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Technology and the Rise of Great Powers: How Diffusion Shapes Economic Competition

Jeffrey Ding, Princeton: Princeton University Press, 2024. 320 pp. US$29.95 paperback, ISBN: 9780691260341

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In 2023, Joe Biden met some friends in the desert for a political scene that's repeated every week, in every country, in offices ranging from the smallest mayoralty to the Presidency of the wealthiest empire in human history: A groundbreaking. A US flag hung from an excavator parked in the orange Arizona dirt, as Biden raised a champagne glass to celebrate the construction of a new fabrication plant from the Taiwanese Semiconductor Manufacturing Company (TSMC). TSMC is perhaps the most structurally important firm in the global economy, accounting for about half of global semiconductor production. One of their biggest customers, Apple, joined Biden on stage, in the personage of CEO Tim Cook, who had risen to power as the firm's supply chain impresario. Apple is the largest phone manufacturer in the world, and occasionally the most valuable company, but it makes no phones: Chips from Taiwan are placed in devices made in China or Malaysia, often by Taiwanese-owned assemblers like Foxconn. TSMC founder Morris Chang was also present. Growing up, his family moved from city to city-fleeing the violence of the Chinese civil war. Educated in the US, Chang worked for American semiconductor pioneers like Sylvana and Texas Instruments, before moving to Taiwan to start his own firm—recruited by a government that, decades earlier had lost that civil war. Chang's wife, Sophie, volunteered for Biden's first senatorial campaign in Delaware.

Sanjay Mehtrota, Indian-American CEO of Micron Technology, another massive semiconductor player, was also present. Like TSMC, Micron had recently committed to multibillion-dollar investments in US manufacturing. A century of global economic history converged here. Immigrant executives shook hands with politicians.

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Their largest military partner and their largest customer feted a Taiwanese firm built up by their small island-nation as a soft-power investment. One nation was conspicuously absent, unmentioned in Biden's remarks but clearly motivating not just US subsidies for TSMC, but a broader campaign to "re-shore" manufacturing and wage trade war over the global movement of chips, cars, antennae, and artificial intelligence.

China was the elephant in the room. Great power competition, and not a little yellow peril xenophobia, drove Biden's renewed industrial liberalism, just as it drove Trump's personalist trade war. This conflict forms the backdrop of political scientist Jeffrey Ding's *Technology and the Rise of Great Powers: How Diffusion Shapes Economic Competition.* Where most debate on technology and geopolitics centers the "eureka!" moments of invention and subsequent claims to monopoly rents in leading sectors (LS) like textiles or chemicals, Ding seeks to reorient readers towards the slower diffusion of general-purpose technologies (GPT), like the factory system or the personal computer, across many years and industries.

He does so with precision econometrics, designing clever quantitative tests of GPT and LS effects on national economic productivity and profits across the so-called First (1780–1840), Second (1870–1914), and Third (1960–2000) Industrial Revolutions. Deeply grounded in the literature of international relations and economic history, Ding uses these tests to explain, respectively, why the British empire and not the Dutch or French dominated the globe, why the US succeeded them in the late 1800s, and why Japan failed to unseat the US as a postindustrial global economic hegemon. In each case, success depends on the long-term diffusion of GPTs and the practical knowledge to use and adjust them, as opposed to specialist research training, across the national economy. Later chapters seek to explain GPT diffusion through the development of national skill infrastructure, before returning to the futurist exercise motivating the book: Whether the US or China will win the AI race. That the GPT of tomorrow is AI rather than solar panels or batteries is taken as given, despite the identification of electrification as a GPT in the literature and earlier in the book. Notably, this analysis relies more on think tanks and industry marketing than the academic literature and precise statistical tests of prior chapters; necessarily so, after all, the AI landscape is shifting under our feet as we discuss it.

If we take "method" to mean the gathering and arrangement of data, then Ding's is without fault. But methods are theory-laden, grounded in commonsense reckonings of how change happens and why. And it is here Ding struggles, though through no fault of his own—these sorts of practical explanations for economic winners and losers are the water in which think tanks, politicians, columnists, and, of course, scholars swim. Summarizing his contribution in the Conclusion, Ding writes

> Akin to a sprint on a narrow lane, great power competition over leading sectors is framed as a race to dominate initial breakthroughs in new industries. In contrast, GPT diffusion theory proposes that by more effectively adopting GPTs across many application sectors, some great powers can sustain higher levels of productivity growth than their competitors. Like a marathon on a wide road, great power competition over GPTs is a test of endurance. (210).

The problem, of course, is that great power competition does not proceed in parallel, with each nation assigned its own lane in a race of whatever length. History makes a

poor laboratory if for no other reason than the players actively help and hinder each other's progress. The moment and location of innovation are a product of history, not an input to it.

