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The not-so-great divergence: Asian and western world energy economy before 1815, and beyond

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Abstract

Here is an examination of Chinese institutional change and why the debate necessitates a new approach toward studying global economic divergence, one that focuses on a separation of historical mathematical evaluations rather than technological advancement. The Great Divergence debate is a historiographical discipline examining state formation in East Asia and its cultural evolution in juxtaposition with parts of Western Europe. The advent of steam power and other technologies in production and transport allowed Britain and others to extend their momentum past Malthusian restraints and separate themselves from "poorer" countries. But recently, the "California School" of historians like Bin Wong, Kenneth Pomeranz, and Andre Gunder Frank contend that China shared several similarities in proto-industrial development with their Western counterparts throughout Eurasia as late as 1750. My article will add impetus to an even newer argument by focusing on separate commentary from historians studying Europe's transition to an Arabic numeral system and China's insistence on traditional numeric methods. Modernity originated from a new abacus based on a ten-place system calculating numbers as large as 10^27, the year some purport it to have first been taught in Europe. Contemporary calculating devices and literacy materials are built on a similar model of arithmetic standards.

Keywords: American culture, Big history, Economic history, Great divergence, History of science, Literacy, Temporality.

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Contents

Contribution of this paper to the literature:
Dynamics of cultural change, which historians of Early Modern industrialization have taken up, favor Eurocentricity. Is it right? Before 1815, state formation in Europe and China resembled each other because of Big History. After the Chinese labor diaspora to the New World, it created a hybrid mathematical world energy economy that is unmistakable.

1. Introduction

Understanding the Great Divergence within a new modern conceptual framework requires historians to advance the notion of making a multiethnic society reasonable and to add economic integration to the Great Divergence debate. A new rhetorical mode of discourse will go beyond comparing commonly held differences and will rather delve into a classification of key characteristics related to technologies, such as the abacus, which arrived in Europe after being in Asia and Rome for centuries. The Great Divergence did not separate the world as much as it also united it into multiethnic patterns and revived traditional perspectives with the colonial expansion of Asian migrations. Sino-Mauritians are the most glaring example (Carter & Kwong, 2009). Later, after the eighteenth century, Sino-Americans arrived in their first wave to the United States. Mahjong, like the abacus's influence, is a Chinese game that spread throughout the world by the early twentieth century when maritime trade among Chinese Americans began. Merchants and other laborers arrived in the United States around 1815. The ancient abacus's use reiterates a striking point as a political forecasting device, which is that global foresight and trends did not favor one fragmented nation-state over another but suffered from the analysis of ethnocentric pattern reductions (Brown, 2012). Abacus and Mahjong by Carter and Kwong (2009) make economic consolidation a valuable historical model after Chinese settlement around the world united diffuse techniques in global trade. Fundamental aspects of our reality, which had been brought about by the spread of the early abacus and games like Mahjong, were inherently Asian.

This paper proposes a Malthusian Emanation Theory (MET) that reframes Thomas Malthus's geometric-arithmetic model beyond population dynamics, applying it instead to the historical dissemination of knowledge, computational paradigms, and energy consumption in technological societies. The model conceptualizes knowledge and technological innovation as expanding geometrically, while human cognition, institutional absorption, and energy resources follow a more constrained, arithmetic trajectory. By integrating this framework with historiographical debates such as the Great Divergence, as well as recent scholarship on historical computing methodologies, this paper presents a novel approach to understanding mathematical development, computational limitations, and the epistemic constraints of energy use in modern societies. Emanation theory has historically been associated with metaphysical traditions that describe the unfolding of existence from a singular source, whether in Neoplatonism, emanationist cosmology, or even technological diffusion models. This paper proposes a novel Malthusian Emanation Theory (MET), which reframes Thomas Malthus's geometric-arithmetic model of population and resource growth as a cultural-epistemological process. Instead of applying Malthus's framework strictly to demographic concerns, this model interprets his geometric and arithmetic distinction as a governing principle of cultural propagation, intellectual expansion, and the dissemination of knowledge within technological societies.

2. Rethinking Mathematics, the Abacus, and Computational Devices

Malthus's primary contention was that population expands geometrically (exponentially), while food production expands arithmetically (linearly), creating inevitable scarcity. If we abstract this principle beyond material resources, it can serve as a model for understanding the proliferation of ideas, technologies, and ideologies. In MET, knowledge, media, and cultural production expand geometrically, propelled by the acceleration of digital and emergent technologies. However, the capacity for societies to integrate, regulate, and assimilate these proliferating epistemes follows an arithmetic trajectory, constrained by institutional inertia, cognitive limitations, and socio-political structures. In Malthusian terms, population control occurs through preventive (social-moral) and positive (catastrophic) checks. In MET, cultural expansion—particularly in digital and technological domains—is subject to analogous constraints.

Preventive checks on cultural diffusion include: Institutional gatekeeping: Academic and governmental institutions act as regulators, filtering which ideas become legitimized; Ideological resistance: Established cultural paradigms, religious doctrines, and traditionalist movements resist rapid intellectual shifts; Technological friction: As ideas disseminate at increasing speeds (e.g., through social media, AI-generated content), societies impose algorithmic regulations and censorship to control their spread.

Positive checks on cultural overproduction include: Information collapse: When digital knowledge accelerates beyond human processing capabilities, misinformation, epistemic nihilism, and cognitive overload function as checks on cultural proliferation; Technological singularities: Certain forms of unchecked technological expansion (AI, automation, biotech) can lead to societal crises, not unlike the Malthusian catastrophe in demography; Sociopolitical backlash: Just as food scarcity leads to famine, rapid cultural transformations can incite reactionary movements, authoritarian resurgence, or conflict over competing epistemologies.

Of the many comparisons that can be made between Europe and China, a fundamental factor must be considered first: ecology, or the difference between the heaven beads and the Earth beads for Chinese abacuses. According to the multi-faceted work of Kenneth Pomeranz, it was a mix of ecology, environment, and human nature that led Europe out of its development slump in the centuries before 1800 (Pomeranz, 2021). By the time the West had acquired its New World territories, making way for resource-laden fields of coal, slave labor, and agency in the global market, China was languishing in its interior, probably due to inferior calculations. This is due in part to the Yangzi Delta, which provided an inverse effect to so much international trade. Instead of scouring overseas resources, they would produce what they needed within their territory. Europe, on the other hand, learned from the abacus to begin complex calculations on paper, without the confusion of heaven and Earth beads. In Russia, the schoty, Russia's version of the abacus, did not divide between heaven and Earth (Moon, 1971). Parry Hiram Moon's theory of holors is a mathematical generalization that extends the concepts of scalars, vectors, tensors, and matrices into a broader framework for multidimensional data representation. Moon introduced holors as a way to formalize structured mathematical objects that encode information in a systematic, hierarchical manner. His work was largely intended to unify diverse mathematical structures in physics and engineering. Holors could be useful in refining multi-dimensional economic models, particularly those dealing with Great Divergence theories and technological diffusion. The abacus, as an early structured computing tool, mirrors the way holors organize data. Essentially, holors provide

a conceptual extension of structured calculations, linking early counting mechanisms (like the abacus) to modern computational paradigms.

