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The Silicon Allies:

Achieving Allied Resiliency Against Threats to the Semiconductor Supply Chain

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The Silicon Allies: Achieving Allied Resiliency Against Threats to the Semiconductor Supply Chain

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I. Introduction

Semiconductors have come of geopolitical age. Just as OPEC's 1973 oil embargo shattered complacency about the assuredness of petroleum supplies, so has the global shortage of semiconductors since 2020 done for chips.

The results of the shortage have been painful.

- **The automobile industry** alone has suffered an estimated $210 billion in lost revenue in 2021 due to semiconductor shortages.[1]
- **America's GDP has been shaved by up to 1%**, according to a Goldman Sachs study.[2]

Some of the reasons for the strain are ephemeral and will naturally ease with time.

- **The COVID-19 pandemic**, fires, drought, and winter storms conspired to make 2020-2022 an extraordinarily challenging period for the semiconductor industry.[3]

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[1] U.S. Department of Commerce, "Results from Semiconductor Supply Chain Request for Information," January 2022, https://www.commerce.gov/news/blog/2022/01/results-semiconductor-supply-chain-request-information.
[2] Jan Hatzius et al., "U.S. Daily: A Semi-Troubling Shortage," Goldman Sachs Economic Research, April 21, 2021.
[3] Bindiya Vakil and Tom Linton, "Why We're in the Midst of a Global Semiconductor Shortage," *Harvard Business Review*, 2021, https://hbr.org/2021/02/why-were-in-the-midst-of-a-global-semiconductor-shortage.

- But…the fact that these incidents had such impact highlights an obvious need for greater resiliency.

Many of the other forces behind the strain, moreover, are years in the making—the result of complex and potentially lasting geopolitical and economic factors including comparative advantage dynamics that undergird the success of the fabless model and the resulting concentration of productive capacity in geopolitically sensitive parts of the world, China's rise, the relentless digitalization of global economies, and climate change.

The United States and key allies ("the Silicon Allies") are actively seeking greater resilience against these risks, with a principal focus so far on cultivating and supporting domestic industries as a hedge against geopolitical and other risks that emerge from having key nodes in the supply chain serviced by overseas suppliers.

- The Silicon Allies, for purposes of this study, are the European Union and its member states; Japan; South Korea; Taiwan; and the United States.
- Nearly half of the links in the supply chain are concentrated among the Silicon Allies plus China, which together comprise 56% of world GDP,[4] 99% of the value chain for semiconductors,[5] and 78% of the market for finished semiconductors.[6]
- The Silicon Allies are liberal democracies, with the United States serving as the connective tissue that links them together as political and economic partners, even if bilateral relations among some of them—notably, Japan and South Korea—are strained at times.

[4] Aaron O'Neill, "The 20 Countries with the Largest Proportion of Global Gross Domestic Product (GDP) Based on Purchasing Power Parity (PPP) in 2020," Statista, January 4, 2022, https://www.statista.com/statistics/270183/countries-with-the-largest-proportion-of-global-gross-domestic-product-gdp/.

[5] Semiconductor Industry Association, "2021 SIA Factbook," May 19, 2021, www.semiconductors.org.

[6] Antonio Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," Boston Consulting Group/Semiconductor Industry Association, 2021, p.7.

- **Of course,** the U.S. has many allies beyond the Silicon Allies, and the EU, Japan, South Korea and Taiwan have important relationships with additional countries as well.
- **India is also an increasingly important player** in the semiconductor supply chain, as it aggressively recruits manufacturers with subsidies and other incentives. Israel, Malaysia, Singapore, and Vietnam also play varying important roles in the supply chain.
- **China**, meanwhile, aims to achieve 70% self-sufficiency in semiconductors by 2025 and is poised to spend over $150 billion through 2030 in pursuit of that goal.[7]

The Silicon Allies cannot achieve their resilience goals unilaterally. Full self-sufficiency—onshoring every step in the process of transforming raw materials into finished semiconductors—is neither realistic due to the price tag nor necessary for achieving resilience.

- **Interdependencies** among each other and with China and other countries will persist for the foreseeable future, reflecting the fact that the supply chain involves thousands of inputs and industries from dozens of countries.

Interdependence is risky, however, and presents three policy challenges for the Silicon Allies.

1. **Asymmetric interdependencies** with China or any other actor.
2. **Manufacturing capacity races** among national strategies.
3. **Tensions between security and economic interests**.

The challenge for the Silicon Allies is how to achieve their resilience goals in the context of this interdependence.

