**CSS** STUDY

# US-China Interdependence: Implications for Switzerland

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# Content

# Foreword

At a time of intense rivalry between the United States and China, the high level of interdependence between the two countries creates a range of economic and strategic challenges for both. US-China interdependence generates mutual economic benefits, but it also has negative security implications. As their interdependence grew over the past few decades, the United States and China came to share an interest in international economic stability. At the same time, they grew increasingly concerned about the effects of interdependence on their respective positions in the intensifying security competition between them.

The challenges arising from US-China interdependence also have profound implications for Europe, including Switzerland. Confronted with US-China rivalry and interdependence, European governments often disagree, at times profoundly, as to how they should position themselves. They understand that US-China interdependence and rivalry have an impact on European security and welfare, generating both economic and security risks. They have grappled with uncertainties over the future trajectory of US-China interdependence, the effects on European welfare and security, and the strategic options available to them.

These issues are of special concern to Switzerland, given its status as a neutral country that has vital economic interests at stake in its relations with both the US and China. This study aims to shed light on the overall implications of US-China interdependence, especially for Switzerland. It proceeds from the macro level, focusing on the overall economic and strategic implications of US-China interdependence and rivalry, to the micro level, analyzing the effects of interdependence in high-tech sectors, including semiconductors and rare earth elements (REEs). The study attempts to trace the implications of interdependence for the US-China rivalry, for Europe, and especially for Switzerland.

Switzerland's own interdependence with the US and China is driven largely by its embrace of open markets. Switzerland relies heavily on the liberal international economy and remains highly vulnerable to exogenous shocks. Exports constitute nearly 70 per cent of its GDP, far exceeding the export-reliance of China and Germany. Switzerland relies to a considerable extent on the US and China for large trade volumes of non-critical goods and for smaller trade volumes of critical and strategically relevant goods. In the first chapter of this study, Michiel Foulon analyzes the overarching economic and strategic implications of US-China interdependence and their effects on Europe and Switzerland.

These implications are especially apparent in the high-tech sector. Competition for technological advantage plays a particularly important role in the broader and increasingly tense framework of US-China relations. In the second chapter, Sophie-Charlotte Fischer discusses the evolution of interdependencies in the high-tech sector between the two countries and then examines the ongoing dynamics of their unraveling. Specifically, the chapter outlines the rationales underlying these dynamics in Washington and Beijing, and then maps some of the tools that both capitals have already deployed to reduce the cross-border flow of technology, capital, and talent.

Against this background, the second chapter also discusses the implications of the partial technological decoupling between the US and China for Switzerland. It finds that Switzerland is already feeling the effects, for example through the extraterritorial effects of US export controls targeting China. Given that Switzerland is one of the few countries in Europe that remains open to Chinese technology in its telecommunications networks and even for government contracts, both Chinese interests in Switzerland and US pressure on Bern may increase further. This chapter also outlines potential scenarios for the further course of US-China technology decoupling and, by extension, its impact on Switzerland.

In the third chapter, Julian Kamasa presents two detailed case studies of interdependencies between the US and China. The chip supply chain and the rare earth elements supply chain are two prominent cases of US-China interdependence. Both are strategically important in the geopolitical rivalry between the two powers. This is because both chips and REEs have been the subject of export controls imposed by either Washington or Beijing for geopolitical reasons. This chapter outlines possible future scenarios for interdependence in these two industries and the likely consequences for Switzerland.

Together, the three chapters in this study aim to provide a thorough analysis of US-China interdependence and what it means for Switzerland. Our hope is that the study will be valuable to government officials, policy analysts, and the interested public.

# 1 Interdependence and Overall US-China Rivalry

*Michiel Foulon*

## 1.1 Introduction

US-China interdependence currently presents a critical dilemma. It generates mutual economic benefits to almost the same extent as concerns about negative security implications. A mix of geopolitical challenges and security concerns drives the rivalry between the two countries. At the same time, the United States and China not only represent the world's largest economies, but also have a complex set of trade and financial interdependencies that generate deep distrust and animosity between their governments. As the US and China became more interdependent over the past few decades, they came to share a joint interest in international economic stability. However, they worry that they will use their military power against one another. How should governments revise foreign policy strategy in ways that account for interdependence's negative security implications without relinquishing its economic benefits?

Interdependence is not uncommon among geopolitical rivals. This was illustrated with the interdependence among European states before 1914 and between Germany and the Soviet Union in the late 1930s and early 1940s. When states are interdependent, they specialize their economies in ways that are mutually beneficial and increase their wealth.[1] This view is familiar to students of liberal international economics and remains one of the foundational rationales of the liberal international economic order. But when states become interdependent, they may also worry about negative security externalities.[2] Negative security externalities of interdependence arise when it weakens supply chains; when it transfers sensitive dual-use technology; when it benefits potential adversary states disproportionately; and when adversary states can weaponize their interdependence by exploiting their negotiating position (as when one state blocks imports from another state because of their bilateral diplomatic or military frictions).

Even as interdependence jeopardizes states' security interests, it would be difficult for states to decouple their economies fully. Interdependence enables and constrains states through strategic interdependence and structural interdependence: the international economy's characteristics.[3] On the one hand, the international economy's structure is to a considerable extent exogenous to states and constrains them. On the other hand, states can manipulate their position in that international economic structure: they can craft strategies to engage or disengage their state's economy with other states' economies. They may successfully disengage some industries but fail to disengage others. States may moreover pursue decoupling and reduce their dependency with one state, but this affects their dependency and trade balance with other states. The US in the late 2010s imposed tariffs on Chinese imports and reduced its bilateral goods trade deficit, but the US trade deficit with other states grew worse. Decoupling is not simply about cutting ties, but also about the international economic structure on which it relies.

US-China interdependence became a source of particular concern to Chinese and Western governments over the last decade. The contrast with the 1990s and 2000s, when the US sought to socialize China into the Western-led liberal international order by means of economic integration, is striking. Since 2010, the US has come to see its interdependence with China more negatively due to international economic instability and negative security externalities. This includes supply chain vulnerabilities, transfer of dual-use technologies, and repayment capacity for government debt. China enjoyed significant economic growth through its export-driven economic growth model, but this did not lead to political and economic liberalization.

Due in part to this interdependence, the overall US-China rivalry has worsened. On the one hand, China threatens to overtake the US power position, especially as it seemingly intends to challenge the international order's status quo. China is expected to challenge the US diplomatically, economically, and/or militarily.[4] It has started to challenge the US and the liberal international economic order; for example, through joining or co-founding international institutions like the Asian Infrastructure and Investment Bank (AIIB) and the New Development Bank (NDB). These institutions are considered challengers to existing US-led international institutions like the International Monetary Fund (IMF). China challenges the international security order, too. China's military modernization

1 David Ricardo, *Principles of Political Economy and Taxation* (New York: Prometheus Books, 1996 [1817]); Robert Carbaugh, *International Economics* (Boston: Cengage, 2019), Chapter 2.

2 Kenneth N. Waltz, *Theory of International Politics,* Reissued 2010 (Illinois: Waveland Press, 1979), 104–07.

3 Robert O. Keohane / Joseph S. Nye, *Power and Interdependence: World Politics in Transition* (Boston: Little, Brown and Company, 1977), 7, 13; Helen Milner, "The Assumption of Anarchy in International Relations Theory: A Critique," in: Friedrich Kratochwil / Edward D. Mansfield (eds.), *International Organization and Global Governance: A Reader* 2006 (New York: Pearson Education, 1994), 1–52.

4 A. F. K. Organski, *World Politics,* Second edition revised and reset, 1968 (AA Knopf, 1958); Jack S. Levy, "Power Transition Theory and the Rise of China," in: Robert S. Ross / Zhu Feng (eds.), *China's Ascent: Power, Security, and the Future of International Politics* (Ihtaca: Cornell University Press, 2008), 11–33.

is aimed, at least in part, at shifting the balance of power with the US in China's favor. On the other hand, the US seeks to preserve the international status quo at a time when China is growing increasingly assertive. China does not accept the ruling by the Permanent Court of Arbitration in The Hague that dismissed China's territorial claims in the South China Sea. China ended Hong Kong's semiautonomous status and curtailed its democratic freedoms, despite its treaty commitment to the contrary. It has also declared its intention to unify Taiwan with mainland China with military force if necessary.

The existing international institutional set-up to resolve US-China conflicts rests on shaky foundations. The US-China Strategic and Economic Dialogue and its successor, the Comprehensive Economic Dialogue, were short-lived. The Comprehensive Economic Dialogue was established in April 2017 and suspended later that year. The widely touted 2020 US-China Phase One Trade Deal was criticized as a fiasco, as the two countries failed to meet trade targets that were written into the deal.[5] The liberal international order's main institutions that were joined or co-founded by the US, such as the World Trade Organization (WTO) and the IMF, remain dominant. However, they are increasingly challenged by China, which cofounded or joined several alternative institutions. They are also increasingly challenged by the US, which laments the WTO's inefficiency and ineffectiveness in managing economic relations with China and which blocked the WTO's appellate body.

Confronted with this interdependence and rivalry, European governments disagree, at times profoundly, as to how they should position themselves. They understand that US-China interdependence and rivalry have an impact on European security and welfare, generating both economic and security risks. They have hitherto grappled with uncertainties over US-China interdependence's future scenarios, the effects on European welfare and security, and the strategic options available to them.

The remainder of this opening chapter unfolds in three sections. It starts by describing what constitutes the US-China interdependence, including its main asymmetries and their role in the overall US-China rivalry. Then it outlines future scenarios for US-China interdependence. It proceeds with an analysis of how Europe is involved in US-China interdependence and Switzerland's strategic options. This includes the need to craft long-term strategic plans to balance economic liberalism and economic nationalism and to interconnect foreign economic strategies with foreign security strategies. The chapter ends by contextualizing the process of technological decoupling and the cases of the semiconductor industry and rare-earth elements (REEs) that the subsequent chapters detail.

5 Chad P. Bown, "US-China phase one tracker: China's purchases of US goods," *Peterson Institute for International Economics,* 19.07.2022.

## 1.2 Interdependence in US-China Strategic Rivalry

The US and China care about the economic benefits of interdependence as much as they worry about its negative security repercussions. The US and China pursue strategies in the international security order that put them at odds with each other. To achieve their security goals, they seek to maintain economic benefits from their interdependence in the international economic order.

### 1.2.1 US Strategy to Mitigate Interdependence's Negative Effects

The US, on the one hand, adopts a strategy aimed at preserving the international security order in the Asia-Pacific. In the strongest wording since the 2011 US reorientation towards Asia, the US National Security Strategy, released in October 2022, prioritizes maintaining the US competitive advantage over China in the region and worldwide.[6] In addition to the US military presence in South Korea and Japan, in 2014 the US signed the Enhanced Defense Cooperation Agreement with the Philippines. In 2021, the United States, Australia, and the United Kingdom signed a security pact to improve security cooperation in the Indo-Pacific, among other things aimed at bolstering Australia's submarine fleet. In September 2022, the US and the Philippines revived their military cooperation following the Chinese military exercises near Taiwan a month earlier.

To achieve its strategic ends in the international security order, the US has adopted a mixed strategy in the international economic order: to preserve benefits from its interdependence with China on the one hand and mitigate its security risks on the other. Specifically, the US seeks to maintain the benefits of the liberal international economic order that remain critical for the US economy. China is the largest export market for US agricultural goods, which totaled 27 billion USD in 2020 alone. Despite the Biden administration's commitment to strengthening the US domestic supply chain, the US still relies much on its interdependence with China for critical imports. Nearly 80 per cent of US imports of rare earth compounds and metals during 2017–2020 came from China.[7]

This dependence on the open international economic order also generated negative security externalities. The US worries about vulnerabilities from its dependence on China for critical imports. The 2022 US National Security Strategy stressed the US concern that China

6 The White House, *National Security Strategy*, October 2022, 24; Michiel Foulon, "Trade and security in US grand strategy vis-à-vis China," in: Salvador Santino F. Regilme Jr. / James Parisot (eds.), *American Hegemony and the Rise of Emerging Powers* (Oxon: Routledge, 2017), 43–59; Michiel Foulon, "Neoclassical Realism: Challengers and Bridging Identities," *International Studies Review,* 17:4 (2015), 635–661.

7 U.S. Geological Survey, *Mineral Commodity Summaries 2022*, 31.01.2022, 134.

"seeks to make the world more dependent on the PRC [i.e. China] while reducing its own dependence on the world."[8] By producing at lower costs compared to the US, China creates incentives for other countries to import the critical materials that it has to offer.[9] The US needs to import REEs in order to produce consumer goods like cellular phones and electric vehicles, as well as for defense applications like F-35 combat aircraft and guidance systems. A 2022 US Department of Defense report stressed risks in the US armed forces' supplies of batteries, energy storage, microelectronics, and kinetic capabilities. Kinetic capabilities' subcomponents require chemicals, electronic components, and REEs that go through the commercial market and generate a vulnerable supply chain.[10] The US worries moreover about interdependence risks regarding forced US intellectual property and technology transfers in sectors such as semiconductors – which China in turn requires for military applications like hypersonic and missile weapons programs. Even as Intel and the Taiwan Semiconductor Manufacturing Company invest in semiconductor factories in the US, the US remains heavily reliant on semiconductor imports.

To address these negative security externalities, most US administrations in recent decades – like the Bill Clinton, George W. Bush, Barack Obama, and the current Joe Biden administrations – relied on the international economic order's legal certainty and institutions. Specifically, when the US sought to settle trade disputes with China, it resorted to institutions like the WTO dispute settlement body. Between 2010 and 2016, the US brought 12 trade enforcement cases against China before the WTO dispute settlement body (which far exceeds the number of cases during 2004–2009). In 2012, President Obama signed an executive order to introduce a trade enforcement unit aimed at addressing trade violations by China, among other countries. President Biden, unlike his predecessor, explicitly supports the liberal international order and its institutions.

But the US at times seeks to mitigate the negative effects of interdependence by acting outside of the international liberal economic order's rules and institutions. Specifically, it has sought to do so through more confrontational foreign economic policies which appeared, at times, aimed at upsetting and dismantling the international economic order. In recent decades, the US lamented the negative consequences of its interdependence with China and the liberal international economic order. In June 2018, the US Trade Representative released a list of hundreds of goods imported from China to the US for which the US would increase tariffs as a direct response to China forcing "transfer of American technology and intellectual property."[11] In 2019, the Donald J. Trump administration blocked the nomination of WTO Appellate Body members, effectively preventing it from hearing trade dispute litigation appeals. President Biden reaffirmed in September 2022 that the US maintains several tariffs against China that were imposed by President Trump. The Biden administration also limited semiconductor exports to China in October 2022 in an explicit attempt to frustrate China's military ambitions. This same year, the US passed the Creating Helpful Incentives to Produce Semiconductors Act, which authorized the investment of over 200 billion USD in semiconductor research and development in order to strengthen the US semiconductor industry. Critics have already questioned whether this act will harm foreign semiconductor producers and whether it is consistent with the WTO's open market principles. In May 2022, US Secretary of State Antony J. Blinken succinctly summarized the mixed US approach to interdependence with China and to the international economic order, stressing that the US seeks to both "defend *and* reform the rules-based international order."[12]

### 1.2.2 China's Strategy to Mitigate Interdependence's Negative Effects

China, on the other hand, adopts a strategy aimed at revising the international security order in the Asia-Pacific. China's strategy is widely seen to aim at overtaking US geopolitical dominance in the Asia-Pacific – or at least to deny the US access to areas close to China's shores and drive the US navy behind the first island chain and possibly out the region altogether. Since around 2010, China has adopted a more assertive foreign policy to challenge the US in the Asia-Pacific and to revise the international order. China placed its first aircraft carrier *Liaoning* in service in 2012.[13] It introduced its Air Defense Identification Zone in 2013 in the East China Sea. After decades of little investment, China started increasing its nuclear arsenal's quality and quantity to become a peer competitor with the US. Today, China's intercontinental ballistic missile arsenal includes multiple independently targetable re-entry vehicles, which permits a missile to carry several warheads that each can strike different targets, according to a 2015 US Department of Defense report.[14] In its 2019 Defense White Paper, China laments that the US provokes and intensifies inter-state competition and undermines

8 White House, *National Security Strategy*, October 2022, 23.

9 Department of Defense, *Securing Defense-Critical Supply Chains: An action plan developed in response to President Biden's Executive Order 14017*, February 2022.

10 *Ibid.*

11 Office of the United States Trade Representative, *USTR Issues Tariffs on Chinese Products in Response to Unfair Trade Practices*, 15.6.2018.

12 Antony J. Blinken, *The Administration's Approach to the People's Republic of China*, Speech at The George Washington University, 26.5.2022, emphasis added.

13 Office of the Navy Intelligence, *The PLA Navy: New Capabilities and Missions for the 21st Century*, 2015.

14 Office of the Secertary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, 2015, 8.

global strategic stability.[15] In recent decades, it has consistently expressed its willingness to act to unify Taiwan with mainland China. China's military modernization is being conducted, at least in part, in anticipation of a conflict over Taiwan.

To achieve its ends in the international security order, China, like the US, adopts a mixed approach to the international economic order: to preserve benefits from its interdependence with the US on the one hand and mitigate its security losses on the other. Specifically, despite significant economic and military gains relative to the US over the past few decades, China needs to continue growing its economy and military. China remains inferior to the US regarding military capabilities and technology. And China continues to benefit from the existing international economic order. Despite China's efforts to boost domestic demand, its export-driven economy remains reliant on foreign markets like the US for consumer electronics. It relies moreover for advanced semiconductors on imports from Taiwan, the epicenter of a potential future armed conflict with the US. Advanced semiconductors are critical for China's economy and military, for example in aircrafts and medical devices. China is in this sense a status quo state that seeks to preserve the international economic order from which it benefits.

But China has long mitigated the negative effects of its interdependence by acting outside of the international economic order's rules and institutions. China has been frustrated by US security and economic dominance at least since the early 1990s. China joined or cofounded novel international economic initiatives like the AIIB and the NDB. In 2010, China restricted its exports of rare earth elements. After the Biden administration in October 2022 limited exports of semiconductors to China, China retaliated by filing a trade dispute with the WTO.

### 1.2.3 US-China Trade and Financial Interdependence: Key Issues

One state's trade deficit and the other state's trade surplus do not necessarily represent an interdependent relationship. One state can have a trade deficit with the other state without it representing an interdependency. One state can be dependent on the other and not the other way round. But the US trade deficit with China, and China's corresponding trade surplus with the US, do reflect an interdependency. It is moreover the geopolitical context that augments the significance of their interdependence.

**Trade balance:** The US-China trade balance varies depending on goods and services. On the one hand, the US-China trade imbalance widened over time. The US trade deficit in goods with China grew after Chinese leader Deng Xiaoping's 1978 reform and opening of the Chinese economy. It exploded following the US-China Relations Act in 2000 and China's WTO accession in 2001. While the US trade deficit in goods with China decreased around the 2007–2008 financial crisis, it worsened in subsequent years. In 2020 it totaled 308 billion USD (US goods imports from China totaled 433 billion USD and goods exports totaled 125 billion USD). By 2021, it was 353 billion USD.[16] Main goods categories of US imports from China comprise agricultural goods, electrical machinery, toys and sports equipment, furniture, and textile products.[17] Figure 1 visualizes the evolution of the US-China trade balance in goods alongside the events discussed in this chapter. On the other hand, in 2020 the US had a trade surplus in services with China of 25 billion USD (US services exports to China totaled 40 billion USD and services imports totaled 16 billion USD).[18] Part of the explanation for the US trade surplus in services rests in US exports of financial services and intellectual property regarding research.

