires are, on average, significantly elongated east–west — a tendency detectable at $P < 0.001$ — because expansion within the same ecological zone is simply easier than crossing one (Turchin, Adams, and Hall 2006). Every empire that ex-

ceeded ten million square kilometers was east–west: the Mongols, the Abbasid Caliphate, Romanov Russia. The three great exceptions — New Kingdom Egypt along the Nile, the Inca along the Andes, the Khmer in the tropical forest — each expanded within a single ecological zone, which is the point. Rome abandoned the conquest of the German forests after twenty thousand legionaries were annihilated in the Teutoburg Forest in 9 CE; Russia, unsurprisingly to anyone who has looked at a vegetation map, spread fastest along the ecotone between steppe and taiga and reached the Pacific by the mid-seventeenth century, while Central Asia took until the late nineteenth. The authors are explicit that this is no ecological determinism — the effect runs through social mechanisms — but the pattern is real, and modern states, interestingly, no longer show it.

The computational synthesis came in 2013. Turchin, Currie, Turner, and Gavrilets laid a grid of hundred-kilometer cells across Afroeurasia and let the diffusion of military technologies — first the chariot, then cavalry — intensify warfare and select for ultrasocial institutions (Turchin et al. 2013). The model explains sixty-five percent of the variance in where imperial societies appeared between 1500 BCE and 1500 CE; strip out the diffusing technologies and it explains sixteen percent. Distance from the steppe is the strongest single predictor, ahead of agricultural suitability. The first hotspots of imperiogenesis — Mesopotamia, Egypt, North China — sit near the steppe frontier, and Egypt, though never on the steppe, was near enough to meet the Hyksos and their chariots and, later, the Scythians and their cavalry. Conquerors could transmit an entire “cultural genome” — religious conversion, linguistic assimilation, the replacement of literate elites, or physical removal such as genocide and expulsion. The exercise closes on the sentence the whole enterprise deserves — a phrase the authors borrow from the historian Arnold Toynbee: history is not “one damned thing after another.”

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The Map Workshop

A science is only as good as its instruments, and the instrument this science built for itself is called Seshat, after the Egyptian goddess of writing and measurement. The name was chosen with a joke and a confession: on her scrolls, the founders write, “we will probably never know what she is writing” — harvest yields, tax lists, temple accounts, anything that would let one measure “the health of Ancient Egyptian society” (François et al. 2016). What the databank actually is follows from a definition borrowed from the historian Tim Hitchcock: a macroscope, the opposite of a microscope, an instrument that shows any single datum in the context of a billion others and can zoom from the whole Neolithic to a single year in a single place. The world sample divides the globe into ten zones, each with three Natural Geographic Areas of about a hundred by a hundred kilometers — Upper Egypt carries thirty-nine historical polities in its column — so that more than four hundred polities across the last ten millennia sit in one comparable frame, with a smallest time step of a single year. The methodological creed is that not-knowing is also information: absence and unknown are recorded as distinct facts, proxies are deliberately redundant, and missing entries are multiplied into twenty imputed datasets rather than thrown away. Even the choice of example tells a story about the enterprise’s temperament: the Nile flood, driven by monsoon rains in East Africa, “not the king, was the real despot in Egypt” — and Seshat’s methods are precise enough to put Manetho’s third-century BCE dynastic chronology itself up for revision (François et al. 2016). A companion overview, “An Introduction to Seshat,” published in 2020, sits behind the Equinox paywall and enters this report only through its abstract (Turchin et al. 2020); for an openly accessible account of the same databank, the journal *Cliodynamics* — which publishes its entire content free of charge — offers the team’s own overview, “Seshat: The Global History Databank” (Turchin et al. 2015).