Authors Robert Brenner and Christopher Isett's article, "England's Divergence from China's Yangzi Delta: Property Relations, Microeconomics, and Patterns of Development," adds to the argument that Europe's divergence from China was not an aberration in history, but a mere facet of Malthusian terms (Brenner & Isett, 2002). The perspective they take contests the "California School" and suggests that China's comparability was just part of a dual Malthusian pattern that both China and Europe shared. Europe was better at its movement of gears and wheels, and of bones. This explains Europe's divergence through data that began as far back as the Medieval period.

The intellectual legacies of von Neumann (1958), Lovelace (1843), Penrose (1989), and Grothendieck (1971) provide essential insights into the intersections of mathematics, computation, and cultural history. von Neumann (1958), widely considered one of the founders of game theory, was instrumental in advancing economic modeling and decision theory, influencing Cold War strategic thought and computational economics. His work on the architecture of digital computing laid the foundation for modern computing, emphasizing logical structuring in ways that continue to shape AI and algorithmic governance. Similarly, Lovelace's (1843) pioneering contributions to computational logic and her prescient vision of general-purpose computing expand our understanding of the origins of algorithmic culture, reinforcing how 19th-century mathematical reasoning continues to inform contemporary discussions on artificial intelligence. The abacus, as one of the earliest computational tools, serves as a historical precursor to these developments. Its use in early mathematical education and trade practices laid the groundwork for numerical abstraction, facilitating structured calculation and financial modeling that prefigured many principles later formalized in game theory and algorithmic decision-making.

The historical transmission of mathematical knowledge can be traced through figures such as Marco Polo, whose travels to China facilitated the diffusion of numerical techniques, trade systems, and economic models between East and West (Craig, 2023). His accounts of Chinese commerce and governance introduced European audiences to the use of paper money, large-scale infrastructure, and financial administration that were previously unknown in the West. The abacus, a vital instrument in Chinese economic administration, likely influenced European mercantile calculations and early banking practices. This cross-cultural exchange highlights the significance of computational devices in shaping the development of global trade networks, reinforcing the argument that mathematical tools were essential in structuring early economic systems long before the Industrial Revolution.

Roger Penrose's exploration of mathematical consciousness and non-computable physics presents a counterpoint to deterministic algorithmic paradigms, opening questions about the limits of mechanized intelligence. His critique of computational theories of mind challenges assumptions about human cognition, offering alternative perspectives that resonate within philosophical and epistemological discourses. Meanwhile, Alexander Grothendieck's radical abstraction in algebraic geometry and his philosophical reflections on mathematical practice disrupt conventional historiographies of modern mathematics. His reclusive later years and rejection of institutional frameworks further mark him as a figure of critical inquiry, situating him within broader critiques of technocratic rationalism and the institutionalization of knowledge. Like the abacus, which represents a fusion of abstract thinking and practical utility, Grothendieck's mathematical formulations serve as a testament to the evolving interplay between concrete calculation and theoretical innovation.

The contemporary canonization of Bruce Lee, particularly in cultural studies and media theory, parallels these mathematical and computational discourses through its focus on embodiment, performance, and transnational identity. Lee's martial arts philosophy, influenced by both Daoist fluidity and Western boxing kinetics, offers an alternative framework for understanding movement and improvisation beyond rigid categorical constraints. In media theory, his legacy is often interpreted as a form of cinematic algorithm—his onscreen presence functions as a codified yet infinitely variable system of action, much like a dynamic neural network that adapts to shifting contexts. The transformation of Lee from a countercultural icon to a figure of global commodification raises important questions about canonization in the digital age and the algorithmic reproduction of identity through digital media. Just as mathematical theorists and technological pioneers have shaped computational paradigms, Lee's methodologies exemplify a form of embodied algorithmic expression, blurring the boundaries between human intention and automated precision.

A Malthusian Emanation Theory (MET) framework applied to American Cultural Studies reveals how technological acceleration, cultural production, and computational limits shape narratives of crisis, expansion, and control. American cinema and media industries, particularly science fiction, speculative fiction, and cybernetic thrillers, often depict themes of epistemic acceleration, computational exhaustion, and systemic collapse, mirroring the geometric-arithmetic tensions MET identifies. From early Hollywood representations of technological optimism to contemporary dystopian narratives in digital media, film has served as both a medium for and a critique of the cultural consequences of unchecked computational expansion.

Hollywood's engagement with themes of knowledge expansion and systemic collapse aligns with MET's central concerns. Classic films criticize the mechanization of labor, prefiguring contemporary anxieties about AI and automation. More recently, films explore the limits of human cognition and machine intelligence, foregrounding the inherent tensions of exponential knowledge production within arithmetic social and institutional frameworks.

Science-fiction worlds where computational excess has led to the subjugation of humanity reflect Malthusian anxieties about an overproduction of intelligence surpassing human control. Similarly, these films raise ethical concerns about AI sentience, power asymmetries, and the eventual obsolescence of human cognition, again echoing MET's premise that knowledge, left unchecked, reaches a Malthusian breaking point. These films function as cultural emanations, visualizing MET's argument that the expansion of computational intelligence and algorithmic governance cannot be sustained indefinitely within human-designed systems. American media industries have long been at the forefront of technological acceleration, but their global dominance in cultural production also reflects the uneven distribution of computational resources and epistemic expansion. The Great Divergence—as framed within MET—suggests that different societies encountered technological limits at different rates based on their historical access to calculative tools and computational paradigms. Hollywood's dominance in global film markets represents an epistemic asymmetry: the ability to control the narrative of technological progress and collapse is as significant as the actual computational advances themselves.