[7] Karen M. Sutter, "China's New Semiconductor Policies: Issues for Congress," Congressional Research Service, April 20, 2021, https://crsreports.congress.gov.

- Meeting this challenge requires having a vision for a recalibrated interdependence *among the Silicon Allies* and *between the Silicon Allies and China*.
- Yet, the Silicon Allies have not yet defined the multilateral elements of their plans, even as they acknowledge to varying degrees that cooperation with partners is necessary to achieve their resiliency objectives.

The Silicon Allies need a shared vision to orient and guide their initiatives.

- Strategies and plans are otherwise at high risk of diverging in ways that undermine shared resiliency goals.

Our recommendation for that shared vision emphasizes reduction of asymmetric interdependencies, especially as to China.

- An asymmetric interdependency exists when a country such as China can hold the supply chain hostage by interfering with one or more links in the supply chain, without feeling a proportional or even greater amount of pain itself.
- Lest we forget, China considers Taiwan—where over 90% of the most leading-edge chips (<10nm) are manufactured[8]—a rogue province and has not ruled out taking the island by military force.
- Allies can reduce asymmetric interdependencies more effectively by working together to align national resilience strategies and work towards common threat perceptions, especially about the risks of new and emerging technologies relevant to semiconductors becoming concentrated in a country such as China that might seek to exploit asymmetric interdependencies for strategic advantage and use the technologies to bolster coercive military and economic power.[9]

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[8] Antonio Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," Boston Consulting Group/Semiconductor Industry Association, 2021, p.5.

[9] Fast Track Action Subcommittee on Critical and Emerging Technologies, "Critical and Emerging Technologies List Update," U.S. National Science and Technology Council, White House Office of Science and Technology Policy, February 2022, http://www.whitehouse.gov/ostp.

Our vision further emphasizes national and multinational initiatives that enhance overall allied resilience against supply chain disruptions, regardless of their cause, while avoiding wasteful races to out-subsidy each other's semiconductor manufacturing capacity.

We also highlight how allied unity on sanctions against Russia for invading Ukraine has the potential to serve as a foundation to build on to ensure that China or any other country, within a framework of global interdependence, cannot exploit that interdependence to harm the Silicon Allies.

- It will not be a straight line, however, from allied unity about Russia to allied unity about how best to address security risks from China.
- China will fiercely oppose any effort by the Silicon Allies to seek greater alignment on their resilience strategies and will seek to divide allied unity—especially when it comes to export controls and sanctions. China is studying multilateral actions against Russia and can be expected to adapt its own security and economic policies based on what it learns.
- The Silicon Allies will have to spot these actions when they manifest and seek unity in the face of efforts to divide them.

Building and sustaining trust is the bedrock for our vision.

- The Silicon Allies practice common liberal-democratic values—rule of law, respect for individual rights, market-oriented economic policies, and a commitment to peaceful resolution of international disputes.
- But they are also intense economic competitors, within the boundaries established by international trade agreements.
- The potential for confusion and miscalculation about goals, intentions and perceived ulterior motives of resilience policies is therefore high, given the tight linkages between security and industrial policies.
- China presents an especially complex challenge, because the Silicon Allies have varying bilateral relations with it.

- **Disagreements will happen.** What is important is that the disagreements are proactively managed to minimize the impact on national and allied resiliency goals. This requires trust.

II. Overview: The Semiconductor Supply Chain

The semiconductor supply chain is extraordinarily complex and includes extensive precommercial research; specialized design tools; libraries of intellectual property; hundreds of specialty and commodity inputs; and dozens of classes of precision engineering equipment.

- **Many of these links** in the supply chain are themselves the products of still more specialty and commodity inputs.

The supply chain is global as well, with industries from dozens of countries playing a part. A semiconductor may travel 25,000 miles and cross international borders 70 times before reaching the end customer.[10]

- **120 countries:** Nearly 2/3 of all countries are part of the supply chain.
- **Fourth most widely traded item in the world**: Finished semiconductors are behind only automobiles and oil (crude and refined).
- **168 industries**: Estimated to have been adversely affected by the semiconductor shortage.

But the supply chain also has numerous chokepoints where a single geographic region or small handful of firms provide a critical service or input—and where disruptions to the ability of these suppliers to meet demand has the potential to derail production.

- **Nearly half of the links in the supply chain** are concentrated in just six places: China, Europe, Japan, South Korea, Taiwan and the United States—in other words, the Silicon Allies and China.