**Strategic goods:** Debates on US-China interdependence have long focused on goods that represent large trade values in US-China trade, like agricultural goods and electrical machinery. However, an equally important cause for concern are goods that represent smaller trade values but with high strategic relevance. REEs and semiconductors, for example, are negligible in their trade value relative to total trade (for example, in 2021 rare earth compounds and metals imported by the US totaled 160 million USD).[19] The almost weightless semiconductors are negligible, too, in their physical weight relative to the final product's total weight. But semiconductors enable a state's advanced military power capabilities. They affect the overall balance of advanced power capabilities between states and thus the outcome of conflict and competition. A 2022 US Department of Defense report on critical risks in the US defense supply chains emphasized moreover risks in the supply of REEs and semiconductors.[20] Much of China's military modernization aims, at least in part, at tilting the balance of power in the Taiwan Strait and the East and South China seas in China's favor. In 2021, the US exported 13 billion USD worth of semiconductors to China, and the US imported 3 billion USD worth of semiconductors.[21]

Strategically relevant trade flows of semiconductors and REEs are dominated by a small number of states. Taiwan dominates in advanced semiconductors, and China dominates in REEs. Moreover, China relies on

15 The State Council Information Office of the People's Republic of China, *China's National Defense in the New Era*, July 2019, 2.

16 US Census Bureau, *Trade in Goods with China,* census.gov, 2023.

17 Office of the United States Trade Representative, *The People's Republic of China,* ustr.gov, 2022.

18 *Ibid.* These figures are rounded to the nearest billion USD.

19 USGS, *Mineral Commodity Summaries 2022*, 134.

20 DoD, *Securing Defense-Critical Supply Chains*.

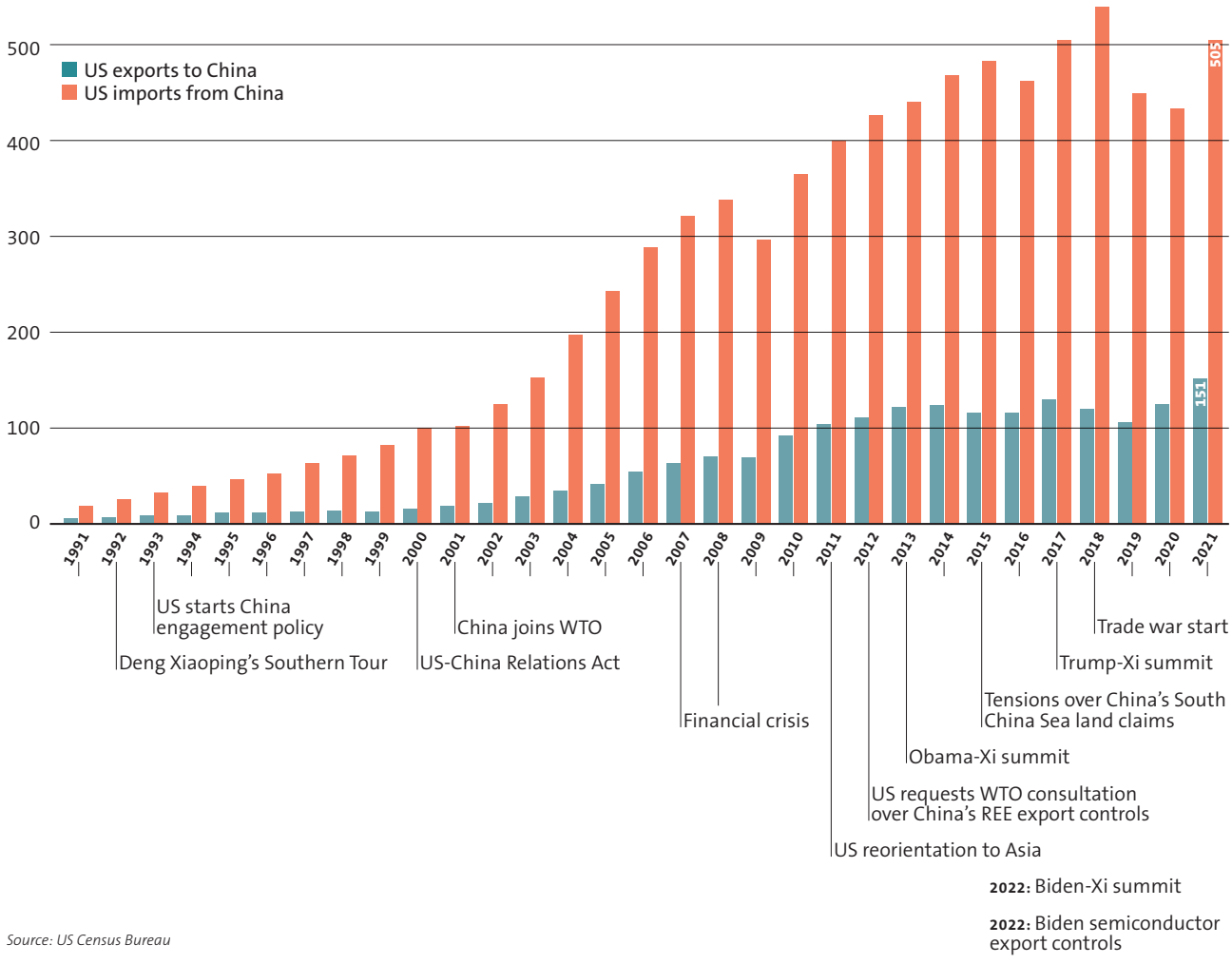
21 Gary Clyde Hufbauer / Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China," *Peterson Institute for International Economics Policy Brief* 22:13 (2022).

Taiwan for imports of semiconductor devices even more than the US did. In 2021, the US imported 2 billion USD worth of semiconductors from Taiwan, and China imported 52 billion USD worth of semiconductors from Taiwan.[22] Such trade flows are also politically highly sensitive. The WTO dispute settlement body in 2012 began arbitrating a case between the US and China regarding China's limitations on exports of REEs; the US relied on China for 78 per cent of its imports of rare earth compounds and metals from 2017–2020;[23] and President Biden in 2022 limited semiconductors exports to China.

**Financial investment and government debt:** Equally important in US-China interdependence are foreign direct investment (FDI) flows and government debt holdings. US FDI to China in 2020 totaled 124 billion USD, whereas Chinese FDI into the US totaled 38 billion USD.[24] Moreover, the US underwent transformation in recent decades from the world's largest creditor to the largest debtor, while China transitioned from net borrower to net lender. Even as China in 2022 reduced some of its holdings of US government debt, China's holdings of US Treasury Securities remain astronomical: by December 2021, China held over 1 trillion USD worth of US Treasury Securities.[25]

These financial relations constrain both the US and China. On the one hand, the dominant position of the US in the international economic and financial system is conventionally seen as a structural advantage that the US enjoys over China. It relies to a considerable extent on US creditworthiness. Credit rating agency Standard & Poor's downgraded the US creditworthiness rating from AAA to AA+, and Fitch Ratings warned the US in 2021 that problems in raising the US debt ceiling could cause the downgrading of its AAA rating. It cited high government spending and debt levels as one of the reasons for the possible downgrade. On the other hand, China is constrained because of the possible damage that reducing its purchases of US government debt could cause to China's economy. Some analysts suggest that China may "weaponize" its

Figure 1: US-China Interdependence Reflected in US-China Goods Trade in Current USD Billion, 1991–2021, with Selected Key Events




*Source: US Census Bureau*

22 *Ibid.*

23 USGS, *Mineral Commodity Summaries 2022*, 134.

24 USTR, *The People's Republic of China*.

25 US Department of the Treasury, *Major Foreign Holders of Treasury Securities*, 2023.

holdings of US government debt: in other words, that China might reduce its holdings of US government debt in order to increase US borrowing costs and to create international financial instability. But such a step could also damage China's economy, for example by reducing China's trade surplus and increasing Chinese unemployment.[26]

### 1.2.4 US-China Institutional Set-up at Crossroads

The institutional set-up to deal with these stresses in US-China interdependence rests on shaky foundations. Over time the institutions, treaties, dialogues, and summits surrounding US-China relations have gradually expanded from economic initiatives to those that also offer a platform for discussions of security, strategy, and geopolitical issues. While this institutional set-up offered a platform, it failed to manage US-China relations efficiently and effectively.

The bilateral dialogues to manage US-China relations have travelled a rocky road. Bilateral dialogues between the US and China broadened over time from economic initiatives to initiatives that marry economic concerns with security, strategy, and geopolitical concerns. However, they failed to provide a stable platform to manage these issues. In 1983 the US-China Joint Commission on Commerce and Trade was established, and in 2006 President George W. Bush and President Hu Jintao started the US-China Strategic Economic Dialogue. The US-China Strategic and Economic Dialogue was launched in 2009 by President Obama and President Hu. It included an economic track and a strategic track. The strategic track was headed by the Secretary of State and provided a forum to voice concerns over security and strategic issues pertaining to cyber accidents, nuclear domains, maritime activity, and US arms sales to Taiwan. This dialogue was renamed as the US-China Comprehensive Economic Dialogue, which was launched in 2017 by President Trump and President Xi Jinping. After the July 2017 meeting, the Comprehensive Economic Dialogue was stalled in November of the same year. The US-China institutional set-up's key treaties include the 1979 Taiwan Relations Act, which outlines official US relations with Taiwan, as well as the 2000 US-China Relations Act, which granted China permanent normal trade relations and paved the way for China to join the WTO in 2011. It also includes the widely touted 2020 US-China Phase One trade deal, which established trade targets that the US and China subsequently failed to meet.[27] Bilateral meetings between heads of state also take place, including in 2016 (Obama-Xi), 2017 (Trump-Xi), and 2022 (Biden-Xi).

Beyond bilateral initiatives, the chief forum to voice and settle disputes in US-China economic relations remains the much-plagued WTO. The WTO is the world's largest international trade organization and has a highly developed set of judicial organs. The WTO's dispute settlement mechanism has been touted as the organization's crown jewel. It allows states to settle trade disputes through an arbitration mechanism. But the WTO has been heavily criticized, and the US and China disagree over substantive and procedural issues. The arbitration cases are expensive and lengthy (for example, the US-China trade dispute case over solar panels and wind towers lasted from 2012 to 2019). Moreover, President Trump effectively blocked the WTO's appellate body in 2019 when he stopped the appointment of new Appellate Body members. The US Trade Representative in February 2022 reported to Congress that it has "become widely accepted in the US that WTO rules do not, and cannot, effectively discipline many of China's most harmful policies and practices."[28] Chinese commentators say that the WTO's dispute settlement mechanism is used by the US to launch trade dispute cases against China, inter alia as pre-election rhetoric and posturing in the run-up to US elections.[29]

## 1.3 Scenarios for US-China Interdependence

Against this backdrop, two main future scenarios for US-China interdependence can be distinguished. First is gradual disengagement, which is the most likely scenario, and second is a breakdown of interdependence, which remains unlikely.

### 1.3.1 Scenario 1: Gradual Disengagement

In the first scenario, the US and China disengage at the levels of industries and procedures. This comprises increasing trade barriers like tariffs and export controls, disintegrating the international institutional set-up, reducing bilateral FDI flows, reducing dependencies on foreign critical goods suppliers, and decreasing China's holdings of US government debt. In this scenario, a Taiwan crisis spans weeks and remains short of armed conflict.

**The US disengages from China**

In the immediate term, the Biden administration will intensify its efforts to reduce US dependency on China. The Biden administration enacted several domestic initiatives

26 Michael Pettis, "China Cannot Weaponize Its U.S. Treasury Bonds," *Carnegie,* 28.5.2019.

27 Bown, *US-China phase one tracker*.

28 United States Trade Representative, *2021 Report to Congress On China's WTO Compliance*, 2022, 20.

29 Christopher A. Ford, *China Looks at the West: Identity, Global Ambitions, and the Future of Sino-American Relations* (Kentucky; University Press of Kentucky, 2015), 364.

to produce more critical goods like REEs and semiconductors. In 2022, it authorized over 200 billion USD of domestic investment to produce semiconductors. Successfully increasing domestic production takes several years. If the US succeeds, then this proves helpful in reducing US dependence on foreign suppliers like China.

In the longer term, US views about China across party lines continue to converge. In 2019, Democratic Senator Chuck Schumer and Republican Senator Tom Cotton requested in a joint letter that the US intelligence services investigate whether TikTok, owned by Chinese company ByteDance, represents a national security concern. President Biden continued much of President Trump's China policy, maintained tariffs imposed by Trump, and imposed the export controls on semiconductors. If a Republican presidential candidate wins the 2024 election, then US China policy could shift to one that operates more outside of the liberal international order's rules and institutions. Long-term goals and trends in US China policy would remain, including the goal of diversifying foreign suppliers of critical goods. In this scenario, this trend persists, meaning that the US invests domestically to produce more critical goods, and expands tariffs and export controls.

This creates a paradox: by imposing tariffs on Chinese imports, the US reduces its trade deficit and dependency on China but maintains or increases its overall trade deficit with other states. All other things being equal, alternative supplies from other states will meet US consumer demand, causing US trade deficits with these states to increase.[30] From 2018 to 2020, the US reduced its trade deficit in goods with China from -418 to -308 billion USD (Figure 1). But during the same period, the US trade deficit in goods with the world as a whole worsened from -870 billion to -902 billion USD.[31]

**China disengages from the US**

China, on the other hand, will continue its policies to reduce its dependency on the US under this scenario. China has already enacted domestic policies to produce more advanced technology goods. China's industrial policy "Made in China 2025," published in 2015, aims to produce more high-technology goods in China and to reduce China's dependence on foreign suppliers. China expects to complete this process of boosting domestic production by 2030. If China succeeds, then this contributes to the disengagement of its economy from the US and Taiwan. Furthermore, in 2022 China reduced its holdings of US government debt to less than 1 trillion USD for the first time since 2010.

In this scenario, US-China disengagement could be accelerated by a Taiwan Strait crisis spanning weeks. The US remains committed to the status quo regarding Taiwan. The US continues to commit to the one China policy. This includes US opposition to Taiwan's independence, opposition to a unilateral change of the status quo in cross-Strait relations, acknowledgment of the position that Taiwan is part of China, and the conduct of only unofficial relations with Taiwan. Nevertheless, US-China tensions over Taiwan have deteriorated in diplomatic, economic, and military terms in recent years. The importance of cross-Strait tensions for US-China interdependence showed when Chinese military exercises over several days in waters near Taiwan in August 2022 produced a panic that it would disrupt Taiwan's semiconductor exports. If cross-Strait tensions disrupt semiconductor supplies, then this would affect China more than the US (given China's higher dependency on the import of Taiwanese semiconductors). In this scenario, the US and China also accelerate and expand their current plans to boost domestic semiconductor production, at the same time that US-China FDI and trade decrease.

Finally, US-China gradual disengagement at the procedural level occurs increasingly outside of the liberal international order's rules. The US and China have not reached a Phase 2 trade deal, and the Biden Administration has expressed, through US Trade Representative Katherine Tai, little appetite to negotiate such a deal. The US and China could consider strengthening or reviving other bilateral institutions or dialogues. This includes reviving the Comprehensive Economic Dialogue, reforming the WTO, and remaining committed to providing legal certainty and a platform to manage their interdependence. But the US and China stalled the Comprehensive Economic Dialogue in 2017, expressed doubts about the usefulness of the WTO, and adopted increasingly confrontational approaches toward one another. This institutional set-up could erode further. In this scenario, US-China disengagement occurs in a disorderly fashion, increases the amount of legal uncertainty, and causes an increase in international economic instability.

### 1.3.2 Scenario 2: Breakdown of Interdependence

In the second scenario, US-China interdependence evolves beyond gradual disengagement. The US and China experience significant internal and/or external shocks, causing US-China interdependence to dissolve. This comprises trade, investment, international institutions, and norms. It includes vast decreases in US-China FDI, US agricultural exports to China, China's exports to the US, and Taiwanese advanced semiconductor exports. In this scenario, this process is accelerated by armed conflict over Taiwan.

**US factors: A sword of Damocles?**

While the US enjoys leeway in the international economy, it is to a considerable extent constrained by the interna-

30 For a discussion: Robert Carbaugh, *International Economics* (Boston: Cengage, 2019), 343–49.

31 US Census Bureau, *Trade in Goods with China*.

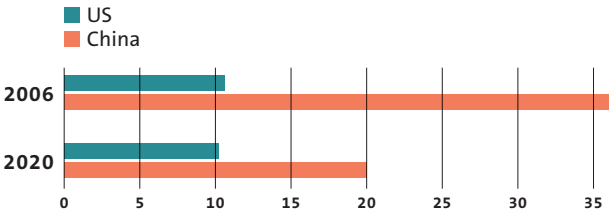
tional economy's structure. Analysts were already arguing by the mid-2000s that the US current account deficit was "a sword of Damocles hanging over the global economy."[32] Today, several structural factors detailed in this chapter – like trade imbalances, federal government debt, household consumption levels, and aging populations – have grown considerably worse. From 2010 to 2020, the US federal government debt-to-gross domestic product (GDP) ratio increased from 74 per cent to 119 per cent; the trade balance with China worsened from -273 billion to -353 billion USD in total; and the population over age 65 increased as a portion of total population from 13 per cent to 17 per cent. In this scenario, these trends persist for the foreseeable future as the US remains vulnerable to internal and external shocks.

**China factors: Will Japan's past be China's future?**

Whether China's economy will continue to grow remains a critical contingency. Media, research, and policy analysts have long perpetuated the discourse that China's rise to overtake the US in economic and/or military terms is inevitable. That a rising state may fail to meet growth expectations is familiar to students of economic history. In the 1980s and 1990s, analysts expected Japan to become the twenty-first century's number one great power, but its economy stagnated. The factors in China's case – like its aging population, export-reliant economy, and dependence on imports for critical goods – have so far not stalled China's economic growth. China's economic future may differ from Japan's past. But several factors contribute to macro-economic instability, complicate China's growth trajectory, and negatively affect US-China interdependence.

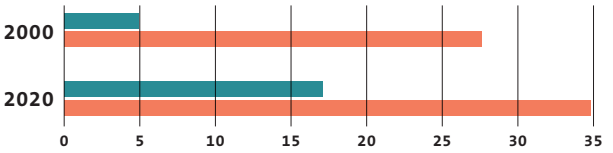
One challenge that China will confront is the need to reduce household savings and to revive domestic consumption, the latter of which declined during the height of the corona pandemic crisis.[33] In 2020, China's household consumption accounted for less than 40 per cent of China's GDP.[34] China has reduced its dependence on exports in recent years but they still accounted for 20 per cent of China's GDP in 2020. This means that China remains vulnerable to international shocks like declines in foreign demand (Figures 2 and 3).

Figure 2: Exports of Goods and Services as Percentage of GDP




*Source: World Bank*

Figure 3: Household Savings as Percentage of Household Disposable Income




*Source: OECD*

A closely related problem that will persist is China's aging population. The share of China's population over age 65 increased from 9 per cent in 2010 to 13 per cent in 2020.[35] China's population aged 65 and over as a percentage of the total population is expected to increase, while China's overall population is expected to decline in the coming decades (Figures 4 and 5).[36] This will strain its social safety net, while China's government debt-to-GDP ratio has worsened in recent years. China struggles moreover to escape the "middle income trap."[37] On the one hand, China's workers become less competitive in labor-intensive production when compared with other developing or middle-income states. On the other hand, China has not yet achieved sufficient innovation in its industries to compete higher in the value chain.

32 Maurice Obstfeld / Kenneth Rogoff 2005 cited in Ricardo Hausmann / Federico Sturzenegger, "Why the US Current Account Deficit is Sustainable," *International Finance,* 9:2 (2006), 2.