Global media divergence has engaged explicitly with the consequences of developing global technological stratification. These narratives present computationally hyper-advanced societies where human agency diminishes

under the weight of artificial intelligence, cybernetic augmentation, and algorithmic governance. The films' aestheticization of decay—contrasting hyper-advanced AI with socio-political collapse—reinforces MET's argument that knowledge production expands beyond the ability of institutions and energy infrastructures to sustain it, leading to systemic failure. The rise of streaming platforms further complicates the intersection of computational expansion and cultural production. These platforms operate on algorithmically driven content dissemination, maximizing engagement through data-driven personalization. However, this exponential growth in content production follows MET's principle of computational Malthusianism: as data expands, human cognitive and institutional processing capacities remain limited. The result is cultural exhaustion, a phenomenon where audiences are inundated with more content than they can meaningfully engage with, leading to algorithmic determinism in cultural consumption.

Furthermore, the energy demands of digital streaming mirror the computational energy crisis that MET outlines. The shift from physical media to cloud-based streaming has intensified data center energy consumption, contributing to a material limit on digital culture's expansion. Just as Malthus predicted resource constraints in human populations, MET suggests that cultural overproduction, driven by algorithmic acceleration, will eventually reach a saturation point where attention, infrastructure, and energy cannot sustain further growth. By applying MET to American Cultural Studies, this paper proposes a framework that situates cinematic and digital cultural production within the broader tensions of computational acceleration, energy constraints, and epistemic overload that are historically intertwined. This theory challenges dominant narratives of infinite technological progress, arguing instead that film and media function as critical reflections of knowledge overproduction and systemic limits.

Ultimately, integrating MET with contemporary American culture and media reveals that the very narratives designed to depict technological collapse are themselves products of a media ecosystem bound by the same scientific constraints. As film, television, and digital media continue to grapple with themes of computational excess, cultural theorists must recognize the underlying Malthusian structure shaping both content and production. By doing so, we gain a deeper understanding of the relationship between cultural knowledge systems, technological acceleration, and the inevitable limits imposed by energy and institutional arithmetic.

The tension between exponential expansion and linear constraints in Malthusian thought not only applies to demographic and cultural systems but also provides a useful intervention in the Great Divergence debate—the historiographical discourse concerning why Western Europe industrialized before other regions, particularly China. Scholars such as Kenneth Pomeranz argue that Europe's economic ascendancy resulted from geographic luck and colonial extraction, while others emphasize technological superiority and institutional divergence. Historical computational methodologies complicate this debate by drawing attention to non-Western systems of calculation and their epistemological implications. If we consider MET within this context, we see that cultural emanation, particularly in the realm of mathematical and technological knowledge, was not a uniform or unidirectional process. Rather than framing Europe's ascendancy as a purely material divergence, MET suggests an epistemic divergence, wherein different mathematical traditions and their computational artifacts (e.g., the abacus, Napier's bones, early mechanical calculators) shaped the trajectory of technological development.

Malthus's geometric-arithmetic argument also offers a compelling framework for revisiting the history of mathematics and computation. While the dominant historiography assumes a linear progression from manual counting tools to digital computing, MET suggests that knowledge diffusion in mathematics has been subject to exponential accelerations and subsequent plateaus, much like Malthus's vision of population and resources. The abacus and pre-modern calculation have become limiting factors. If we extend MET to historical computation, we see that mathematical advancement was not purely a function of cognitive evolution but was instead constrained by technological materiality. The abacus, for example, facilitated arithmetic operations at a rate that could be considered "arithmetic growth" compared to the "geometric growth" enabled by later devices like logarithmic tables and mechanical calculators. This suggests that the computational epistemologies of different societies created distinct limitations on economic and technological acceleration, providing an alternative explanation for the Great Divergence.

Just as Malthus's theory suggests that the human population will inevitably face a crisis point due to material constraints, MET argues that our current mathematical foundations, rooted in binary logic and conventional arithmetic, may be reaching a point of epistemic exhaustion. The dominance of Western mathematical frameworks, with their emphasis on formalism and abstraction, has constrained alternative computational paradigms, particularly those based on non-Western logic, analog computing, or emergent AI-driven models. Thus, MET calls for a complete reevaluation of how we conceptualize mathematics, computation, and historical calculating devices. By integrating a Malthusian emanationist framework with historiographical debates like the Great Divergence, this paper proposes that our contemporary computational crisis, marked by the limitations of digital computation and the challenges of post-binary logic, demands not just new technologies but a fundamentally new way of understanding mathematical thought itself.

For further exploration of the Great Divergence within this context, the most recent scholarly contribution is Peer Vries' *Escaping Poverty: The Origins of Modern Economic Growth* (Vries, 2023). This work offers a comprehensive reassessment of economic development patterns, interrogating Eurocentric narratives while engaging with global historical frameworks that account for technological diffusion and institutional transformations. Vries challenges the traditional emphasis on European exceptionalism by demonstrating that industrialization and economic growth were not predetermined by cultural or geographical factors but rather by contingent economic policies and state-driven innovations. His research suggests that factors such as the role of financial institutions, resource allocations, and infrastructural expansions played a decisive role in shaping global economic trajectories. Additionally, Vries examines the underestimated contributions of Asian economies in early modern development, highlighting how the movement of knowledge and technical expertise between East and West contributed to economic transformation long before the Industrial Revolution took hold in Europe. By incorporating insights from the abacus, economic modeling, and computational history, a broader, more nuanced understanding of the Great Divergence emerges, one that moves beyond simplistic dichotomies to embrace a multifaceted global history of economic evolution.

3. The Great Divergence and the Computational Divide

During the middle of the twentieth century, education and literacy materials were being distributed to educate young Americans about recent contact with the Chinese through missionaries, letters, and diplomatic correspondence

that explained technological acumen in the region, which had existed since those Medieval times. Missionaries were still using the abacus to calculate their accounting duties. One of the most notable was the American Board of Commissioners for Foreign Missions. One of their promotional films was "Letter from China" in the 1940s, distributed by Periscope Films. The film takes place in Fuzhou, China. The film shows Fuzhou through a "Letter to Dad" from Reverend E. Walter Smith as he occupies a rural airfield, and a Douglas DC-3 plane brings missionaries to the Fujian Province. Another film, "Children of China," was produced in the early 1940s by Encyclopedia Britannica with Dr. L. Carrington Goodrich of Columbia University. One emphasis of each of these films was to show how empirically similar life was in China to the West. Additionally, educational reform in the United States relied on diversifying its curriculum with information such as this, and China also had a stint with reform in 1904. Zhang Zhidong's reforms included simplifying Confucian classics and advocating for utilitarianism. Many of Zhang's reforms included experimenting with Western-style schools. And without a uniform national standard for mathematics education, it was common to fund reform policy with "transformative research" techniques.