[10] Accenture and Global Semiconductor Alliance, "Globality and Complexity of the Semiconductor Ecosystem," 2020.

- The U.S. accounts for 38% of the overall semiconductor value chain—the biggest share among the Silicon Allies and China[11]—and semiconductor firms based in the U.S. held almost half of the total semiconductor global market in 2020.[12]
- Around 60% of demand for chips based on the headquarters of the electronic device maker and more than two-thirds based on the location of the device manufactured/assembled are concentrated in the Asian Pacific region.[13]
- Taiwan and South Korea are home to around 80% of semiconductor manufacturing foundries[14] and 100% of manufacturing capacity for the most advanced semiconductors.[15]

The existence of chokepoints is not new. They've been a factor in the semiconductor supply chain for decades. Some examples:

- An explosion at a Japanese chemical plant in 1993 disrupted the global supply of epoxy resin and caused prices for DRAM memory chips to nearly triple.
- In 1999, an earthquake in Taiwan forced a production complex there to shut down; prices for memory chips tripled.
- The earthquake and resulting tsunami off the coast of Fukushima, Japan in 2011 affected global supplies of silicon wafers and hydrogen peroxide (key inputs for chip production) and also forced several fabs to shut down for months.
- When Russia invaded Ukraine in 2014 and annexed Crimea, neon prices increased by 600%.

More recently, the COVID-19 pandemic, a fire at a major Japanese semiconductor factory, a historic drought in Taiwan that stalled water-hungry semiconductor manufacturing

[11] Semiconductor Industry Association, "2021 State of the U.S. Semiconductor Industry," p.15.
[12] Semiconductor Industry Association., "2021 State of the U.S. Semiconductor Industry," p.14.
[13] Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," p.11.
[14] Dashveenjit Kaur, "Is the World Still Too Dependent on Asia to Solve the Chip Shortage?," *Tech Wire Asia*, January 18, 20220, https://techwireasia.com/2022/01/is-the-world-still-too-dependent-on-taiwan-to-fight-the-chip-shortage/.
[15] Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," p.5.

processes, and winter storms in Texas that disrupted chip operations at several major facilities all conspired to make the past few years an extraordinarily challenging period for the semiconductor industry.[16]

- Another example: Russia's war on Ukraine in 2022 has disrupted production of neon in Ukraine, while sanctions on Russia threaten to disrupt shipments of palladium and C4F6.[17] Industry stockpiled these materials prior to the war, but the stockpiles won't last forever—industry sources suggest that supplies may last through the end of the year, at best.

This constellation of suppliers and choke points is the product of evolutionary pressures exerted by the comparative advantages that countries and their industries possess with respect to different links in the supply chain.

- The American semiconductor industry leads the world in semiconductor design.
- China is an important source of raw materials and leads the world in assembly, packaging, and testing.
- Korean industry, led by Samsung and SK Hynix, excels in manufacturing, especially for memory chips.
- Japan is strong in refining raw materials, semiconductor manufacturing equipment, lithography, and certain specialized materials.
- Taiwan is home to Taiwan Semiconductor Manufacturing Company (TSMC), which operates the world's biggest foundry and utilizes leading-edge semiconductor manufacturing process technologies.
- In Europe, the Dutch firm ASML manufactures the exquisitely complex lithography machinery needed to produce the most leading-edge chips; European industry is also a leading source of IP for chip architecture.

[16] Vakil B and Linton T, "Why We're in the Midst of a Global Semiconductor Shortage."
[17] Russia and Ukraine are important sources of neon for use in lithography, and Russia is an important source for palladium and C4F6, used as a component material and as part of manufacturing processes, respectively.

III. Resilience Amidst Interdependence

A resilient supply chain, according to the Biden administration, is "one that recovers quickly from an unexpected event," whether the cause is accidental or the result of purposeful action by a state or non-state actor.[18]

- Achieving resilience will not be easy, but major improvements are possible.

The national resilience strategies of the Silicon Allies, if implemented, have the potential to significantly improve the ability of the semiconductor supply chain to recover from an unexpected event.