33 International Monetary Fund, "People's Republic of China: Selected Issues," imf.org, 04.02.2022.

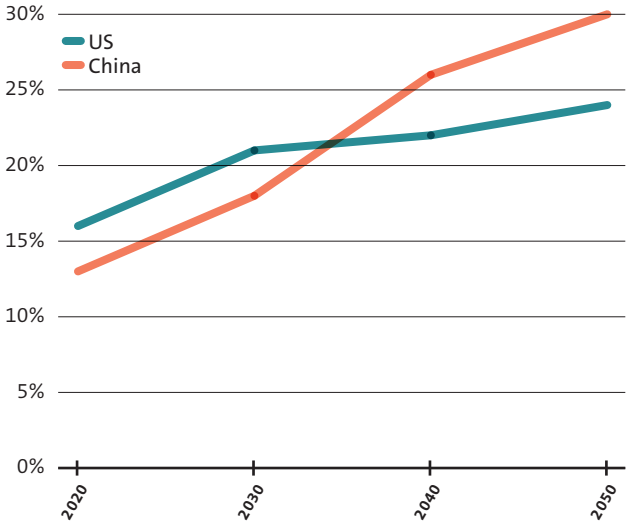
34 Tianlei Huang / Nicholas R. Lardy, "Can China revive growth through private consumption?," *Peterson Institute for International Economics,* 10.01.2023.

35 World Bank, "Population estimates and projections," databank.worldbank.org, 2022.

36 United Nations, *World Population Prospects 2022*, 2022, 6.; International Monetary Fund, "Aging is the real population bomb," imf.org, 2022.

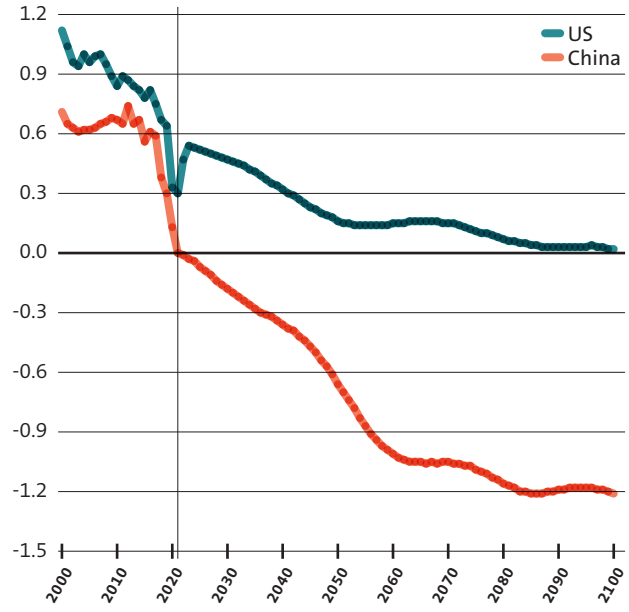
37 Ryan Hass / David Dollar, "Anxiety about China's rise will only hinder America's response," *Brookings,* 15.03. 2021. (Podcast/Audio)

Figure 4: Projection of Population Aged 65 and Above as Percentage of Total Population




*Source: World Bank*

Figure 5: Projected Rate of Annual Population Change in Percentage




*Source: United Nations Data Portal*

An equally important challenge will be the survival of the Chinese Communist Party (CCP). China's economic growth increased the living standards of large portions of its population. But economic growth risks raising inequality and causing environmental decline.[38] It could increase the domestic pressure for democratization and raise challenges to the CCP's authority and legitimacy. The November 2022 demonstrations against China's Covid policies included some calls for removing President Xi and the CCP.

**The upsetting factor: Conflict over Taiwan**

A breakdown of US-China interdependence would be accelerated by armed conflict over Taiwan. Some analysts suggest that interdependence deters states from starting armed conflict.[39] The US and China understand that armed conflict will hurt their economies. The US relies on China for critical imports like REEs. China relies on Taiwanese imports for advanced semiconductors.

The high costs of a breakdown of interdependence will not guarantee that large-scale armed conflict will be avoided, as best shown by interdependent European states descending into world war in 1914. The US continues to support Taiwan's self-defense against the use of force.[40] The US will continue to disengage from Europe, continuing a trend that has been apparent since the end of the Cold War. China could further assert itself in the Asia-Pacific and further narrow its power gap compared to the US. It expressed its willingness to unify Taiwan through military means and conducted military exercises surrounding Taiwan in August 2022 and April 2023. It declared that it is prepared to act to unify Taiwan with mainland China. Analysts disagree over when conflict occurs and how long it will last. The latter will depend on the resolve of the US and China: their willingness to endure the economic and human escalation costs.

**A breakdown into spheres of influence, but not mutually exclusive blocs**

Considering these developments, a scenario in which US-China interdependence breaks down is not unrealistic. The US and other Western states will continue to label China a competitor. China has joined or co-founded international economic institutions that challenge post-World War II Western-led international institutions like the IMF. The US and Europe increasingly demonstrate protectionist tendencies including tariffs and government support for domestic industries. The US and China advance their own terms of trade and technology use, nurture their own alliances, and promote their own international normative and institutional structures.

But this differs from the bloc formations that arose during the second half of the 20th century. A breakdown of US-China interdependence will more likely result in spheres of influence but also a certain level of interdependence that remains inescapable. Some US-China interdependence will be inevitable for addressing global challenges like the environment, pandemics, and international economic crises.[41] China will moreover remain an impor-

38 Jinghan Zeng, *The Chinese Communist Party's Capacity to Rule: Ideology, Legitimacy and Party Cohesion* (Hampshire: Palgrave Macmillan, 2016).

39 Joseph Nye, "For the US and China, interdependence is a double-edged sword," *Financial Times,* 04.02.2020.

40 White House, *National Security Strategy*, 24.

41 Nye, *For the US and China, interdependence is a double-edged sword*.

tant export market for Western economies.[42] China's economic partners include traditional US security partners like Japan, South Korea, Australia, and the United Kingdom (UK) through initiatives like the AIIB and the Belt and Road Initiative. In other words, the US, China, and their partner states will not neatly fit within one "camp." Instead, they will each have a different mix of economic and security interests in relation to one another.

## 1.4 Europe's Strategy and US-China Interdependence

### 1.4.1 Europe's Involvement in US-China Interdependence

Confronted with this reality, European states have different dependencies, different vulnerabilities to supply chain disruptions, and different foreign policy strategies to deal with dependencies and vulnerabilities. In 2020, some European states enjoyed a trade surplus with the US. These included France, Germany, Italy, Switzerland, and Belgium. Other European states suffered a deficit. These included Poland, the Netherlands, and the UK. And while some European states, like France, Germany, Italy, Poland, the UK, and the Netherlands, suffered significant trade deficits with China (the UK's at 57 billion USD in 2020), other states' trade deficits were far smaller (2 billion USD for Belgium and 0.2 billion USD for Switzerland) (Table 1). The importance of export markets in the US and China also varies for European states. The US constitutes the largest export market for Germany, Switzerland, and the UK, but only the fifth-largest for the Netherlands and the eighth-largest for Poland. China constitutes the second-largest export market for Germany, but the ninth-largest for Italy and the Netherlands and the 19th-largest for Poland (Table 2). European states' dependency on REEs imports, too, varies. Sweden, for example, discovered in January 2023 Europe's largest REEs reserves which it may over time leverage to reduce its dependence on external suppliers (depending on its raw materials mining processing capacity).

Table 1: Selected European States' Trade Balance, 2020

| | trade balance with US | trade balance with China |
|---|---|---|
| **Belgium** | 10 | -2 |
| **France** | 9 | -21 |
| **Germany** | 41 | -25 |
| **Italy** | 32 | -22 |
| **Netherlands** | -11 | -35 |
| **Poland** | -1 | -34 |
| **Switzerland** | 52 | -0.2 |
| **UK** | -3 | -57 |

*Source: World Bank*

Table 2: The Ranking of the US and China in Selected European States' List of Export Markets by Trade Volume, 2020

| | US ranking | China's ranking |
|---|---|---|
| **Belgium** | 4 | 8 |
| **France** | 3 | 7 |
| **Germany** | 1 | 2 |
| **Italy** | 3 | 9 |
| **Netherlands** | 5 | 9 |
| **Poland** | 8 | 19 |
| **Switzerland** | 1 | 3 |
| **UK** | 1 | 6 |

*Source: World Bank*

Due in part to their different dependencies and different supply chain vulnerabilities, European governments adopt widely different foreign policy strategies. The European Union in 2019 characterized China simultaneously as a cooperation partner, an economic competitor, and a systemic rival.[43] In 2022, the UK shifted its official position and labeled China a threat. Germany adopted its 2030 National Industrial Strategy, advancing state support for key European sectors and aiming to keep value chains within Europe. Germany and France converged in 2022 on the idea that Europe should do more to promote its national industries and to protect them from unfair American and Chinese competition. Belgium adopted its first-ever National Security Strategy in 2021. And Switzerland adopted its first-ever China strategy in 2021, labeling China mostly as a partner. European governments understand moreover

42 Shaun Breslin, "Alliances: Do we need a New Vocabulary for talking about European Strategy?," in: Michiel Foulon / Jack Thompson (eds.), *The Future of European Strategy in a Changing Geopolitical Environment: Challenges and Prospects* (The Hague: The Hague Centre for Strategic Studies, 2021), 9–10.

43 High Representative of The Union For Foreign Affairs and Security Policy, *A Strategic Outlook*, 12.03.2019, 1.

that the US is adopting more assertive – and, as the Trump administration demonstrated at times, even hostile – policies towards Europe.[44] In response, Germany developed longer-term strategies to link economic strategies with security strategies to deal with dependencies on the US and China. Meanwhile, other European states have foreign policy strategy horizons of four to five years and have yet to integrate their economic and security strategies.

### 1.4.2 Switzerland's Strategy and Economic Engagement with US and China

Switzerland's interdependence with the US and China is driven largely by its foreign policy strategy principle of open markets. Switzerland is one of the states that relies widely on the liberal international economy and remains highly vulnerable to exogenous shocks. Exports constitute nearly 70 per cent of its GDP, which far exceeds the export-reliance of China and Germany. Switzerland's geographical distance from the Asia-Pacific means, moreover, that its trade routes and supply chains are vulnerable to disruptions and delays. The time horizon for most of its strategic documents is around four to five years. Both the Swiss Foreign Policy Strategy (2020–2023) and the Swiss China Strategy (2021–2024) span three years. The Foreign Economic Policy Strategy details economic criteria to systematically analyze and prioritize potential economic partners, on the one hand, but these criteria do not consider risks from interdependence (like lack of supply chain diversification), on the other.

Switzerland relies to a considerable extent on the US and China for large trade volumes of non-critical goods and for smaller trade volumes of critical and strategically relevant goods. Specifically, Switzerland relies for exports and imports more on the US than on China. In 2021, Swiss exports totaled 30 billion CHF to China and 58 billion CHF to the US. Swiss imports from China totaled 18 billion CHF, including major goods categories like organic chemicals, apparel and clothing, and electric machinery. Swiss imports from the US totaled 22 billion CHF, including major categories like pearls and optical instruments and apparatuses. The US was Switzerland's most important export market in 2020, including for major product categories like electric machinery and pharmaceutical products. China was its third most important export market, including for categories like pearls, clocks and watches, and pharmaceutical products. In 2020, Switzerland enjoyed a 52 billion USD trade surplus with the US while running a -1 billion USD trade deficit with China. However, for imports of critical goods like semiconductor devices, Switzerland relies more on China than on the US. In 2019, Switzerland imported certain semiconductor devices and related goods more from China than the US.[45]

### 1.4.3 Strategic Options

While several strategic options exist, the most plausible options at this moment are disengagement in selected issue-areas or a fuller disengagement that revises the principle of open markets in foreign economic policy. The paragraphs below outline the main characteristics of each option and consider their main advantages and disadvantages. They all evolve broadly within the likely US-China interdependence scenario, discussed in the preceding section, in which the US and China gradually disengage. These options reconcile economic liberal and economic nationalist elements. While each of the options is discussed separately for analytical purposes, they are not mutually exclusive and can overlap in the real world.

**Option 1: Selective disengagement**

As detailed in this chapter's introduction, interdependence generates economic benefits and security risks. It increases a state's welfare but also generates security risks by weakening supply chains and potentially benefiting adversary states. It requires governments to revise foreign policy strategy in ways that account for security risks without relinquishing economic benefits.

One option could therefore be to disengage in selected issue-areas. This requires compartmentalizing non-critical goods (like clothing and textiles, precious stones, and agricultural goods) and critical goods (like advanced semiconductors, dual-use technologies, and REEs). Interdependence of the former can be maintained for economic benefits through specialization. Disengagement should be preferred for the latter. In early 2023, Sweden discovered Europe's largest REEs reserves. However, depending on permit regulatory changes and Europe's raw material mining and processing capacity, it might require over a decade before the materials are available on the market.[46] If European states seek to reduce their dependency on REEs imports from China, they must find alternative suppliers. It requires geographically diversifying the supply chains of dissociated critical imports.

This requires moreover interconnecting trade strategies and security strategies. On the one hand, Swiss strategic documents stress that economic interdependence makes Switzerland vulnerable to security risks. On the other hand, they prioritize potential trading partners based on economic criteria – not security criteria. These

44 Michiel Foulon, "Turbulent Trade: Europe and the Biden Challenge," *CSS Policy Perspectives* 9:1 (2021).

45 World Bank, "Switzerland Electrical apparatus; parts for diodes, transistors and similar semiconductor devices and photosensitive semiconductor devices imports by country in 2019," wits.worldbank.org, 2022.

46 Richard Milne, "Reasons for scepticism over Swedish rare earths find," *Financial Times*, 26.01.2023; Antonia Zimmerman, "Sweden's rare earths discovery won't end EU's China reliance – yet," *Politico*, 16.01.2023.

economic criteria include "the country's potential in terms of economic policy," "its actual economic relationship with Switzerland" in terms of trade volume, and "the chances ... of successfully entering into an agreement."[47] These economic criteria contrast with what the Swiss Foreign Economic Policy Strategy identifies as chief challenges: geopolitical changes, supply chain disruptions, and US-China rivalry.[48] Catering to the need of considering security risks in trade relations requires revising the criteria to select economic partners.

Specifically, a revised strategy for selecting economic partners considers those issues that are critical to Switzerland's security: Does the new economic cooperation or agreement contribute to the strategic goal of improving resilience by geographically diversifying consumers and/or the supply chain? Does it leave Switzerland with enough flexibility without being tied to the state or to economic cooperation with it? Does it improve or shorten the value chain? Does the new cooperation comprise rules regarding standards of use for dual-use technology? Such considerations offer moreover opportunities for cooperation between the Federal Intelligence Services and the Swiss academic and think tank community regarding scientific evaluations of new economic partnerships against their economic, societal, and security impact. If scientific assessments reveal negative impacts from proposed economic partnerships, then they can be used as leverage in negotiations and official dialogues. This includes when Switzerland considers expanding its economic relations with key players like the US and China.

This selective disengagement can be done in cooperation with likeminded states on an issue-by-issue-basis. Broad coalition building may be difficult in the short term given that European states are positioned differently regarding the US and China and adopt different foreign policies. Instead, issue-based coalitions address compartmentalized issues like collaboration on semiconductor production, without such compartmentalized issues spilling over to broader political cooperation and coalition formation.

An advantage of this selective engagement approach is that it is more pragmatic and achievable in the short term. An additional advantage is that it advances Switzerland's security position by reducing those aspects of economic dependencies with the US and China that pose security risks and preserving economic benefits from existing trade relations through specialization. A disadvantage is that it requires a careful selection and balancing act between economic liberalism and economic nationalism, which risks sacrificing economic benefits or suffering security risks.

47 Schweizerische Eidgenossenschaft, *Swtizerland's Foreign Economic Policy Strategy*, November 2021, 38.

48 *Ibid.*, 5–6.

**Option 2: Fuller disengagement**

However, a careful balancing act between maintaining economic benefits and mitigating security risks may not be attainable. This is the case when non-critical goods and critical goods cannot easily be compartmentalized; when selective issue-based disengagement spills over to other issues; or when great external shocks occur, such as the economic repercussions of armed conflict in the Taiwan Strait. This second option of fuller disengagement requires recalibrating Switzerland's foreign economic policy strategy principle of opening trade. This principle suits its highly export-dependent economy. At the same time, Switzerland's strategic documents acknowledge the challenge that Switzerland "will have to weigh up its economic interests against its security and foreign policy principles and position itself accordingly."[49] Switzerland already seeks to oppose international demands to open its agricultural policy. And in the financial investment side of interdependence, Switzerland has already started the process of establishing an investment control framework. This aims to prevent security threats from foreign investors who purchase Swiss companies, while preserving Switzerland's appeal and openness for FDI. In full disengagement in the trade domain, Switzerland also confronts a careful balancing act of securing access to foreign markets on terms as favorable as those that other states enjoy, on the one hand, and of satisfying a degree of economic nationalism, on the other. In this scenario, a fuller and broader disengagement of critical and non-critical goods unfolds. This requires expanding relations with alternative economic partners like the EU. A disadvantage of this option is that it reduces economic benefits from interdependence with the US and China regarding goods that do not pose security risks.

## 1.5 Concluding Discussion

European governments face seemingly contradictory dynamics from their interdependence regarding the US and China: they enjoy interdependence's economic benefits but also lament its security risks. Europeans understand that the direction of US-China interdependence will greatly affect European wealth and security for decades to come. How should governments revise foreign policy strategy in ways that account for interdependence's negative security implications without relinquishing its economic benefits?

This study argues that European governments must enact two innovations. One is to craft long-term strategic plans to balance economic liberalism and economic nationalism. The other is to interconnect foreign economic strategies with foreign security strategies.

49 *Ibid.*, 19.

The remainder of this study extends this debate by moving from this chapter's strategic level to the industry and operational level. Chapter 2 unravels the industry level of technological decoupling. On the one hand, states enjoy leeway to manipulate their position in the international economy, which enables them to enact decoupling policies. On the other hand, states are constrained by the exogenously given international economic structure, meaning that fully decoupling will be difficult and that some interdependence is inescapable. Accordingly, chapter 2 lays out technological decoupling's key dynamics, implications, and prospects. Chapter 3 unpacks the operational level. It provides detailed case studies of semiconductors and REEs. It considers chief characteristics like highly fragmented supply chains and reveals these cases' political implications and strategic options for Switzerland. Chapters 2 and 3 work broadly within this opening chapter's likely scenario of gradual disengagement and elaborate on an additional variable that could radically change the course of events. Chapters 2 and 3 should be read in tandem: they are different sides of the same coin.

# 2 Technological Decoupling: Dynamics, Implications, and Prospects

*Sophie-Charlotte Fischer*[1]

## 2.1 Introduction

Technology is one area in which the United States and China have become increasingly interdependent, in particular since China's accession to the World Trade Organization (WTO) in 2001.[2] Several motivations have fueled this development. For example, cooperation on research and development (R&D) was considered beneficial in promoting innovation that both countries would profit from. Moreover, the large Chinese and US markets offered attractive opportunities for investors as well as technology companies. The US and China were also both interested in increasing efficiency and cost savings through specialization in technology supply chains, for example by building on China's massive manufacturing capacity.[3] Finally, key figures in the US government in the 1990s and 2000s believed that deepening economic cooperation more broadly could catalyze political change and fuel China's integration into the liberal international order.[4]

This period was still characterized by sporadic national security concerns in Washington over Chinese access to US technology. For example, in the 2000s, the US became concerned about China's access to US satellite technology and significantly tightened US export controls in response.[5] American government officials also routinely articulated their concerns over restricted market access for American companies in China, instances of forced technology transfers, and the theft of American intellectual property by Chinese actors. Yet, despite these concerns, the technological integration between the two countries continued until Sino-American relations became increasingly tense during the tenure of former President Barack Obama (2009–2017).

The deteriorating US threat perceptions of China, first under Obama and then under his Republican successor Donald J. Trump, cast doubts upon the mutual benefits of technological interdependence. China's increasingly assertive authoritarian political model at home, aggressive "wolf warrior diplomacy" abroad, and military posturing in the Indo-Pacific raised serious concerns over Beijing's intentions. Moreover, China's astonishing technological rise over the last two decades, coupled with a strengthening of its efforts to use civilian technologies for its military modernization efforts, called the durability of the long-held US military-technological advantage into question. In addition, the COVID-19 pandemic highlighted the vulnerability of global supply chains, including in critical high-tech sectors like semiconductors.