Making new Great Divergence literature based on a history of calculating devices means examining what already exists on the issue and how it can be incorporated into present research discussions. With Europe's access to slave labor, resource-rich peripheries, and mercantile expansion, the East had no obvious counterpart. If we consider Pomeranz's depiction of North China's hinterlands, where rival Mongolian steppe people kept them engaged in an isolated rivalry, the most that China's late imperial regime could point to as a comparison would be these rival frontier peoples. South China's Guangzhou region also continued a legacy of regional development – rice to the south and dry farming in the north. Yet, the "Origin and Development of the Chinese Abacus" by Li (1977) demonstrates that, like many Chinese customs, the design and function of the abacus remained unchanged for around 1,300 years. Japanese modifications and European alterations were next in line. In the Yangzi Delta, China had direct non-market access to its means of production.

The English experience of a Smithian dynamic of economic evolution was driven instead by land scarcity. This preceded the Qing period of landlords, who lost the effective ability to vary rents with supply and demand and use the abacus for accounting. Whether it was East Asian "paddy zones" or colonial American "cotton belts" of production, valuations thrived in either case. In turn, peasant property was heavily taxed, and the average size of household plots in China remained below 5 acres due to population growth (Brandt, Ma, & Rawski, 2014). Such degrees of taxation are assumed to justify peasant poverty as a feature of Chinese society, but Thomas Rawski has conducted comparative studies showing that the Chinese were relatively undertaxed compared to other parts of the world despite having similar living standards; this is one reason for statistical difficulties in the modern era.

To further critique the "California School's" Sinocentric view, Brenner and Isett assess Pomeranz's use of the "global conjuncture" concept by focusing on separation rather than conjuncture. Separation is what the Great Divergence principle relies on most, but Brenner and Isett shift that separation as far back as the late Medieval period instead of relying on Chinese parity with the West. Between 1430 and 1550, the grain-buying power of Europeans declined sharply. It did not return to 1350 levels until 1840 or later (Pomeranz, 2021). Similarly, in the history of the abacus, we can shift its origin to as far back as the Babylonians in 600 BC (Melville, 2001). The word abacus itself comes from the Phoenician word abak, meaning sand. The Chinese numbers compare well with Europe, as Pomeranz accurately describes, but the rice-buying power of day laborers' wages fell from 1100 onward and returned to prominence between 1500 and 1750. What is more important is acknowledging the virtues of state formation in the comparison between the West and East. Unlike Europe, China was not only following a tradition of ecological change at home, but it was also having an inverted response to global trade, hence its lack of peripheral territories. It is clear from archival records as late as the 1940s that state-initiated efforts to formalize the practice of local governance began in the last decade of the Qing dynasty. The Guomindang regime strengthened these efforts with limited success. Only after 1949 did the new communist regime succeed in extending the reach of the state to local society at the village level and gain more publicity in the form of U.S. missionaries and films.

Ancient history tells us a story of capitalism exemplified by a Mesopotamian "Silk Road" but what more can it say about India? From as far back as China's Han Dynasty, 206 BC, there was an effort to standardize the currency, expand market relations, and promote long-distance trade carried out by merchants. But it was also Hindu base ten that arrived in Spanish logarithms between the tenth and fifteenth centuries. Wilhelm Schikard wrote letters to Johannes Kepler about using calculation and mechanics in tandem. A calculator such as Schickard's also relied on John Napier-type logarithms that made colonial expansion a feature of accounting. China's preponderance for an authoritarian centralized state has been less examined under these auspices. Capitalism worked in Europe, but it stagnated in China due to timing. Historians have discussed China's "commercial revolution" in the eleventh and twelfth centuries when pathbreaking technological innovations, gunpowder, the compass, and the printing press, happened. Much of this was continued when China was ruled by the invading Mongols and then later by the Ming dynasty (Kocka, 2017). In the late twentieth century, another "commercial revolution" spawned an analogous cascade of development in China with innovative technology (McCord, 1993). Europe was fortunate enough to have access to resource-laden market dynamics when it did, and it did, by accessing the reservoir of New World territories during its Industrial Revolution phase. This inevitably persisted by influencing their beliefs about world markets from a European point of view. Prasannan Parthasarathi in *Why Europe Grew Rich and Asia Did Not: Global Economic Divergence, 1600–1850*, trusts upon Eurasian pressures and a preponderance of Indian and Chinese cultural exchanges with Britain, whereby Bengal and South India grew into its unique literature and economy (Parthasarathi, 2011). Indians were not yet a dynamic migration power but, today stand as the highest-earning ethnic group in the United States.

To understand why China did not achieve a comparable Industrial Revolution, historian Victoria Tin-bor Hui harkens back to the Warring States period in Chinese history beginning in 656 BC. During this time in China, there was a system of sovereign territorial states similar to Europe in the Early Modern period, AD 1495–1815 (Hui, 2005). In both cases, this formative period witnessed war, the formation of alliances, the development of a centralized bureaucracy, the emergence of citizenship rights, and the expansion of international trade. Partition theory is akin to the Great Divergence in that, comparable to number theory or combinatorics, a positive integer of n is also a sum of positive integers that differ only in their order. 1 + 3 or 3 + 1 yield the same result. Using an e-abacus diagram, researchers can plot the separate references a digital humanities scholar can decode, deciphering which English letter coincides with a Syriac language letter, one of the oldest languages in the world (Ali, Ahmed, Sami, & Mahmood, 2021). The common Sinocentric perspective maintains that China was destined to have authoritarian rule under a

unified empire; it is just a matter of finding out when it began. To put this into context, some adages have meanings diluted by time, such as "Middle Kingdom." Hui points to the correct use of the Chinese word Zhongguo, which refers to the "Middle Kingdom," but is defined as "central states." Zhong means central, and Guo means states. Informal checks and balances are necessary to create accurate comparisons. Furthermore, these checks and balances encourage accurate comparisons with Europe that make "time" a variable that needs to be considered. Hui does this by avoiding the common parallel of Early Modernity and instead compares Early Modern Europe to ancient Chinese history. The ancient Chinese system emerged from the ruins of a prior feudal order. Zhou formed a feudal hierarchy after conquering Shang around 1045 BC, and the Zhou hierarchy eventually crumbled in 770 BC after a barbarian attack forced them to relocate to Loyang from Hao, eastward. Independent Guo began to keep court chronicles (Chunqiu or Spring and Autumn Annals). Historians of China generally date the beginning of this multi-state era to 770 BC. Hui dates the onset of the ancient Chinese system to be in 656 BC and ended at the establishment of the universal empire in 221 BC (Hui, 2005). The concept of Waltzian Realism, created by Kenneth Waltz, also known as neorealism, argues for a structuralist view of state formation, something that is cycled in ancient Chinese dynasties toward unification before Europe had the opportunity to do the same, thus advancing the claim that they were farther ahead than previously thought.

