

“As Large of a Lead as Possible”?



Taking Stock of the Biden Administration’s Agenda on Critical and Emerging Technologies

Case Study by Florian Klumpp and Jakob Hensing

If you only read one page...

1

The Biden administration's agenda on critical and emerging technologies is best characterized by the slogan "as large of a lead as possible" (rather than "small yard, high fence").

2

Overall, the measures did what they were designed to do: extend the US tech edge over China - though the effort was extremely costly.

3

Despite associated strategic drawbacks, promoting tech supremacy is fundamentally a reasonable strategy to protect national security from a US perspective.

4

In a technologically bifurcating world, fostering voluntary buy-in through cooperation among allies would offer the best path to safeguarding US security and prosperity.

5

Though unlikely under Trump, this is the path US stakeholders and international partners should advocate for.

Table of Contents

| | |
|--|----|
| Introduction | 4 |
| Motives and Aims: How Much Strategy Amid Ambiguity? | 6 |
| Maintaining and Widening the US Tech Lead: Achievements and Limitations | 8 |
| “As Large of a Lead as Possible”: A Sensible Strategy to Advance US National Security? | 17 |

Introduction

On October 23, 2024, Jake Sullivan took to the Brookings Institution’s podium one last time as US National Security Advisor to President Joe Biden to deliver a closing speech in defense of the administration’s key industrial and tech policies. Addressing both domestic and foreign audiences, Sullivan stressed how a positive-sum logic had driven the agenda and how allies continued to play an indispensable role in US considerations. Overall, he contended, with a nod to Alexis de Tocqueville, that the administration’s approach had advanced US “interest rightly understood” and had demonstrated that international economic integration could go hand in hand with supporting democracy and national sovereignty – when done right. He explicitly emphasized that this also applied to “technology protection policies,” recognizing that export controls and other restrictive measures have been a particularly distinctive and contentious part of the administration’s track record. Having reiterated the by-now-familiar claim that such restrictions only applied to a “small yard” of technologies considered to be genuinely foundational to US national security, Sullivan then swiftly turned his gaze to the future. Looking ahead to the next few years, he asked whether decision-makers would sustain the political will to make the necessary investments domestically and overseas, and whether they would end up empowering relevant agencies and strengthening implementation capacity.

These were important questions when Sullivan posed them in October, and they have taken on even more significance since the election that enabled Donald Trump’s return to power. While Trump will likely continue to embody a generally tough stance on China, he is also widely seen as transactional and erratic in his behavior, as well as hostile to strong institutions that control business actors – a combination that will probably yield some divergence from the policies of his predecessor. Still, at the end of a Biden presidency that saw an unprecedented intertwining of economic, technology and security policy, a more systematic and even-handed stocktaking is in order than Sullivan delivered in his speech. This is not just a matter of chronicling past decisions, but also of establishing the impact to date of key strands of policy that will, broadly, still be continued by the new administration. Moreover, an assessment of the accomplishments, challenges and limitations of US policies will prove important for other governments across the globe who are crafting their own security strategies in the face of deep uncertainty and pondering their opening gambit vis-à-vis the second Trump administration.

In pursuit of such a stocktaking, this article addresses three questions:

1. What were the Biden administration’s guiding motives and strategic aims regarding Critical and Emerging Technologies (CETs)?
2. Looking back, how successful have the measures that the Biden administration implemented been in furthering its strategy’s core tenet of maintaining “as large of a lead as possible” on certain CETs?
3. To what extent has this agenda proven to be a compelling paradigm to advance US national “interest rightly understood” (beyond questions of specific implementation)?

In addressing these questions, we have drawn strongly on the work of others to bring greater structure to different strands of the ongoing discussion, to draw out some key learnings and to identify important unknowns that need to be elucidated further to enable a well-founded assessment. Indeed, one of our observations is that the empirical record on the impact of

key measures is still far too patchy to allow for a conclusive verdict on whether they have ultimately advanced US national security. Nevertheless, what is clear is that securing “as large of a lead as possible” on key CETs was never an aim to be easily combined with applying restrictions with surgical precision. Despite the frequent mantra of ‘derisking, not decoupling’, US measures have led to a significant upheaval of supply chains; ultimately, a far-reaching bifurcation of global technology ecosystems seems increasingly likely.

If the world is indeed facing a harder technology decoupling scenario, a Trump administration may well be able to bully many countries into staying aligned with the US, not least on account of their sheer military dependence. A less abrasive and more reliable option, however, would be to foster voluntary acquiescence and buy-in by advancing a positive vision of a global technology order that better leverages cooperation among partners. That would comprise closer consultation and alignment with core allies than under the previous administration, but it would also call for a reinforced commitment to advancing global access to technology for civilian developmental purposes. Given Beijing’s regional and global demeanor over the past decade, it makes sense for the US to deem containing China’s adversarial capabilities of paramount importance. However, it would also be wise to explicitly keep a door open to adjusting certain restrictions in case of a credible and sustained change in Beijing’s policies. While such an approach is unlikely under the new administration, it would foster a more stable and sustainable foundation for US security and prosperity for the decades ahead.

Motives and Aims: How Much Strategy Amid Ambiguity?

Sullivan's October 2024 speech came a little more than two years after he originally sketched out an agenda to preserve global US tech leadership. The central aim, he explained at the time, would now be to “maintain as large of a lead as possible” over competitors in computing-related tech, biotech and clean energy tech. This marked an explicit departure from the previous premise of merely maintaining a “relative advantage” over competitors in these realms.

That this should be a concern not just for economic policymakers – notably for Gina Raimondo at the Department of Commerce, who would also become a central figure in fleshing out and implementing the CET agenda – but also of critical importance for the national security advisor, was due to two reasons. For one, Sullivan and other senior national security figures saw CET as “force multipliers” affecting not just public prosperity and well-being but also military capabilities. Secondly, they came to the conclusion that China, unlike any other actor since the end of the Cold War, had “both the intent to reshape the international order and, increasingly, the economic, diplomatic, military, and technological power to advance that objective,” as codified in the 2022 National Security Strategy.