- In the United States, Congress has passed legislation called the CHIPS for America Act (Chips Act) that would, if signed into law, invest $52 billion in domestic manufacturing and research and development (R&D).
- Japan has challenged the Japanese semiconductor industry to triple their annual revenue by 2030[19] and has committed $6.8 billion in funding.[20]
- Korea is rallying government and private sector support around its K-Semiconductor Strategy.
- Taiwan has long promoted its semiconductor industry with favorable regulations, initiatives to cultivate industrial talent, and a supportive investment environment, including more recently a national effort to establish and expand science parks across Taiwan to boost the industrial clustering effect.[21]
- The European Commission has proposed a European Chips Act to bolster Europe's semiconductor industry by funding more R&D and commercial

[18] The White House, "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth," June 2021.
[19] Takashi Mochizuki, "Japan Sets Goal of Tripling Domestic Chip Revenue by 2030," Bloomberg Quint, November 16, 2021, https://www.bloombergquint.com/business/japan-sets-goal-of-tripling-domestic-chip-revenue-by-2030.
[20] "政府、半導体生産強化に７７４０億円計上へ," The Sankei News, November 20, 2021, https://www.sankei.com/article/20211120-VG2OB6SWWNJN7MJ6UE4GXLSUPA/.
[21] Executive Yuan Department of Information Services, "Taiwan Solidifying Leading Advantages in Global Semiconductor Market," Republic of China (Taiwan) Executive Yuan, April 15, 2021, https://english.ey.gov.tw/Page/61BF20C3E89B856/3b097381-95dd-41a1-99dc-171a614306ed.

manufacturing, strengthening information sharing on supply chain risks, and giving the European Commission the authority to allocate chip supplies in response to severe shortages.

What is *not* achievable at an acceptable cost is self-sufficiency. Consider the cost of fully self-sufficient local supply chains for each of the Silicon Allies:

- $1 trillion in upfront investments, according to an industry study.[22]
- $10s of billions annually would be required to sustain the investment.
- Semiconductor prices would increase 35-65%, according to the study.
- The environmental impacts of an industry that already utilizes significant energy, water, and hazardous materials would be amplified as well.

Bottom line: interdependence will remain a fact of life for the foreseeable future.

- A common thread running through the Silicon Allies' national initiatives is recognition that the semiconductor supply chain is resolutely global.
- Some measure of interdependence among suppliers, regions and countries is not only inevitable, but desirable when it reflects comparative advantages at various points in the supply chain that support innovation and keep prices competitive.

But interdependence is a source of great risk.

- Some links in the supply chain are fragile because the bench of suppliers for the link is not very deep or the suppliers are concentrated in a country such as China that might block them from exporting their products for geopolitical reasons.

Interdependence presents three policy challenges for the Silicon Allies.

1. Asymmetric interdependencies with China or any other actor.
2. Manufacturing capacity races among national strategies that result in poor returns on public investments in resilience.

[22] Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," p.4.

3. Tensions between security and economic interests, where short-term economic interests clash with long-term security and economic interests, especially as to the research, development, and export of critical and emerging technologies.

IV. Asymmetric Interdependence

Asymmetric interdependence exists when a country (e.g., China) can hold the supply chain hostage by interfering with one or more links in the supply chain, without feeling a proportional or even greater amount of pain itself.

- Chokepoints in the supply chain are obvious areas where a risk of asymmetric interdependence can emerge.
- Technologies and skills that serve as competitive barriers and accelerants for innovation are also areas where asymmetries can emerge.

China's use of trade as an instrument of sharp power highlights the risk of asymmetric interdependence—and the importance of eliminating it.

- China holds trading partners hostage when they do things that the Chinese Communist Party does not like.
- Examples abound: Norway and Japan in 2010; the Philippines in 2012; Mongolia and South Korea in 2016; Canada in 2019; and Australia, repeatedly but most recently in 2021, to name a few.[23]

Japan, South Korea, and Taiwan are especially exposed to Chinese coercion.

- China is by far their largest bilateral trading partner, accounting for around half of Japan's total trade and a quarter of South Korea and Taiwan's total trade in 2021.

[23] Bonnie S. Glaser, "Time for Collective Pushback against China's Economic Coercion," Center for Strategic and International Studies, January 13, 2021, https://www.csis.org/analysis/time-collective-pushback-against-chinas-economic-coercion.

- The reverse is not true: China's trade with these countries makes up a much smaller fraction of its total trade, in the mid- to high-single digits. The bilateral trade relationship is asymmetric in China's favor.
- And lest we forget, China considers Taiwan a rogue province and has not ruled out taking the island by military force.

Interdependence among the Silicon Allies carries risks too.

- Japan and Korea have an uneasy relationship, owing to Japan's treatment of Koreans during World War II and persistent tensions between the two countries over whether Japan has properly atoned for its actions.
- Tensions between them spilled over into semiconductors in 2019 when Japan removed Korea from its "whitelist" of countries that enjoyed preferential treatment for export licensing in apparent retaliation for a Korean court ruling that ordered Japanese companies to pay reparations to Koreans who were forced into labor during World War II.