Joseph Schumpeter did not only used the term capitalism in his research, but he was also deeply influenced by how the economy changed. He found this in innovation. He developed his theory of the business cycle, where innovations trigger growth with more and more entrepreneurs joining in. Max Weber, likewise, attributed special significance to a "spirit of capitalism" that Weber derived from the Calvinist-Puritan ethic beginning in the sixteenth century. Chinese merchants were not wholly convinced by the opium trade, for example, and Confucianism spelled the end for Dutch and English traders in Hong Kong's port of entry in the Early Modern world in protest. By contrast, Early Modern Europe failed to deliver on the promise of a single dominant state. The Chinese trajectory that had a logic of balancing, domination, rising costs of administration, self-strengthening reforms, divide-and-conquer strategies, and ruthless stratagems placed them into the logic of domination fully. Why not Europe? Europe failed because it did not follow the logic of domination entirely. Del Gandio (2012) in "From Affectivity to Bodily Emanation: An Introduction to the Human Vibe" wants readers to fulfill the phenomenological paradigm of human experience (Del Gandio, 2012). I want to focus on the scientific paradigm instead, and to do that means accepting a novel body politic that is not part of a human body-environment relationship as Gandio wants to understand. Abacus history tells us emanation starts from an epistemology of fragmentation, and thus the epistemology of emanationism notices sameness across cultures over time. Temporality was on the side of mercantile expansion in Europe and the West, while the pursuit of mercantilist policies helped construct roads, bridges, and canals, and promoted nascent industries critical to Europe's military power abroad before it witnessed Asia's association with modernism.

The Industrial Revolution was a distinctly English phenomenon, but it innately speaks to the fragmented reality of Europe, particularly Prussia in Eastern Europe, and explains why Baruch Spinoza's association with mathematician Johannes Hudde and anatomist Theodor Kerckring made calculations a rational quality. British industrialization spread to the rest of Western Europe as it practiced expansion abroad, also influencing the epistemology of emanation for both Western and later Eastern society. To Eurocentric historians of this debate, Europe's age of discovery is referred to as a latecomer to international trade. It is rather ironic to note that, aside from the apparent challenge Sinocentric scholars present regarding China's comparable reputation in the Early Modern world, the Portuguese, Spanish, Dutch, and English sequesters abroad made Joint Stock Companies and finance capitalism the norm all over the world. For them, and conquistadors like Hernan Cortes, it was about supply and demand. Agrarian capitalism and mining were not new to the Chinese mind, but they did interrupt what China considered to be a central status on the world stage. Europe leveraged English industrialization, and even before 1800, was forging their dynastic disputes into competition for valuable silver deposits, land, and spices, to name a few. The 1602 Dutch "United East India Company" was one of, if not the most important colonial trade apparatus. The Dutch Republic and the English constitutional monarchy established after 1688-1689 consolidated public debt to help pay for all these excursions. In Europe and China, a framework of the household economy helped make clothing and other manufactured goods from rural or countryside areas, and abacus accounting did all the work. European artisanal production by the fifteenth century resembled the moral doctrine of other authors of stature, namely Baruch Spinoza, who inspired new enlightenment virtues they saw in themselves for others. Capitalism became the dominant principle in England and the Netherlands. There was also an increase in reading skills among urban populations, and a growing dissemination of newspapers, books, and listings of all kinds.

Cycles of silver gave birth to modern world trade using a universal currency, renewing emanationism and the epistemology of calculations. Was this kind of unique prosperity a miracle? Some scholars think so (Jones, 2003). We must look at the verifiable data that exists now. Before the Industrial Revolution, authors Dennis Flynn and Arturo Giraldez made certain to link Europe's "late-blooming" with the nascent sixteenth century alongside Asia. Their thesis is that Europe versus non-Europe discussions do not need any more reinforcement, but rather they want the field to focus on the highly integrated global economy that has existed since the sixteenth century (Flynn & Giráldez, 2002). If we want to explain miracles, then we must develop a working methodology. Their article focuses on two significant cycles in the evolution of the global silver market. The first phase – The Potosi/Japan cycle – spans the 1540s to the 1640s and generated the birth of global trade, and a second silver phase out of fragmentation – The Mexican Cycle – which covered the first half of the eighteenth century and was related to significant demographic growth in China, also attributable to new crops in the Americas. These two silver cycles bolster the authors' contention that a highly integrated global economy has existed since the sixteenth century and that all analyses of world regions should recognize an interconnected economic, demographic, and ecological force on a global scale. Arbitrage Trade created deficits that China counterbalanced with mercantilist trade. Chinese traders exported some non-silver products like silk and ceramics to make up for this arbitrage trading. While it is true that Chinese porcelain was the most universally admired and imitated product in the world, the 1540s to 1640s could be viewed in terms of "multiple arbitrages," rather than a single arbitrage. The silver market co-existed with silk, ceramics, and other non-silver goods. During the Mexican Silver Cycle of 1700–1750 and the surge of American crops, three changes occurred in the eighteenth century that set the course of China's subsequent history of calculations around the world: the establishment of Europe's presence globally, the doubling in territorial size of the Chinese empire, and the doubling of the Han Chinese population. New World crops contributed to massive ecological changes not only there but also around the world and in China (Hämäläinen, 2010). By the eighteenth century, sweet potatoes were grown in all the

provinces of Yangzi and Sichuan. These and other crops spread through the intermediaries of the Philippines and other Pacific Islands. There was a massive Mexican-Peruvian silver boom in the eighteenth century that more than doubled the production of the Potosi-Japan silver cycle of the 1540s to 1640s. Eighteenth-century silver flowed to Asia in the most successful form of global money in history, which was the Mexican pesos, as well as the Dos Mundos and Bustos pesos. The extensive royal buildings that grace Madrid today stem from the eighteenth century during the Mexican Cycle of silver production.

The next great emanation cycle was the Tea and Opium Cycle. The Battle of Plassey in 1757 led to British control of Bengal and represented a fundamental change in Asian trade patterns. The three decades of the 1750s, 60s, and 70s marked decades of British rise to power and a French-Dutch decline. Opium and tea became the high-profit markets and remained so for quite some time. It is not wholly unique to find some historians, like Andre Gunder Frank, accused of switching their viewpoints after encountering China, the "ultimate sink" of global trade patterns and the world's money, silver (Arrighi, 1999). Giovanni Arrighi exposes Frank's Eurocentric theory early on in his career. Examples include World Accumulation, 1492-1789, and Dependent Accumulation and Underdevelopment, both of which were published in 1978. In his book ReOrient, Frank wants us to deconstruct the assumptions of Western social theory and change our perspective (Frank, 1998). Instead, he deduces through his research that Asia was displaced from being the center of the world economy after 1800.