Fueled by rising mutual suspicion, Washington and Beijing have begun to take a series of steps to reduce their technological ties. While views in the US on the desired degree of separation differ[6], a rare bipartisan consensus has emerged that America's technological ties with China must be reduced to protect US national security. Recent actions by the administration of President Joe Biden reflect the resolve to slow China's technological rise and the readiness to incur significant costs to realize this objective. However, the US government is also acutely aware that it can only achieve this objective by closely collaborating with technologically advanced allies in Europe and Asia.

In reaction to rising tensions with the US, Beijing has tried to accelerate its long-standing efforts to become technologically more self-reliant. These efforts focus on staggering investments in those technology sectors that are considered strategically important and in which China still relies on the capabilities of the US and its allies (e.g., semiconductors).[7] In addition, Beijing sought to selectively retaliate against US measures by wielding its own levers of influence to restrict the access of foreign companies and investors to the Chinese market.[8] Yet, over the past few months, it has also become clear that China has relatively limited options to push back against Washington without inflicting prohibitively high costs on its own economy.

While the selective technological decoupling of the US and China that has already started will likely continue, there are also several uncertainties that will shape the further trajectory. These notably include America's ability to marshal support from its allies in Europe and Asia for restrictions on technology transfers targeting

1 The views expressed in this chapter represent only the author's views at the time of writing. It was completed and submitted during the author's tenure at the Center for Security Studies.

2 Pengfei Han / Wei Jiang / Danqing Mei, "Mapping U.S.-China Technology Decoupling: Policies, Innovation, and Firm Performance," *SSRN Scholarly Paper* (2020).

3 Stephanie Segal / Dylan Gerstel, *Degrees of Separation: A Targeted Approach to U.S.-China Decoupling – Interim Report*, (Washington, DC: Center for Strategic and International Studies, 2021).

4 Kurt M. Campbell / Ely Ratner, "The China Reckoning: How Beijing Defied American Expectations," *Foreign Affairs* 97:2 (2018), 60–70.

5 Tim Hwang / Emily S. Weinstein, "Decoupling in Strategic Technologies: From Satellites to Artificial Intelligence," *Center for Security and Emerging Technology Issue Brief* (2022).

6 Maxwell Bessler, "Demystifying the Debate on U.S-China Decoupling," *Center for Strategic and International Studies,* 16.11.2022.

7 James T. Areddy, "Fearful of Getting Cut Off, China Pushes for Self-Reliance," *Wall Street Journal,* 03.05.2022; Lauren Dudley, "China's Quest for Self-Reliance in the Fourteenth Five-Year Plan," *Council on Foreign Relations,* 08.03.2021.

8 "China Slows Reviews of Mergers Involving US Companies – WSJ," *Reuters,* 04.04.2023.

China and Beijing's ability to speed up the development of its domestic technology industries. Moreover, significant events such as a potential invasion of Taiwan or even an escalating threat thereof could dramatically alter the context in which the US-China tech decoupling is currently taking place and hence, its further development.

This chapter zooms into the dynamics of technological decoupling between the US and China. The first section maps some of the key policy instruments that both governments have already deployed and discusses the likely further trajectory of their technological decoupling. Building on this assessment, the second section changes the perspective and analyzes the repercussions of the decoupling dynamics in the area of technology for Switzerland. The third section then sketches out three scenarios that could significantly alter the context in which the US-China tech decoupling currently evolves and hypothesizes about the likely implications for Switzerland. The fifth section reviews the chapter's main findings and offers some final reflections.

## 2.2 Decoupling Dynamics

In recent years, the term "decoupling" has gained popularity among Western policymakers, think tankers, and journalists. However, a lack of a clear and concise definition has made substantive discussions on this complex policy issue even more challenging. For the purpose of this chapter, decoupling refers to the process of separating previously interdependent systems or some of their components with the objective of increasing their independence. Technological decoupling then specifically refers to the dissolution of interdependencies between states' technology ecosystems. However, in this context, decoupling is not considered to be an absolute end-state. It is also possible to decouple only some of the links between these technology ecosystems, rather than completely separating them.

Interdependencies between state's technology ecosystems are dissolved, for example, through the implementation of restrictive policy instruments. These instruments can target a variety of linkages between the systems, including cross-border flows of technological goods, capital (e.g., foreign direct investment in tech companies), talent (e.g., students and researchers), and data. To complement and to some extent also enable this process, states might also invest in their domestic industries and partner with other states to re-strengthen their technological capabilities.

In the following, some of the key policy measures that the US and the Chinese government have already implemented to reduce their technological ties will be mapped. Due to the limited scope of this chapter, the mapping is not exhaustive. The section will also touch upon the motivations that have spurred the deployment of the different instruments. The second part of this section then discusses the likely future trajectory of the US-China tech decoupling. In this assessment, current trends and some structural factors that may affect the willingness of Washington and Beijing to further reduce the ties between their technology ecosystems will be taken into consideration.

### 2.2.1 United States

In the United States, the aim to decouple the American and Chinese high-tech ecosystems is neither an officially declared government goal nor does it follow a coherent set of policies. Rather, technology has become the focal point for an array of Washington's concerns over Chinese government practices. This is mirrored in the diverse motivations underpinning the implementation of US policy instruments to date that have the effect of dissolving Sino-American high-tech ties. In other words, decoupling from China in technology is the result of the cumulative effects of policy instruments that address different US government concerns.

These concerns primarily relate to how China's acquiring and deploying technology affects US national security and foreign policy interests.[9] Specifically, the US is concerned about China's ability to leverage emerging technologies for bolstering its economic prowess and modernizing its military, contributing to the further erosion of US competitiveness and power projection capabilities in the Indo-Pacific. A related concern is China's Military-Civil Fusion Strategy (MCF), which implies the conversion and use of primarily civilian technologies for military purposes and vice versa and Beijing's multi-pronged strategies to acquire foreign technology through licit and illicit channels to bolster its domestic capabilities.[10] Another concern is the Chinese government's use of technology for surveillance purposes, the export of its evolving model of "digital authoritarianism" abroad, and the involvement of Chinese technology companies in human rights abuses. Finally, the COVID-19 pandemic and the resulting supply chain disruptions have highlighted concerns in Washington about the dependability of mainland-based technology supply chains and emphasized the necessity for diversification.

To address these diverse concerns, the US has implemented a variety of restrictive policy instruments targeting the ties between the American and Chinese high-tech ecosystems. The Trump administration, which initiated the current wave of policy instruments that have

9 The White House, *Interim National Security Strategic Guidance*, March 2021.

10 Jake Sullivan, *Remarks by National Security Advisor Jake Sullivan at the Special Competitive Studies Project Global Emerging Technologies Summit*, Washington DC, 16.09.2022.

the effect of a partial decoupling, focused primarily on unilateral instruments. In a few cases, the Trump administration used legal instruments and political pressure to align the actions of allies with the US objectives vis-à-vis China.[11] The Biden administration not only continued several of Trump's restrictive policies, but even expanded the use of some of them and introduced a number of additional unilateral measures. In contrast to Trump, Biden seeks to complement them more actively with bi-, mini-, or multilateral measures. The administration emphasizes the need to collaborate with technologically advanced allies, especially in Europe and Asia, to make some of its measures more effective and less costly in the long run.[12]

The instruments that the US has implemented so far can be grouped by the type of relevant flows between the American and Chinese tech ecosystems that they target, including technology, capital, and talent. However, as will be shown below, some of the instruments that the US government has already deployed target several of these flows at once. Within these categories, some of the key instruments that the US government has deployed during the Trump and Biden administrations (2017–present), will be mapped below.

**Technology flows**

Export controls have become a key instrument for the US government to disrupt flows of critical technologies to China and to address different national security concerns. The export controls that the US government has implemented so far target both specific technologies as well as specific Chinese companies and other entities involved with technology. One significant set of export controls that the US government announced in October 2022 targets exports of semiconductor and supercomputer manufacturing and testing equipment, as well as relevant components, to China. The US government is targeting these technologies because they are critical for China's efforts to upgrade its domestic semiconductor industry and produce the chips needed to advance priority industries such as Artificial Intelligence (AI). Moreover, the US and a few select allies dominate the development of cutting-edge semiconductor manufacturing equipment. The scope of the controls is especially broad through the application of the so-called foreign direct product rule (FDPR). The FDPR implies that US export controls also cover certain China-bound advanced computing items that were made in other countries but with certain US products or technologies.[13] Thus, these extraterritorial effects also affect trade and scientific cooperation of other countries with China.

Other US export controls target specific Chinese entities by placing them on the US Bureau of Industry and Security's "Entity List" (EL), which specifies licensing requirements for the transfer of some or all items covered by the US Export Administration Regulations (EAR) to listed companies, persons, or other entities. These measures have been linked, for example, to concerns over Chinese spying activities, human rights abuses, and companies' links to the Chinese military. Already in 2019, the US government "blacklisted" Chinese telecoms giant Huawei. The government had alleged that Huawei's 5G gear could be exploited by Chinese authorities for spying on US citizens, companies, and the government. Through the blacklisting, the US blocked Huawei's access to American technology, including, for example, semiconductors as well as Google's Android operating system. In 2020, the scope of the measure was further expanded through an FDPR.[14] In another move in 2019, the US government added Chinese technology companies to the entity list for their implication in "human rights violations and abuses in the implementation of China's campaign of repression, mass detention, and high technology surveillance against Uyghurs, Kazakhs, and other members of Muslim minority groups in the Xinjiang Uyghur Autonomous Region."[15] In 2021, the BIS added seven Chinese supercomputing entities to the list to prevent them from leveraging US technology for China's military modernization efforts.[16] These are just a few examples, as more and more Chinese entities have been added to the list under both Trump and Biden.

In addition to limiting technology flows through export controls, the US has also banned the import and sale of certain technologies from Chinese vendors in the United States. In a recent decision, the US Federal Communications Commission (FCC) prohibited the sale of new communications equipment produced by Chinese companies Huawei, ZTE, Hytera, Hikvision, and Dahua on national security grounds. This decision was also linked to concerns over the ability of Chinese authorities to exploit these communication technologies to spy on their American users.[17]

11 Alexandra Alper / Toby Sterling / Stephen Nellis, "Trump Administration Pressed Dutch Hard to Cancel China Chip-Equipment Sale: Sources," *Reuters,* 06.02.2020.

12 Gina M. Raimondo, *Remarks by U.S. Secretary of Commerce Gina Raimondo on the U.S. Competitiveness and the China Challenge*, 30.11.2022.

13 Bureau of Industry and Security, *Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use; Entity List Modification*, 13.10.2022.

14 Richard Altieri / Benjamin Della Rocca, "U.S. Further Tightens Huawei Blacklist, Putting a 'Blanket Ban' on the Company," *Lawfare,* 28.08.2020.

15 Bureau of Industry and Security, *Addition of Certain Entities to the Entity List*, 09.10.2019.

16 U.S. Department of Commerce, *Commerce Adds Seven Chinese Supercomputing Entities to Entity List for Their Support to China's Military Modernization, and Other Destabilizing Efforts*, 08.04.2021.

17 Diane Bartz / Alexandra Alper / Diane Bartz, "U.S. Bans New Huawei, ZTE Equipment Sales, Citing National Security Risk," *Reuters,* 01.12.2022.

Lastly, the US also seeks to reduce its technology flows with China by diversifying its supply chains. This includes the strengthening of the US's own capabilities in key industries such as semiconductors to maintain and further expand its competitiveness. For example, the CHIPS and Science Act of August 2022 provides USD 52.7 billion "for American semiconductor research, development, manufacturing, and workforce development."[18] Apart from investing in its own industry, the US government also seeks to intensify its cooperation with "like-minded" allies in Europe and Asia on securing tech supply chains. For example, with its proposed "Chip 4 Alliance," the US aims to convince Japan, South Korea, and Taiwan to jointly establish a "democratic semiconductor supply chain" and to weaken China's role in the industry. So far, the US has struggled to marshal the full support from the Asian allies and partners due to concerns over Chinese retaliation and regional security dynamics.[19]

However, the Biden administration seemingly succeeded in bringing Japan and the Netherlands on board with its export controls on semiconductor manufacturing equipment that it announced in October 2022. Following their unilateral implementation, the US government intensified its efforts to persuade Tokyo and The Hague to adopt controls similar to Washington's, given some of their companies' strong position in the production of semiconductor manufacturing equipment. Following several months of negotiations, the Dutch and Japanese agreed to implement their own export controls that complement those of the United States. As of the current writing, however, there are still uncertainties surrounding the specific design and scope of these controls.[20]

**Capital flows**

The US is also reducing the ties of its tech industry to China by restricting capital flows related to technology. Most notably, in 2018 then-President Trump signed the Foreign Investment Risk Review Modernization Act (FIRRMA) into law. The legislation was motivated by growing concerns of policymakers in Washington over certain types of Chinese investments in US tech companies and the transfer of American technology enabled by them.[21] FIRRMA significantly expanded the jurisdiction of the Committee on Foreign Investment in the United States (CFIUS), which conducts investment reviews on national security grounds. Following FIRRMA, CFIUS now also assesses investments in certain US businesses that are involved with critical technology, critical infrastructure, or sensitive personal data that do not directly confer control over a business to the investor. Data from the US Treasury have shown that security reviews significantly increased after CFIUS obtained its expanded screening powers. However, whether these reviews actually helped to prevent US technology transfers to China remains unclear.[22]

**Talent flows**

The US government has also imposed restrictions on tech talent flows between America and China. The Trump administration issued a proclamation denying visas to Chinese graduate students who had previously been affiliated with an institution in China that has links to the government's Military-Civil Fusion Strategy.[23] The Biden administration has continued this policy despite considerable criticism. Critics have argued that the US tech industry and universities rely on foreign talent, including from China, to remain competitive. Hence, preventing Chinese tech talent from coming to the US on national security grounds may hurt rather than benefit America's technological competitiveness.[24]

In a more recent move to choke off the flow of tech talent and related expertise, the Biden administration has also targeted American workers in the semiconductor industry in China. The aforementioned October 2022 US export controls on advanced semiconductors and manufacturing equipment also restrict the ability of US persons to support the production of certain semiconductors at facilities in China without a license. In response, several China-based semiconductor companies have suspended their US employees.[25] Given China's long-standing efforts to attract foreign talent to its semiconductor industry in the hope of accelerating its development, these restrictions could be a blow to its efforts to acquire specialized expertise.

### 2.2.2 China

For China, technological progress is essential in cementing its status as a global power and achieving the country's "great rejuvenation": Beijing views its current development path as a "return to greatness" rather than the emergence of a new great power.[26] Technological innova-

18 The White House, *FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China*, 09.08.2022.

19 Christian Davies et al., "US Struggles to Mobilise Its East Asian 'Chip 4' Alliance," *Financial Times,* 12.11.2022.

20 Sophie-Charlotte Fischer, "Silicon Curtain: America's Quest for Allied Export Controls against China," in: Brian G. Carlson, Oliver Thränert (eds.), *Strategic Trends 2023* (Zurich: CSS/ETH, April 2023), 39–60.

21 Michael Brown / Pavneet Singh, "China's Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable A Strategic Competitor to Access the Crown Jewels of U.S. Innovation," *Defense Innovation Unit Experimental,* January 2018.

22 Martin Chorzempa, "US Security Scrutiny of Foreign Investment Rises, but so Does Foreign Investment," *Peterson Institute for International Economics,* 01.09.2022.

23 Executive Office of the President, *Suspension of Entry as Nonimmigrants of Certain Students and Researchers From the People's Republic of China*, 06.04.2020.

24 Stuart Anderson, "Biden Keeps Costly Trump Visa Policy Denying Chinese Grad Students," *Forbes,* 10.08.2021.

25 BIS, *Implementation of Additional Export Controls*; Lisa Lin / Karen Hao, "American Executives in Limbo at Chinese Chip Companies After U.S. Ban," *Wall Street Journal,* 16.10.2022.

26 Zheng Wang, "The New Nationalism: 'Make My Country Great Again'," *The Diplomat,* 16.05.2016.

tion plays a critical role in this endeavor. First, technology is vital in moving China's industries up the value chain, enabling continued economic growth, and avoiding the "middle-income trap."[27] Furthermore, technology is essential for China to catch up militarily with more advanced states, particularly the United States, and eventually achieve its goal of having a "world-class" military.[28] Access to cutting-edge technology in areas such as Artificial Intelligence has also become increasingly crucial for Beijing to exert control domestically. Finally, achieving technological leadership "is also an ideological end in itself – it provides the final proof of China's restoration as a great power after decades of struggle."[29]

The Chinese government actively promoted the deepening of diverse technological links with the United States. However, Beijing has also been pushing for greater technological self-reliance as reflected in various strategic government papers, dating back to at least the 2000s.[30] Major government plans such as the 2006 *National Medium- and Long-Term Plan for Science and Technology Development* have called for strengthening China's domestic innovation resources and industries, while reducing its reliance on foreign technology.[31] Also, the 2015 *Made in China 2025 Plan,* launched to modernize industries and to make China a global powerhouse in high-tech sectors, underscored the need to decrease dependencies on foreign technology and to raise "domestic content of core components and materials to 40 percent by 2020 and 70 percent by 2025."[32] Interestingly, these ongoing efforts on Beijing's part received only scant attention until the relationship between the US and China began to deteriorate.

Given Beijing's increasingly contentious relationship with the US, especially during the Trump and now the Biden administration, the Chinese leadership has sought to speed up the development of its domestic technological capabilities. In May 2020, the Chinese Communist Party's Politburo proposed a new model of economic development termed the Dual Circulation Strategy (DCS), emphasizing a stronger focus on the domestic economy as driver of economic growth. As the name implies, the strategy consists of two legs: an internal cycle (referring to the domestic circle of production, distribution, and consumption) and an international cycle (referring to global markets). While the two are described as complementary, the strategy's emphasis is on strengthening the internal cycle and decreasing the dependency on foreign critical technologies. As the South China Morning Post put it, the DCS "is China's strategic approach to adapting to an increasingly unstable and hostile foreign environment."[33] The *14th Five-year plan* (2021–2025) integrates the DCS and underscores the objective of increasingly engaging in the domestic development of key technologies.[34]

To reduce its interdependence with the US and to strengthen the domestic economy, Beijing has also deployed a range of instruments that affect technology, capital, and talent flows between the two countries. Along these lines, some of China's key instruments and the motivations underlying their deployment will be mapped below.

**Technology flows**

Against the background of increasing tensions with the United States, the Chinese government has doubled down on its efforts to strengthen its domestic technology industries to reduce dependencies. To this end, the Chinese government has continuously increased its budget for research and development. In 2021, China's investment in R&D was USD 405 billion, 14 per cent more than the previous year and second only to US R&D spending.[35] According to the current 14th Five-Year Plan, Beijing strives for an annual increase in R&D spending of 7 per cent. The government has also significantly raised its investments in domestic technology industries that are considered strategic, such as semiconductors. In recent years, the government has announced some staggering investments in sectors considered strategically important and in which China still significantly relies on Western imports and know-how. For example, in 2019, the government in Beijing announced the establishment of a USD 29 billion fund to boost the development of its domestic semiconductor industry.[36] These investments demonstrate the government's resolve to speed up the development of its domestic technological capabilities. However, it remains unclear whether they will help to achieve the desired effects, especially as US export controls on technology and know-how start to bite.

It is noteworthy that Beijing has increased its efforts to achieve greater self-reliance and reduce inter-

27 Andrew B. Kennedy and Darren J. Lim, "The Innovation Imperative: Technology and US–China Rivalry in the Twenty-First Century," *International Affairs* 94, 3 (2018), 553–72.

28 Robert O. Work / Greg Grant, "Beating the Americans at Their Own Game" (Washington, DC: Center for a New American Security, 2019); Elsa B. Kania, "Artificial Intelligence in China's Revolution in Military Affairs," *Journal of Strategic Studies* 44, 4 (2021), 515–42.