Perhaps deliberately, the exact definition of national security which underpinned the whole enterprise, and the characteristics that distinguished certain technologies as “critical,” were never genuinely clarified (despite frequent reference to the broad technology fields mentioned above). As such, one throughline of the justification revolved around the desire to prevent China's use of US technology to drive its own military development. Repeatedly invoking the image of a “small yard with a high fence,” the Biden administration intended to make sure that certain chokepoints in technologies with reasonably direct military relevance would be heavily protected, without restricting broader trade and investment.

However, measures toward this end were always publicly presented as only one component of what Sullivan referred to as a broader “modern industrial and innovation strategy.” In addition to advancing security objectives, this strategy simultaneously sought to achieve economic policy goals, both on the domestic front and in relation to other countries. In this vein, what came to be widely known as ‘protect’ measures, safeguarding existing advantages, were to be combined with major investments in the domestic sci-tech ecosystem and talent landscape, as well as with international partnerships. Sullivan underlined this three-pronged approach when coining the term “new Washington Consensus” to describe what he claimed to be a novel bipartisan assessment of the broader US position in the world – one dominated by concerns about a hollowed-out domestic industrial base, tech-infused great power competition, the climate crisis, and wealth inequality.

While the small-yard-high-fence imagery invoked traditional arguments in favor of restrictions on military and dual-use goods, the Biden administration's agenda on CET transcended this logic in several ways from the outset. Regarding the military domain, the agenda went beyond a restrictive logic to pursue maximum advantage on a range of foundational technologies – whose foundational character also made the boundary between civilian and potential military applications notoriously hard to define. This was deemed essential for guaranteeing that the US would prevail in a military confrontation with China – arguably the most effective deterrent against adversarial action. While this aspect of the

strategy could still be presented in terms of a traditional national security rationale, it was also fused with the aspiration to safeguard long-term prosperity for the American middle class. The agenda aimed to do this by generating jobs and profits, but also by building leverage for economic statecraft to deter economic threats such as unfair competition from abroad and to reduce costs in case of shock events.

The slogan best characterizing the Biden CET agenda was never “small yard, high fence”, but “as large of a lead as possible”.

From an American perspective, the desirability of all these aims is entirely understandable. However, the multiplicity of objectives and lack of clear boundaries opened the door to contradictions and misunderstandings, as detailed in the following sections. In any case, a key takeaway is that the programmatic slogan that best characterized the overall Biden CET agenda was never “small yard, high fence” but rather “as large of a lead as possible.”

Whether the adopted measures have indeed widened the US lead on relevant technologies should, therefore, be the central yardstick for assessing the agenda’s success to date. Similarly, the question of whether and under which conditions such a maximum lead ultimately serves US national security interests should be the key consideration in assessing the overall case for the agenda.

Maintaining and Widening the US Tech Lead: Achievements and Limitations

As many commentators and administration spokespeople have observed, the size of the US lead in any CET domain can logically be increased in two ways. The first way would be by accelerating the development of the US' own capabilities, also often referred to as the 'promote' component of the agenda, or as 'running faster'. In US discourse, this element has frequently subsumed the aspect of international cooperation – this in contrast to the European Union's approach of explicitly naming international partnerships ('partner') as a distinct strand of action. Second, the lead can be increased by holding back potential rivals, often termed the 'protect' part of the agenda. The following section considers each of these two board components of the US strategy in turn. It highlights the key measures that have been adopted and discusses their effectiveness as well as their potential unintended consequences, drawing on prominent lines of criticism advanced by other observers.

'Promote': The Measures

Strengthening the United States' own technological capabilities was an important aspect of two large-scale industrial policy initiatives, both signed into law in August 2022. The first policy initiative, the Inflation Reduction Act (IRA), includes stipulations on CET, though its main thrust is broader than emerging technologies. It directs nearly 400 billion US dollars' worth of incentives and investments to support green energy, ranging from technological innovation via commercialization and manufacturing to ultimate usage. To what extent companies are eligible for tax credits often depends on whether they manufacture certain components or final products in the US. Many of the projects that were funded by the IRA have undoubtedly contributed to advancements in critical and emerging technologies. This latter aspect was even more explicitly the focus of the second policy initiative worth mentioning, namely the CHIPS and Science Act ("CHIPS" serving as a catchy abbreviation of the slogan "Creating Helpful Incentives to Produce Semiconductors"). This act provided 52.7 billion US dollars in federal incentives and tax credits to advance domestic semiconductor manufacturing and research and development (R&D) – though it is often overlooked that actual Congressional appropriations for investments in STEM, workforce development and scientific R&D have significantly fallen short of the original amount of money allocated.

Beyond these massive industrial policy schemes, the Biden administration sought to spur innovation and growth through further policy levers. The Executive Order on Advancing Biotechnology and Biomanufacturing Innovation, issued in September 2022, assigned around 40 tasks to different federal agencies, aiming to improve cross-agency coordination, regulatory clarity and funding. Similarly, the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence called for new measures to support the US AI ecosystem and attract immigrants with expertise in critical areas to study and work in the US. Fulfilling a requirement from this executive order, the Biden administration released a National Security Memorandum on Artificial Intelligence and a closely related Framework to Advance AI Governance and Risk Management in National Security. Both documents are primarily aimed at maintaining US leadership in the development of frontier AI systems, accelerating their adoption across US national security agencies and developing governance frameworks to support US national security. Finally, focusing on key inputs for next-

generation clean tech, the Biden administration also moved to increase the United States' capacity to mine, produce, process, and recycle critical minerals and materials.