Andre Gunder Frank is also part of this "California School" of Sinocentric thought. What Frank uses as his framework is a theory on the rise of the West that is based on three contentions: the first is a free-ride on the Asian train argument. Next, Europeans obtained money from gold and silver mines found in the Americas. Lastly, digging up silver led to other profitable businesses, like lucrative slave plantations. What Europe bought into the wealth of Asia itself, buying commodities that they resold for a profit in Europe, Africa, the Americas, and Asia, was not a way for Europe to profit from the intra-Asian trade but from calculations, most of which the abacus enabled earlier in history. Europeans could hold out in Asia for three centuries but were unable to position themselves in the global economy because silver cycles benefited Asian economies more, ironically. Or, as other historians contend, it was more like the "ultimate sink" argument that pervaded until 1800, when China no longer bore the brunt of a global trade imbalance. It becomes clear to see how the decline of the East preceded the West. But why were Asian polities weakening? Frank argues that Asian successes permitted the decline of the East and not European penetration. Industrialized economies in Europe used import substitution and export promotion to create a new hegemonic order. There was a rise with Europe at the center, not China, and a rise in capital. After 1750, the expansion of the global economy was generated by labor, land, capital, and labor-saving technology. Qing China was caught in an all too familiar "High-Equilibrium Trap" that Pomeranz describes.

If it is true that Europe experienced advantages along with Malthusian terms and it was China's preponderance to encounter traps or hindrances, what gave the West such a dominant trajectory toward expansion after 1750? Landes (1999) claims that sometime in the medieval and Early Modern era, Europe took a decisive path apart from other civilizations (Duchesne, 2005). The Wealth and Poverty of Nations reinforces the theory, arguing that temperate places in Europe and North America were afforded an advantage (Landes, 1999). Tropical climates, in contrast, simply could not work as hard or efficiently as their counterparts in Europe and North America. The affordability of abundant natural resources and a refusal to let them go to waste is part of a theme that highlights the Eurocentric wisdom that has evaded other nations. Part of Landes's thesis is that New World conquest and imperialism were not immoral, but stimulated capital, industrial commerce, and trade in a way that accounted for the emanation of New Worlds from fragmentation (Alexander, 2024). Economic historians have rallied behind Landes in some respects, echoing the tenets he puts forth that western history did not build off the back of the rest of the world, but moved ahead of the pack with gears, widgets, and clock calculations.

In the article, "A Grand Tour of Exotic Landes," Charles Tilly's review of Landes's book *The Wealth and Poverty of Nations* aims its critique at the questionable use of statistics, a problem compounded by diverse use of the abacus's methodology (Tilly, 1999). Tilly writes, "he deploys statistics when they suit his arguments but overrules them when they do not," suggesting that Landes's summary of technological change is more biased than he would care to admit. For example, Landes compares per capita product figures for Mexico, Barbados, and the contemporary United States in 1700, 1800, and 1989, but uses a footnote to mention that these figures are but "figments" (Landes, 1999). Despite the warning, he then assures his readers that his Sinocentric opponents are overstating the importance of said statistics. And in another stroke of academic fate, Landes in his work *Unbound Prometheus* is accused by Tilly of using analyses he derived there, a publication from 1969, to promote obsolete information for his future studies. These types of substantial criticism were what Andre Gunder Frank had to also endure after releasing *ReOrient* (Frank, 1998). For Eurocentric historians, the condemning association with this side of the debate may spell disaster.

To call the West a "late bloomer" misses the mark in arguing for a British or Albion advantage only after the Industrial Revolution. Instead, Landes must acquiesce to examining the roots of expansion both theoretically and chronologically. Though, unlike Victoria Hui, who used Ancient Chinese state formation as her example, Landes derives his argument from the prevalence of ecological circumstances, or better put, anomalies. It may be hard to find a historian who would have said with certainty that the "statistics" or an analytical study of Europe during the Early Modern period would have proposed that Europe was destined for exponential expansion and China to a centralized authoritative regime. The only explanation for that would have to be accidents and rare luck, which is a retreat from normative global statistics calculating mechanisms.

Rather than be hampered by political correctness, Landes takes the moral high ground in his argument, just as Spinoza would as an Enlightenment rationalist. He does this by using economic explanations and framing nature's inequalities as unyielding next to human dependency. After all, it is not the Europeans' fault for countries that were poorly situated in tropical or semi-tropical climates near the equator. Richer countries are in temperate zones, Landes reminds readers. Guy, 1999, author of "The Morality of Economic History and the Immorality of Imperialism," provides insight into the reasoning of David Landes (Guy, 1999). He accepts the Max Weber thesis that Protestantism, and Calvinism more specifically, were at the forefront of industrialization compared to Muslims, Catholics, Jews, and other non-conformists such as Quakers or the diversity of worship related to Judaism. Max Weber's thesis applauded the efforts of these religious reformers because if it were not for them, the Industrial Revolution would not have had the same enduring impression on the human psyche. Invention and religious temperament turn the arguments of a morally corrupt Europe into a contradiction, for it was the Protestant ethic that instilled values of respect, honor, and order into the cultural consciousness. If there is any connection between

what imperialism inflicted on indigenous populations as an immoral ethic and the economic history of the West, then it should be reconstituted to fit the parameters of more than valuations. And this is exactly what Landes ventures out to do. Landes relies on a counter-moral argument which then positions the Sinocentric side of this debate into a conundrum of a "numbers only" approach. Historians must concentrate more on this vantage. In the case of The Wealth and Poverty of Nations, Landes pardons the rise of Western nations who were merely acting out a natural, rational means of making a profit, arguing that in that case there is no real culpability. The only exploitation was of a clear opportunity for the taking. Joel Mokyr argues that Europe's rise out of stagnation was not a complete accident. Mokyr is part of this eclectic group of historians seeking explanations for Europe's divergence (McCord, 1993). If it was not a happenstance of coming upon good economic fortune, then what was it? Mokyr agrees with the common consensus that Europe was largely lagging behind the rest of the world before the Industrial Revolution. According to Mokyr, Europe was a relatively backward, poverty-stricken region. Interestingly, this may be a stipulation that supports Europe's great divergence. China, by comparison, had already demonstrated its lead, but that same pace could not be sustained. Subsequently, when Industrialization arrived in Europe, checks on authoritative power grew the trend toward led to more expansion. This points to a fortuitous slump or equilibrium trap. Also, two historical giants, Mancur Olson and Douglass C. North, seem to have had little intellectual influence on Landes (Höijer, 2004), who does not list them in his bibliography.