The workshop’s first shocking product is a compression. Fifty-one measures of social complexity — population, territory, bureaucracy, money, texts, infrastructure — were collected for 414 polities across ten world regions and the last ten millennia, and when the principal components are computed, a single dimension explains 77.2 percent of all the variance (Turchin et al. 2017). The suspected second dimension never materialized. Knowing how big a society’s capital city is, one can predict to a respectable degree how many levels its hierarchy has, whether its texts are abundant, whether it mints coins — cross-validation coefficients run from the mid-zero-fifties up to 0.84. Societies in “Mississippi and China,” on different continents, without contact, built the same structure. Yet the dimension is not a staircase, and the shape of its steps carries its own lesson: traits like writing, money, and infrastructure are a ratchet that survives collapses. Italy’s polities had writing, texts, and coins before Rome’s rise — and kept them after Rome’s fall. The paper also carries a private grief: the archaeologist Garrett Fagan, who built much of the coding scheme and oversaw the Roman entries, died on 11 March 2017, before it appeared.

The second product is a verdict in an old argument. What drove the six-orders-of-magnitude climb from bands of hundreds to states of billions — agriculture, irrigation, markets, money, big gods? Turchin and colleagues tested over a hundred variables across 373 societies, in more than a hundred thousand model combinations (Turchin et al. 2022a). One predictor stands alone: IronCav, the compound of iron weapons and cavalry, significant at the highest level on every target — social scale, hierarchy, government. The functionalist contenders fail; their best models are “essentially without statistical support.” Agriculture is necessary but not sufficient: in regions where farming arrived by 500 BCE, nearly a quarter of the world’s farming regions never built a macrostate before 1500, and the typical gap between the adoption of agriculture and the rise of large states is two millennia. The cavalry result carries a natural-experiment guarantee: mounted archery was invented exactly once, by stateless people of the Pontic-Caspian steppes, so it cannot be a consequence of state-building — agrarian China, richer than the steppe in everything else, “had to go to great lengths to secure plentiful supplies of horses.” The sequence is legible in empire sizes: bronze weapons around 3000 BCE accompany Akkad and the Old Kingdom of Egypt; the chariot carries the Hittites, the Shang, and the New Kingdom past the one-million-square-kilometer threshold; cavalry pushes the ceiling above three million square kilometers, with the megaempires following three to four centuries later; and for the next two thousand years the maximum fluctuates around three million square kilometers, until gunpowder. The horse is a better

predictor of megaempire than iron. The American counterfactual clinches it: Tenochtitlan held more people than Naples — between 150,000 and 300,000, against roughly 224,000 — the largest city of the empire that conquered Mexico, yet the Mexica controlled less than thirty thousand square kilometers, throttled by supply on human backs; the only American megaempire, the Inca, arose exactly where domesticated transport animals, llamas, existed. On Hawaii, Kamehameha I unified the entire archipelago as soon as Western weapons became available. And the origin of one complexity marker is hidden in language itself: the Latin word for money, *pecunia*, derives from *pecus*, cattle — in early Rome wealth was counted in herds, a reminder that even the money which later empires minted and taxed began as livestock.

The war machines themselves obey global, not local, logic. Charting forty-six military technologies across 373 polities from the Neolithic to the Industrial Revolution, the best models explain up to ninety-six percent of the variance — and the drivers are world population, centrality on the Silk Roads network, and the iron-plus-cavalry package, while the properties of individual polities, size and administrative sophistication included, contribute nothing detectable (Turchin et al. 2021). Military technology evolves almost entirely as an exogenous variable. Hence one of the workshop's most quietly subversive findings: the Arabian Peninsula adopted the full Eurasian military package around 300 CE, two centuries before Islam — not because Arabia was a strong state, but because the trade routes ran past it. Spatial proximity alone does not suffice; the technologies themselves spread, and where they spread, arms races followed. The sequence of the horse runs from chariot to riding to light auxiliary cavalry to the hard saddle, the armored cataphract, and the stirrup — and finally heavy cavalry, "a major branch of troops across Afro-Eurasian societies between c. 550 and 1400 CE" (Turchin et al. 2021).

Finally, the map. Which cells of the Old World did empires actually hold, and why those? Across ten-thousand-square-kilometer cells, the best predictors of imperial density between 1500 BCE and 1500 CE are the duration of agriculture in the cell, with a correlation of 0.64, and its distance from the Eurasian steppe, at 0.63, combined in a model that explains fifty-eight percent of the variation; the agricultural productivity of the land itself correlates at 0.01 — essentially nothing (Currie et al. 2020). The interpretation respects a floor: some minimal productivity is essential, but beyond it, richer endowments do not make large states more likely. Institutions take time to evolve, and the steppe's war pressure took millennia to spread — Eurasia, stretched mostly along latitudes, helped the transfer along. The "tilted axes" of world

history, in other words, survive quantitative scrutiny; they just turn out to run through institutions and cavalry rather than through soil.