In parallel, the Biden administration kicked off or strengthened several bilateral, minilateral (collaboration among a small group of partners) and multilateral formats to foster international cooperation and coordinate joint actions, including so-called friendshoring. One such bilateral effort was initiated in June 2021 in the form of the US-EU Trade and Technology Council (TTC), establishing 10 working groups to find common ground in a number of policy areas, mainly focusing on CET governance, capacity building and protection. Another noteworthy bilateral format is the United States-India initiative on Critical and Emerging Technology (iCET). Launched in January 2023, iCET is slated to enable cooperation and co-development as well as co-production in CET and more deeply connected innovation ecosystems. More specifically, the two countries intend to cooperate in fields like semiconductors, artificial intelligence, quantum, biotechnology, and clean energy. Regarding initiatives on the minilateral level, the US is cooperating with key allies within the frameworks of the Chip 4 Alliance, trilaterals with Japan and South Korea, the Quadrilateral Security Dialogue, and the AUKUS strategic partnership. Finally, the Biden administration has also cooperated on CET through NATO, the G7, the Americas Partnership for Economic Prosperity (APEP), and, when it comes to clean tech, the Indo-Pacific Economic Framework for Prosperity (IPEF).

‘Promote’: Assessment of Success

As the Biden administration's ‘promote’ measures effectively amounted to an embrace of activist industrial policy, prominent strands of criticism emerged on the topic, largely along familiar lines. Various commentators have questioned the effectiveness and efficiency of mobilizing public funding toward industrial development. Critics have pointed out that subsidy schemes may have led companies to announce investments in US manufacturing capacity, but that actual implementation lagged, with some of these investments facing delays, being cut back or even halted. Where investments did take place, companies were furthermore confronted with talent shortages and sluggish sales amid continued inflows of Chinese-made goods. Echoing common concerns about so-called policy capture, some observers further argued that most financial support is ending up in the coffers of the largest chip companies, while smaller but essential innovators of next-generation semiconductor technology and equipment producers receive insufficient funds. Generalizing this line of criticism, stakeholders of the libertarian-leaning ilk (like the Cato Institute) decried the administration's flagship CHIPS Act as “wasteful, distortive, and dysfunctional,” and warned that it may even end up stifling production and innovation in the medium term.

The empirical evidence paints a mixed picture when it comes to this part of the discussion. As Martin Chorzempa of the Peterson Institute of International Economics has shown, measures to bolster domestic manufacturing capacity in the semiconductor industry, including through the CHIPS Act, have in fact resulted in a drastic increase in manufacturing construction spending and fostered potentially high-performing, large-scale manufacturing clusters. According to analysis by the Boston Consulting Group and the Semiconductor Industry Association, this has put the US on track to increase its share of global aggregate fabrication capacity (‘fab capacity’) and attract a significant share of global advanced-logic chip fabrication by 2032.

At the same time, the cost of these achievements has been very high and will likely amount to a massive overrun compared to original budget assumptions. Moreover, as projects have started to become operational, questions about the scarcity of talent and the sustainability of

jobs on offer sometimes proved prescient. More fundamentally, the extent to which a sheer increase in manufacturing capacity, including at the more advanced end of semiconductor production, will translate into a further invigoration of the innovation ecosystem remains to be seen. Overall, however, this is mostly a discussion about whether the large sums of money involved have been optimally allocated. That the impact of this set of measures on the US’ ability to “run faster” is net positive seems fairly uncontroversial – notwithstanding criticism from a few more radical voices, whose concerns about distortions so drastic that they could positively harm the US innovation system in the longer term are not backed up by much tangible evidence.

That the impact of ‘promote’ measures on the US’ ability to “run faster” is net positive seems fairly uncontroversial.

Regarding international partnerships, some of the used formats have indeed served as platforms for exchange and substantive work. iCET probably stands out as a framework that “has delivered,” in many regards, as Carnegie India’s Rudra Chaudhuri and Konark Bhandari have shown in a [detailed assessment](#).

[NATO’s intensified activity in defense innovation and deep tech](#) may be considered another positive example, and some of the TTC working groups also recorded constructive outcomes. The overall perception of the TTC, however, is rather one of a “[talk shop](#)” that has fallen short of resolving significant transatlantic disagreements and of delivering clear policy outputs, especially when it comes to advanced technologies. Highly consequential decisions such as the adoption of export controls (further discussed below) were addressed [at the bilateral level](#) instead (notably with Japan and the Netherlands). Likewise, Europeans were largely [left perplexed](#) by some aspects of the Inflation Reduction Act, a far-reaching piece of legislation on which there had been very little consultation and which included elements widely seen as detrimental to European interests, even if some of those concerns may have been [unwarranted](#). While friendshoring has often been invoked as an important element of the US agenda, commentators have noted the term’s enduring [vagueness](#) in definition and objectives. In addition, the concept has important practical [limits](#), notably in terms of the reliability of supposedly trustworthy partners and the risks associated with concentrated dependencies, even if the counterpart is deemed “friendly” (as is the case with the US being dependent on Taiwan in the realm of advanced semiconductors).

Overall, the American track record on CET under Biden has not involved acting in close concert or with much meaningful consultation with even closest US allies. While the specific benefits of a more coordinated approach to “running faster” are best spelled out at the level of specific science and industry ecosystems, this is clearly an area marked more by potential missed opportunities than by forceful policies that could be assessed in terms of their effectiveness and unintended consequences. The third section of this article picks up this theme again as part of its broader assessment of whether and under which conditions “as large of a lead as possible” on CETs is ultimately a compelling recipe to advance US security interests. Before that, however, we turn to the ‘protect’ side of the agenda, which comprised an even more controversial set of measures than the ‘promote’ strain just discussed.

‘Protect’: The Measures

Measures in the ‘protect’ bucket essentially intend to prevent tech and knowledge leakage from the US to China. This primarily includes efforts to prevent US goods and services, investments and knowledge from making their way to China, its companies or individuals, but it also consists of measures against inflows of technology and capital from China if they are deemed possible enablers of undesired knowledge transfer.