As a multilateral bloc with the United States and Europe, however, the asymmetry shifts, especially when it comes to China's ability to access cutting edge technologies and equipment.

- China is asymmetrically dependent on the Silicon Allies when it comes to access to modern chips and the technologies needed to produce them.
- Need proof? Witness the debilitating impact that Washington's sanctions on Huawei have had on the ability of the company to source semiconductors for its mobile device line of business. Or the impact that export controls on leading-edge lithography equipment is projected to have on China's ability to produce the most advanced chips.

Still, prudence is necessary when the Silicon Allies use sanctions and export controls against a major trading partner such as China. Washington's actions against Huawei, though grounded in the rule of law, rely on a significant degree of allied consensus on the

reasonableness of the law and its application—and an assessment of the costs, including the risk of retaliatory actions by China that exploit asymmetric interdependencies where it has the upper hand.

- The Silicon Allies should use China's asymmetric interdependencies effectively but wisely.

V. Manufacturing Capacity Races

State support for semiconductors has a long history. Silicon Valley's debt to military contracting as a lifeline from the 1950s through the 1980s is well-documented,[24] and the semiconductor industries in China, Japan, South Korea and Taiwan emerged in no small part due to extensive support from their respective national governments.[25]

- Direct and indirect subsidies, preferential treatment in public procurement, public investments in workforce development, and immigration policy are among the many forms that government support for national semiconductor industries can take.

To be sure, while it is true that state support for the sector has influenced the configuration of the global semiconductor supply chain in important ways, market forces and regulatory policies in adjacent domains such as environmental policy have still been the keystone factor.

- Labor costs, natural resource endowments, and energy and other utilities costs are among the factors driving comparative advantages and regional differentiations across the supply chain.

Humility about the ability of governments to cause tectonic shifts, especially in the near- to medium-term, is warranted—and reflected in the Silicon Allies' national resiliency

[24] See, e.g., Thomas Heinrich, "Cold War Armory: Military Contracting in Silicon Valley," *Enterprise & Society* 3, no. 2 (2002): 247–84 and accompanying references.
[25] See, e.g., Antonio Varas et al., "Government Incentives and U.S. Competitiveness in Semiconductor Manufacturing," September 2020.

strategies, which generally reflect the stubborn persistence of interdependence as a fact of life.

- The good news is that achieving greater resiliency does not require tectonic shifts. For example, the U.S. could significantly enhance resilience by directing the $52 billion in CHIPS Act funding to a strategic subset of links in the supply chain.[26]

On the other hand, state support can tilt the balance on whether discrete projects that support resilience—such as construction of new fabs—move forward or not.

- State support for fabs by South Korea and Taiwan, for example, makes the total cost of ownership for comparable fabs built and operated in the United States unattractive by comparison, unless the U.S. government provides greater financial incentives to close the 30 to 40% cost gap—which the CHIPS Act would provide.[27]

Projected demand for chips is finite, however, even if the current shortages make it feel otherwise.

- When it comes to constructing new fabs, there is only so much productive capacity to go around until productive capacity exceeds demand. If that happens, fabs go bust unless governments only support those projects that appear to be financially viable over the long term—as the CHIPS Act would require for U.S. projects. (Or, unless a government is willing to pour taxpayer dollars into money-losing projects on a sustained, decades-long basis.)

The difficulty with predictions, as Yogi Berra quipped, is that they're about the future. Gauging which projects will be financially viable over the long term will inevitably require making assumptions about what other governments may do in the future with respect to their own resiliency plans. If other governments come under political pressure to defend their domestic industry from losing market share to foreign competititors, their actions could undermine the financial viability of resiliency projects in other countries.

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[26] See, e.g., Will Hunt, "Sustaining U.S. Competitiveness in Semiconductor Manufacturing: Priorities for CHIPS Act Incentives," Georgetown University Center for Security and Emerging Technology, January 2022.
[27] Varas et al (2020).

The Silicon Allies are at risk of competing for finite market share where the level of state support determines which of the Silicon Allies "wins."

VI. Tensions Between Security and Economic Interests

It is impossible to overstate the strategic importance of semiconductors. Technology is foundational to economic prosperity and military power, and semiconductors are essential components in most modern technologies.