Literature for this section:

Pieter François, Peter Turchin, et al. 2016. A Macroscope for Global History: Seshat Global History Databank, a Methodological Overview. *Digital Humanities Quarterly* 10. DOI: 10.63744/e3j3d5qsvq99

Peter Turchin, et al. 2020. An Introduction to Seshat. *Journal of Cognitive Historiography*. DOI: 10.1558/jch.39395 (consulted as abstract only)

Peter Turchin, Rob Brennan, et al. 2015. Seshat: The Global History Databank. *Cliodynamics: The Journal of Quantitative History and Cultural Evolution* 6(1). DOI: 10.21237/C7CLIO6127917 (open access)

Peter Turchin, et al. 2017. Quantitative Historical Analysis Uncovers a Single Dimension of Complexity That Structures Global Variation in Human Social Organization. *PNAS* 115: E144–E151. DOI: 10.1073/pnas.1708800115

Peter Turchin, et al. 2022a. Disentangling the Evolutionary Drivers of Social Complexity: A Comprehensive Test of Hypotheses. *Science Advances* 8. DOI: 10.1126/sciadv.abn3517

Peter Turchin, et al. 2021. Rise of the War Machines: Charting the Evolution of Military Technologies from the Neolithic to the Industrial Revolution. *PLoS ONE* 16. DOI: 10.1371/journal.pone.0258161

Thomas E. Currie, Peter Turchin, Edward A. L. Turner, and Sergey Gavrilets. 2020. Duration of Agriculture and Distance from the Steppe Predict the Evolution of Large-Scale Human Societies in Afro-Eurasia. *Humanities and Social Sciences Communications* 7: 34. DOI: 10.1057/s41599-020-0516-2

Why Some Shocks Kill

The same drought that ruins one society leaves another unscathed, and the difference is rarely the weather. This is the question cliodynamics was built to answer with data: what, exactly, determines whether a shock kills?

One part of the answer is timing — not of the shock, but of the societies around it. The rise and fall of empires and cities runs, curiously, in synchrony from East Asia to the Mediterranean, while South Asia goes its own way; Turchin and Hall borrowed the explanation from theoreti-

cal ecology, where driving processes need not be the synchronizing ones (Turchin and Hall 2003). Weak shared disturbances can entrain even independent oscillators, but chaotic systems synchronize only through resetting catastrophes — and Eurasia suffered three of them, each about three centuries apart: the Mongol storm, the Black Death, and the seventeenth-century crisis. The ecological cautionary tale comes first, though, and it is the report's most elegant warning about coincidence. The nineteenth century believed the lynx populations of Canada, tracked through Hudson Bay fur returns, followed the sunspot cycle; by the mid-twentieth century the two series ran in perfect antiphase. Spurious synchrony, Elton's lesson. When the reset does come, it is continental: the "long" seventeenth century, opening around 1570, brought the Thirty Years' War — a third to a half of Germany's population lost — and "the English decapitated their king," while every Eurasian polity outside South Asia convulsed at once. Even plague has an upside-down effect that structural-demographic theory alone anticipates: epidemics strike the lower orders hardest, leaving proportionally more elites — too many elites — and hence unusually unstable states, which is one reason pestilence-ridden polities collapse; the Black Death itself traveled precisely along the trade routes of the world-system. South Asia's exemption has geography to thank: the Himalaya wall plus a steppe gradient kept the resets out. Denemark's verdict on the whole pattern was "intoxicating": "If there are regular empirical patterns, then history is not just a collection of accidents."