Formal economic histories of Chinese state formation use the concept of institutions to their advantage, but emanation proves better when attempting to understand it as a history of calculations. Unlike David Landes's overreliance on culture, economic historians such as R. Bin Wong or Morris Bian situate their arguments in the history of patterns. There are two main analytical challenges in comparing European and Asian political economies: first is comparing closely European practices with those found elsewhere, and second, observing more carefully the economic connections forged in the Early Modern period (Wong, 2019). Accurate economic histories regularly encounter parallels, even for authors of disparate intellectual opinions. It is the data that matters most, and institutions are what harbor the social confluence of groups. In his article, "The Search for European Differences and Domination in the Early Modern World: A View from Asia," R. Bin Wong reiterates that the world before 1800 was overwhelmingly agrarian, and production possibilities were largely the same everywhere. It was either through expansion or an increase in the rates of mechanized factory production that enabled societies to grow in mathematical unison across varying time periods. Economists and historians should wisely reconsider their evaluation methodology here. China was not alone in its pursuit; between 1500 and 1700, Japan was also increasing its productive abilities and rapidly urbanizing its population with calculating societies and people who were proficient in mathematics. Production centers were located in areas of high demand with regional specializations such as silk, lamp oil, and soy sauce in Japan's Osaka, Kyoto, and Kobe cities. An entire maritime trading network around port cities flourished in Southwest Asia. China's commercial revolution was adopted in places such as present-day Shanghai, where cotton textiles, silk, and rice were central nodes, and offshoot items such as salt, fish, bamboo, pottery, metal goods, embroidery, tobacco, and vegetable oils contributed to widespread commercialization. To solidify the production patterns between Asia and Europe, one only needs to look to the logic of exchange. China's "native banks" were financial institutions driven by Smithian logic and divisions of labor before Europe. The very first zhangju appears to have been established in 1736 by a Shanxi merchant in Zhangjiakou, who committed 40,000 taels. It acted as a bank for loans or deposits and helped facilitate Russian-Chinese trading, a precursor to one of the major border frontiers of trade in contemporary China.

To better understand how a sufficient economic framework can explain state formation, it is crucial that the historiography address periodization. If it is not clear, it should go without saying that the East was in many ways a suitable rival to Europe in the Early Modern period. Morris Bian has taken the common assumptions about this temporal dichotomy and presents a unique narrative of Chinese economic history that is neither Early Modern nor ancient; rather it spans from 1937 to 1957 (Bian, 2009). In it, Bian traces the development of industries associated with the Chinese Communist Party (coinciding with Kuomintang), doing away with the commonly held myth that China borrowed its planned social-economic system wholesale from the Soviet Union. The Sino-Japanese War from 1937-1945 was a crescendo in a tumultuous history after the fall of the Qing Dynasty in 1911. As was the case in the Early Modern period, Japan's proximity to China made it a fierce competitor. It also created a distinct pattern of factory formation. The "connective tissues" of Guizhou's regional economic institutions refer to the connections that sustained key elements of Guizhou's regional communities. After September 1953, Mao Zedong announced a new general socialist transition, which was designed to address the "pressing need for cadres for industrial reconstruction" (Bian, 2009). In contrast to their European counterparts, centuries of history resulted in China not undergoing an Industrial Revolution, but a political one, burdened with the task of reconstructing Malthusian-induced crises. Some projects included state-owned heavy industry, mining, national defense, ordinance manufacturing, and artillery factories relocated away from the periphery.

During the early 1930s, work emulation campaigns in China were established by the Nationalist government to foment a response to languishing motivation. This is similar to the situation in the United States. The adoption of an accounting system characterized by cost calculation and state-owned enterprises as motivations were features of modern capital enterprises. Bian cites Arif Dirlik, who argues that the New Life Campaign was the "Guomindang version of a 'cultural revolution' for China," and he may be correct (Bian, 2009). The New Life Campaign was designed to instill Confucian moral values and a modern military ethic into the people. Academic scholars who ventured to the United States, as well as to European universities in England and Germany, ignited the passion for learning in China. A typical coming-of-age story is that of Qian Changzhao, who studied political economy and economics at the University of London and Cambridge University and finally returned to China infused with the ideals of Fabianism. Qian became deputy director of the National Defense Planning Commission and deputy director of the National Resources Commission. This only attests to the viability of a European and Chinese comparison that was emboldened by an exchange of ideas – whether in the Early Modern period or the early twentieth century. In 1936, the Three-Year Plan for Heavy Industrial Reconstruction was made a central facet of the commission's organizational structure. Some financial plans began as early as 1933. In early 1941, the National Resources Commission made another comprehensive economic plan, the Outline of the Three-Year Plan for National Defense Industries. Between 1942 and 1944, the National Resources Commission would establish new factories or expand existing ones.

4. Energy as a Constraint on Knowledge Growth

While Malthus framed food production as the primary limiting factor on population growth, MET extends this logic to energy as the fundamental constraint on computational and intellectual expansion. The historical transition from manual computing (abacus, slide rule) to energy-intensive computation (electromechanical machines, digital processors) mirrors Malthus's arithmetic-geometric distinction. Pre-industrial computation and the arithmetic limitations became pronounced as pre-modern computational tools, which relied on human labor and analog devices, constrained mathematical complexity and limited the speed of scientific discovery. Industrial and digital computation represent geometric expansion, such as the advent of mechanical and electronic computing, which allowed for the geometric acceleration of knowledge production, enabling breakthroughs in physics, economics, and artificial intelligence. The energy crisis has evolved into a crisis of knowledge production. Today, the exponential growth of data processing, artificial intelligence, and quantum computing is encountering energy limitations, leading to a new computational bottleneck. Just as Malthus predicted a crisis of resource scarcity, MET predicts a forthcoming crisis in knowledge production due to the unsustainable energy demands of contemporary digital infrastructures.

Given the inherent limitations of energy-intensive digital computation, this paper argues for the necessity of a post-binary mathematical framework—one that moves beyond the constraints of classical arithmetic and explores alternative epistemologies of computation. Historical calculating devices, such as the abacus and other non-Western mathematical systems, provide a foundation for reimagining computational architectures that are less dependent on exponential energy consumption. Emerging fields such as neuromorphic computing, analog AI, and quantum mechanics suggest that alternative logics, inspired by historical epistemic traditions, could circumvent the Malthusian crisis of digital knowledge production. By integrating insights from MET, the Great Divergence, and energy studies, this paper proposes a reorientation of computational thought—one that does not merely optimize existing systems but fundamentally rethinks the underlying principles of mathematical abstraction and calculation.