In this way, it becomes clear that the "when" of invention and adoption is a function of both state capacity and financial markets—the coordinating mechanism of global capitalism, largely beyond Ding's scope. As Carlotta Perez (2003) observed, financial and technical revolutions are linked: The risk of innovation is subsidized by speculation, which is paid off by adoption, before returns diminish and financiers grow bored, turning to more insular and esoteric instruments detached from productive enterprise, leading to crashes that restart the cycle. The state builds an opportunity space for new technologies after they erupt into the market, and excludes disfavored players from that space. No trains without tracks, no tracks without right-of-way.

Further problems—for both Ding and the LS theorists he argues against—arise when you consider the historical standpoint of the industrialist, investor, or politician eyeing potential innovations. The banal truth is that both LS and GPT theories are retrospective explanations. The race must be run before a winner can be declared. But regardless of its predictive value for the future of great power competition, the LS approach, perhaps accidentally, also identifies classes of technologists and financiers who are fighting for market share *right now*—contained within but not unified by the national borders Ding's method relies upon. The long view of GPT diffusion leads Ding to suggest broad, practical training as an economic development program. The immediate problem is that to maximize shareholder profits, leading sectors and the financiers behind them will often fight for their business needs and tax burdens over any long view of national economic development. As a result, the US has largely gotten rid of the on-the-job training that Ding observes in the First and Second Industrial Revolutions, and shifted that burden to universities that have themselves been defunded through local tax revolts, with debt-fueled tuition revenue filling the gap (Greene 2021). The second Trump administration's cancelation of green energy and semiconductor projects (and their training programs) and their war on the scientific institutions building AI is due in no small part to a revanchist turn among the executives and financiers (e.g., Musk, Andreeseen, Thiel) who are most optimistic about AI as a GPT! It may be the case that AI is figured as a potential GPT today, more so than batteries, not because of its impact in the workplace but because of the massive influx of financial capital into a market with few alternatives for "unicorn" investments. Perhaps we are at the end of Perez's cycle rather than the beginning of Ding's.

The "where" of innovation is also a product of inter- and intra-state conflict. Yesterday's winners have more human and financial capital to invest tomorrow. If finance is the coordinating mechanism of global production, then the rise of a great power will be identified with new financial institutions that spin up new technologies and techniques in different parts of the world, more so than the technologies and techniques themselves (Arrighi 2010). Here, China does not pose the threat to the US that the US posed to Britain or that Britain posed to the Netherlands. This is in part because, until recently, US financiers funded so much of the twenty-first century Chinese boom, and the biggest Chinese companies were listed on the New York Stock Exchange or the NASDAQ.

The economic geography of 2025 looks so different from 1925 or 1825 because of how those earlier great power conflicts were resolved. The economic boundaries between China and the US are not as stark as those between the US and the USSR. China is the US's third-largest trading partner, and the US is China's largest. The US lost leadership in, e.g., steel production because the state opened its postwar domestic market to international producers in the name of supporting Cold War allies vulnerable to internal or external Communist threats (Stein 1998). As the domestic industry shrank, the US substituted it with finance to "hedge the risks that emerged from currency, trade, and investment instabilities. [Financial services] soon became the master and not the servant of production in the US" (Stein 2010, 296). The small island nation of Taiwan may not be a great power, but its government built a world-class training infrastructure to support cutting-edge, GPT-producing firms like TSMC that carved out a safe harbor for Taiwan in the conflict between the US and China. This was, to Ding's point, a multi-decade process of training, building, and learning (Tin 2025). Now the US wants its industrial production back, but the technical and training infrastructure isn't there. The neoliberal assault on public education and the replacement of state industrial policy as a domestic coordinating mechanism with monetary policy and financial markets means that this is a decades-long task. In-shoring incentives for companies like TSMC cannot cover up fifty years of underinvestment in American workers.

To his credit, Ding would agree with all the above. He is a fastidious methodologist, whose careful argument for GPTs as engines of economic dynamism emerges both from an impressive collection of data and from the strict controls placed on other factors. But if there's one thing *Technology and The Rise of Great Powers* proves, it's that history doesn't hinge on the brilliance of lone inventors or analysts. Geopolitics motivates the book, and its tide passes through newspapers, briefings, and think tanks like Georgetown's Center for Security and Emerging Technology or Oxford's Center for the Governance of AI—previous employers of Ding's. This is a welcome argument for de-escalation in the new Cold War: If the rise of great powers is owed not to a few leading sectors but the broader embrace of practical tools and training, then sanctions and spycraft are at best counterproductive. But it remains to be seen what the leading sectors themselves, or the states desperate for external scapegoats, have to say about that.

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