Whether climate alone can kill was tested, and answered no, on the oldest data there are. Mid-Holocene Europe, between 7000 and 3000 BCE, shows boom-and-bust cycles of roughly five hundred years in its settlement density, reconstructed from forty-eight thousand radiocarbon dates (Kondor et al. 2023). Climate variation alone produces the wrong rhythm — cycles of about two hundred years — and harsher shocks merely depress the total population. But agent-based models in which conflict grows with density reproduce both the period and the amplitude of the archaeological record, and conflict depresses simulated population about six times as strongly as climate variation does. Two details deserve their place in any account of prehistory. First, conflict breaks out even when free land remains — which explains the eerie "empty spaces" that surround the dense clusters of the early Neolithic. Second, with no endogenous aggressor formation there are no cycles at all: conflict must be modeled as a dynamic process in its own right, not as an external jolt applied from outside. The archaeological anchor stands in a German mass grave: Schöneck-Kilianstädten, one of the earliest direct testimonies of collective killing in Europe's farming villages.

What decides the outcome of a shock, then, is what accumulated before it. Hoyer and colleagues built the Crisis Database — 169 crises — and compared how societies fared under similar environmental stress (Hoyer et al. 2023). The Mughal Empire, the Ptolemaic Kingdom, and the Ashikaga Shogunate rode out severe droughts; the Sassanids, the Ming, and the Aztec and Inca states — already weakened before the Spaniards arrived — did not. The common denominators of fragility are the theory's three old friends: popular immiseration, elite overproduction, and state fiscal distress, all of which accumulate slowly and invisibly, before the shock. The Qing illustrate the arc within one dynasty: early stability through state granaries despite the Little Ice Age, later collapse under similar climate stress once overpopulation and a flood of frustrated examination candidates had dissolved the state's cohesion. The Ottomans supply the counterfactual: the drought of the 1590s was the longest in the Eastern Mediterranean in six centuries, and parts of Anatolia lost over half their population between the 1580s and the 1630s — yet the empire held, because its irrigation and water infrastructure held. And at Monte Albán, the Zapotec capital, the ninth-century "collapse" was no drought story at all: the inhabitants, as the archaeologists put it, "voted with their feet," while other, drier places in the same valley grew — the real corrosion was rising inequality and the concentration of power after about 800 CE. The authors' conclusion is the report's most quotable prescription: "a science of climate resilience requires a science of cultural evolution." Destruction even has its bright side, the data insist — wages rose after the Black Death. Another finding cuts against instinct: only two of the great upheavals of England and France ever coincided in time — the Civil War and the Fronde, both in the seventeenth century; otherwise the two states' worst civil wars alternated rather than overlapping, as if they had taken turns in the abyss. This very exception shows where the cliodynamic mechanism is at work: synchrony does not arise on its own — it takes a resetting catastrophe, and the seventeenth-century crisis, one of the three great continental resets, threw the cycles of both states into the same phase.

Literature for this section:

Peter Turchin and Thomas D. Hall. 2003. Spatial Synchrony Among and Within World-Systems: Insights from Theoretical Ecology. *Journal of World-Systems Research* 9: 37–64. DOI: 10.5195/jwsr.2003.248

Dániel Kondor, et al. 2023. Explaining Population Booms and Busts in Mid-Holocene Europe. *Scientific Reports* 13: 9310. DOI: 10.1038/s41598-023-35920-z

Daniel Hoyer, et al. 2023. Navigating Polycrisis: Long-Run Socio-Cultural Factors Shape Response to Changing Climate. *Philosophical Transactions of the Royal Society B* 378: 20220402. DOI: 10.1098/rstb.2022.0402

The Open Wager

Not every question on cliodynamics's desk is about dynasties and grain prices. The deepest ones are about gods.