Our discussion here does not address the various measures – sometimes included under the ‘protect’ heading – that were neither designed to increase the CET lead on China, nor ended

up producing such a lead as a relevant side effect. A prime example of such measures are the tariffs the Biden administration levied in case of serious injury caused to domestic producers, continuing an approach employed by the previous Trump administration. Certain Section 301 tariffs specifically aimed at China form a special case, as those were officially motivated by concerns about tech transfer, intellectual property and innovation policy. Originally also imposed under Donald Trump, these tariffs were expanded under the Biden administration, now covering imports from China across sectors such as legacy semiconductors, electric vehicles, batteries, and solar cells. Still, while somewhat related to the CET discussion (for example, due to their effects on relevant companies), increasing the US technology edge over China has arguably not been the principal motive of these tariffs.

Another caveat regarding the scope of our analysis: it only selectively engages with steps addressing concerns regarding espionage and sabotage via critical infrastructure, as well as issues of general cybersecurity, blackmail and misinformation. The Biden administration adopted various measures designed to keep US knowledge and sensitive personal information out of China's reach by restricting the use of Chinese goods and services in the US. These efforts included attempts to make Chinese-made telecommunications equipment obsolete in US systems (design-out), to stop approving licenses for US companies to supply Chinese telecommunication firms, to restrict sensitive personal data flows to countries of concerns, and to ban Tik Tok or force its sell. While undoubtedly relevant for a broader discussion of tech governance, many of these measures were at best indirectly related to the US lead on cutting-edge technologies. We do discuss the legislation set in motion to effectively ban Chinese-made connected vehicles as well as certain software and hardware. We also consider the legal efforts made to restrict the flows of genomic data to China. The reason of taking these measures into account is that they arguably went beyond a critical infrastructure rationale and amounted to attempts to deliberately shape the future of the global technology ecosystems, as detailed below.

Given this focused scope, the most prominent and widely discussed set of measures clearly concerns export controls. Starting in October 2022, the Bureau of Industry and Security (BIS) of the Department of Commerce announced a series of export controls, targeting advanced computing semiconductors, electronic design automation software, semiconductor manufacturing equipment, as well as items that support supercomputer applications and end-uses. From the outset, as the BIS stressed at the time, these controls were explicitly designed to limit "China's ability to both purchase and manufacture certain high-end chips used in military applications." Updates in 2023, April 2024 and December 2024 sought to close loopholes for circumvention, significantly broadened the scope of controlled manufacturing equipment and semiconductors beyond those used to train and run AI models, applied a more expansive interpretation of the so-called foreign direct product rule imposed on third-country companies using US parts in their tools and, finally, repeatedly added companies to the entity list. Additional export controls targeting quantum computing items are underway; AI models could be next.

Following a similar line of reasoning, the Biden administration issued an executive order in August 2023, calling for targeted action addressing outbound investments facilitating "advancement by countries of concern in sensitive technologies and products critical for the military, intelligence, surveillance, or cyber-enabled capabilities." After months of considering how to implement the order, the US Department of the Treasury released a pre-publication version of its final rule in late October 2024. The rule will restrict certain types of US investments in China, specifically in the realms of semiconductors, microelectronics, quantum information technologies, and artificial intelligence. Beginning in 2025, some covered transactions will be prohibited outright, while others will require a post-transaction notification.

While impossible to fully disentangle from related concerns about cybersecurity and data security, the screening of certain inbound investments was also one of the Biden administration’s tools of choice to address tech and knowledge leakage. The Foreign Investment Risk Review Modernization Act, already passed by Congress in 2018, expanded the jurisdiction of the interagency Committee on Foreign Investment in the United States (CFIUS). Post-Act, CFIUS had the authority to review mergers and acquisitions as well as certain investments in businesses involved in critical technologies, critical infrastructure and sensitive personal data. President Biden then issued an executive order in 2022, directing CFIUS to also consider whether investments are relevant for maintaining US leadership in advanced technologies (i.e., computing-related tech, biotech and clean energy tech) due to having implications for supply chain security, cybersecurity and sensitive personal data.

Finally, as noted, measures on connected vehicles and genomic data have fused a logic of protecting critical US infrastructure and sensitive data with an ostensibly deliberate attempt to undermine the development of China’s innovation system. Regarding connected vehicles, a BIS Notice of Proposed Rulemaking (NPRM) released in September 2024 indicated plans to restrict the use of certain hardware and software (as well as vehicles themselves) provided by entities owned, controlled or influenced by the Chinese state (very broadly defined). While motivated in the first instance by concerns about sabotage and espionage, “part of the US strategic intent behind the new measures is to get auto OEMs over the hump of alt-China diversification,” as Reva Goujon and Gregor Sebastian have argued. As they force global automotive firms to build supply chains that explicitly exclude China when serving the sizeable US market (and possibly the European and other markets if allies follow suit), these measures are likely to hamper the vibrancy and innovation capacity of the Chinese automotive industry, thereby also slowing down the development of autonomous driving capabilities as a potential dual-use technology.

Regarding biotechnology, the proposed BIOSECURE Act would effectively force US companies to choose between access to public funding and cooperation with Chinese partners like WuXi AppTec and BGI, which occupy a central role in China’s manufacturing, research and trial processes. Underpinning this Act are intellectual property concerns but above all fears surrounding the illicit transfer of US genomic data to Chinese state actors, who might conceivably use it for nefarious purposes, ranging from individual blackmail to the development of targeted bioweapons (in a dystopian scenario). An important side effect of this Act will likely be the disruption of the Chinese biotechnology industry writ large, which will in turn slow down China’s innovation capacity in a field deemed critical. Finally, the Biden administration’s decision to let the Science and Technology Cooperation Agreement with China expire in August 2024 can also be interpreted in a similar light.