29 Julian Baird Gewirtz, "China's Long March to Technological Supremacy," *Foreign Affairs,* 27.08.2019.

30 Lauren Dudley, "China's Quest for Self-Reliance in the Fourteenth Five-Year Plan," *Council on Foreign Relations,* 08.03.2021.

31 The State Council. The People's Republic of China, *The National Medium- and Long-Term Program for Science and Technology Development (2006–2020) An Outline*, 2006.

32 Enda Curran, "From 'Made in China' to 'Made by China for China'," *Bloomberg,* 15.02.2017.

33 Frank Tang, "What Is China's Dual Circulation Economic Strategy and Why Is It Important?," *South China Morning Post,* 19.11.2020.

34 Center for Security and Emerging Technology, *Translation: Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035*, 2021.

35 Gemma Conroy / Benjamin Plackett, "Nature Index Annual Tables 2022: China's Research Spending Pays off," *Nature,* 16.06.2022.

36 Yoko Kubota, "China Sets Up New $29 Billion Semiconductor Fund," *Wall Street Journal,* 25.10.2019.

dependencies with the US by promoting the development and adoption of open-source technology in China. This move aims to decrease China's dependency on proprietary foreign software and hardware and to bolster its domestic ICT industry by promoting open-source alternatives. Considering its still substantial reliance on foreign technology, especially regarding semiconductors, one critical open-source technology for China is the RISC-V open-source chip architecture managed by the Switzerland-based RISC-V foundation.[37] The architecture is becoming increasingly competitive with the commercial alternatives Arm and x68. However, it is estimated that it will be at least five years before RISC-V takes a significant share of the market.[38]

**Capital flows**

China is also taking steps to redirect capital flows between the US and Chinese technology ecosystems. One such measure was the establishment of the Shanghai Stock Exchange Science and Technology Innovation Board (STAR market) in July 2019, at the request of Chinese leader Xi Jinping. The STAR market is part of Beijing's broader ambitions to bolster its technology sector, foster innovation, and reduce dependence on foreign technology. The market serves as a new fundraising platform for high-tech companies, especially start-ups, and aims to support the growth of innovative companies in the country. One feature of the STAR market is its more relaxed listing requirements compared to other stock exchanges, making it easier for small tech companies to conduct an Initial Public Offering (IPO) and raise capital. Since its inception, the STAR market has grown quite significantly, with about 1,200 listed companies, including some high-value listings such as the Semiconductor Manufacturing International Corporation (SMIC).[39]

The Chinese government has also targeted inward flows of foreign investment in Chinese companies, including in certain technology sectors. In early 2021, the Chinese government implemented a tighter review mechanism for foreign direct investment in China on national security grounds. The measure expanded the coverage to additional types of investments, introduced a new multistage review process of investments, and added new sectors, other than the military or defense-related businesses to its scope, including key technology.[40] Therefore, foreign investors face increased barriers to invest in Chinese technology industries considered "key" by the Chinese government.

**Talent flows**

Talent flows between the US and China have always been asymmetric with a disproportionally higher number of Chinese students, researchers, and tech workers going to the United States to work and study and few returning home. Research by the MacroPolo Initiative at the University of Chicago has shown, for example, that the majority of current top-tier AI researchers come from China, but the majority of top-tier AI researchers globally work in the United States.[41] The Chinese government views tech talent as key to increasing its self-reliance in technology. At the recent Communist Party Congress, Xi Jinping even vowed to assemble a "legion of talent" to speed up its development of homegrown technologies.[42] Attracting talent from overseas, especially from Chinese communities, has become a priority for the government. Therefore, betting on the promises of China's rapidly evolving tech sector, Beijing has tried to lure tech talent back by offering incentives to investors, founders, and researchers. For example, Chinese investors have established venture capital funds aimed at attracting executives and researchers from top-tier technology firms in the United States.[43] However, despite these efforts, prevailing conditions in China such as political concerns and a lack of dynamism in the research environment have made it difficult for Beijing to fully realize its objectives.[44]

### 2.2.3 Future Decoupling Trajectory

The ongoing technological decoupling between the world's two largest economies can be attributed to the deteriorating relations between the US and China, as well as their respective strategic objectives and national security concerns surrounding technology. Given the current trajectory of the Sino-US relationship, it is probable that both governments will continue to take selective measures to reduce the ties between their high-tech ecosystems.

Current trends in the relationship between Washington and Beijing, especially in conjunction with recent steps taken by the Biden administration, suggest that Washington will likely introduce additional policy instruments to unwind some of its technological linkages with China. US Secretary of Commerce Gina Raimondo stressed in a recent speech that Washington does not seek to sever ties with China but that it will protect its national security, especially as it relates to technology.[45]

37 Rebecca Arcesati / Caroline Meinhardt, "China Bets on Open-Source Technologies to Boost Domestic Innovation," *MERICS*, 19.05.2021.

38 Ann Cao, "Tech War: China Is Betting on This Chip Design Standard to Fight US Tech Curbs," *South China Morning Post*, 02.12.2022.

39 Trustee Chair Team, "Two Years In, How Does the STAR Market Measure Up?," *Center for Security and International Studies*, 24.01.2022.

40 Howard Hao Wu / Tracy Wut, "China Enacts New Foreign Investment Security Review Measures," *Baker McKenzie*, 04.01.2021.

41 MacroPolo, "The Global AI Talent Tracker," macropolo.org.

42 "China's Xi Vows Victory in Tech Battle After US Chip Curbs," *Bloomberg*, 16.10.2022.

43 Don Weinland, "China in Push to Lure Overseas Tech Talent Back Home," *Financial Times*, 11.02.2018.

44 Luna Sun, "China Wants to Be a Global Talent Hub, but What If They Don't Want to Come?," *South China Morning Post*, 08.11.2022.

45 Raimondo, *Remarks by U.S. Secretary of Commerce Gina Raimondo on the U.S. Competitiveness and the China Challenge*.

In the future, the US government is likely to impose further export controls on strategic technologies beyond semiconductors. Biotechnology and quantum technology may become future targets.[46] The US may also expand its import restrictions on communication technologies developed by Chinese tech companies. At the same time, the US government will likely double down on domestic investments in strategic industries to strengthen its competitiveness and collaborate with allies to secure technology supply chains.

There are, however, several uncertainties that will likely shape future US policies and their success. The first is the support of US allies for further restrictive measures by Washington targeting China's technology sector. As the US no longer has a quasi-monopoly over critical technologies in a globalized world economy, Washington needs the support of allies that control important segments of industries for them to be effective and to save costs.[47] Despite the Biden administration's success in convincing the Dutch and Japanese governments to impose export controls on semiconductor manufacturing equipment, there are still differences in the perceptions of China among US allies. Balancing economic and security interests remains a challenge for many countries. For example, senior EU officials, including European Commission President Ursula von der Leyen and European Council President Charles Michel, appear to have differing opinions on how to approach Beijing, with von der Leyen seeking a tougher stance than Michel. The lack of a unified position on China among member states was evident in recent visits by French President Emmanuel Macron and German Foreign Minister Annalena Baerbock. These visits show that member states still have diverging views on China. It remains to be seen how this will affect future policy decisions regarding technology issues vis-à-vis China, but it highlights the need for continued diplomatic efforts on the part of the US to build consensus among allies.[48] However, the stakes for the US are high, and it is also conceivable that Washington will increase its political pressure on allies and where possible use of instruments with extraterritorial effects, such as the FDPR, to align their actions with its strategic objectives.

A second uncertainty concerns the costs of decoupling the American and Chinese high-tech ecosystems. Due to the many variables involved, economists have been hesitant to offer projections regarding the costs of decoupling. However, it is clear that the loss of access to the Chinese market creates massive costs for American tech companies with notable stakes in China (e.g., in the semiconductor industry). Moreover, the diversion of supply chains and greater reliance on US allies in Europe and Asia will likely increase labor costs and thus may also affect prices for affected American companies and consumers. This comes at a time when the inflation rate in the US is already leaving consumers scrambling. However, the recently introduced US export controls on semiconductors reflect Washington's willingness to pay a much higher price and to take greater risks to selectively decouple from China than previously assumed.

As Beijing faces increasing pressure from export controls and other US measures, the question of whether China might be able to develop a technology ecosystem with little or no input that Washington and its allies can control is receiving increasing attention. As can already be seen, China is seeking to further accelerate its indigenous technology development efforts by allocating additional resources to its strategic industries. It will likely seek to supplement these resources with foreign technology that it still has access to – through legal and illegal channels – and to double down on open-source technologies and inputs, such as the RISC-V chip architecture. How far this process can go remains unclear. Even as RISC-V becomes more competitive, China still faces significant hurdles in overcoming US and allied export controls on semiconductor manufacturing equipment to produce higher-end chips using the open-source architecture. Other uncertainties for China include economic growth rates and the dynamism of its technology industry, both of which have been hit hard by the COVID-19 pandemic and Beijing's zero-Covid policy.

## 2.3 Implications for Switzerland

US-China tech decoupling is a complex and rapidly evolving development that also affects Switzerland as a highly globalized, small, and politically neutral country. Overall, the US-China tech decoupling highlights that technology has become politicized and that it has, once again, become an important resource for states seeking to exert their power at the international level. These dynamics are critical for Bern, which will also have to increasingly treat its technological capabilities as a strategic resource to advance its foreign, economic, and security policy objectives at home and abroad. This requires continuing investments in the competitiveness of Switzerland's technology ecosystem and a more prominent role for these issues in Swiss bilateral relations with other technologically advanced states.

Moreover, as a small, open economy, Switzerland is heavily reliant on global trade and investment, and any changes in the global economic and technological landscape are very likely to have an impact on the country. As a global technology hub, Switzerland is home to

46 Ana Swanson, "The Biden Administration Is Weighing Further Controls on Chinese Technology," *New York Times,* 27.12.2022.

47 Demetri Sevastopulo, "US Tries to Enlist Allies in Assault on China's Chip Industry," *Financial Times,* 14.11.2022.

48 Suzanne Lynch / Barbara Moens, "Biden splits EU's top ranks over China," *Politico,* 13.03.2023.

several innovative technology companies and research institutions like ETHZ and EPFL. If the decoupling process leads to a shift in the global technology landscape, this could have implications for the competitiveness of Switzerland's technology sector. Over the last three years, Swiss companies have already felt the increased prices and short supply of semiconductors resulting from strained supply chains during the COVID-19 pandemic.[49] However, this trend also underscores the need for Switzerland to assess its critical supply chains against potential future geopolitical disruptions, to identify possible vulnerabilities and to make these supply chains more resilient. In addition to possible supplier diversification, in a few cases where it may be feasible, Switzerland may also want to consider stockpiling selected components and products.

In addition, decoupling has introduced new risks and uncertainties for Swiss companies that operate in both the US and China, as they face increased regulatory hurdles such as new restrictions on investments. At the same time, the measures adopted by the US that have extraterritorial effects can also directly affect companies and universities in Switzerland. For example, ETHZ and EPFL were already affected by the FDPR targeting Huawei in 2020, and other entities have also been affected by the extraterritorial effects of US export controls.[50] Given the apparent willingness of the US government to make even broader use of such instruments going forward, the China business of Swiss companies, as well as collaboration by universities and other entities with Chinese companies, researchers, and institutes may also be increasingly affected.

Another significant implication of the US-China decoupling for Switzerland is the potential impact on its political relationships. As the two powers have become increasingly hostile towards each other, Switzerland, as a neutral country, has to navigate an increasingly complex international environment. Bern has long relied on its strong relationships with both Washington and Beijing, and it has sought to maintain its neutrality while also promoting its own interests. However, the dynamics of technological decoupling have introduced new challenges to this balancing act, requiring Switzerland to be more strategic in its approach towards the two countries.

One key challenge in this regard is the continued cooperation of the Swiss government, universities, and companies with Chinese entities. For example, in contrast to most other European countries, Switzerland has not banned equipment from the telecoms giant Huawei from its 5G networks. In addition, the federal government has selected Alibaba as a cloud infrastructure provider to store some of its data.[51] These decisions make Switzerland one of the few remaining places in "the West" for Chinese tech firms to do business as it involves such government contracts. In addition, the established links between Swiss universities and Chinese institutions and researchers can raise not only security concerns in cases where a military affiliation and funding are involved, but also political risks.[52] Given the narrowing of Beijing's options to acquire foreign technology, Switzerland may become an increasingly important source for China to do so. Moreover, as the tensions between the US and China intensify, especially regarding technology, Switzerland's position could alienate Washington and also European governments that are increasingly critical of China's technological ambitions and intentions.

However, as tensions between the US and China surrounding technology rise, the situation could also present an opportunity for Bern to position itself "in between" the US and China and to use Switzerland's unique attributes to mitigate at least some of the negative effects of the tech decoupling for global governance. For example, Bern could offer a platform for jointly tackling global governance challenges, like climate change, that require the US and China's commitment and at least partially technological solutions. So far, however, neither Washington nor Beijing seems to perceive Switzerland as playing such a role, and against the backdrop of Russia's war against Ukraine, Swiss neutrality is being met with increasing skepticism abroad. Some organizations in the technology sector, however, seem to see Swiss neutrality as an advantage. The RISC-V Foundation – the organization managing the aforementioned RISC-V open chip architecture – moved its headquarters from the US to Switzerland in 2019 to underscore its geopolitically neutral position in the chip ecosystem and to avoid becoming a target in the US-China rivalry. Should Bern wish to position Switzerland as a "tech intermediary," it will have to undertake significant diplomatic efforts to establish this role vis-à-vis the US and China.

## 2.4 Outlook: Three Scenarios

The above assessment was based on the assumption that the main parameters of the US-China relationship are relatively stable. However, there are several possible developments that could radically change the context of the current dynamics of technological decoupling. This section outlines three scenarios, each of which would have a significant impact on US-China technological decoupling,

49 "Mangelware Computerchips – 2700 statt 10 Dollar: Chipkrise führt zu enormen Preisaufschlägen," *Schweizer Radio und Fernsehen,* 23.03.2022.

50 Adrienne Fichter, "Wie sich die ETH den USA unterwirft," *Republik,* 30.11.2020; Eidgenössisches Departement für auswärtige Angelegenheiten, *China-Strategie 2021–2024*, 2021.

51 "Swiss Government Finalises Cloud Contracts with Five Tech Firms," *Swissinfo,* 27.09.2022.

52 Katrin Büchenbacher et al., "Chinas Armeeforscher an der ETH: wie riskant ist das?," *Neue Zürcher Zeitung,* 23.05.2022.

and then discusses the implications for Switzerland. The order in which they are presented does not reflect an assessment of their likelihood.

**Scenario I: The use of Weapons of Mass Destruction (WMD) in Ukraine**

*Situation:* Russia is continuing its war of aggression against Ukraine. As the Kremlin grows increasingly desperate in the face of mounting Russian military losses and biting sanctions, Russia decides to use nuclear, chemical, or biological weapons on the battlefield in Ukraine. While much of the international community, including India and Brazil, is clearly attributing their use and condemning Moscow's actions, Beijing's response is more ambiguous (which may be more likely in the case of the use of chemical or biological weapons). While China's continued support for Russia after the invasion had already strained its relations with the US administration and the EU, Beijing's ambivalent response after Russia's use of WMD – in violation of longstanding international norms – significantly raises the stakes.

*Effects on Tech Decoupling:* In response, the EU is significantly toughening its stance on trade with China, targeting especially strategically important areas such as technology. It is also prepared to incur high costs if Beijing decides to retaliate. This shift in Brussels' approach to Beijing is more in line with Washington's. In the EU-US Trade and Technology Council, the EU and the US jointly develop comprehensive export controls targeting China's access to cutting-edge technology, as well as additional restrictions that limit China's ability to sell technology in the EU and US markets.

*Implications for Switzerland:* In such a scenario, Switzerland would likely come under increasing pressure by the US and especially the EU. It will likely be pushed to either support the technology controls imposed on China or to face significant political and economic consequences from Brussels. The EU could even go so far as to link future collaboration with Switzerland in different policy areas of vital interest to Bern to its stance on China. Tighter EU and US measures against China's technology sector would also have effects on already strained global technology supply chains and probably also affect Swiss companies and consumers. Lastly, such a scenario would significantly limit Switzerland's leeway to position itself between the US and China.

**Scenario II: The US elections in 2024**

*Situation:* A Republican candidate wins the US presidential election in 2024. The President adopts an isolationist "America First" approach and turns away from allies in Europe and the Asia-Pacific. At the same time, under the new administration, the US government's stance towards Beijing becomes more assertive and its decoupling rhetoric more aggressive.

*Effects on Tech Decoupling:* As the US government turns away from allies, their support for bi-, mini-, and multilateral decoupling measures further decreases. Talks within the EU-US Trade and Technology Council stall, and eventually the forum is dissolved. Where possible, Washington uses political pressure and the extraterritorial effects of its policy instruments to align the actions of European countries and states in the Asia-Pacific region with its own policy instruments targeting America's remaining tech ties with China. The EU strengthens its efforts to become technologically more sovereign and to decrease its dependence on both the US and China.

*Implications for Switzerland:* This scenario could have varying implications for Switzerland. As US-EU collaboration unravels, Switzerland's room for maneuver may expand, enabling it to position itself as "tech intermediary" between the competing powers. However, the reverse could also be the case. Switzerland may come under increasing political pressure from both the US and the EU to act in accordance with their respective policies towards China, thereby significantly limiting the room to carve out its own position. Moreover, with decreasing trust between the US and the EU and both actors turning inwards, the degree of fragmentation of global tech supply chains may further affect Switzerland's access to certain technologies and components.

**Scenario III: Escalating tensions over Taiwan**

*Situation:* Tensions between the US and China over Taiwan continue to rise. Beijing further increases its military presence in the South China Sea and expands its military maneuvers around the island. The situation threatens to spiral out of control when the US obtains credible intelligence that the PLA is preparing an invasion of Taiwan. The US president decides to declassify the intel and to make it public.

*Effects on Tech Decoupling:* Escalating tensions between the US and China over Taiwan could have different effects on technological decoupling. First, an imminent attack could further strengthen the willingness of the US government to accept significant costs for cutting China off from US technology. The issue could also shore up greater support by US allies in Europe and the Asia-Pacific for isolating China technologically. Moreover, given Taiwan's significant role in the manufacturing of semiconductors and the real risk of destruction of the facilities, countries and companies will likely seek to stockpile certain types of chips immediately, resulting in skyrocketing prices and global shortages.

*Implications for Switzerland:* Switzerland could come under increasing pressure to support the US and possibly its joint actions with the EU and other like-minded states against China. Consequently, such a scenario would significantly limit Switzerland's ability to position itself between the US and China. Tougher US or joint

measures targeting China's access to Western technology (coupled with retaliatory measures from Beijing) would also have a significant impact on global technology supply chains and markets, with spillover effects on the Swiss economy.

## 2.5 Conclusion

This chapter has provided insights into the current dynamics of technological decoupling between the US and China. It has revealed that the motivations driving these dynamics are complex. A general deterioration of Sino-American relations and an intensifying economic, military, and ideological competition has put the spotlight on the close technological ties between the US and China. Thereby, it has led to concerns inside the US government over the implications of China's technological ambitions for American national security and foreign policy interests. In response, the US has started to introduce a variety of policy instruments to unwind the linkages in technology, capital, and talent between the American and Chinese high-tech ecosystems.

In Beijing, US moves to reduce its technological ties with China have exacerbated long-standing concerns about China's dependence on Western technology and the implications for the realization of its related strategic goals. Beijing has therefore introduced its own measures, such as increased investment and incentives for the return of technical talent from overseas Chinese communities to China, to accelerate the development of its domestic technological capabilities. It has also selectively restricted relevant cross-border flows.

Given current trends, the process of selective technological decoupling is likely to continue. Both the United States and China have identified their technological capabilities as a key vector for exerting power at the international level and are willing to pay high costs to increase their relative competitiveness. However, the technological decoupling of the two great powers also has implications for other states embedded in the globalized world economy – including Switzerland.