The Big Gods hypothesis, among the most influential ideas in the science of religion, holds that moralizing gods — deities who watch, judge, and punish deceit and oath-breaking — made large societies possible: strangers who cannot trust each other can trust an all-seeing enforcer. In 2019 a *Nature* letter claimed to settle the direction of causation: complexity came first (Whitehouse et al. 2019). Measuring social complexity across 414 polities over ten millennia, the authors found that the sharpest rises in complexity preceded the appearance of moralizing gods — in twelve regions with before-and-after data, the growth rate was more than five times greater before the gods arrived, and none of the regions ran the other way. Moralizing religion, on this reading, was a maintenance mechanism for empires that already existed, not the scaffolding that raised them. The paper was then retracted — a coding error had let a script convert every "unknown" into an "absent," and the flaw had hidden in plain sight — and the episode is worth recounting for what it teaches about a young science. One commentator observed that a retraction stamp "might just as well read 'NEVER HAPPENED,'" while the authors warned against turning retraction into a culture of fear (Whitehouse et al. 2022). The retake used corrected data, 121 variables, and 372 polities, and the conclusion survived: social complexity remains the stronger predictor of moralizing gods, and in the reverse direction the effect dissolves entirely once warfare, agriculture, and pastoralism are controlled for — above all, cavalry warfare. The retelling is also a lesson in how codebooks read real religions: the Akan god Densu, who intervenes only after repeated provocation and can be bribed with offerings, is "inferred absent"; the Hittites punished theft, kin-murder, and perjury, but counted ritual offenses just as heavily and promised every soul the same afterlife, so their gods are absent too. Egypt had enforced Maat by the second dynasty, around 2800 BCE; Rome's gods punished perjury by 500 BCE, nearly a millennium before the city acquired an official religion.

The systematic test of the rival explanations followed in the same year, and its result is one sentence long: warfare wins (Turchin et al. 2022b). Against Big Gods, animal husbandry, resource scarcity, and affluence

— the running order of fashionable theories — models built on military technology, cavalry, agriculture, and pastoralism explain three quarters of the variance in the rise of moralizing religion, while the Big Gods coefficient is indistinguishable from zero. The timing repeats: the sharpest rises in social complexity precede moralizing religions, on average by three centuries. The proposed mechanism has the steppe's fingerprints again: around 1000 BCE, mounted archers of the Pontic-Caspian steppe, combining the composite bow with iron, forced agrarian societies to multiply their infantry — and mass armies, the argument runs, needed religions that would make strangers march. The authors are the first to mark the boundary of their result: the direct evidence that militarization produces moralizing religion is, for now, "presently scant." The comparison with the Big Gods camp is nonetheless instructive, because both sides made the same bet — that a database spanning ten thousand years could adjudicate a question philosophy had circled for centuries — and the database answered.

It answered a much older question the same way. Karl Jaspers placed the "Axial Age" between 800 and 200 BCE, when, he claimed, the great moral breakthroughs — in Greece, Israel, Iran, India, and China — created the spiritual foundations of humanity. Mullins and colleagues tested the claim with twelve proxies of axial traits, ten regions, five millennia, and a resolution of one century, and the answer is negative: the traits appear hundreds, sometimes thousands, of years earlier, and in regions nobody calls axial (Mullins et al. 2018). The Akkadian Šurpu liturgy, late in the second millennium BCE, already lists moral sins by category; Hinduism may be the world's oldest organized religious system with moralizing norms, from the early second millennium BCE; Hittite rulers were not gods. Italy is the report's quiet natural experiment: neither Greek philosophy nor Christianity produced an axial breakthrough there — indeed, Christianization coincided with more autocracy and sharper inequality. Japan poses the converse riddle: Buddhism created axiality in India, abetted it in China, and left Japan's god-touched rulers untouched by it. "Common notions about an Axial Age," the authors conclude, "are simply not well supported by the historical record."

What the field proposes to do with all of this is written down in its own founding survey. The Cultural Evolution Society was established in June 2015; within months it counted more than sixteen hundred interested scholars from over thirty disciplines and fifty nations, and its survey of 236 members yielded 422 candidate grand challenges, distilled by semantic analysis into eight — among them the modeling of culture as a complex adaptive system, the study of how cultural traits are transmitted and accumulated, the integration of methods across disciplines,

and the building of new structures for funding and public engagement (Brewer et al. 2017). The survey's two implementation proposals — distributed field sites for cultural evolution and coordinated research projects — read like Seshat's biography in advance. The historical framing is worth keeping in view: Darwin treated humanity cautiously in 1871; E. O. Wilson's *Sociobiology* detonated a controversy in 1975 with its final chapter on humans; and within a decade the dissent had bred new fields — evolutionary psychology, gene–culture coevolution, and their siblings. The aspiration the survey records for the next one is a sentence with Dobzhansky's cadence: nothing about humanity makes sense except in the light of evolution.