‘Protect’: Assessment of Success

If the shift toward active industrial policy under the ‘promote’ banner generated considerable controversy, the debate on this expansive set of ‘protect’ measures has been even more heated. In terms of whether these measures have helped achieve “as large of a lead as possible” on certain CETs, there have been two broad thrusts of criticism – one on the effectiveness and another on the cost of the adopted measures. Existing critiques following these two throughlines often also include more fundamental points, such as concerns that reduced interdependence will lead to a loss of future US leverage over China. These underlying arguments go beyond the question of whether the Biden administration has been able to pursue its agenda successfully on its own terms; rather, they address whether this agenda amounted to a sensible strategy in the first place. For this reason, they are discussed in the final section of this article.

Regarding effectiveness, various observers have questioned the measures' impact in slowing down China's technological development in relevant areas. One reason for this is easy circumvention: critics have accused the Biden administration of only "damming half the river" by moving unilaterally and failing to ensure that other countries do not supply China with the technology in question. Another reason for this lack of effectiveness is the adaptability of technology ecosystems. As Ansgar Baums has argued, a "chokepoint fallacy" may have led US policymakers to drastically overestimate their ability to constrain Chinese technological development by withholding some supposedly critical inputs, while disregarding engineers' ability to find alternative solutions. As Baums writes, "there is more than one way of achieving one's goals; hence, there is no 'secret sauce' that can protect anyone for long." This latter point is further amplified by those drawing attention to the diminishing marginal utility of export controls when expanding from hardware to software (including cloud-based compute and AI models). While it should be comparatively easy, at least in theory, to prevent physical chips and bulky manufacturing equipment from entering China, this task becomes exponentially more difficult when the technology to be restricted is intangible. Lastly, and perhaps most problematically in terms of US strategic intent, some critics contend that the very adoption of the restrictions only gave China an incentive to invest into domestic innovation capacity, further accelerating its catch-up and ultimately its ability to eclipse the US.

Empirically, much of this remains hard to judge due to a lack of conclusive evidence. As Gregory Allen has rightly cautioned, considering the effects of export controls in isolation can be highly misleading. The same goes for using simplistic counterfactuals. As Allen states: "Much depends upon the state of the global market landscape, the complexity of the controlled technology, the current technological sophistication of the targeted country, the design of the export control regulations, and the robustness of the controls' implementation and enforcement. Only a detailed analysis can hope to reach anything approaching insight." That said, at least some of the arguments outlined in the last paragraph do seem well-founded. For sure, it would be a mistake to dismiss the semiconductor controls as entirely futile in terms of causing a delay in the development of Chinese capabilities. Even Paul Triolo, hardly a cheerleader of the measures, noted in a November 2024 piece that Chinese firms were facing "severe limitations on their access to technology, support, and spare parts" and that "China's semiconductor industry seems unlikely to 'catch up' to the rest of the world, given the nature of the heavy controls imposed by the United States and allies as well as the complexity of the technology roadmap ahead." Despite considerable disruptions in the global supply chains, however, the 'protect' measures have only affected Chinese access to targeted technologies to a limited degree, as observed by a New York Federal Reserve report. The report points out that the Chinese semiconductor industry can draw on domestic innovation and rely on increased purchases from non-US firms.

Moreover, there is evidence that Chinese companies have managed to circumvent export controls and stockpile critical goods; they have reportedly even been able to purchase small batches of Nvidia's most advanced N100 chips. While the Dutch semiconductor equipment manufacturer ASML's business was eventually hit by export controls, its sales data suggest a flurry of Chinese purchases of slightly older deep ultra violet (DUV) lithography machines in the lead-up to the adoption of these measures. Moreover, the controls have given rise to a game of cat and mouse between US regulators and key firms like Nvidia, which has specifically been developing chips that fully exploit the latest regulatory performance thresholds for sales to China.

In terms of domestic manufacturing capabilities, an August 2024 tear-down analysis suggested that Chinese firms were now merely three years behind Taiwan's industry leader TSMC (even if there are some big open questions about China's ability to produce the most advanced chips at a reliable quality; whether these firms can improve their yield to an extent

where they become cost competitive remains to be seen). Lastly, it is important to keep in mind that the US controls are ultimately not meant to target specific advanced semiconductors in and of themselves, but rather are intended to address the potential AI capabilities enabled by this hardware. Given this fact, then, certain developments in areas like advanced packaging (efficiently combining multiple chips for higher computing power), alternative chip designs and less compute-hungry AI models have cast even further doubt on the use of constraining China in the longer term via ‘protect’ measures. In this regard, Ritwik Gupta, Leah Walker and Andrew Reddie draw attention to Tencent’s Hunyuan-Large model, which has reportedly achieved state-of-the-art results despite having been trained exclusively with non-export-controlled Nvidia H20. In their assessment, this case exemplifies “broader gains in efficiency in machine learning that have eroded the moat that the United States initially built via its existing export controls.”

While Biden-era ‘protect’ measures may not have been as effective as envisaged, they were arguably not self-defeating in terms of their stated purpose.

While many of the points raised by skeptics of the Biden administration’s measures are thus convincing, the least compelling strain of criticism outlined above is the argument that the US controls had decisively accelerated the Chinese quest for autonomous capabilities. Certainly, the Chinese government has recently been driving this shift toward autonomy: Beijing has reportedly been ramping up investments into its domestic semiconductor industry, has banned the sale of US firms’ chips to certain industries and is strengthening its own toolbox for controlling tech-related outflows. In this context, the removal of competition from superior foreign suppliers could conceivably create an opportunity for domestic equipment firms as well as materials and manufacturing companies, now confronted with much more urgent demand also from commercial customers. But, as both Gregory Allen and Michael Laha have convincingly argued, the Chinese self-reliance strategy had already firmly gathered momentum prior to the adoption of key US measures and would likely have advanced irrespective of these decisions. While the Chinese push for autonomy may have taken a different and seemingly more muscular form in response to the American actions, the availability of external inputs would surely have accelerated China’s home-grown innovation and tech uptake that are now occluded or at least rendered considerably more difficult, most notably by facilitating technology transfer and reverse-engineering. While Biden-era ‘protect’ measures may not have been as effective as envisaged, they were therefore arguably at least not self-defeating in terms of their stated purpose – an important point we will return to in the closing section of this article. In terms of the seemingly limited slowdown of Chinese advancements in key areas, however, this caveat does not really change the overall picture.