- Leading-edge semiconductors are especially critical, because they are integral to the most cutting-edge applications, including AI, high performance computing, augmented and virtual realities, and autonomous systems, to name a few.

The Silicon Allies cannot afford to cede leadership when it comes to semiconductors.

- Leadership means avoiding asymmetric interdependencies, especially with China, that expose the Silicon Allies to economic coercion.
- It also means preserving a global trade regime that enables competition and supports innovation.

China is an inescapable factor shaping the geopolitics of the semiconductor industry, because of its three roles in the ecosystem:

1. As a supplier: Chinese industry plays a significant role in the supply chain as a key supplier of critical inputs (such as rare earth elements), a manufacturer of commodity chips, and the global leader in assembly, packaging, and testing.
2. As a market: China is the biggest or second biggest (after the U.S.) market for semiconductors, depending on the metric.[28]
3. As a revisionist power: The Chinese Communist Party views technology leadership as an essential element of its drive for indigenous innovation to support the party's economic, military modernization, and geopolitical ambitions, which

[28] Varas et al., "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era."

appear increasingly at odds with the Silicon Allies' shared interest in upholding a rules-based international order.

China considers its semiconductor industry as a core component of its effort to transform the country into an innovation powerhouse.[29]

- Follow the money: China's plan is backed by financial support from the government, amounting to $73 billion as of now, which is unrivaled by any other country. In addition, China has expanded its semiconductor preferential tax policies, including up to a 10-year corporate tax exemption for semiconductor manufacturers, valued at over $20 billion.[30]

The Silicon Allies must continue to outcompete China, but the playing field is not level.

- "China plays by a different set of rules that allow it to benefit from corporate espionage, illiberal surveillance, and a blurry line between its public and private sector," according to a study group convened by Eric Schmidt and Jared Cohen. "Beijing views these asymmetries as our problem, not theirs."[31]

On top of that, the Silicon Allies have legacy investments and manufacturing operations in China that cannot be undone overnight.

- South Korean semiconductor champions Samsung and SK Hynix, for example, have critical operations in China. China-based facilities produce 42 percent of Samsung Electronics' total NAND flash output. And SK Hynix's operations in Wuxi account for 47 percent of the company's total DRAM chip output.

[29] Tim Stratford et al., "China's 14th Five-Year Plan: Spotlight on Semiconductors," Covington, April 2021.
[30] Semiconductor Industry Association, "Taking Stock of China's Semiconductor Industry," July 13, 2021, https://www.semiconductors.org/taking-stock-of-chinas-semiconductor-industry/.
[31] China Strategy Group, "Asymmetric Competition: A Strategy for China & Technology," 2020, https://www.documentcloud.org/documents/20463382-final-memo-china-strategy-group-axios-1.

The post-Cold War multilateral export control regime is poorly suited to dealing with the challenge presented by China's ambitions.[32]

- The regime is primarily focused on nonproliferation and the direct contribution of various technologies—some special purpose, many dual-use—to military power. The regime is not concerned with technologies that enhance economic power, even when that power could be used coercively to exploit asymmetric interdependencies.
- The incumbent regime is unlikely to evolve, not least because Russia is a voting participant in 3 out of 4 of the multilateral export control institutions and can block significant reforms.[33] As the target of an embargo waged by countries opposed to its war against Ukraine with few powerful allies other than China, Russia is hardly likely to accept major changes that could undermine China's interests.

VII. Multilateral Aspects of the Silicon Allies' Resiliency Strategies Are Weak Links

Cooperation among allies is necessary to tackle the challenges posed by asymmetric interdependencies, subsidy races, and tensions between security and economic interests, especially as to China.

- There is strength in numbers.[34] None of the Silicon Allies can achieve self-sufficiency at an acceptable cost. They will have to rely on each other and, to varying degrees, on China and other countries.
- The Silicon Allies can undermine each other. They could respond to the current wave of resiliency initiatives with subsequent waves of subsidy initiatives to out-

[32] Kevin Wolf and Emily Weinstein, "COCOM's Daughter: A New Multilateral Export Control Regime Is Needed To Address Contemporary National Security and Human Rights Issues," Georgetown University Center for Security and Emerging Technologies, 2022 (forthcoming).

[33] Russia is a member of the Wassenaar Arrangement, the Missile Technology Control Regime (which it presently chairs), and the Nuclear Suppliers Group; it does not participate in the Australia Group.