The report can now close the circuit it opened. Turchin named the discipline and wagered that history's clocks could be read; Korotayev showed that the anthropologists' zero correlation between population and warfare was an artifact of ignoring the time lag that the theory itself predicts; Scheidel let buried coins testify about a census debate two millennia old; Orlandi showed the theory retracing the fall of the Qing; François built the macroscope; Currie, Turner, and Gavrilets mapped the steppe's shadow across Afroeurasia; Kondor and Hoyer confronted the machinery with climate and found it stronger; Whitehouse, Mullins, and the Seshat collective pointed it at the gods and at Jaspers. What the framework still needs is a richer account of the state itself, a demonstrated mechanism from mass armies to moralizing gods, and an applied science of resilience that can do for the twenty-first century what the granaries did for the early Qing. The counterintuitive implication of the whole enterprise stands unchanged after nearly two decades of testing: instability is not an external shock imposed on otherwise stable societies; it is endogenous to the logic of social life — which means it can, in principle, be foreseen, and in principle, averted. The wager on history remains open.

Literature for this section:

Harvey Whitehouse, et al. 2019. Complex Societies Precede Moralizing Gods Throughout World History. *Nature* 568. DOI: 10.1038/s41586-019-1043-4 (retracted; see Methodical Transparency)

Harvey Whitehouse, et al. 2022. Testing the Big Gods Hypothesis with Global Historical Data: A Review and "Retake." *Religion, Brain & Behavior* 12. DOI: 10.1080/2153599X.2022.2074085

Peter Turchin, et al. 2022b. Explaining the Rise of Moralizing Religions: A Test of Competing Hypotheses Using the Seshat Databank. *Religion, Brain & Behavior* 12. DOI: 10.1080/2153599X.2022.2065345

Daniel Mullins, et al. 2018. A Systematic Assessment of “Axial Age” Proposals Using Global Comparative Historical Evidence. *American Sociological Review* 83. DOI: 10.1177/0003122418772567

Joe Brewer, Michele J. Gelfand, et al. 2017. Grand Challenges for the Study of Cultural Evolution. *Nature Ecology & Evolution* 1: 70. DOI: 10.1038/s41559-017-0070

Methodical Transparency

The twenty-nine works treated in this report are the most highly cited publications of the Turchin team and its collaborators published outside the team’s own journal, *Cliodynamics*; the selection was made on citation counts from the OpenAlex bibliographic database. Every work was analyzed afresh from its complete text, with all numerical claims in this report verified against the working digests of that reading. One exception is noted: “An Introduction to Seshat” (2020) lies behind the Equinox paywall and was consulted only as an abstract; it is cited accordingly.

Two source problems deserve explicit disclosure. First, the 2019 *Nature* letter on moralizing gods (Whitehouse et al. 2019) is retracted, following the discovery that data labeled “unknown” had been treated as “absent” and that an analysis script converted all missing values to zero; the corrected reanalysis (Whitehouse et al. 2022) preserves the paper’s central conclusion, and this report relies on the corrected version. Second, a numerical discrepancy exists in the literature about Hong Xiuquan, the leader of the Taiping Rebellion: the dedicated structural-demographic analysis of the Qing collapse (Orlandi et al. 2023) reports that he failed the state examinations four times, while the polycrisis study (Hoyer et al. 2023) reports five. This report follows the dedicated Qing analysis, four times. One direct quotation from the primary literature is reproduced from the *Secret History of the Mongols* and one pharaonic saying from the Orlandi team’s and Turchin’s sources; both are marked as quotations in the text. Nothing in this report is drawn from prior review texts; the reading, the digests, and the present account were produced independently for this version.

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1. Compiled with the assistance of the author’s local AI installation: the coding agent Qwen Code (model GLM-5.3-Flash), a custom-built memory server for long-term knowledge, and the reference-management system Zotero. The setup is described on the author’s website: logies.de/ai-workstation-linux-vm. Provided without guarantee.↩