Switzerland has already been directly affected by the US-China tech decoupling, and further repercussions are likely to be felt, especially if the US expands its use of export controls with extraterritorial effects and technology supply chains are increasingly restructured. To the extent possible, Bern should prepare to mitigate some of the foreseeable effects, including by increasing the resilience of its companies and critical technology supply chains to possible future disruptions. In addition, Switzerland will need to recalibrate its positioning among the great powers and determine how to maintain its neutrality and advance its interests in the face of rising tensions. Positioning the country as an intermediary between the great powers on global governance issues related to technology may provide an opportunity to leverage its unique attributes while reminding other countries of the value of a technologically advanced and politically neutral country. Finally, to maintain its own competitiveness and security, Bern will have to adjust its view of the country's technological capabilities, seeing them not only as a catalyst for economic growth and scientific cooperation, but also as an increasingly important geopolitical asset for asserting its security and interests at the international level.

# 3 Case Examples: Chip Industry and Rare Earth Elements Industry

*Julian Kamasa*

## 3.1 Introduction

The chip supply chain and the rare earth elements (REEs) supply chain are two prominent examples of US-China interdependence, both of which play an essential part in the geopolitical rivalry between the two powers. This is because both chips and REEs have been the subject of export controls imposed by either the US or China for geopolitical reasons. Beijing restricted the export of REEs in 2010, while the US drastically reduced Chinese access to American high-end chips in 2019 and 2022. It is no coincidence that Washington politicized chips while Beijing did so with REEs.

These measures reflect the leverage of the respective country within the whole supply chain. The chip supply chain can be described as geographically highly fragmented, featuring high degrees of specialization, often extremely high barriers to entry, and low resilience against crises and supply shocks. However, the US is in a dominant position within the chip supply chain, partly because of its close relations with Taiwan and South Korea. China, which is still catching up, is not. The opposite is true, however, in the case of REEs. This industry is marked by regional concentration, average degrees of specialization, and comparatively lower profit margins than in the chip industry. Here, China is dominant in all steps along the supply chain, even monopolizing the steps with higher added value such as processing and manufacturing. This means that US reliance on China for REEs is comparatively higher than China's reliance on the US for chips. However, as both case examples will show, both countries are eager to use industrial policy schemes to mitigate potential supply risks. The implications of these developments for Switzerland will be examined against the background of three hypothetical scenarios.

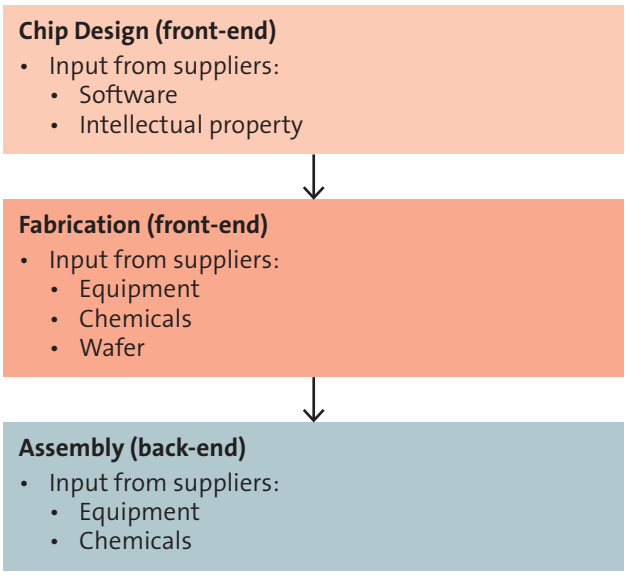
## 3.2 Chip Industry

### 3.2.1 Significance and Characteristics of the Chip Industry

Chips are essential for all kinds of electronic steering, processing, sensing, storage, and control functions in a whole range of devices: from coffee grinders, washing machines, cars, solar panels, computers, and smartphones to fighter jets. Different kind of chips are used for varying functions. The most advanced ones (7nm and lower) are typically used for demanding tasks (e.g. processing of information) in high-tech devices such as supercomputers and are usually complemented by basic chips which fulfill basic tasks (e.g. regulation of device temperature). This means that both the most advanced and the most basic chips can obtain a certain critical character, if shortages occur.

Chips are significant for national security for many reasons. *First,* the dual-use character of new technologies means that the supply chain for a military device may not differ from the supply chain for a civilian device. This means that if shortages along one part of that supply chain occur for commercially available devices, the same could be true for a device with relevance for national security. *Second,* national security is highly reliant on a resilient critical infrastructure.[1] For instance, the energy supply, public transport, telecommunications, hospitals, emergency services, or the police are highly dependent on applications and devices that run on the use of chips. Access to chips is key, and long-lasting shortages could have negative implications for some parts of a national critical infrastructure. *Third,* the chip industry is highly fragmented region- and task-wise.[2] Hence, small disruptions along the supply chain do have immediate effects. Certain tasks along the supply chain are carried out by one company, which does not allow for redundancies and increases the potential for supply risks. This means that it is an industry that cannot flexibly scale up production when demand exceeds supply, and this can result in shortages for both commercially used and militarily used devices.

Graph 1: Chip Production Steps




*Source: Stiftung Neue Verantwortung*

1 BABS, "Die kritischen Infrastrukturen," babs.admin.ch.

2 Jan-Peter Kleinhans / Nurzat Baisakova, "The global semiconductor value chain: A technology primer for policymakers," *Stiftung Neue Verantwortung,* October 2020.

The semiconductor supply chain is rather complex and can be best described as highly specialized and fragmented across the world, very efficient in the absence of crises, and at the same time not resilient against crises. The simplified overview of the chip production process consists of three major steps: chip design, fabrication, and assembly (see Graph 1). Both chip design and fabrication are called the "front-end" of the production process, while assembly is the back-end. Both ends of this process rely on inputs from suppliers such as software, intellectual property, equipment, chemicals, or silicon wafers. There are two business operating models. First, a rather traditional model, where so-called integrated device manufacturers (IDMs) cover the three main chip production steps mostly themselves. Intel and Texas Instruments from the US are typical and market-dominating IDMs, while Samsung from South Korea is both an IDM and a foundry. The second business model arose as the result of growing demand for more advanced chips, which requires a significantly higher degree of specialization. Here, chip design companies focus solely on the design and do not have any fabrication capacities. Hence, such companies are also called "fabless." The fabrication is carried out by companies specialized in fabrication only (short: fabs), which often are contract manufacturing companies, also called "foundries." The assembly is then done by Outsourced Semiconductor Assembly and Testing companies (OSATs), which again, are specialized in this step only. While IDMs appear to be more resilient against supply chain risks due to their lower degree of specialization, so far not even Intel has been able to make the most advanced 5nm chips. These, which are most likely are also 3nm chips, are produced by foundries such as TSMC and Samsung. What both business models have in common, however, is that no company is fully self-reliant due to a high input reliance from suppliers ranging from intellectual property and software to equipment and chemicals. Key industrial actors of both business models are predominantly in the US, Taiwan, and South Korea (see Graph 2).

The following sections focus mostly on the supply chain of the second business model. Here, it seems worth noting that interlinkages between fabs and fabless companies, software (electronic design automation, EDA), and intellectual property (IP) companies are very high. This is because the chip design must perfectly match with the fabrication facilities of the respective chip to be produced. This means that suppliers of fabless companies must already match the requirements of a respective fab or foundry when they develop the software or IP for the chip design. This is due to the fact that, switching from one fab company to another, even with the same chip size, is a process that takes years, because the fabless companies must redesign a chip completely to achieve perfect matching with the new fabrication facility. Considering that in 2020, it cost 540 million USD to design a 5nm chip, underlines how important close collaboration with fabs is and how costly redesigning chips could be. Furthermore, this means that for chip design, the barriers to entry are rather high for any kind of emerging actors unless they focus on application-specific chips (ASIP) instead of general-purpose chips. In the first production step, companies from the US are in a very dominant position from chip design to IP (see Table 1 and Graph 2).

Once chip design is completed, a chip is made at a wafer fabrication production plant. The foundry business allows companies a high degree of specialization on a specific product with specific partners. This enables companies such as TSMC or Samsung to focus on cutting-edge chips, which have the highest density of transistors in relation to their size and are, thus, the most powerful ones. The investment into a 5nm production facility is said to be about 20 billion USD. Making chips requires the use of more than 500 machines, air purity requirements are 1,000 times higher than in modern surgery rooms, and over 1,000 chip production steps can take up to four months' time.[3]

Both foundries and IDMs rely on supply inputs such as wafer, equipment (semiconductor manufacturing equipment, SME), and chemicals. The wafer, typically made of the raw material silicon, is the foundation of a chip. The most demanded size is 300mm, which is said to be the most efficient and productive for the fabrication process. As of 2021, five companies control over 90 per cent of the 300mm wafer market. To transfer circuit patterns on the wafer, SME is key. The smaller the chip, the more complex the process and the more sophisticated the equipment that is needed. For example, the production of chips smaller than 7nm is only possible using extreme ultraviolet lithography (EUV) machines, which currently no company but the Dutch-based ASML can supply. ASML, however, relies on more than 5,000 vendors, which is a good case in point of how complex the whole fabrication step within the overall chip supply chain is. Chemicals and gases play an important role within the fabrication process, too. Since most companies are supplying the chip industry with chemicals among other industries, the degree of specialization is comparatively low, while competition is high. As well as other suppliers, these companies must closely collaborate with fabs to meet the necessary purity requirements for the fabrication process. Overall, the fabrication step is marked by a distribution of labor between Taiwan and South Korea for fabs, on the one hand, and Europe and the US for equipment, on the other (see Table 1).

The last step contains the back-end process of chip production, which is assembly. The wafer with its integrated circuits needs to be tested and packaged by OSATs. These companies rely on a much lower scale on

3 ASML, "How microchips are made," asml.com.

Table 1: Characteristics and Key Actors of the Supply Chain

| Production step | Characteristics | Key Actors ranked by revenue | Emerging Actors |
|---|---|---|---|
| Chip Design | High costs for cutting-edge chips, close cooperation with fabrication companies, focus on consumer electronics | Qualcomm, NVIDIA, AMD, Broadcomm, (US), Mediatek (Taiwan), Marvell (US) Novatek, Realtek (Taiwan), Will Semiconductor (China), Cirrus Logics (US) | Alibaba, Amazon, Facebook, Google, or Tesla with a focus on ASIP |
| Software (electronic design automation, EDA) | Highest R&D spending across the chip supply chain, very close cooperation with fabrication companies, high US-market concentration | Cadence Design Systems, Synopsys (US), Siemens (Germany), ANSYS, Keysight Technologies, Xilinx, elnfochips (US), Altium Limited (Australia), Zuken (Japan), Silvaco (US) | Chinese actors until the US implemented export controls in 2019 on software |
| Intellectual Property | Development and licensing of chip IP; close cooperation with fabrication companies | Arm (United Kingdom, China), Synopsys, Cadence Design Systems (US), Imagination Technologies (United Kingdom, China), CEVA (US) | Chinese investors securing access to IP of Western companies |
| Fabrication | Highly complex processes; very high costs; high market concentration in Taiwan and South Korea | TMSC (Taiwan), Samsung (South Korea), UMC (Taiwan), GlobalFoundries (US, Abu Dhabi), SMIC, Hua Hong Group (China), PSMC, VIS (Taiwan), Nexchip (China), Tower (Israel) | IDMs such as Intel taking over small foundries (Tower) and entering the foundry business. |
| Wafer | High market concentration in Asia and Europe; limited costs | Shin Etsu, Sumco (Japan), SK Siltron (South Korea), Siltronic (Germany), GlobalWafers (Taiwan) | Silicon producing countries such as China |
| Equipment | High degree of specialization and market concentration; high reliance of suppliers | Applied Materials (US), ASML (Netherlands), Tokyo Elektron (Japan), Lam Research, KLA (US) | Possibly Chinese companies |
| Chemicals | High competition; little degree of specialization; dominance of Japanese companies | Shin Etsu, Sumitomo Chemicals, Mitsui Chemicals (Japan), BASF, Linde, Merck (Germany), Taiwan Specialty Chemicals (Taiwan), LG Chemicals (South Korea) | |
| Assembly | Low costs, labor intensive; little market concentration; Taiwanese market dominance | ASE (Taiwan), Amkor (US), JCET (China), Siliconware, PTI (Taiwan), TFMC, Huatian (China), KYEC, ChipMOS, Chipbond (Taiwan) | Fabrication companies providing advanced packaging |

*Sources: TrendForce, Markets and Markets, Business News Korea, Tech Insights, Utmel Electronics*

equipment and chemicals suppliers and opening a line of production is more labor- than capital-intensive. While Taiwan is in a very dominant position here, it is the only step within the supply chain where China with 26 per cent has a much bigger market share than the US with 18 per cent (see Table 1 and Graph 2).

### 3.2.2 US-China Interdependence

One finding of the previous section is that, due to the complexity of the chip supply chain, it appears to be evident that no country is even close to being or becoming totally self-reliant. Hence, the chip industry is characterized by a high degree of interdependence. Another finding is, however, that a lot of tasks are carried out by highly specialized companies with few or no competitors. These choke points within the supply chain offer significant bargaining power and geopolitical leverage to the countries where such companies are based. Here, the US is in a considerably powerful position.

The US essentially dominates the first step of the overall chip production process. Since software, intellectual property, and chip design are key for the fabrication of chips, this gives the US a lot of geopolitical leverage. In addition, this step of the supply chain is characterized by very high barriers of entry in terms of financial cost and know-how. This means that China is not now able, and will not be able, to catch up very quickly to reduce the gap with the US. Therefore, Washington can issue export controls with direct effects on Chinese companies, for example by not supplying selected Chinese companies with US hardware and software. In addition, Washington can cut off the supply of US components to third parties, should they provide those selected companies with hardware and software for chip production. Both have been used by the US since 2019, effectively targeting the Chinese telecommunications company Huawei and the foundry SMIC. Recent US export controls from fall 2022 include not only software and hardware, but also US persons, which targets know-how and brain power. This latest package bears far-reaching implications and could slow down Chinese ambitions significantly.[4]

The fact that China has not retaliated against US export controls in any way shows that it does not have significant leverage over the US or that such a step would result in too much self-damage. Beijing is dominant as far as essential raw materials like silicon and the back-end process of assembly are concerned. In fact, about 70 per cent of the global supply of silicon comes from China. Export controls on silicon would not directly hurt the US, because the silicon wafer producing companies are based in Germany, Japan, South Korea, and Taiwan. These wafer companies are suppliers of fabrication companies. Three of the ten most profitable foundry companies are Chinese, so export controls on silicon would likely backfire on these companies, which are already struggling with US export controls. Assembly could be where China has significant leverage. Since that is the last step of the production process, the effect of restrictive measures would, however, hit consumers around the world rather than target US chip companies.

This may explain why Beijing appears to be emphasizing greater technological self-reliance, and ultimately self-sufficiency, as foreseen by the "Made in China 2025" policy (MIC 2025). Whether China will be able to achieve the ambitious goals stated by MIC 2025 is more than questionable. The recent export control measures issued by Washington may surely increase Beijing's ambition to achieve even greater independence from the US. However, and quite paradoxically, to be less dependent on the US in the longer run, China needs greater interdependencies with the US in the short to medium term, which is why recent US export controls could hurt China to a great extent and slow down Beijing's ambitions significantly. In addition, the US is trying to reduce deficiencies in the foundry business, which essentially concerns the production of the most advanced chips, using industrial policy tools such as the American Chips Act, which allocates 52 billion USD for this purpose.[5]

### 3.2.3 Scenarios

Against the background of the complexity of the chip supply chain, ongoing market disruptions due to both the corona pandemic and the Russian invasion of Ukraine, and increasing geopolitical tensions between China and the US, three scenarios concerning the chip industry are worth considering. The order of the three scenarios does not reflect their relative possibility. It is important to note that hypothetically, all three scenarios could overlap.

**"Uncertainty is the New Normal"**

*This scenario means that the industry may not return to a pre-2020 state. Rather, business as usual may mean that the chip industry is characterized by ongoing uncertainty and sudden, widespread shortages.*

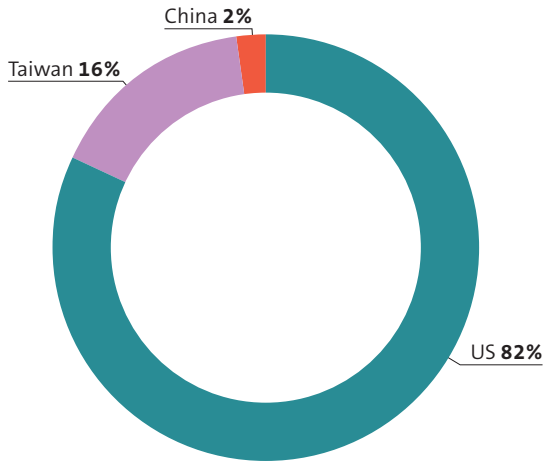
The EU and the US may accelerate efforts to decarbonize their economies in order to combat climate change and, especially in the case of the EU, to reduce dependency on Russian fossil fuels. If China were to follow, then this would have a huge impact on demand for solar panels, smart grids, or electric vehicles (EVs), given the

4 Reva Goujon et al., "Freeze-in-Place: The Impact of US Tech Controls on China," *Rhodium Group,* 21.10.2022.

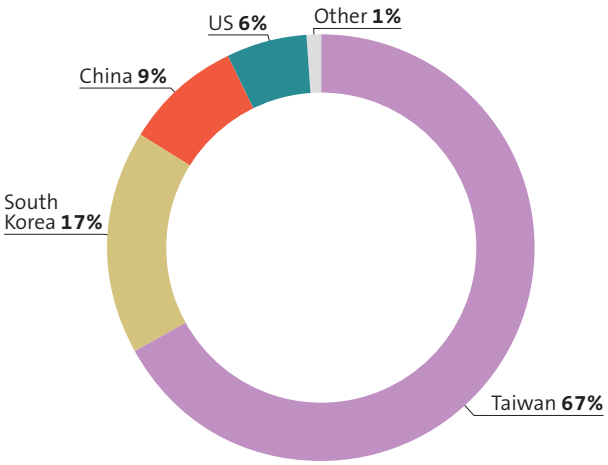
5 White House, "Factsheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China," whitehouse.gov, 09.08.2022.

Graph 2: Top 10 Company Market Shares by Country 2022

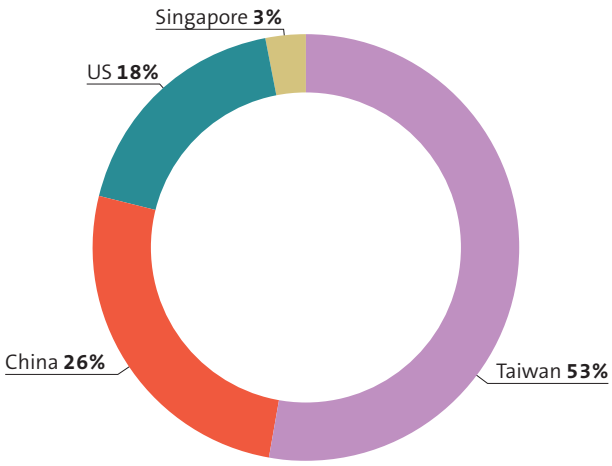
**Chip Design (fabless)**



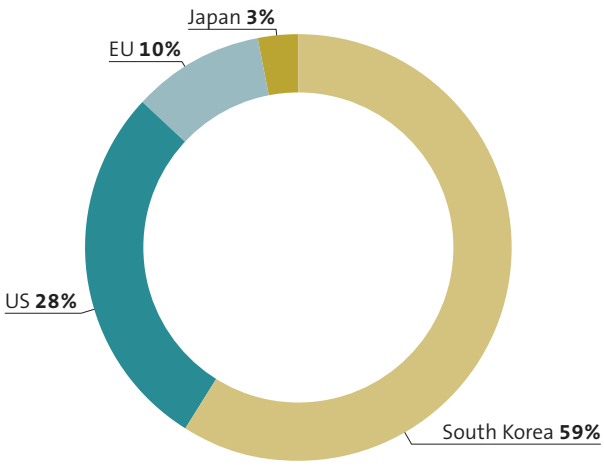

**Fabrication (foundries)**




**Assembly (OSATs)**




**Integrated Device Manufacturers (IDMs)**




*Source: CompaniesMarketcap*

size of the Chinese population. As a result, the supply of chips needed for this transition could be unable to meet the increase in demand, resulting in shortages. In this scenario, this tense situation is accompanied by ever more pronounced geopolitical rivalry between a US-led Western camp of democracies, and a China-led authoritarian camp of states. China, slowly catching up where it can, is starting to become more assertive in issuing export controls, for instance for low-end chips as well as for testing and packaging. Since low-end chips complement high-end chips in high-tech electronics, this move creates additional uncertainty in the supply chain. Any kind of uncertainty is difficult for the fragile chip supply chain, resulting in unforeseen and widespread shortages affecting not only consumer goods but also, due to the presence of dual-use technologies, goods with relevance for critical and military infrastructures.