[34] Andrew J. Grotto and Martin Schallbruch, "The Great Anti-China Tech Alliance," *Foreign Policy*, 2019, https://foreignpolicy.com/2019/09/16/the-west-will-regret-letting-china-win-the-tech-race/.

capacity each other, resulting in significant waste of public resources and needlessly duplicative productive capacities that frustrate resiliency goals.

- Perhaps more worrying still, industry from allied governments could use subsidies to free up capital that they could then spend building advanced manufacturing capacity in China for leading-edge semiconductors.
- Commodity chip manufacturing capacity is a different matter: the Silicon Allies can achieve their resiliency objectives notwithstanding China's semiconductor manufacturing capacity. Also, commodity chips do not contribute to military and economic power in the same way that leading edge chips promise to do. Finally, the major chip manufacturers face a difficult "pay to play" dynamic when it comes to China, where the government links access to its domestic market for semiconductors on whether the vendor has a manufacturing presence in China.
- The success of export controls on critical and emerging technologies will depend on multilateral cooperation as well. It is the only way to ensure that China cannot use allied technologies to unfairly compete against the Silicon Allies' semiconductor industries and enhance its ability to coerce other countries with military and economic power

The Silicon Allies have flagged multilateral cooperation as important in their written strategies and public statements.

- U.S. President Biden convened allied heads of state on the margins of the G20 meeting to discuss resilience and the semiconductor supply chain and has directed his administration to work with European allies and Australia, India and Japan through the U.S.-E.U. Trade and Technology Council (TTC) and the Quad, respectively.[35]

[35] The White House, "Fact Sheet: Biden-Harris Administration Bringing Semiconductor Manufacturing Back to America," January 21, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/21/fact-sheet-biden-harris-administration-bringing-semiconductor-manufacturing-back-to-america-2/.

- Korea and the United States committed to forge closer ties on semiconductors,[36] including a bilateral dialogue begun in December 2021.[37]
- Japan's semiconductor strategy emphasizes multilateral cooperation with the U.S., the E.U. and Taiwan.
- Taiwan and the United States announced in December 2021 a new bilateral cooperation framework called the Technology Trade and Investment Collaboration (TTIC), which will focus in part on semiconductor resilience.
- European leaders have emphasized multilateral cooperation and foreign investment in semiconductor productive capacity in Europe.
- Allied cooperation on export controls against Russia since its invasion of Ukraine is unprecedented and resolute.

So far, these efforts have yielded little in the way of concrete outcomes for semiconductor resilience, beyond commitments for continued engagement.

- This is understandable at this early stage, and there is intrinsic value in the signals these efforts have sent about the importance of multilateral cooperation.
- But it remains to be seen whether stated interest among allies in cooperating will result in coordinated action that supports competition, innovation, and democratic values, against a backdrop of China's economic and geopolitical ambitions.
- Allied unity on Russia sanctions is a bright spot, but there is no guarantee that this unity about Russia will spill over to unity over the role of export controls in allied efforts to address China's economic and geopolitical ambitions.

[36] U.S.-ROK Leaders' Joint Statement. (2021). The White House. https://www.whitehouse.gov/briefing-room/statements-releases/2021/05/21/u-s-rok-leaders-joint-statement/.
[37] "S. Korea, U.S. Launch New Dialogue on Semiconductor Partnership," Yonhap News Agency, December 9, 2021, https://en.yna.co.kr/view/AEN20211209005700320.

VIII. Recommendations: Emphasis on Trust

The Silicon Allies will have to manage several dynamics if they are to successfully tackle, on a multilateral basis, the challenges posed by asymmetric interdependencies, subsidy races, and tensions between security and economic interests.

- The Silicon Allies are fierce economic competitors, especially when it comes to semiconductors. Competition has served consumers well, in semiconductors and many other sectors, but it has bred mistrust among national governments about each other's plans and intentions.
- Bilateral friction among allies is a factor as well. Japan's removal of Korea from its export whitelist forced Korean semiconductor manufacturers to search for alternative supplies of precursor materials they had previously imported from Japan. Some Japanese exporting companies reportedly struggled as well after losing long-term customers in Korea.[38]
- Seams exist among the multilateral channels for engagement on strategic matters generally (e.g., on China's rise) and on semiconductor resiliency specifically. The incumbent channels are primarily bilateral (e.g., TTC and TTIC), limited multilateral (e.g., the Quad), or multilateral with sharp divisions (e.g., the incumbent export control regimes).
- Relations with China vary as well, especially in terms of exposure to economic coercion and the importance of the Chinese market for domestic industry as both a destination for goods and services as well as a location for supplies of key inputs and offshored manufacturing.