Malthusian Emanation Theory provides a framework for understanding not only historical constraints on knowledge production but also the contemporary limits imposed by energy consumption and epistemic saturation. As societies face the dual crises of data overload and energy scarcity, the need for a paradigm shift in computational epistemology becomes increasingly urgent. By revisiting historical mathematical traditions and computational devices, this paper calls for a radical reassessment of how mathematical knowledge is structured, transmitted, and sustained in the face of impending resource constraints. The implications of this analysis extend beyond historical computation and energy studies, offering a critical intervention in debates on artificial intelligence, algorithmic governance, and the future of knowledge production in an era of technological acceleration and ecological precarity.

Douglass C. North's theory of institutional change structure abides by the "rules of the game," which, as Bian cites, is a devised constraint structured by human interactions, organizations, and groups of individuals bound by some common purpose. I liken it to Mahjong, the Chinese strategy game. Something else especially useful to know is the concept of path dependence, which connects the past, present, and future in a sequence of causality (Deakin & Meng, 2022). Any modern history would benefit from using it, and Bian exemplifies its utility by referencing it in his history of Chinese state-formation, and not good fortune. The historiography of this topic is never relegated to only the Early Modern era, but Europe's divergence during the Industrial Revolution is instead an important pivoting point in a grand entanglement of global economic history. The dynamics of economic and institutional change, in Europe and Asia, are further exemplified in Mokyr's assertions of formal institutions. In his work, *The Gifts of Athena*, he expounds on methodologies of economic welfare and institutions (Mokyr, 2004). Britain's Industrial Revolution was not nearly a race between the East and the West as some claim, as much as it was the result of a deemphasis on formal institutions in Europe, where fragmented states held sway rather than a centralized political system. Mokyr calls it the "Knowledge Economy," and it is central to themes of economic change and the epistemology of emanationism. As a historian of science, Mokyr is concerned with technology as knowledge. Mokyr's article "The Institutional Origins of the Industrial Revolution" argues that the importance of institutions extends beyond politics. "Cultural Beliefs" allowed inventors and entrepreneurs to cooperate freely. Another historian, P.H. Vries, makes a similar claim. He argues that the role of the state system in Europe was part of an exceptional economic history (Vries, 2023). Bin Wong makes a case for "Making Modern Economies" in his book *China Transformed*, where the logic of technological change is wrapped up in contingent possibilities, and it takes Joel Mokyr to be that edifying voice (Wong, 2019). Cultural values and the rate with which technological changes occur are part of his descriptive generalizations, but it beckons for more rationale. Calculating devices as a historical accounting tool did not create a profit, but they evaluated the statistics and arithmetic. Technology became part of the public good, rather than private interests. But after 1400, Mokyr argues, China's philosophical outlook radically changed to be hostile toward so much technology. But this assumption has problems. It is mostly due to the notion that the Chinese state actively suppressed technological change. Why would it change slowly down? One argument has been that technological change is rare. Though, as is the case with the development of calculating devices, it may rather have been sequestered to a certain subset of the population and not shared widely as a means of keeping sacred knowledge, sacred. Social constraints, likewise, are described by Mokyr as "micro-inventions," but they barely describe the case of "macro-inventions" through history. The possibilities of technology as a unique frontier of knowledge now have more merit. From coal to steam, to chemicals to electricity, these shifts are a part of the Smithian dynamics of economic growth and numerical calculation everywhere.

In addition to cognitive and institutional constraints, energy scarcity represents a fundamental Malthusian limit on modern computation. AI-driven economies demand exponentially growing energy inputs, yet energy resources (from fossil fuels to renewable sources) follow an arithmetic availability curve dictated by extraction limits, storage inefficiencies, and geopolitical factors. The intensification of high-performance computing, cryptocurrency mining, and AI model training exacerbates this dynamic, illustrating a computational energy crisis analogous to Malthus's resource scarcity model. Under MET, digital and post-binary computational models must undergo a paradigm shift to escape this Malthusian constraint. The dominance of binary logic, inherited from Western mathematical traditions, may itself be a limiting factor. Emerging non-binary computation, such as neuromorphic computing, quantum computing, and biological computation, represents potential emancipatory emanations that could redefine the relationship between knowledge production and energy constraints. However, without a fundamental shift in how computational logic is structured, these advances may merely delay, rather than resolve, the impending computational Malthusian crisis. By framing computational and epistemic development as subject to the same geometric-arithmetic tensions that Malthus identified in population dynamics, we can better understand the

historical and contemporary crises of knowledge expansion. The Great Divergence, when seen through this framework, reveals the urgent role of mathematical epistemology in shaping economic and technological histories. While the limits of digital computation point toward an urgent need for new paradigms in mathematical thought and energy-efficient knowledge production, it also suggests that the academy should turn historically scientific discourses into a culturally relevant debate.

5. Conclusion

As societies approach the threshold of what current computational infrastructures can sustain, MET highlights the necessity of alternative knowledge systems, ones that account for both the material and epistemic constraints imposed by a world governed by exponential acceleration yet bound by arithmetic reality. Why did sustained economic growth occur in Europe and not in China? The works reviewed in this article are a response to the current and earlier literature depicting Europe as an ever-growing behemoth and China as a nation of stagnation. It is mostly due to an ethnocentric methodology used by historians. In reality, sustained economic growth occurred in Europe and China at varying periods throughout history based on calculations that can be interpreted with partition theory or a new mathematical model. The Warring States period in Ancient Chinese history predates existing theories that posit a comparison to only the Early Modern period, but what has lasted in a Big History way is the abacus (Spier, 2015). The distortions of capital-using technologies were in place several centuries before 1700, and China was already practicing many of the Smithian techniques of cyclical trading. Consider Thomas Ertman, who wrote that the Church brought Christianity to the Angles, Saxons, and Jutes, but it was the "technologies of rule" from Carolingian neighbors that made a pattern of "shared rule," or "equal government" popular to diversify education (Ertman, 1997). The ultimate cause and timing of the Great Divergence are still up for debate, but in the three centuries before 1800, advanced industry near the Yangzi Delta thrived on abacus calculation ability, emanation timing, and integration. Europe and China fundamentally carried different economies but shared related knowledge economies, something Mokyr formulates circuitously to the debate as a new epistemology of emanation out of fragmentation. There cannot be only one path of economic growth, and as such, we must acknowledge multiple trajectories toward the modernity of nation-states.

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