**"China and Russia issue Export Controls"**

*This scenario assumes an export control/embargo on raw materials by China in cooperation with Russia. Such a concentrated effort could have implications for the already volatile security of chip supply chains.*

In 2021, China accounted for 70 per cent of global silicon production. Although it does not have significant silicon wafer production capabilities, the low fi-

nancial barriers to entry in this area allow China to develop and establish wafer producing companies in a collaborative effort with China-based foundries. In 2021, Russia accounted for 37 per cent of global palladium production, making it the second most important supplier after South Africa (40 per cent). Neon as a side product of steel manufacturing is mainly produced in Russia and then extracted and purified in Ukraine for export. The main facilities in Ukraine are in Mariupol and Odessa.

Russia is struggling both militarily abroad and economically at home. While the politicization of gas exports towards the EU has not exactly worked out as planned, Moscow responds to Western restrictions on high-technology exports by issuing export controls on neon and palladium to so-called unfriendly countries. In the meantime, Western countries increase public and political pressure on Beijing regarding human rights abuses in the province of Xinjiang as well as the erosion of democratic standards in Hong Kong. As a response, China issues tight export controls vis-à-vis these Western countries, covering all kinds of raw materials needed for high-tech. Ukraine accounts for 70 per cent of global neon gas supply, but Russia has successfully developed its own extraction and purification capacities and cut off exports of neon to Ukraine while increasing exports of both palladium and purified neon gas to China.

Not fully prepared for this comprehensive measure, wafer producing companies in Germany, Japan, South Korea, and Taiwan struggle as diversification of silicon supply is costly and often limited due to longer time horizons of establishing new non-Chinese silicon mining capabilities. The results are not only large price increases of chips, but also large shortages. Western states are trying to prioritize the use of chips for key strategic sectors exclusively, which results in distributional conflicts among various interest groups and long delivery periods for everyday goods such as washing machines, computers, smartphones, and fridges.

**"China invades Taiwan"**

*This scenario is the elephant in the room: a PLA invasion of Taiwan and direct military confrontation between the US and China.*

China has managed to circumvent US export controls faster and more effectively than anticipated. This has allowed China to gain more independence from Taiwan's semiconductor ecosystem by developing a resilient Chinese chip ecosystem. Beijing sees a window of opportunity as Washington is still supporting Ukraine with weapons and expertise, while the replacement of these weapons is slowed down due to labor force shortages. The support of Ukraine has proven militarily successful, but politically it gives new momentum to political approaches tilting towards less international engagement. Hence, Beijing assumes that Washington's support for Taiwan may be politically and materially limited. A naval blockade of Taiwan followed by an invasion by the PLA has the effect that all kinds of key facilities of the chip supply chain based in Taiwan are destroyed by Taiwan in order to prevent the transfer of technology and know-how to the invader. Wide-scale losses of know-how, brain power, and chip production capacities are the logical consequence, leading to huge economic turmoil for countries with close economic ties to Taiwan.

### 3.2.4 Effects on Switzerland

Switzerland as a landlocked country without a lot of natural resources is highly reliant on secure supply chains and global market stability. Swiss companies, especially in the field of high technology, are particularly exposed to shortages of chips.[6] The same is true for Swiss-based suppliers of European carmakers.[7] This is also the case for the domestic defense industry. Sophisticated databases crucial for domestic security can also be affected by a lack of chips. Similarly, critical infrastructure is reliant on stable supply chains of chips needed for control and steering functions in electric grids, for instance. Given the importance of chips and the overall geopolitical turmoil, the association for Switzerland's mechanical and electrical engineering industries (Swissmem) added semiconductors as a new sector of interest in December 2022. The goals of the activities are fivefold: enhancing the importance of the chip industry in politics and society; committing to good framework conditions; strengthening research; enabling international cooperation; and ensuring access to funding instruments.[8] This acknowledgement shows that the geopolitics of chips have reached Swiss industry, too.

Other countries and supranational organizations acknowledged the strategic importance of chips slightly earlier than Switzerland. Both the US and the EU are already ramping up their industrial policies with subsidy programs worth up 50 bn USD and EUR respectively. Washington and Brussels aim to enhance cooperation under the newly established EU-US Trade and Technology Council (TTC), which could be the technological alliance that the failed Transatlantic Trade and Investment Partnership (TTIP) did not have a chance to be. Whether these approaches will be successful for the EU and the US remains to be seen and depends on their implementation. In a best-case scenario, increased chip-producing capacities of Switzerland's largest trading partners are beneficial for Swiss companies that supply bigger chipmakers,

6 HANDELSchweiz, "Bedeutung von Chips im internationalen Handel und für den Standort Schweiz," *Interview mit Judith Bellaiche, Geschäftsführerin SWICO und Nationalrätin GLP,* 15.03.2023.

7 Bernhard Fischer, "Der Schweiz fehlen die Mikrochips," *Handelszeitung,* 27.10.2021; Auto Gewerbe Verband Schweiz, "Wie der Chipmangel auch Schweizer Zulieferer trifft," agvs-zs.ch, 21.10.2021.

8 Adrian Vogel, "Neuer Industriesektor Semiconductors (SEMI)," swissmem.ch, 05.12.2022.

mainly in the US.[9] However, the status of Switzerland regarding the TTC is unclear.[10] The developments on an EU level seem less beneficial for Switzerland, because the EU Chips Act includes potential export controls of chips in a very vaguely defined "crisis" and is generally protectionist in nature.[11] Therefore, in a worst-case scenario of a large-scale shortage of chips, Switzerland may not be able to import chips made in its geographical proximity, because in times of a crisis both the EU and the US will prioritize their key industries over those of a third country like Switzerland. Both Paris and Berlin have not forgotten about Swiss defense procurement procedures as well as refused arms exports to aid Ukraine militarily, which may not be helping Bern when reliant on French and German goodwill. Switzerland's overall strained relationship with the EU may not prove helpful, either. Therefore, Switzerland's best and cheapest industrial policy may be the stabilization of its political relations with the EU.

What is yet to be clarified, and what probably remains the most crucial aspect, is the question regarding the position that Switzerland would take if there were a large-scale (military) confrontation between Western countries and China. On the one hand, Switzerland could leverage on its neutrality status. On the other hand, this approach runs the risk of causing Switzerland to be excluded from ever-closer US-EU cooperation concerning the supply of chips. The latter seems more likely, because the US is already pushing third countries to ensure that US components, intellectual property, or know-how will not help China to develop a cutting-edge chip industry. In a military confrontation, this firm stance in Washington will be tougher rather than softer.

## 3.3 Rare Earth Elements

### 3.3.1 Significance and Characteristics of REEs

REEs are key to clean energy, consumer electronics, health, and defense. Without REEs, there would be no permanent magnets, which are important to generate electricity from wind turbines and get EVs moving. Catalytic converters in conventional cars are also important, as they remove pollutants. Another application of REEs are phosphors, which are crucial for energy-efficient LED lights.

Table 2: Rare Earth Elements and their Use in Applications and Products

| Type | Element | End-Product/Application |
|---|---|---|
| **LREEs** | Lanthanum (La) | Oil-refining, hybrid-car batteries, camera lenses, night-vision goggles |
| | Cerium (Ce) | Catalytic converters, oil refining, glass-lens production |
| | Praseodymium (Pr) | Aircraft engines, carbon arc lights |
| | Neodymium (Nd) | Hard drives, high-power magnets, laser-range finders, guidance systems |
| | Promethium (Pm) | Portable ×-ray machines, nuclear batteries |
| | Samarium (Sm) | High-power magnets, PC cleansers, precision-guided weapons, stealth technology |
| | Europium (Eu) | Computer Displays, lasers, optical electronics |
| | Gadolinium (Gd) | Cancer therapy, MRI contrast agent |
| | Scandium (Sc) | Aerospace components, aluminum alloys |
| **HREEs** | Terbium (Tb) | Solid-state electronics, sonar systems |
| | Dysprosium (Dy) | Lasers, nuclear-reactor control rods, high-power magnets |
| | Holmium (Ho) | High-power magnets, lasers |
| | Erbium (Er) | Fiber optics, nuclear-reactor control rods |
| | Thulium (Tm) | X-ray machines, superconductors |
| | Ytterbium (Yb) | Portable ×-ray machines, lasers |
| | Lutetium (Lu) | Chemical processing, LED lightbulbs |
| | Yttrium (Y) | Lasers, computer displays, microwave filters |

*Source: Scientific American*

9 "US «Chips and Science Act»: Auswirkungen auf die Schweiz," *SRF Tagesschau*, 09.08.2022.

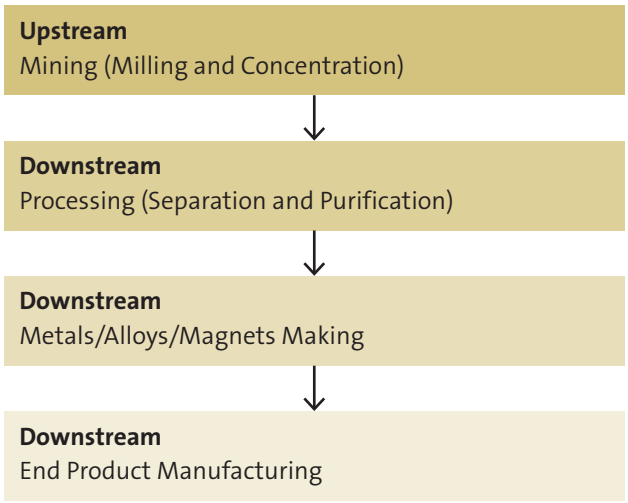
10 Philippe Lionnet, "EU und USA starten Technologieallianz," *Die Volkswirtschaft*, 09.03.2022.

11 Stephan Israel, "EU investiert in Chips und macht Industriepolitik à la française," *Tages Anzeiger*, 08.02.2022.

Furthermore, REEs are used in smartphones' batteries, displays, sensors, or speakers. Without REEs, laptops would be substantially heavier and without high-quality displays. In the health sector, REEs are needed for magnetic resonance imaging. As far as defense is concerned, REEs are key to laser, radar and night-vision systems, sonar and stealth technology, fiber-optic data transmission, precision-guided missiles, and jet engines – for instance for the F-35 fighter jet (see Table 2).[12]

Essentially, rare earth elements are a key component of critical applications for both energy security and national security. This is not different from other raw materials. However, two factors make REEs distinct from other raw materials. First, the whole supply chain from mining to manufacturing is very unevenly geographically distributed, with certain parts entirely monopolized by China (see Graph 4). Second, among raw materials with assessed high supply risks, evaluations by the EU, the UK, and the US rank REEs as having the highest supply risk of all critical raw materials.[13] The characteristics of REEs and the supply chain from upstream to downstream (see Graph 3) may help explain both China's dominance and the likelihood of supply risks.

Graph 3: From REE Mining to End Product Manufacturing




*Source: International Energy Agency*

But first, what are these elements? REEs are a group of 15 chemical elements occurring alongside each other in the periodic table, plus scandium and yttrium. They all belong to the group of metals, which is why the term "rare earth metals" is often used as well. Based on atomic weight, REEs can be grouped into Light Rare Earth Elements (LREEs) and Heavy Rare Earth Elements (HREEs). This distinction is important because HREEs occur in lower concentrations than LREEs. In general, the terminology "rare" can be misleading, because the abundance of REEs in the Earth's crust is not low per se. It is even on par with common industrial metals such as nickel, copper, or zinc. However, what makes REEs "rare" is their often insufficient concentration for real economic significance.[14] This is because REEs occur in one ore, often even alongside other minerals, with varying concentration. This means that it is not possible to conduct target-oriented mining of these highly demanded and, thus, economically significant REEs. In fact, REEs are in very unequal demand and value. According to the International Energy Agency (IEA), demand for Praseodymium, Neodymium, Terbium, and Dysprosium could double, even triple, within the next two decades.[15] This is because these elements are practically indispensable for permanent magnets, which are used in EVs, wind turbines, smartphones, or laptops. It is possible to substitute REE-based permanent magnets, but the alternatives come with increased weight and less energy-efficiency. This is because the Neodymium-Iron-Boron magnet (NdFeB) is the strongest type of magnet, which is also why it is so efficient. In contrast to alternative magnets such as an electrical one, the NdFeB-based power generator in wind turbines requires little to no maintenance, making it ideal for offshore wind turbines. Essentially this means that it is, in theory, possible to substitute the NdFeB permanent magnet, but in practice that means more use of other raw materials, increased weight and size, and less energy-efficiency.

Against this background, it is not surprising that permanent magnets make up 91 per cent of revenue of all REE products, although it accounts for not more than 35 per cent of all REE products. The permanent magnet is, therefore, very valuable. Conversely, this means that the remaining 65 per cent of REE applications have little (9 per cent) economic value.[16] For mining companies, this means that they need to mine tons of rock hoping for sufficient concentration of economically valuable REEs such as Neodymium, Praseodymium, Dysprosium, and Terbium. The mining step alone will not, however, reveal the concentration of each REEs. The next step of the supply chain will do that. Therefore, despite huge global demand for some REEs, the mining of REEs may, quite paradoxically, not

12 Lee Simmons, "Rare-Earth Market: By monopolizing the mining of rare-earth metals, China could dictate the future of high-tech," *Foreign Policy,* 12.07.2016; Russell Parman, "An elemental issue," *U.S. Army,* 26.09.2019; European Commission, *Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study*, 2023.

13 European Commission, *Study on the Critical Raw Materials for the EU*, 2023; British Geological Survey, *UK criticality assessment of technology critical minerals and metals* (BGS, Nottingham: 2021); Bruno Venditti, "*The 50 Minerals Critical to U.S. Security*," *Elements*, 01.03.2022.

14 REIA, "Rare Earth Elements: Small Market, Big Necessity," global-reia.org.

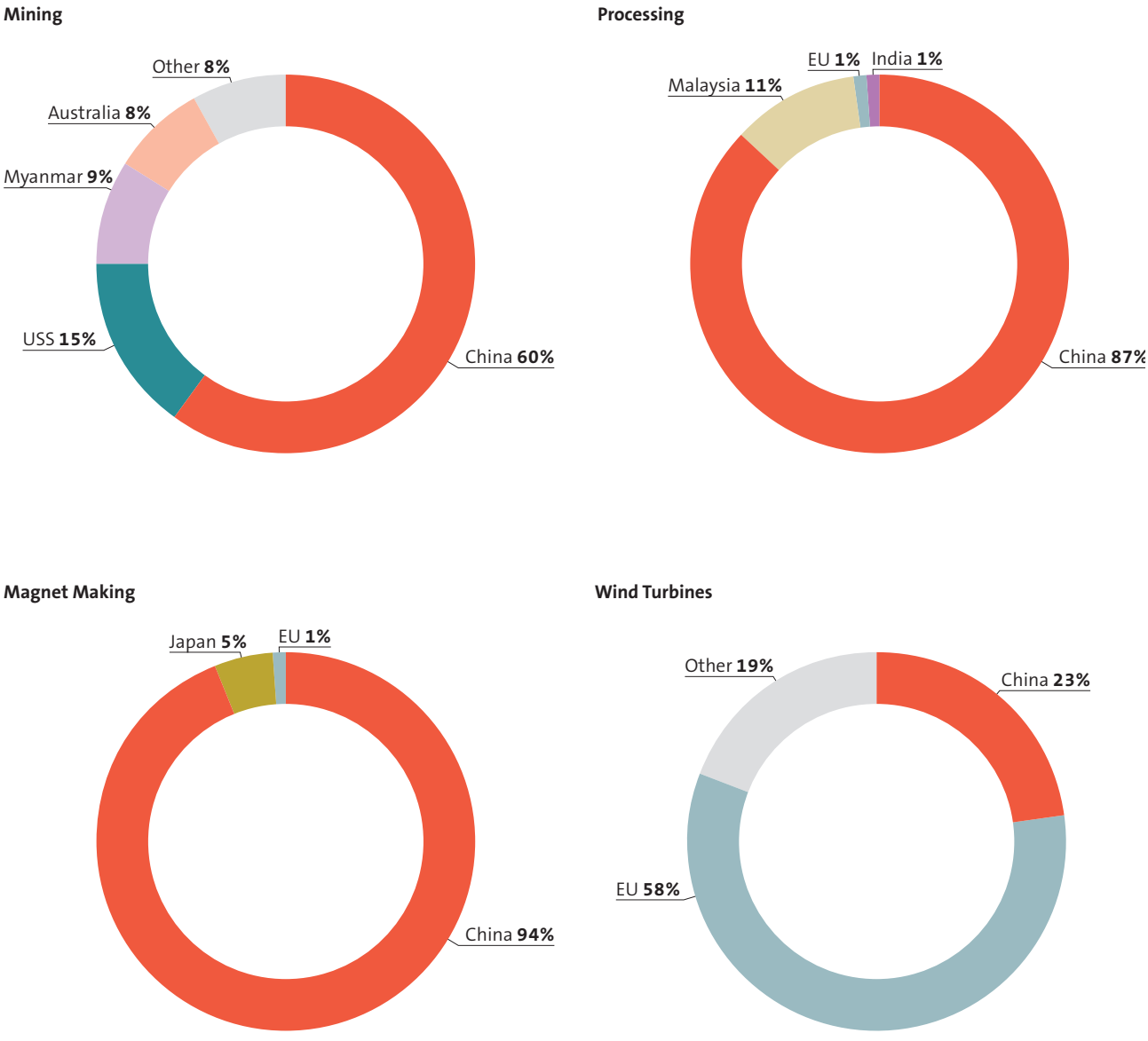
15 International Energy Agency, *The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions*, March 2022.

16 REIA, *Rare Earth Elements*.

generate big revenue. China is in a quite powerful position with 60 per cent market share for REE mining, down from 95 per cent in 2010. China's initial focus on mining has, thus, shifted over the past few years to the far more economically significant step of the supply chain: processing and end-product manufacturing. This means that China imports more mined REEs than it exports.

In what is called the downstream stage of the supply chain, processing concentrated raw materials into phosphors, metals, alloys, or magnets is more resource-intensive. In this separation process, REEs are being separated from one another into individual elements of highest purity. This step can be repeated from hundreds to thousands of times and produces lots of chemical waste as a side effect due to intensive use of acids and solvents for the separation. China has a market share of 87 per cent for light and heavy REEs processing. The only non-Chinese company capable of both mining and processing is the Australian-based Lynas Corp., which processes REEs in Malaysia mined at Mount Weld in Australia. Another

Graph 4: Market Shares by Country of the Wind Turbine Supply Chain 2019/2021




*Sources: US Department of Energy, US Geological Survey, European Raw Materials Alliance*

non-Chinese processing plant is in Estonia, but in this case raw materials are mainly imported from Russia, where REEs are mined (see Graph 4). However, this concerns LREEs. All HREEs are processed in China, giving the country a real monopoly. Some HREEs such as Dysprosium or Terbium are particularly heat resistant, making them indispensable ingredients of permanent magnets used in high temperatures. When REEs are pure enough, they are processed into phosphors, metals, alloys, or magnets. Here as well, China is dominant both in metal/alloy making and high-power magnet manufacturing with market shares well above 90 per cent (see Graph 4).