The lack of a clearly demonstrable slowdown of Chinese capabilities is also often seen as a driver of the Biden administration’s tendency to continuously enlarge the US’ small yard, as Sullivan would put it. As Michael Froman has warned, the absence of clear guardrails on when and how technology areas are added to the yard as well as rules on the adjustment of thresholds may lead policies to be “applied on an ad hoc basis and in response to special pleading.” Froman points out that this risks “endless expansion with limited effectiveness—and too little consideration of their costs.” Against this backdrop, calls for a more cohesive approach with clear guiding principles, codified in an economic security strategy and backed up with greater bureaucratic capacity, are increasingly commonplace.

These considerations point to the second important thrust of criticism, introduced at the start of this section: the issue of costs, specifically the domestic economic cost of the adopted measures as well as the economic disadvantages these measures have had on US firms. Echoing Froman’s comments above, Paul Triolo has described the widening scope of export controls as “haphazard” and unpredictable, rendering them a “nightmare” for industry. More fundamentally, and tapping into a long legacy of anti-protectionist thought, some

have warned that export controls can “only hurt the US in revenue, innovation, agility, and being competitive against other countries” due to foregone economies of scale and scope. In an important twist to the arguments already discussed, the US Semiconductor Industry Association (SIA) warned that excessive export controls and the resulting efforts of foreign firms to design-out and those around US inputs could harm US firms’ revenues. Ultimately, the argument continues, “the commercial innovation that is essential to America’s economy, national security, and technological leadership” is hurt in the process, suggesting an adverse impact to the ‘promote’ side of the agenda. While outbound investment screening mechanisms are still under discussion, they have similarly been criticized for potentially foregone growth opportunities or negative effects they may have on American academic research and industry, hampering innovative potential while driving costs, delays and shortages.

In addition to such adverse side effects of the controls themselves, prominent industry figures have added warnings about Beijing’s potential reactions to US measures, with the SIA accusing the US government of “prompting continued escalatory retaliation by China.” These concerns were amplified by Beijing signaling its readiness to retaliate through export controls on critical raw materials such as gallium and germanium, further backed by its track record of asymmetric retaliation in past disputes on trade and related matters. When talking specifically about semiconductors, the picture is further complicated by Beijing doubling down to attain global dominance in the production of less sophisticated so-called legacy chips, including a seemingly deliberate attempt to undercut US and other foreign competitors in this domain. As this would affect many of the same companies that are also involved in high-end semiconductor supply chains, this move raises concerns not only about dependency and vulnerability to coercion regarding legacy chips, but also about potential adverse effects on these firms’ cutting edge innovation capacity – providing a potential rationale for yet another drastic expansion of the “small yard.”

In terms of empirical proof, the limited evidence does suggest that ‘protect’ measures have indeed been costly and have had certain negative effects on US companies, investors and employees in targeted sectors. The New York Federal Reserve cost-benefit analysis (cited above) paints a bleak picture, noting a “broad-based decoupling of U.S. firms from China ... not offset by the creation of new supply chain relations in other countries.” The analysis estimates that this caused a 130 billion US dollar reduction in the market capitalization of affected US companies, alongside declines in revenues, bank lending, profitability, and employment.

This significant impact occurred despite Chinese retaliation to US measures remaining relatively subdued so far. While Beijing has continuously expanded its toolbox of economic statecraft to support its broader bid of “keeping value chains at home,” export controls on critical raw materials were adopted rather hesitatingly through licensing requirements in 2023. An outright ban of gallium, germanium and antimony exports to the US followed only in December 2024, after several rounds of US measures being expanded upon. This cautious response likely reflected the challenging economic outlook that China has been facing more generally since the COVID-19 pandemic, rendering further escalation, with possible spillovers into other sectors, an unattractive prospect.

Importantly though, the Biden administration never claimed that ‘protect’ instruments could be put to use wholly without economic drawbacks. In his most recent speech, Sullivan again acknowledged that trade-offs are inevitable and difficult to resolve. Up to a certain point, direct economic costs in return for envisaged national security gains are the very nature of said policies, though critics like Triolo have vented their (somewhat understandable) frustration that “there has been little effort to run the numbers on all of this.”

As a criticism of the Biden-Sullivan agenda on its own terms, the cost argument does matter if these costs indeed reach such an extent that they become detrimental to US firms’ ability to keep ‘running faster’, as claimed by the SIA. A [CSIS analysis](#), using R&D expenditure, patent filings and earning call transcripts as proxy indicators, however, casts doubt on this key claim and suggests that the short-term innovation capabilities of US companies affected by export controls were not actually hindered. Indeed, the analysis found that companies affected by the 2022 export controls had increased their R&D spending by 68 percent since that year, while non-impacted peers had recorded only a 27 percent increase. While author Andreas Schumacher is careful to note potential industry-specific explanations and cautions that “the findings of this study should not be interpreted as an endorsement for policymakers to indiscriminately expand export controls,” this contribution does suggest that at least the concerns about the extent of self-harm inflicted by the US might be somewhat overblown.

“As Large of a Lead as Possible”: A Sensible Strategy to Advance US National Security?

Having discussed the efficacy of the concrete measures adopted by the Biden administration to achieve “as large of a lead as possible” in the domain of CET, this final part of the paper takes a step back to assess more fundamentally whether and under which conditions such an approach ultimately advances US security interests.

The bottom line of the discussion in the previous part is that the measures applied under the Biden administration indeed seem to have enabled the US to widen the tech gap with China, at least temporarily, by boosting its own capacities and narrowing access to US tech and the knowledge behind it. However, the effort was very costly. This was both due to the direct outlays required for the ‘promote’ measures and the collateral economic damage caused by the ‘protect’ measures – partially caused by their increasingly expansive application after initial steps did not prove as effective as hoped.