Trust is foundational, and when it comes to semiconductor policy, the Silicon Allies should take neither its existence nor its durability for granted.

- As open societies with electorally-accountable legislatures, vibrant private industries, actively engaged civil societies, and free press, initiatives to support semiconductor resilience will inevitably reflect the mixed motives of multiple

[38] Tetsuya Hakoda, "（社説余滴） ３年目の「愚策の極み」箱田哲也：朝日新聞デジタル," Asahi Shimbun, July 4, 2021, https://www.asahi.com/articles/DA3S14961375.html.

constituencies, even if certain motivations—such as concern about the national security implications of asymmetric interdependence—are in fact predominant.

- The messy reality of mixed motives means that national initiatives aimed at building resilience are inevitably vulnerable to caricature as narrowly self-interested initiatives whose primary purpose is boosting domestic industry at the expense of allies' domestic industries.

Transparency about resilience initiatives is the antidote to suspicion about ulterior motives.

- The Silicon Allies should exchange information about the ends and means of their semiconductor resilience strategies, including direct and indirect forms of state support and associated funding levels.
- The goal should be to develop a common operating picture on critical dependencies in the supply chain—links that serve as choke points, competitive barriers, and accelerants for innovation—and the market and policy conditions relevant to them.

There are several mechanisms the Silicon Allies could use to facilitate such an exchange, including bilateral (e.g., U.S.-Korea, U.S.-Taiwan, etc.) and multilateral engagements.

- Our bias is for multilateral engagements organized by the United States as the country with the most robust political connective tissue with the Silicon Allies on a bilateral basis.
- Ultimately, what's important is that the mechanism(s) reduce the chances of misperception and caricature about the ends and means of national initiatives. This will help reduce the chances that the Silicon Allies' national resilience initiatives distort competition and work at cross-purposes.

National legislatures must be part of these engagements, due to their budget and oversight roles and because they are deliberative bodies where arguments about the

means and ends of policy—including the mixed motives of various stakeholders—are publicly aired, potentially giving rise to misperceptions about the dominant drivers.

The Silicon Allies should cultivate a norm of consultative multilateralism when it comes to any unilateral action that could impact supply chain resilience.

- Trust is low among some allies, namely Japan and South Korea. The roots of mistrust have deep and complex political roots that cannot be brushed aside.
- The goal of constructive multilateralism should be to reduce the chances that political disputes spill over into semiconductors.

Transparency and exchanges on threat perceptions relating to China—and which technologies and resources might enable China to pursue policies that jeopardize the Silicon Allies' security and economic interests—are similarly important.

- Achieving allied parity on export policy will be difficult, due to the tensions between economic and security interests.
- China is not Russia. Allied unity on sanctions and export controls on Russia will not necessarily translate to unity on sanctions and export controls on China.
- Some degree of unity, however, is necessary, because achieving resilience against asymmetric interdependencies with China and denying China the ability to use allied technologies to achieve military advantages will require allied cooperation.
- As guiding categories for pursuing unity, the Silicon Allies should focus on building consensus on which technologies have the potential to serve as chokepoints, competitive barriers, proximate contributors to military power, and accelerants that could give China enduring asymmetric advantages.[39]

[39] These categories are derived from China Strategy Group, "Asymmetric Competition: A Strategy for China & Technology."

Workforce challenges may be an area ripe for engagement as well. Projected growth in semiconductor manufacturing will strain an already constricted pipeline of talent into the field; this is a problem that all semiconductor manufacturers are facing.

X. Conclusion

The Silicon Allies need each other. Interdependence among them, and with China, helps keep prices low and supports innovation.

Preserving its advantages requires that the Silicon Allies manage the risks of asymmetric interdependencies, subsidy wars, and tensions between security and economic interests.

Trust will be the difference between fragmented national initiatives that might produce short term economic benefits and aligned national initiatives that enhance overall resilience, support innovation and fair competition, and protect national security.

Further work is required to articulate an action plan with milestones, deliverables, and success metrics for strategic cooperation on resiliency initiatives. Key questions include:

- What principles should guide an allied initiative to deepen strategic cooperation to eliminate asymmetric interdependencies, reduce the risk of manufacturing capacity races, and manage the tensions between security and economic interests?
- How should such engagement be structured to advance these objectives while considering the Silicon Allies' varied and complex political and economic relationships with China?
- What additional countries, beyond the Silicon Allies as defined here, ought to be consulted or possibly even included in these efforts?