In both upstream and downstream steps, approximately 40 metric tons of rock must be mined resulting in not more than one ton of purified and separated REEs. The footprint of this is one ton of solid waste, often including radioactive elements, 20,000 gallons of acidic wastewater, and airborne contaminants. It is important to note, however, that both contamination and waste could be contained, if both the upstream and downstream steps strictly complied with comprehensive environmental standards.[17] This has simply not been the case in China so far, although recent policies do aim at reducing solid waste. Low environmental and social standards allow Chinese companies to offer prices that Western companies cannot compete with, as Western companies operate in different regulatory frameworks and must comply with high environmental and social standards. However, this is not the only reason explaining China's dominance. Until the 1980s, the US was the dominant rare earth supplier.[18] China's current position goes back to economic reforms under Deng Xiaoping, who in 1987 emphasized Beijing's aims quite openly by saying "the Middle East has oil, China has rare earths."[19] The political will to have a vertically integrated REE supply chain in China was heavily backed up by state subsidies and accompanied by cheap labor and low environmental standards. For Western states, there was little political attention towards mining. In addition, the approach towards REE mining and processing was and still is guided by a "not in my backyard" (NIMBY) mindset based on the false assumption that mining cannot be done responsibly.[20]

### 3.3.2 US-China Interdependence

The REEs supply chain differs from the chip supply chain. While the US is in a very dominant position in the chips business, the dependence on China for REEs is huge. The net import reliance as a percentage of consumption is as high as 93 per cent. The major import source is China with 78 per cent, followed by Estonia (6 per cent), Malaysia (5 per cent), and Japan (4 per cent).[21] The lack of processing plants means that, although the US is the second-largest REE mining country with considerable capacities in the Mountain Pass mine in California, it must export the mined elements mostly to China for processing. This creates political vulnerabilities, and it also means that the US is only competitive in the least profitable step of the REEs supply chain: mining. Stronger geopolitical rivalry between Washington and Beijing has intensified concerns about China politicizing REEs.

These concerns seem legitimate. In 2010, territorial disputes with Japan resulted in tight export controls issued by the Chinese government and a complete embargo vis-à-vis Japan. This policy resulted in a tenfold price increase in the REE market. Japan, the US, and the EU issued a complaint at the WTO, which was successful. China had to abandon this practice by 2015.[22] Both price increase and supply insecurity meant that many countries evaluated the possibility of reducing REE-intensity in products, diversifying supply chains, finding substitutes, evaluating domestic mining, and promoting recycling. What 2022 was for Russian gas, 2010 was for Chinese REEs. Ever since, the US has started to evaluate potential supply risks and come up with solutions to diversify its supply chain. This is, however, easier said than done. An estimate by the US Government Accountability Office from 2015 stated that it could take up to 15 years to set up an overhauled supply chain for the defense sector. In 2019, a US Army intelligence officer stated that the "U.S. military supply chain is highly vulnerable to any Chinese efforts to limit access to rare earths."[23]

Political measures in the US aimed at increased resilience against potential Chinese export cuts focus on two aspects. The first measure is to stockpile key REEs and strengthen a domestic supply chain. The US Government's inventory includes dysprosium, europium, and yttrium, and potential acquisitions for 2022 may add neodymium, praseodymium, and samarium-cobalt alloy as well as rare earth magnet block.[24] In February 2021, the Australian company Lynas received 30 million USD from the US Department of Defense (DoD) to set up an LREEs processing plant in Texas. In February 2022, MP Materials Corp., which operates the mine at Mountain Pass in Cali-

17 So-called ethical or responsible mining is possible and particularly pronounced in Sweden or Finland. KU Leuven, "Full documentary – Responsible Mining in Europe: A new paradigm to counter climate change," youtube.com, 20.10.2022; Boliden, *Boliden Sustainability Index 2021*.

18 IEA, *The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions*.

19 Grace Hearty, Mayaz Alam, "Rare Earths: Next Element in the Trade War?," *CSIS,* 20.08.2019.

20 A Rock and a Hard Place, "NIMBY Challenges, Ukraine's Supply Chains, and Material Independence with Corby Anderson, Part 2," listennotes.com, 14.10.2022. (Podcast/Audio)

21 USGS, *Mineral Commodity Summaries 2022*.

22 IEA, *The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions*.

23 Russell Parman, "An elemental issue," *U.S. Army,* 26.09.2019.

24 USGS, *Mineral Commodity Summaries 2022*.

fornia, received 35 million USD financial support from the US DoD to set up a processing plant for HREEs.[25] In addition to emerging LREE processing capabilities, being able to process HREEs would allow the company to set up a non-Chinese supply chain for high-power magnets in the US. Several other projects are on their way in the US. However, some experts doubt whether it is realistic to achieve ambitious goals within just a few years, as they point out that it takes more than political declarations to increase the US market share by a politically decided factor by a specific year. Essentially, expertise on REEs appears to be rare. Capacity-building through education and training is facing a major challenge called by experts the "generational workforce gap," which is the effect of a lack of know-how and necessary skills resulting from the declining US role in the REE market since the 1990s. This does not mean that the US cannot catch up, but rather that the timeline of political goals may not be realistic.[26] Recent developments within private tech companies may, however, have some large-scale effects to reduce demand for REEs. For example, Apple used 45 per cent of recycled REEs in its products in 2021 and is aiming to increase recycling capabilities.[27] Among many other carmakers, Tesla introduced an REE-free induction-motor instead of a more energy-efficient permanent magnet motor in some of its models.[28] Large-scale recycling of REEs from EV motors will be possible at the end of their lifecycles, which will not be within ten years' time, since the big rollout of EVs has just started.

The second measure is to set up a non-Chinese supply chain of REEs in cooperation with like-minded partners such as Australia, Canada, Japan, the UK, and the EU. Brussels may be an important partner, since it bolstered its ambitions for greater independence from China with the European Critical Raw Materials Act proposed in March 2023.[29] Increased international cooperation may also happen against the background of China's own efforts to raise its standing against growing competition. In 2015, China issued a consolidation process resulting in the establishment of six state-owned companies. In late 2021, this process went even further in consolidating three of these six companies into one huge state-owned enterprise called China Rare Earth Group Co. Ltd., accounting for two-thirds of China's HREEs supplies. This step is said to increase competitiveness, pricing power, and efficiency. It is not surprising that the highly demanded and profitable Dysprosium and Terbium are the main focal points of this new megacompany.[30] Growing demand, political instability in Myanmar, and China's Covid policy led to a situation in early 2022 in which prices for Chinese REEs were close to the 2011 level.[31] The US is, therefore, keen to set up cooperative formats that would enable a coordinated approach in which like-minded states complement one another instead of creating inefficient redundancies. Explicit mention of this was made during the second meeting of the TTC in May 2022 in Versailles.[32] Another important aspect of international cooperation is access to reserves, which aside from the US are to be found to a high extent in Australia and Greenland and to a lesser extent in Tanzania, South Africa, Canada, Brazil, and Sweden.[33] The large REE reserves in Greenland are, for example, one reason why former US President Donald Trump wanted to buy it from Denmark. In sum, while 2010 proved to be some sort of a wake-up call for the US and its partners, it took over ten years to increase industrial capacities in the downstream steps of the REE supply chain, and even then on a very low level. Roadblocks such as scarcity of talent or environmental concerns remain present and cannot necessarily be overcome with large subsidies. The case of China shows that its dominant position in the market goes back to political ambitions stated in the 1980s and early 1990s. With low environmental standards, cheap labor, and big state support, it took China 20–30 years to become a dominant actor. Against this background, it appears to be rather unrealistic that for the US and its partners, a dominant market position could be achieved in under 20 years' time.

### 3.3.3 Scenarios

Against the background of the complexity of the REEs supply chain, ongoing market disruptions due to volatilities related to geopolitical tensions between China and the US, China's zero-Covid strategy, the Russian invasion of Ukraine, and the related rise in demand for renewable energies, three scenarios concerning REEs are worth considering. The order of the scenarios does not reflect their relative likelihood. It is important to note that hypothetically, all three scenarios could overlap.

**"Uncertainty is the New Normal"**

*In this scenario, ongoing trends simply continue, and sudden shortages may occur due to market imbalances, with*

25 MP Materials, "MP Materials Awarded Department of Defense Heavy Rare Earth Processing Contract," mpmaterials.com, 22.02.2022; Hearty, Alam, *Rare Earths: Next Element in the Trade War?*.

26 A Rock and a Hard Place, "Generational Workforce Gaps in Mining and the Timeline Problem of Critical Mineral Development, Corby Anderson Part One," listennotes.com, 07.10.2022. (Podcast/Audio)

27 Apple, "Apple expands the use of recycled materials across its products," apple.com, 19.04.2022.

28 James Edmondson, "Rare Earths in EVs: Problems, Solutions and What Is Actually Happening," *ID Tech Ex,* 28.10.2021.

29 European Commission, "Critical Raw Materials Act," ec.europa.eu, 16.03.2023.

30 Qian Zhou, Sofia Brooke, "China Merges Three Rare Earths State-Owned Entities to Increase Pricing Power and Efficiency," *China Briefing,* 12.01.2022.

31 Eric Onstad, "Rare earth prices set to keep on the boil after sharp rally," *Reuters,* 07.02.2022.

32 White House, "U.S.-EU Joint Statement of the Trade and Technology Council 16 May 2022 Paris-Saclay, France," whitehouse.gov.

33 REIA, *Rare Earth Elements*.

*demand suddenly outgrowing supply. Decades of shortages may become the new normal.*
Within the whole geopolitical competition, a "race to net-zero" is a prestigious ambition, and China is mobilizing all of its resources to become climate neutral ahead of the US and the EU. This fits into the Chinese narrative that its political system is superior in comparison to Western democracies when combating not only the coronavirus, but also global warming. Although China's population is in decline, the effect of going green due to the size of the country is still big enough to increase the demand for solar panels, wind turbines, and electric vehicles to a large scale. This affects the supply side substantially and at scale. Supply of REEs is overwhelmed by that increase in demand and results in huge shortages. As a result, China prioritizes the use of raw materials for its domestic market, which leads to de facto export quotas of REEs. While the US and the EU have already made efforts to increase domestic mining capabilities, the elimination of Chinese REEs weighs heavy. The results are high prices, massive energy supply risks due to a partly implemented decoupling from fossil fuels, and damage to the political image of Western countries in their ambitions to meet net zero targets.

**"China and Russia issue Export Controls"**
*This scenario assumes an export control/embargo on REEs by China in cooperation with Russia. Such a concentrated effort could have implications for the already volatile security of REE supply chains.*

Although Russia alone is currently not a big actor in the REE market, it is estimated that 17 per cent of non-compliant global REE reserves are in Russia. The ongoing war in Ukraine leads to more polarization between a US- and EU-led Western camp and a China-led authoritarian camp. Disputes over human rights abuses in Xinjiang, as well as the political status of Hong Kong and Taiwan, lead to huge tensions between Western countries and China. Beijing, thus, provides know-how, labor, and equipment to Russia for REE mining. Although this cooperation grants Chinese mining companies de facto access to Russian raw materials, Russia is too isolated to decline China's offer, which looks like a quick win at first. As long as the confrontation with the West endures, Moscow is happy to take part in a Chinese-led alliance and, after the failed gas-embargo, issue export restrictions where it hurts both Washington and Brussels. In their quest to gain access to new sources of raw materials, littoral states of the Arctic find themselves confronted with Chinese-backed Russian advances in this region, which almost results in a direct military confrontation between NATO states and Russia.

For the US as well as its European partners, energy insecurity due to Chinese and Russian export controls on REEs rises as the struggle for new mining sources becomes extremely complex in practice. On top of that, diversification approaches prove very costly as it takes a lot of time and years of training for countries to develop their own comprehensive mining capabilities. Reducing carbon emissions to meet the global target of net-zero, as well as general energy security, effectively become the subjects of geopolitics.

**"China invades Taiwan"**
*This scenario is the elephant in the room: a PLA invasion of Taiwan and direct military confrontation between the US and China.*

China has managed to circumvent US export controls on most advanced chips more effectively than anticipated and has gained more economic independence from Taiwan's world-leading semiconductor ecosystem. As Washington is still supporting Ukraine with weapons and expertise, while the replacement of these weapons is slowed down due to labor force shortages, Beijing sees a window of opportunity. Hence, Beijing assumes that Washington's support for Taiwan may be politically and materially limited. A naval blockade of Taiwan followed by an invasion by the PLA has the effect that economic decoupling between China and the US increases even more due to comprehensive sanctions. Similarly to what Russia is arguing in 2022 concerning its gas exports to European countries, Beijing limits exports of raw materials for technical reasons related to Western sanctions. Market prices for REEs as well as other critical raw materials increase significantly, and huge disruptions along a wide range of supply chains follow. On top of general economic insecurity, the supply of energy amid the green energy transition is under threat in Western countries.

### 3.3.4 Effects on Switzerland

Switzerland as a landlocked country without a lot of natural resources is highly reliant on secure supply chains and global market stability.[34] Swiss companies – especially the Swissmem industry, but also research facilities – are particularly exposed to shortages of end-products containing REEs.[35] This industry sector employs 320,000 people in Switzerland and accounts for about a third of Switzerland's exports. Secure supply chains are, therefore, of high relevance for Switzerland as a key global location for innovation and high tech. As far as commitments to combat climate change and energy security are concerned, Switzerland will have to increase the share of wind energy. To this end, it will need reliant REEs supply chains for more wind turbines and, potentially, for replacement of outdated ones. The same is true for the electrification of

34 Alessandra Hool / Luis Tercero / Patrick Wäger, "Kritische Rohstoffe: ein Thema für die Schweiz der Zukunft," in: *swissfuture* 02 (2022).

35 ESM Foundation, "Schlüsselkompetenzen der Zukunft in der Schweizer MEM-Industrie," esmfoundation.org, 27.02.2018.

the mobility sector, regardless of whether it has its own carmaking industry or not. Quite importantly, the acquisition of F-35 fighter jets from the US manufacturer Lockheed Martin appears to rely on a scenario with secure REEs supply chains.

In contrast to the US, the EU, the UK (after leaving the EU), Japan, and South Korea, Switzerland has no screening and evaluation mechanism put in place regarding a classification of which raw materials do pose supply risks. The US and the EU issue assessments of all kinds of raw materials, classifying them as critical and non-critical ones. This assessment results in specific policy recommendations to counteract potential supply bottlenecks and risks with diversification and/or recycling of raw materials. The EU has also published an extensive Foresight Study aimed at detecting and anticipating potential supply risks. In addition, Brussels has high ambitions to reduce its dependency on China and increase its self-sufficiency across the supply chain of strategic raw materials as foreseen in the European Critical Raw Materials Act.

Washington and Brussels aim to enhance cooperation in this sector under the newly established TTC. In what ways Switzerland as a non-EU member state could navigate between the US and China in case of a major confrontation, is, again the crucial question. The lack of a resource strategy and a screening process for critical raw materials is certainly not helpful in this context and may leave Switzerland ill-prepared for all kinds of the abovementioned scenarios. What Switzerland could leverage upon, however, is Geneva being a key global commodity trade location for over 550 companies, which also trade raw materials such as REEs. Here, potential political leverage could be in certification and inspection of goods, where Geneva is the world's leader.[36] In addition, Glencore plc, an important global actor in the commodity trading and mining business, is located in the Canton of Zug. Hence, both serving as a global financial platform for commodity trade and hosting a key industrial actor may provide Switzerland with considerable geopolitical leverage, if used well.

## 3.4 Conclusion

This chapter showcased two examples that are both essential parts of the geopolitical rivalry between the US and China. The first example, providing some insights into the complexities of the chip supply chain, shows that the US, along with its close partners Taiwan and South Korea, are dominant actors in the chip industry. Particularly in the front-end stages such as chip design, software, and IP, the US is the leading nation, and due to high barriers of entry in this field, it seems unlikely that this will drastically change anytime soon. China is quite strong in the back-end stage of assembly, but despite large state subsidies has failed to catch up in other segments along the supply chain, which may also explain why China has not answered US export restrictions in any way. This shows that the ecosystem of any segment along the chip supply chain is highly complex and that spending money alone is not a guarantee of immediate positive effects. The US, which has always been at the forefront of the chip industry, has acquired a lot of know-how about the specificities of designing and making chips. This high level of expertise means that the US can leverage on it vis-à-vis China by issuing effective export restrictions. Domestically, this know-how can also be of great help when implementing industrial policy such as the US Chips Act. Despite the strong US position, the known unknown variable in the overall equation is Taiwan's crucial role as a chip-making location exposed to China's territorial claims. What this looming security threat to a core location of global chip production means is not fully clear. The supply shortages linked with the pandemic showcase the vulnerability of this supply chain, and many states are trying to address this issue. Switzerland is no exception to this high exposure to supply chain risks, but it does not seem that Bern is keen on implementing any sort of industrial policy, which given the country's historical liberal approach towards state subsidies is not surprising. The traditional Swiss role of an "in-between" non-aligned actor that talks and trades with everyone may be put to a test if US and EU Chips Acts prove to be successful, and if China becomes ever more expansionist. Policymakers in Bern as well as the Swiss high-tech private sector would be well-advised to take a closer look at increased EU-US cooperation and proactively seek ways to cooperate with both Washington and Brussels.

The second case example of rare earth elements is a clear contrast to the chip supply chain, where high degrees of specialization mean that no country is even close to self-sufficiency. As far as REEs are concerned, China is almost self-sufficient. The only part in which it is reliant on the outside world is mining. Otherwise, global market shares of almost 90 per cent for processing and end-product manufacturing mean that China is a monopolistic actor here. This means that, in contrast to chips, the Chinese high-tech sector is being supplied with raw materials overwhelmingly made and processed in China. For the US, the opposite is true. Its high-tech sector, which includes the defense industry, is more than 90 per cent reliant on Chinese imports of processed REEs. Should China limit its exports due to either growing domestic demand or because of geopolitical motives, the US is in a highly vulnerable position. Both the Trump and Biden administrations realized this and implemented industrial policies to become more China-independent. In contrast to the chip industry, in which one needs a vast ecosystem, high

36 "Trading & shipping: The world commodity capital", ge.ch.

levels of know-how and spending, the REE industry seems to have lower barriers of entry. The costs for new facilities fall below the billions, and the biggest roadblock may be environmental concerns and the lack of trained personnel. If the United States were to increase the recycling capabilities of REEs, address environmental problems, and implement targeted education and training initiatives, then it would face no huge obstacles to becoming once again the important actor in the REE industry that it used to be until the 1980s.

Both cases show different degrees of specialization, barriers to entry, market concentration and interdependence. While China is trying to establish its own chip supply chain for most advanced chips, the US is struggling to set up a non-Chinese supply chain for rare earth elements. High barriers to entry, intense and time-consuming research and development as well as high complexity have the effect that achieving self-sufficiency across the chip supply chain is a matter of decades, rather than years. The same is true for the REE supply chain, though for different reasons. Long planning cycles of up to 15 years to operate a mine at full capacity means that diversification of the REE supply chain is likewise not a political aim to be achieved within years, but rather decades. For Switzerland, Western initiatives towards more supply security in both the chips and the REE industry may seem beneficial at first glance. However, a lot will depend on how open US and EU initiatives will be to like-minded third countries like Switzerland. Again, Swiss policymakers and key industrial actors may be well advised to follow these policy developments closely and to clarify the Swiss status sooner rather than later.

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