Importantly, these high costs had little to do with specific operational shortcomings or implementation mistakes. Rather, they were arguably inherently connected to the ambition of achieving “as large of a lead as possible.” On the ‘promote’ side of the equation, government-driven efforts to actively promote domestic technological advancements will always be costly and optimal allocation of funds will remain a difficult feat to accomplish – despite a growing base of experience and good practices to draw on from past industrial policy efforts. Even more crucially, when it comes to the ‘protect’ side of the agenda, better technical implementation and calibration may somewhat improve the cost-effectiveness ratio, but a logic of maximum advantage ultimately precludes highly targeted execution – not least due to inherent features of the relevant technology ecosystems.

By focusing many of their measures on semiconductors, the US did manage to target an industry in which American firms indeed play a key role (especially at the design stage) and whose setup presents a rare case of a genuine chokepoint. This chokepoint mainly presented itself in the form of the very small number of key equipment suppliers based in Europe and Japan, which possess unique capabilities that are extremely difficult to replicate. Still, restrictions had to be significantly and continuously expanded, as their impact was less drastic than the widespread chokepoint imagery suggests. As it is very difficult to identify comparable chokepoints in other industries (say, biotechnology), restrictions in these industries will likely have to be even more fundamental and expansive to achieve the desired effect, especially as the most crucial tech will increasingly be intangible. Their economic collateral damage will be correspondingly greater, providing governments and companies in affected countries with massive incentives to either circumvent the restrictions or to find alternative solutions to achieve a similar end.

In the present case, this logic strongly intersects with China’s techno-nationalism, which already pre-dated Xi Jinping but which he has worked hard to foster and expand. As noted above, China’s ambitions to catch up and ultimately eclipse the US, as well as its aspirations to eliminate its own dependencies by fostering domestic technology providers largely existed prior to significant US technology restrictions. What has arguably changed in recent

years, however, is the country’s growing tendency to step out of the technological trajectory already charted by the US. This is perhaps most visibly exemplified by Huawei’s mobile operating system Harmony OS and by China’s push for using the open-source instruction set architecture RISC-V for chip design to avoid established, proprietary American alternatives.

In combination, these trends strongly suggest a mid-term scenario of harder decoupling and of the emergence of two substantially separate technology stacks – one American-led and one Chinese-led. If this is indeed the future to come, a lot will hinge on which innovation system is fundamentally stronger, once deprived of important inputs from the other side. From a US perspective, there are reasons for confidence that the American system would prevail, but this is of course anything but certain. Moreover, some have argued that China might be structurally well-positioned to tilt the power balance in its favor in such a techno-economic stand-off with the US, due to its tighter business-state relations.

Some observers have taken this argument one step further, arguing that the US may lose leverage over China as a result of such a technology decoupling. For one, they note that a hard bifurcation of technology stacks would preclude future US containment of Chinese tech development and usage. What is more, as Thomas J. Christensen has noted, the US could lose “coercive diplomatic leverage” and room for deterrence in an acute crisis, especially if China were to come to the conclusion that it would be cut off from US technologies “on an unconditional basis.” As Jessica Chen Weiss has argued, “both deterrence and prosperity require some degree of economic integration and technological interdependence. If policymakers overplay competition with Beijing, they risk more than raising the likelihood of war and jeopardizing efforts to address the many transnational challenges that threaten both the United States and China. They also risk setting the United States on a path to what could become a pyrrhic victory, in which the country undermines its own long-term interests and values in the name of thwarting its rival.” Relatedly, Henry Farrell and Abraham Newman have warned that concerns about unchecked US power may even lead its allies to reduce their exposure to US-led global information and financial networks, resulting in a “slow erosion of the US ability to weaponize key economic networks, constraining its ability to project power globally.” Seeking a maximum lead over China could inadvertently end up undermining not only American affluence, but also its global influence. Ultimately, a weakened US would be confronted with an emboldened China in a less interlinked environment, creating the conditions for a more confrontational climate that could open the door to even more aggressive Chinese behavior vis-à-vis Taiwan or in the South China Sea.

While the various authors cited differ regarding the extent to which they have still expressed support for aspects of the Biden administration’s CET strategy, this line of argument fundamentally considers an aspiration of achieving absolute supremacy at the leading edge of technology misguided and self-defeating. Even though there are few voices left that extol the virtues of interdependence as a pathway towards a convergence of interests, this perspective still sees merit in technological and economic entanglements as a source of influence and leverage. Indeed, it invokes an alternative theory of deterrence that relies on the threat of a penalty, in the form of a withdrawal of cooperation in case of a breach (“deterrence by punishment”).

Indeed, it invokes an alternative theory of deterrence that relies on the threat of a penalty, in the form of a withdrawal of cooperation in case of a breach (“deterrence by punishment”).

This line of criticism raises important strategic drawbacks of a far-reaching technology decoupling (and hence of the “maximum-lead” approach that could contribute to such a scenario) that certainly merit careful consideration.

However, having taken all the different strains of criticism into account, we argue that, from a US national security perspective, a version of the Biden administration’s strategy is fundamentally justifiable for two main reasons. First, the strategy’s foundational notions are sound, notably including the understanding of emerging technologies as “force multipliers” and the framing of China as a country with the intent and growing means to

We argue that, from a US national security perspective, a version of the Biden administration’s strategy is fundamentally justifiable.

reshape the regional and global order, not least through utilizing these technologies for its military modernization. In this context, the recent case of Russia’s aggression against Ukraine also casts doubt on how viable a deterrence-by-punishment approach can be when facing an ideologically committed adversary, especially one bound by few constraints of domestic political accountability. Beijing leaves no doubt regarding its determination to achieve reunification with Taiwan, by force if needed, and it seems unlikely that any future threat of technological sanctions in an acute crisis scenario would be sufficient to restrain China from this course of action. This is why the logic of “deterrence by denial” – that is, seeking to make certain technologies unavailable or more difficult to access with the goal of weakening China in any military confrontation – is understandably considered a much more reliable safeguard.

Second, it is dubious whether the US is in a position to effectively pursue the supposed alternative approach of cultivating sustained strategic interdependence with China even if it were firmly committed to doing so. While the Biden-Sullivan agenda on CETs may have contributed to China’s growing embrace of qualitatively different technology architectures and design, Beijing was acutely aware of the constraints arising from its dependence on the US and committed to building up independent capabilities long before this US agenda took shape. The relevant mid-term counterfactual is therefore not one where China remains highly exposed to US leverage, but rather one where it may still use fundamentally the same technology stack but would largely rely on providers and supply chains over which the US nevertheless has no control. In terms of strategic leverage, this makes little difference. As Gregory Allen put it: “[T]here is simply no policy that the United States could articulate that would persuade China to abandon its goals of de-Americanization and decoupling

There is scope to make the approach less costly,
more likely to succeed and less damaging
for the rest of the world.

in the semiconductor equipment sector. As the United States and allied governments consider reforms to semiconductor equipment controls, they should focus less on how to change China’s goals and more on how to make achieving those goals as expensive and complicated as possible.”

While it undoubtedly comes with considerable risks and costs, pursuing a maximum lead on CETs over adversaries can therefore be considered a sensible strategy from the vantage point of US national security interests in the military and economic realm. Still, there is clear scope to improve the Biden administration’s approach in order to make the entire effort less costly, to increase chances of success and to simultaneously make it less damaging for the rest of the world.

Central to these improvements would be a more positive vision of beneficial cooperation among partners. As outlined above, the maximum-lead paradigm has so far led to measures often perceived as being initiated and implemented on unequal footing and without considering allies’ valid concerns. Some positive exceptions like the iCET notwithstanding, frameworks launched to change this dynamic have largely fallen short. Even though sheer military dependence provides the US with a powerful tool to force allies to follow their lead in an increasingly bifurcated global technology order, they will struggle to generate voluntary compliance and comprehensive buy-in – both necessary for better effectiveness, cost-benefit ratio and sustained ability to keep ‘running faster’. An excessively unilateral approach would not only feed political resistance to proactively contributing to US efforts, but would also hinder partners in [the EU](#) and [East and Southeast Asia](#) in doing so, since this unilateralism would undermine their economies and technology ecosystems.

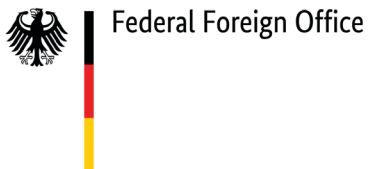
This must also be seen in a broader context of the Biden administration hardly even trying to argue that some of its key economic and trade policies were compliant with basic principles of the multilateral trading order and consistently [avoiding trade agreements](#) offering better access to the US market. As Adam Tooze [put it](#) acerbically in a broader retrospective on Bidenomics: “To sell a clean energy Marshall Plan in Washington today, start by dismissing any

pretension to the complex hegemonic calculus of the original. What the moment calls for is an *America First* export promotion.” Besides generally undermining a rules-based economic system, such an approach has severe negative implications for low-income countries who rely on technology and knowledge transfers as well as access to export markets. Sullivan himself acknowledged that “in the next decade, American leadership will be measured by our ability to ... build alignment and complementarity across our policies and our investments” instead of “competing with each other over where a fixed set of investments is located.” Similarly, Deputy National Security Advisor for International Economics Daleep Singh has admitted difficulties in implementing a positive-sum industrial policy and promised improvements.

In the coming years, most countries across the globe will try to pragmatically navigate the various options presented by the technology and economic cooperation formats offered by the US, China and their respective allies. At the same time, scale and geographical spread of technologies will continue to matter both in terms of their economics and their strategic utility. A reinforced commitment to advancing global access to technology for civilian developmental purposes – including through ‘protect’ measures that rely less on blunt restrictions and make the most of innovative technological solutions to achieve the same national security rationale – would therefore be a key contribution to the pursuit of “US interest rightly understood.”

Finally, and without illusions about any outsider’s ability to change Beijing’s outlook, the US should refrain from excessively broad measures that appear to be aimed at stifling China’s economic development in general . Indeed, it should explicitly maintain the possibility of rolling back restrictions in case of a credible and sustained change in regional and global posture. The foundational nature of CETs makes for a compelling national security argument, but it also means that restrictions will have considerable civilian economic costs in affected countries. To avoid unnecessary tensions and a hardening of attitudes among parts of the Chinese population that may harbor their own criticism of their government’s policies, it is important that CET restrictions remain tied to political behavior and decisions, rather than becoming an accepted and inherent feature of the relationship between the world’s two largest powers.

Unfortunately, none of these suggestions are likely to particularly resonate with the incoming Trump administration’s plans on CET, global economic governance and US-China relations. That makes it all the more important for domestic US stakeholders to continue to make the case for reasonable and evidence-based policies. International partners like the EU, meanwhile, urgently need to get their own strategic objectives straight, invest in their own capabilities and do what they can to persuade the US administration of their vision, as aligned and cohesively as possible. This will require a clear-eyed appreciation of the political realities in Washington and Beijing, as well as a coming-to-terms with a world in which averting large-scale conflict – rather than maximizing efficiency through global cooperation – will increasingly be a tall order.



This publication is part of a GPPi project on the strategic agenda on critical technologies in Germany and Europe. The project is funded by the German Federal Foreign Office. The publication solely reflects the opinion of its authors.

Reflect. Advise. Engage.

The Global Public Policy Institute (GPPi) is an independent non-profit think tank based in Berlin. Our mission is to improve global governance through research, policy advice and debate.

Cover Photo: The White House / Flickr

Reinhardtstr. 7, 10117 Berlin, Germany

Phone +49 30 275 959 75-0

gppi@gppi.net

gppi.net